AO 120 (Rev. 08/10)

TO: **Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450**	**REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK**

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Central District of California on the following

☐ Trademarks or ☒ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED March 23, 2016	U.S. DISTRICT COURT Central District of California
PLAINTIFF Nichia Corporation		DEFENDANT VIZIO, Inc.
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 7,901,959	March 8, 2011	Nichia Corporation
2 7,915,631	March 29, 2011	Nichia Corporation
3 8,309,375	November 13, 2012	Nichia Corporation
4 7,855,092	December 21, 2010	Nichia Corporation
5		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy

23739027.1

AO 120 (Rev. 08/10)

TO: **Mail Stop 8** **Director of the U.S. Patent and Trademark Office** **P.O. Box 1450** **Alexandria, VA 22313-1450**	**REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK**

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Central District of California on the following

☑ Trademarks or ☐ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
SACV15-1963-DMG-KESx	11/23/2015	Central District of California

PLAINTIFF	DEFENDANT
VIZIO, Inc.	Vizo, Inc.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	4621356	10/14/2014	VIZIO, Inc.
2	4053025	11/8/2011	VIZIO, Inc.
3	3235417	4/24/2007	VIZIO, Inc.
4	4369035	7/16/2013	VIZIO, Inc.
5			

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY
	☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1			
2			
3			
4			
5			

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT
Plaintiff's Notice of Dismissal Pursuant to Federal Rules of Civil Procedure 41(a) or (c) filed 3/21/2016.

CLERK	(BY) DEPUTY CLERK	DATE
KIRY K. GRAY	G. Kami	3/23/2016

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/942,792	11/13/2012	8309375	0020-5147PUS12	2357

2292 7590 10/24/2012

BIRCH STEWART KOLASCH & BIRCH
PO BOX 747
FALLS CHURCH, VA 22040-0747

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Yoshinori Shimizu, Naka-gun, JAPAN;
Kensho Sakano, Anan-shi, JAPAN;
Yasunobu Noguchi, Naka-gun, JAPAN;
Toshio Moriguchi, Anan-shi, JAPAN;

IR103 (Rev. 10/09)

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

2292 7590 07/12/2012
BIRCH STEWART KOLASCH & BIRCH, LLP
PO BOX 747
FALLS CHURCH, VA 22040-0747

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/942,792	11/09/2010	Yoshinori Shimizu	0020-5147PUS12	2357

TITLE OF INVENTION: LIGHT EMITTING DEVICE AND DISPLAY

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	~~$1740~~ 1770.	$300	$0	~~$2040~~ 2070.	10/12/2012

EXAMINER	ART UNIT	CLASS-SUBCLASS
MUSTAPHA, ABDULFATTAH B	2812	438-021000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Birch, Stewart, Kolasch & Birch, LLP
2 ____
3 ____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE
NICHIA CORPORATION

(B) RESIDENCE: (CITY and STATE OR COUNTRY)
Anan-shi, Japan

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

☒ Issue Fee
☒ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies ____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**

☐ A check is enclosed.
☒ Payment by credit card. Form PTO-2038 is attached.
☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 02-2448 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)

☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27. ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature ____ Date October 11, 2012

Typed or printed name D. Richard Anderson Registration No. 40,439

Electronic Patent Application Fee Transmittal

Application Number:	12942792
Filing Date:	09-Nov-2010
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimizu
Filer:	David Richard Anderson/Patti Young
Attorney Docket Number:	0020-5147PUS12

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl issue fee	1501	1	1770	1770
Publ. Fee- early, voluntary, or normal	1504	1	300	300

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**2070**

Electronic Acknowledgement Receipt

EFS ID:	13964292
Application Number:	12942792
International Application Number:	
Confirmation Number:	2357
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimizu
Customer Number:	2292
Filer:	David Richard Anderson/Patti Young
Filer Authorized By:	David Richard Anderson
Attorney Docket Number:	0020-5147PUS12
Receipt Date:	11-OCT-2012
Filing Date:	09-NOV-2010
Time Stamp:	16:15:00
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$2070
RAM confirmation Number	3163
Deposit Account	022448
Authorized User	ANDERSON, RICHARD D.

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	20121011IssueFee.pdf	115405 3a11e84b22057a224780d23d6b7a2726190d4496	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	31735 fce7100ff15178123825f208d61f309df9c78ff8	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	147140	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	12/942,792
Filing Date	11-09-10
First Named Inventor	Yoshinori Shimizu
Art Unit	2812
Examiner Name	A.B. MUSTAPHA
Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

Examiner initial *	Cite No.	Document Number: Number - Kind Code 2 (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear
/A.M./	1	US-2012/0132857 -	05-31-2012	Le Toquin	
/A.M./	2	US-3, 882,502	05-06-1975	Peabody et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial *	Cite No. 1	Foreign Patent Document: Country 3 Code, Number 4 Kind Code (if known) 5	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear	T

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	10/02/2012

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not Considered. Include copy of this form with next communication to applicant. 1. Applicant's unique citation design number (optional). 2 See Kinds Codes of USPTO patent Documents. at www.uspto.gov or MPEP 901.04. 3. Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4. For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5. Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. 6. Applicant is to place a check mark here if English language Translation is attached.

ut

Substitute for form 1449B/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Complete if Known	
Application Number	12/942,792
Filing Date	11-09-10
First Named Inventor	Yoshinori Shimizu
Art Unit	2812
Examiner Name	A.B. MUSTAPHA
Attorney Docket Number	0020-5147PUS12

Sheet 2 of 2

NON PATENT LITERATURE DOCUMENTS

Examiner Initial *	Cite No. 1	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T 2
/A.M./	3	U.S. Office Action in co-pending application no. 12/689,681 dated September 7, 2012.	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	10/02/2012

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

1. Applicants unique citation designation number. (optional) 2. Applicant is to place a check mark here if English language Translation is attached.

af

FEE TRANSMITTAL

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 180.00

Complete if Known	
Application Number	12/942,792 Conf. No.: 2357
Filing Date	November 09, 2010
First Named Inventor	Yoshinori SHIMIZU
Examiner Name	A.B. MUSTAPHA
Art Unit	2812
Attorney Docket No.	0020-5147PUS12

METHOD OF PAYMENT (check all that apply)

☐ Check ☑ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): ____

☑ Deposit Account Deposit Account Number: 02-2448 Deposit Account Name: Birch, Stewart, Kolasch & Birch, LLP

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☐ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☑ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☑ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
Application Type	**Fee ($)**	**Small Entity Fee ($)**	**Fee ($)**	**Small Entity Fee ($)**	**Fee ($)**	**Small Entity Fee ($)**	**Fees Paid ($)**
Utility	380	190	620	310	250	125	
Design	250	125	120	60	160	80	
Plant	250	125	380	190	200	100	
Reissue	380	190	620	310	750	375	
Provisional	250	125	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	**Fee ($)**	**Small Entity Fee ($)**
Each claim over 20 (including Reissues)	60	30
Each independent claim over 3 (including Reissues)	250	125
Multiple dependent claims	450	225

Total Claims ____ - 20 or HP = **Extra Claims** 0 x **Fee ($)** ____ = **Fee Paid ($)** 0.00

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims ____ - 3 or HP = **Extra Claims** 0 x **Fee ($)** ____ = **Fee Paid ($)** 0.00

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims **Fee ($)** ____ **Fee Paid ($)** ____

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets ____ - 100 = **Extra Sheets** 0 / 50 = **Number of each additional 50 or fraction thereof** 0 (round **up** to a whole number) x **Fee ($)** ____ = **Fee Paid ($)** 0.00

4. OTHER FEE(S) **Fees Paid ($)**

Non-English Specification, $130 fee (no small entity discount) ____

Other (e.g., late filing surcharge): 1806 - IDS Fee 180.00

SUBMITTED BY			
Signature		Registration No. (Attorney/Agent) 40,439	Telephone 703-205-8000
Name (Print/Type)	D. Richard Anderson		Date September 26, 2012

ut

Docket No.: 0020-5147PUS12
(Patent)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application of:
Yoshinori SHIMIZU et al.

Application No.:	12/942,792	Confirmation No.:	2357
Filed:	November 09, 2010	Art Unit:	2812
For:	LIGHT EMITTING DEVICE AND DISPLAY	Examiner:	A.B. MUSTAPHA

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Applicant(s) hereby submit(s) an Information Disclosure Statement for consideration by the Examiner.

I. LIST OF PATENTS, PUBLICATIONS OR OTHER INFORMATION

The patents, publications, or other information submitted for consideration by the Office are listed on the attached PTO/SB/08.

II. COPIES

☑ a. Copies of foreign patent documents, non-patent literature and other information are provided.

☐ b. REFERENCES PREVIOUSLY CITED OR SUBMITTED: Copies of any information not provided can be found in one or more of the following applications which has been relied upon for an earlier filing date under 35 U.S.C. § 120:

U.S. Application No. and U.S. Filing Date

12/028,062 filed February 8, 2008 ωA

III. CONCISE EXPLANATION OF THE RELEVANCE/OTHER INFORMATION

☐ a. NON-ENGLISH LANGUAGE DOCUMENTS: A concise explanation of the relevance of all non-English language patents, publications, or other information listed is as follows:

☐ b. ENGLISH LANGUAGE SEARCH REPORT OR FOREIGN PATENT OFFICE COMMUNICATION: An English language version of the search report or Foreign Patent Office communication that indicates the degree of relevance is attached.

☑ c. OTHER: The following additional information is provided.

US 3,882,502 and US 2012/0132857 were cited in an Office Action issued in co-pending US Application 12/689,681 dated September 7, 2012.

IV. STATEMENT UNDER 37 C.F.R. § 1.97(e)

The undersigned hereby states that:

☐ a. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **30 days** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☐ b. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☑ c. No item of information contained in the IDS was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of IDS was known to any individual designated in 37 C.F.R. § 1.56(c) more than **three months** prior to the filing of the IDS; or

☐ d. Some of the items of information in the IDS were cited in a communication from a foreign patent office. Such items were first cited in a communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office. As to the remaining items of information, to the knowledge of the person signing the certification after making reasonable inquiry, such remaining items were not known to any individual designated in 37 C.F.R. § 1.56(c) more than **three months** prior to the filing of this statement.

V. STATEMENT UNDER 37 C.F.R. § 1.704(d)(1)

Patent Term Adjustment Reduction Should Not Apply

☐ The undersigned hereby states:

This Information Disclosure Statement is in compliance with 37 C.F.R. §§ 1.97 and 1.98 and will not be considered a failure to engage in reasonable efforts to conclude prosecution (processing or examination) of the present application under 37 C.F.R. § 1.704(c)(6), (c)(8), (c)(9), or (c)(10), because each item of information contained in the Information Disclosure Statement:

☐ (i) Was first cited in any communication from a patent office in a counterpart foreign or international application or from the Office, and this communication was not received by any individual designated in § 1.56(c) more than thirty days prior to the filing of the information disclosure statement; or

☐ (ii) Is a communication that was issued by a patent office in a counterpart foreign or international application or by the Office, and this communication was not received by any individual designated in § 1.56(c) more than thirty days prior to the filing of the information disclosure statement.

VI. FEES

☐ a. This Information Disclosure Statement is being filed concurrently with the filing of a new patent application or Request for Continued Examination. No fee is required.

☐ b. This Information Disclosure Statement is being filed within three months of the filing date of an application. No fee is required.

☐ c. This Information Disclosure Statement is being filed before the mailing date of a first Action on the merits. No fee is required. If a first Office Action on the merits has issued, please consider this IDS under 37 C.F.R. § 1.97(c) and see the statement under 37 C.F.R. § 1.97(e) above. If no statement has been made, charge our deposit account for the required fee.

☐ d. This Information Disclosure Statement is being filed before the mailing date of a Final Office Action or before the mailing date of a Notice of Allowance or before an action that otherwise closes prosecution in the application (see 37 C.F.R. § 1.97(c)(1)).

☐ No statement. The fee as required by 37 C.F.R. § 1.17(p) is provided.

or

☐ See the above statement. No fee is required.

☑ e. This Information Disclosure Statement is being filed after the mailing date of a Final Office Action or after the mailing date of a Notice of Allowance or after an action that otherwise closes prosecution in the application (see 37 C.F.R. § 1.97(d)), see the statement above. The fee as required by 37 C.F.R. § 1.17(p) is provided.

VII. PAYMENT OF FEES

☑ The required fee is listed on the attached Fee Transmittal.

☐ No fee is required.

If the Examiner has any questions concerning this IDS, please contact the undersigned. If it is determined that this IDS has been filed under the wrong rule, the USPTO is requested to consider this IDS under the proper rule and charge the appropriate fee to Deposit Account No. 02-2448.

Dated: September 26, 2012

Respectfully submitted,

By

D. Richard Anderson
Registration No.: 40,439
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road, Suite 100 East
P.O. Box 747
Falls Church, VA 22040-0747
703-205-8000

Attachment(s):
- ☑ PTO/SB/08
- ☑ Document(s)
- ☐ Foreign Patent Office Communication
- ☐ Foreign Search Report
- ☑ Fee
- ☐ Other:

Cet

Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	12/942,792
Filing Date	11-09-10
First Named Inventor	Yoshinori Shimizu
Art Unit	2812
Examiner Name	A.B. MUSTAPHA
Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

Examiner initial *	Cite No.	Document Number Number - Kind Code 2 (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	US-2012/0132857 -	05-31-2012	Le Toquin	
	2	US-3, 882,502	05-06-1975	Peabody et al.	

FOREIGN PATENT DOCUMENTS

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Sheet 2 of 2

Complete if Known	
Application Number	12/942,792
Filing Date	11-09-10
First Named Inventor	Yoshinori Shimizu
Art Unit	2812
Examiner Name	A.B. MUSTAPHA
Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

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	3	U.S. Office Action in co-pending application no. 12/689,681 dated September 7, 2012.	☐
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Electronic Patent Application Fee Transmittal

Application Number:	12942792
Filing Date:	09-Nov-2010
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimizu
Filer:	David Richard Anderson/Patti Young
Attorney Docket Number:	0020-5147PUS12

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
	Total in USD ($)			**180**

Electronic Acknowledgement Receipt

EFS ID:	13846732
Application Number:	12942792
International Application Number:	
Confirmation Number:	2357
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimizu
Customer Number:	2292
Filer:	David Richard Anderson/Patti Young
Filer Authorized By:	David Richard Anderson
Attorney Docket Number:	0020-5147PUS12
Receipt Date:	26-SEP-2012
Filing Date:	09-NOV-2010
Time Stamp:	17:44:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$180
RAM confirmation Number	4817
Deposit Account	022448
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		20120926IDS.pdf	431816 edaf928dbe060c0176fc15b07fb5436a7229f0ae	yes	9

Multipart Description/PDF files in .zip description

Document Description	Start	End
Miscellaneous Incoming Letter	1	1
Transmittal Letter	2	7
Foreign Reference	8	9

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
2	Non Patent Literature	20120907FinalRejection.pdf	651775 b850e066ac202b2cef5d9f6338f9bc44f65c94d1	no	12

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
3	Fee Worksheet (SB06)	fee-info.pdf	30282 3351edc7655c85b1d26762d18a31c60f7817eabb	no	2

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Sheet	1	of	2

Complete if Known	
Application Number	12/942,792
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Art Unit	2812
Examiner Name	A.B. MUSTAPHA
Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

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/A.M./	1	US-5,247,533	09-21-1993	Okazaki et al.	
/A.M./	2	US-5,408,120	04-18-1995	Manabe et al.	

FOREIGN PATENT DOCUMENTS

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/A.M./	3	JP	7-335942	12-22-1995	Nichia Chem Ind Ltd.		✔

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	08/21/2012

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Examiner initial *	Cite No. [1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T [2]
/A.M./	4	Singaporean Examination and Search Report issued on July 2, 2012 in counterpart Singapore Patent Application No. 201007151-2.	✔
/A.M./	5	Singaporean Examination and Search Report issued on July 5, 2012 in counterpart Singapore Patent Application No. 201007150-4.	✔

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/942,792	11/09/2010	Yoshinori Shimizu	0020-5147PUS12	2357

2292 7590 08/09/2012
BIRCH STEWART KOLASCH & BIRCH
PO BOX 747
FALLS CHURCH, VA 22040-0747

EXAMINER	
MUSTAPHA, ABDULFATTAH B	
ART UNIT	**PAPER NUMBER**
2812	

NOTIFICATION DATE	DELIVERY MODE
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12/942,792	09 November, 2010	SHIMIZU ET AL.	0020-5147PUS12

		EXAMINER	
BIRCH STEWART KOLASCH & BIRCH PO BOX 747 FALLS CHURCH, VA 22040-0747		ABDULFATTAH MUSTAPHA	
		ART UNIT	PAPER
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/Charles D. Garber/
Supervisory Patent Examiner, Art Unit 2812

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/A.M./	1	US-3,560,849	02-02-1971	Anderson	

FOREIGN PATENT DOCUMENTS

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Examiner Signature	/Abdulfattah Mustapha/	Date Considered	08/01/2012

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/A.M./	2	U S. Office Action issued in co-pending U.S. application no. 12/689,681 on May 10, 2012.	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	08/01/2012

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Sheet 1 of 2

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	3	JP 7-335942	12-22-1995	Nichia Chem Ind Ltd.		✓

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Attorney Docket Number	0020-5147PUS12

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	4	Singaporean Examination and Search Report issued on July 2, 2012 in counterpart Singapore Patent Application No. 201007151-2.	✔
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PATENT ABSTRACTS OF JAPAN

(11)Publication number : 07-335942
(43)Date of publication of application : 22.12.1995

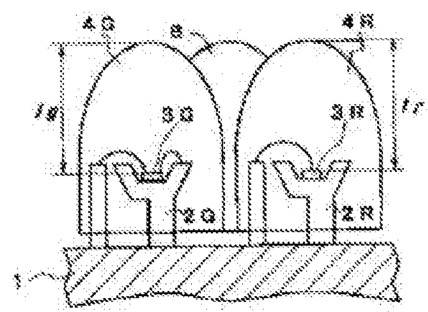
(51)Int.Cl. H01L 33/00
G09F 9/33

(21)Application number : 06-131531
(22)Date of filing : 14.06.1994

(71)Applicant : NICHIA CHEM IND LTD
(72)Inventor : NAGAI YOSHIFUMI

(54) FULL-COLOR LED DISPLAY

(57)Abstract:
PURPOSE: To obtain the stable white balance with high luminance and small power consumption by a method wherein a green color LED and a blue color LED which have respective light emitting chips made of gallium nitride system compound semiconductor are combined together.
CONSTITUTION: Respective lead frames of a red color LED, a green color LED and a blue color LED (B) are electrically connected to the surface of a board 1 on which wiring patterns are formed. The green color LED has a green light emitting chip 3G which is composed of a sapphire substrate and a gallium nitride system compound semiconductor layer built up on the sapphire substrate and whose dimensions are 100μm thick and 350μm square. The green light emitting chip has a double-hetero structure composed of an InGaN active layer and a GaAlN cladding layer. The blue color LED (B) has a blue light emitting chip whose dimensions, etc., are the same as those of the green light emitting chip 3G except that the composition of the InGaN active layer is different. Further, in order to adjust directional characteristics, the substrate of the red light emitting chip 3R of the red color LED is polished.



CLAIMS

[Claim(s)]
[Claim 1]A full color LED display comprising:
A red LED lamp which constitutes stroke matter.
A green LED lamp.
A light emitting chip in which said green LED lamp and a blue LED lamp consist of a gallium nitride system compound semiconductor in a full color LED display which a blue LED lamp is connected on the same board, and changes.

[Claim 2]A full color LED display given in Claim 1 in which a half angle of the directional characteristics of the aforementioned red LED lamp is characterized by being the same as that of a half angle of the directional characteristics of a green LED lamp and a blue LED lamp.
[Claim 3]With resin or glass, the mold of the aforementioned red LED lamp, a green LED lamp, and the blue LED lamp is carried out to the shape of a lens, they change, and a light emitting chip The peak of a mold lens of the aforementioned red LED lamp, Distance with the surface of a light emitting chip which it had in the red LED lamp The peak of a mold lens of said green LED lamp and a blue LED lamp, A full color LED display given in Claim 2, wherein it is adjusted so that it may become substantially equal to distance with the surface of a light emitting chip which it had in the green LED lamp and a blue LED lamp, and a half angle of the directional characteristics of a red LED lamp is adjusted.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]The LED lamp to which the mold of the light emitting chip was carried out with resin, glass, etc. as for the present invention. Red LED, green LED, and blue LED which constitute stroke matter especially are related with the full color LED display which is connected on the same board and changes about the LED display which connects on the same board it (is hereafter called LED). [two or more]
[0002]
[Description of the Prior Art]That with which the light emitting chip installed on the leadframe was able to compare regularly LED sealed by lens shape with resin, glass, etc. on the substrate is known by the LED display. Although the thing of the multicolor which used red LED and green LED is already put in practical use by the present LED display, the full color display has not yet resulted in utilization in a trial production stage.
[0003]As for the full color LED display made as an experiment now, SiC is used for red LED as a material of a light emitting chip at GaP and blue LED at GaAlAs, GaAsP, and green LED. However, compared with the luminous intensity of red LED, the luminous intensity of green LED and blue LED was low, and since blue LED in particular had 1/100 or less, there was a fault that a high-intensity display was not obtained.
[0004]The aforementioned display has increased the number of green LED and blue LED to the number of red LED in stroke matter in order to compensate this fault, but when the number of LED in stroke matter increases, the resolution of the whole display worsens and, moreover, there is a fault that power consumption is large. Since the directional characteristics of each LED differed when the light ratio of LED of each luminescent color and what is called a white balance are using LED which consists of three kinds of light emitting chips when displaying white further again, there was a fault of not being fixed.
[0005]
[Problem to be solved by the invention]Accomplish the present invention in order to solve the above-mentioned fault, and the place made into the purpose uses LED with high luminous intensity, and realize little display of power consumption with high-intensity, and. It is in realizing the full color LED display in which the white balance stable by combining LED which can furthermore adjust directional characteristics easily is obtained.
[0006]
[Means for solving problem]In order to improve the luminosity of a full color LED display, it is necessary to use high green LED and blue LED of luminous intensity first. Directional characteristics need to arrange in in order to obtain the stable white balance a few LED which corresponded as much as possible to stroke matter. We newly find out the blue LED and green LED which can satisfy the demand simultaneously, and came to solve the above-mentioned problem. Namely, the full color LED display of the present invention, In the full color LED display in which it is connected on the same substrate and red LED which constitutes stroke matter, green LED, and blue LED change, above-mentioned green LED and blue LED are provided with the light emitting chip which consists of a gallium nitride system compound semiconductor.

[0007]The 2nd of the present invention is characterized by the half angle of the directional characteristics of red LED being the same as the half angle of the directional characteristics of green LED and blue LED. That is, since it is blue LED and a green LED identical material, the directional characteristics of the conventional red LED are adjusted to green and blue LED.
[0008]With resin or glass, the mold of the 3rd of the present invention is carried out to the shape of a lens, it changes, and a light emitting chip red LED, green LED, and blue LED The peak of the mold lens of the aforementioned red LED lamp, Distance with the surface of the light emitting chip which it had in the red LED lamp The peak of the mold lens of the above-mentioned green LED lamp and a blue LED lamp, It is adjusted so that it may become substantially equal to distance with the surface of the light emitting chip which it had in the green LED lamp and a blue LED lamp, and the half angle of the directional characteristics of a red LED lamp is adjusted. It cannot be overemphasized that green LED and blue LED are provided with the light emitting chip which consists of a gallium nitride system compound semiconductor.
[0009]In red LED used in the LED display of the present invention, LED provided with the material of the conventional light emitting chip can be used, these LED has the degree of luminescent light of 1 cds or more, and, as for the radiant power output, GaAlAs, GaAsP, etc. have 1 mW or more.
[0010]Next, these are provided with the light emitting chip which consists of a gallium nitride system compound semiconductor (InXAlYGa1-X-YN, 0<=X, 0<=Y, X+Y<=1) as mentioned above although it is green LED and blue LED which are the characteristics of the present invention. As for the light emitting chip, it is preferable that it is terrorism structure in the double which makes InGaN an active layer and makes GaN or GaAlN a cladding layer. Because, the light emitting chip which makes InGaN an active layer can change the luminescent color even to a green region from the region of the wavelength of 380 nm - 580 nm, and purple-blue by making composition ratio (In/Ga) to Ga of In or less into 0.4. Since a gallium nitride system compound semiconductor is a transited [directly] type semiconductor, when it considers it as a light emitting chip, it can realize LED with high luminous intensity. That in which both have 1 cds or more is specifically used for the degree of luminescent light of green LED used for the LED display of the present invention, and blue LED, and, as for optical power, it is preferable to use a thing of 0.5 mW or more.
[0011]As for the half angle of red, green, and blue LED, it is preferable to adjust to the range of **20 degrees - **70 degrees to the center of a LED lens. It is because luminosity will become low if larger [if smaller than 20 degrees, the directivity of a display will become strong and a white balance will not be stabilized easily, and] than 70 degrees.
[0012]Although there are various methods in adjusting the half angle of each LED, when green LED and blue LED are used as the light emitting chip which consists of a gallium nitride system compound semiconductor, the height of the surface of a red LED chip is equalized with the height of a gallium nitride system compound semiconductor light emitting chip, and a half angle is adjusted. Because, the thickness of a gallium nitride system compound semiconductor light emitting chip is only 150 micrometers or less, and the GaAlAs which is a light emitting chip of red LED is not less than 300 micrometers in the thickness to it. The directional characteristics of three kinds of LED can be doubled by using in many cases what has the same shape of lead frame and lens shape for LED used on a display, and doubling the height of the surface of the chip of red LED with green and blue LED, if these are the same. This is a characteristic effect at the time of the thickness of a light emitting chip using a gallium nitride system compound semiconductor light emitting chip of 150 micrometers or less for green LED and blue LED, and using the light emitting chip consisting of material which is different from a gallium nitride system compound semiconductor in a top thicker than 150 micrometers for red LED.
[0013]
[Function]By using as the identical material the light emitting chip which constitutes green LED and blue LED, the LED display of the present invention can do lens shape of the resin etc. which seal the size of a light emitting chip, the form of the leadframe which places a light

emitting chip, a light emitting chip, and a leadframe as it is the same. Since this green and blue LED are the same, the half angle of a mold lens is also the same, and when a display is constituted, it can do that it is easy to stabilize a white balance.
[0014]A gallium nitride system compound semiconductor is also a transited [directly] type semiconductor, and, as for LED using this, the luminous intensity of 1 cds or more and 0.5 mW or more of optical power have both. therefore, by using such LED as a green component and a blue component, rather than the display constituted from a conventional material, the number of LED is lessened, and is boiled markedly, and what has high luminosity can be realized.
[0015]What is necessary is to adjust only red LED for adjusting the half angle of a mold lens, since green LED and blue LED are the same. A half angle can be adjusted by equalizing the distance of the surface of the light emitting chip which is in red LED for that purpose, and the peak of a mold lens with green LED and blue LED. Thereby, all of the half angle of 3 colors will gather, and it becomes possible to obtain the stable white balance.
[0016]
[Working example]Fig.1 is a plan view showing one working example of the full color LED display of an application concerned. this shows the display screen -- red LED (R), green LED (G), and blue LED (B) -- one piece is arranged in the shape of [each] delta, and forms stroke matter, respectively. Fig.2 is a schematic cross section showing the structure of the stroke matter of the display of Fig.1, and the leadframe 2 of red LED (R), and green LED (G) and blue LED (B) is electrically connected to the surface of the substrate 1 by which pattern wiring was carried out, respectively.The leadframe in particular of blue LED is not illustrating.
[0017]Red LED (R) has the red light chip 3R of 100 micrometers in thickness, and a 350-micrometer angle which laminated GaAlAs on a GaAs substrate.
The mold of the leadframe 2R on which the light emitting chip 3R was placed is carried out to the shape of a lens with a transparent epoxy resin, and it forms the mold lens 4.
By grinding a GaAs substrate, the thickness of the red light chip 3R is adjusted so that it may become the same as that of the thickness of a green emission chip and a blue light chip. As for the mold lens 4, the mold of the half angle of the directional characteristics is carried out using B, G, and a mold that will R all be **30 degrees from a lens center. The luminous intensity of this red LED (R) has 2 cds and a luminous wavelength of 640 nm in 10 mA and 2V.
[0018]Next, green LED (G) has the green emission chip 3G of 100 micrometers in thickness, and a 350-micrometer angle which laminated a gallium nitride system compound semiconductor on silicon on sapphire.
A green emission chip makes InGaN an active layer, and let it be terrorism structure to double which makes GaAlN a cladding layer.
This green emission chip 3G is also placed on the leadframe 2R and the leadframe 2G of identical shape, and the mold is carried out with the same lens shape as red LED (R) with the same transparent epoxy resin 4. The luminous intensity of this green LED (G) has 4 cds and a luminous wavelength of 420 nm in 20 mA and 3.6V.
[0019]Next, blue LED (B) only differs in composition of InGaN of the green emission chip 3G and an active layer, it is the same in thickness and all sizes, and the luminous intensity of blue LED has 1 cd and a luminous wavelength of 360 nm in 20 mA and 3.6V.
[0020]By grinding the substrate of the red light chip 3R of the aforementioned red LED (R), in order to adjust directional characteristics, Distance (lr) from the surface of the chip to the peak of the mold lens 4R is made substantially equal to the distance (lg) from the surface of the green emission chip 3G of above-mentioned green LED (G) to the peak of the mold lens 4G. It cannot be overemphasized that green LED (G) and blue LED (B) are the same.
[0021]The plan view showing the form of the red light chip 3R seen from the mold lens 4R side and the plan view showing the form of the green emission chip 3G similarly seen from the mold lens 4G side are compared and shown in Fig.3. The slash part of Fig.3 shows the light-emitting part of the light emitting chip. It cannot be overemphasized that the form of the green emission chip 3G and the blue light chip 3B is the same. As mentioned above, since the green emission chip 3G is using sapphire as the substrate, as shown in this figure, positive and negative two

electrodes are formed from the same surface side. The chip central part is made to emit light by arranging the position of the ball at the time of furthermore carrying out the wire bond of the two electrodes on a diagonal line. On the other hand, it arranges the ball on a corner by the present invention that a ball of a red light chip is usually provided by central part of the rectangular chip.
Therefore, a light-emitting part of the red light chip 3R is carried out in the center.
Thus, it becomes possible by doubling the position of the light-emitting part of the red light chip 3R with the green emission chip 3G and the blue light chip 3B to improve the directivity of a LED display further.
[0022]In delta arrangement, LED of R, G, and B every one piece each as mentioned above the pixel carried out, When the full color LED display of the present invention was obtained by arranging the length 480 and width every 640, the luminosity was tens times bright compared with what uses the conventional green LED and blue LED, and usable enough outdoors. Furthermore, the white balance was adjusted very well and this display had the white of the same color tone in the angle of **30 degrees from the display transverse plane.
[0023]
[Effect of the Invention]according to [as described above] the present invention -- red LED, green LED, and each blue LED -- since realization of a full color display is attained by every [a piece], stroke matter can be made small compared with the conventional display, and resolution is markedly alike and improves. Also in directional characteristics, since green LED and blue LED are identical materials, what is necessary is to adjust only red LED, when 3 colors is put in order on a display, and maintenance is also dramatically easy.
[0024]Further again the chip size of the light emitting chip of the conventional red LED as a secondary effect, Usually, by below a 200-micrometer angle making the red light chip size into the 350-micrometer angle of the same size as a green emission chip and a blue light chip by the present invention to very small one, Directional characteristics can be made further easy to double, and the life of the red LED itself becomes good and the reliability of a display improves.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]The plan view showing one working example of the full color LED display of the present invention.
[Drawing 2]The schematic cross section showing the structure of the stroke matter of the display of Fig.1.
[Drawing 3]The plan view comparing and showing the form of the red light chip 3R seen from the mold lens side, and the form of the green emission chip 3G.
[Explanations of letters or numerals]
1 .... Substrate
2 .... Leadframe
3 .... Light emitting chip
4 .... Mold lens

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12) 公開特許公報（Ａ）　(11)特許出願公開番号

特開平7－335942

(43)公開日　平成７年(1995)12月22日

(51)Int.Cl.[6]	識別記号	庁内整理番号	ＦＩ	技術表示箇所
Ｈ０１Ｌ　33/00	Ｎ			
Ｇ０９Ｆ　9/33		0834－5H		

審査請求　未請求　請求項の数３　ＯＬ　（全４頁）

(21)出願番号　特願平6－131531

(22)出願日　平成６年(1994)６月14日

(71)出願人　000226057
日亜化学工業株式会社
徳島県阿南市上中町岡491番地100

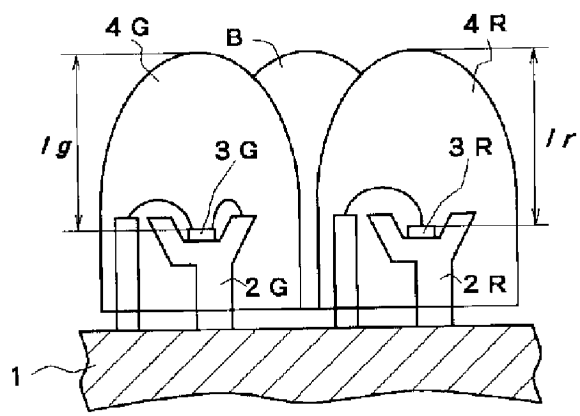
(72)発明者　永井　芳文
徳島県阿南市上中町岡491番地100　日亜化学工業株式会社内

(54)【発明の名称】　フルカラーＬＥＤディスプレイ

(57)【要約】

【目的】　光度の高いＬＥＤを使用して、高輝度で消費電力の少ないディスプレイを実現すると共に、さらに指向特性を容易に調整できるＬＥＤを組み合わせることにより安定したホワイトバランスが得られるフルカラーＬＥＤディスプレイを実現する。

【構成】　フルカラーＬＥＤディスプレイで、緑色ＬＥＤランプ（Ｇ）および青色ＬＥＤランプ（Ｂ）は窒化ガリウム系化合物半導体よりなる発光チップを備えており、赤色ＬＥＤランプ（Ｒ）の指向特性の半値角が、緑色ＬＥＤランプおよび青色ＬＥＤランプの指向特性の半値角と同一となるように調整されている。



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【特許請求の範囲】

【請求項１】　一画素を構成する赤色ＬＥＤランプと、緑色ＬＥＤランプと、青色ＬＥＤランプとが、同一基板上に接続されて成るフルカラーＬＥＤディスプレイにおいて、前記緑色ＬＥＤランプおよび青色ＬＥＤランプは窒化ガリウム系化合物半導体よりなる発光チップを備えることを特徴とするフルカラーＬＥＤディスプレイ。

【請求項２】　前記赤色ＬＥＤランプの指向特性の半値角が、緑色ＬＥＤランプおよび青色ＬＥＤランプの指向特性の半値角と同一であることを特徴とする請求項１記載のフルカラーＬＥＤディスプレイ。

【請求項３】　前記赤色ＬＥＤランプ、緑色ＬＥＤランプ、および青色ＬＥＤランプは発光チップが樹脂またはガラスでレンズ状にモールドされて成り、前記赤色ＬＥＤランプのモールドレンズの頂点と、その赤色ＬＥＤランプ内に備えられた発光チップの表面との距離が、前記緑色ＬＥＤランプおよび青色ＬＥＤランプのモールドレンズの頂点と、その緑色ＬＥＤランプおよび青色ＬＥＤランプ内に備えられた発光チップの表面との距離にほぼ等しくなるように調整されて、赤色ＬＥＤランプの指向特性の半値角が調整されていることを特徴とする請求項２に記載のフルカラーＬＥＤディスプレイ。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、発光チップが樹脂、ガラス等でモールドされたＬＥＤランプ（以下、ＬＥＤという）を同一基板上に複数接続して成るＬＥＤディスプレイに関し、特に、一画素を構成する赤色ＬＥＤと緑色ＬＥＤと青色ＬＥＤとが同一基板上に接続されて成るフルカラーＬＥＤディスプレイに関する。

【０００２】

【従来の技術】ＬＥＤディスプレイには、リードフレーム上に設置された発光チップが樹脂、ガラス等で例えばレンズ形状に封止されたＬＥＤを、基板上に規則的に並べられたものが知られている。現在ＬＥＤディスプレイには、赤色ＬＥＤと緑色ＬＥＤを用いたマルチカラーのものがすでに実用化されているが、フルカラーディスプレイは未だ試作段階で実用化には至っていない。

【０００３】現在試作されているフルカラーＬＥＤディスプレイは、発光チップの材料として、赤色ＬＥＤにＧａＡｌＡｓ、ＧａＡｓＰ、緑色ＬＥＤにＧａＰ、青色ＬＥＤにＳｉＣが用いられている。しかし、赤色ＬＥＤの光度に比べて、緑色ＬＥＤおよび青色ＬＥＤの光度が低く、特に青色ＬＥＤは１／１００以下しかないため、高輝度のディスプレイが得られないという欠点があった。

【０００４】この欠点を補う目的で、前記ディスプレイは一画素中の赤色ＬＥＤの数に対して、緑色ＬＥＤ、青色ＬＥＤの数を増やしているが、一画素中のＬＥＤの数が増えると、ディスプレイ全体の解像度が悪くなり、しかも消費電力が大きいという欠点がある。さらにまた白色を表示する際、各発光色のＬＥＤの光度比、いわゆるホワイトバランスが、３種類の発光チップからなるＬＥＤを使用していることにより、各ＬＥＤの指向特性が異なるため、一定しないという欠点があった。

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【０００５】

【発明が解決しようとする課題】本発明は上記欠点を解決するために成されたものであって、その目的とするところは光度の高いＬＥＤを使用して、高輝度で消費電力の少ないディスプレイを実現すると共に、さらに指向特性を容易に調整できるＬＥＤを組み合わせることにより安定したホワイトバランスが得られるフルカラーＬＥＤディスプレイを実現することにある。

【０００６】

【課題を解決するための手段】フルカラーＬＥＤディスプレイの輝度を向上させるには、まず光度の高い緑色ＬＥＤと青色ＬＥＤを用いる必要がある。さらに、安定したホワイトバランスを得るためには指向特性ができるだけ一致したＬＥＤを一画素に数少なく並べる必要がある。我々はその要求を同時に満足できる青色ＬＥＤと緑色ＬＥＤとを新たに見いだし、上記問題を解決するに至った。即ち本発明のフルカラーＬＥＤディスプレイは、一画素を構成する赤色ＬＥＤと、緑色ＬＥＤと、青色ＬＥＤとが、同一基板上に接続されて成るフルカラーＬＥＤディスプレイにおいて、前記緑色ＬＥＤおよび青色ＬＥＤは窒化ガリウム系化合物半導体よりなる発光チップを備えることを特徴とする。

【０００７】さらに、本発明の第２は、赤色ＬＥＤの指向特性の半値角が、緑色ＬＥＤおよび青色ＬＥＤの指向特性の半値角と同一であることを特徴とする。つまり、青色ＬＥＤと緑色ＬＥＤ同一材料であるので、従来の赤色ＬＥＤの指向特性を緑、および青色ＬＥＤに調整する。

【０００８】また本発明の第３は、赤色ＬＥＤ、緑色ＬＥＤ、および青色ＬＥＤは発光チップが樹脂またはガラスでレンズ状にモールドされて成り、前記赤色ＬＥＤランプのモールドレンズの頂点と、その赤色ＬＥＤランプ内に備えられた発光チップの表面との距離が、前記緑色ＬＥＤランプおよび青色ＬＥＤランプのモールドレンズの頂点と、その緑色ＬＥＤランプおよび青色ＬＥＤランプ内に備えられた発光チップの表面との距離にほぼ等しくなるように調整されて、赤色ＬＥＤランプの指向特性の半値角が調整されていることを特徴とする。なお緑色ＬＥＤと青色ＬＥＤとは窒化ガリウム系化合物半導体よりなる発光チップを備えていることはいうまでもない。

【０００９】本発明のＬＥＤディスプレイにおいて使用する赤色ＬＥＤには、ＧａＡｌＡｓ、ＧａＡｓＰ等、従来の発光チップの材料を備えるＬＥＤを使用でき、それらＬＥＤは発光光度１ｃｄ以上、発光出力は１mW以上を有している。

【００１０】次に本発明の特徴である緑色ＬＥＤおよび

青色ＬＥＤであるが、これらは前記のように窒化ガリウム系化合物半導体（$In_XAl_YGa_{1-X-Y}N$、$0 \leq X$、$0 \leq Y$、$X+Y \leq 1$）よりなる発光チップを備えている。その発光チップは、ＩｎＧａＮを活性層にし、ＧａＮまたはＧａＡｌＮをクラッド層とするダブルヘテロ構造であることが好ましい。なぜなら、ＩｎＧａＮを活性層とする発光チップは、ＩｎのＧａに対する組成比（Ｉｎ／Ｇａ）を０．４以下とすることにより、波長３８０ｎｍ～５８０ｎｍと青紫の領域から緑色の領域にまで発光色を変化させることができる。また、窒化ガリウム系化合物半導体は直接遷移型の半導体であるため、発光チップとした際に光度の高いＬＥＤを実現できる。具体的には、本発明のＬＥＤディスプレイに使用する緑色ＬＥＤ、および青色ＬＥＤの発光光度は、両者とも１ｃｄ以上を有するものを使用し、光出力は０．５mW以上のものを使用することが好ましい。

【００１１】また赤色、緑色、青色ＬＥＤの半値角はＬＥＤレンズの中心に対し±２０゜～±７０゜の範囲に調整することが好ましい。２０゜より小さいとディスプレイの指向性が強くなりホワイトバランスが安定しにくく、７０゜よりも大きいと輝度が低くなるからである。

【００１２】各ＬＥＤの半値角を調整するには種々の方法があるが、緑色ＬＥＤ、および青色ＬＥＤを窒化ガリウム系化合物半導体よりなる発光チップとした際、赤色ＬＥＤチップの表面の高さを窒化ガリウム系化合物半導体発光チップの高さと同一にして半値角を調整する。なぜなら、窒化ガリウム系化合物半導体発光チップの厚さは１５０μｍ以下しかなく、それに対し、赤色ＬＥＤの発光チップであるＧａＡｌＡｓ等はその厚さが３００μｍ以上ある。ディスプレイで使用されるＬＥＤにはリードフレーム形状、レンズ形状が同一のものが使用されることが多く、これらが同一であれば、赤色ＬＥＤのチップの表面の高さを、緑色、青色ＬＥＤに合わせてやることにより、３種類のＬＥＤの指向特性を合わせることができる。これは発光チップの厚さが１５０μｍ以下の窒化ガリウム系化合物半導体発光チップを緑色ＬＥＤおよび青色ＬＥＤに使用し、１５０μｍより厚い上に窒化ガリウム系化合物半導体と異なる材料よりなる発光チップを赤色ＬＥＤに使用した際の特有の効果である。

【００１３】

【作用】本発明のＬＥＤディスプレイは、緑色ＬＥＤ、青色ＬＥＤを構成する発光チップを同一材料としていることにより、発光チップの大きさ、発光チップを載置するリードフレームの形状、発光チップおよびリードフレームを封止する樹脂等のレンズ形状を同一とできる。この緑色と青色のＬＥＤが同一であるから、モールドレンズの半値角も同一であり、ディスプレイを構成した際にホワイトバランスを安定させやすくできる。

【００１４】また窒化ガリウム系化合物半導体は直接遷移型の半導体でもあり、これを用いたＬＥＤは両者とも光度１ｃｄ以上、光出力０．５mW以上ある。従ってこれらのＬＥＤを緑色成分、および青色成分として用いることにより、従来の材料で構成したディスプレイよりも、ＬＥＤの数を少なくして格段に輝度の高いものを実現できる。

【００１５】さらに、緑色ＬＥＤおよび青色ＬＥＤが同一であるので、モールドレンズの半値角を調整するには赤色ＬＥＤのみを調整してやればよい。そのためには赤色ＬＥＤにある発光チップの表面と、モールドレンズの頂点との距離を緑色ＬＥＤ、および青色ＬＥＤと同一にすることによって半値角を調整できる。これにより、三色の半値角が全て揃うことになり、安定したホワイトバランスを得ることが可能となる。

【００１６】

【実施例】図１は本願のフルカラーＬＥＤディスプレイの一実施例を示す平面図である。これはディスプレイ画面を示しており、赤色ＬＥＤ（Ｒ）、緑色ＬＥＤ（Ｇ）、青色ＬＥＤ（Ｂ）それぞれ１個づつがΔ状に配列されて一画素を形成している。また図２は図１のディスプレイの一画素の構造を示す模式断面図であり、パターン配線された基板１の表面に、赤色ＬＥＤ（Ｒ）と、緑色ＬＥＤ（Ｇ）と、青色ＬＥＤ（Ｂ）のリードフレーム２がそれぞれ電気的に接続されている。なお、青色ＬＥＤのリードフレームは特に図示していない。

【００１７】赤色ＬＥＤ（Ｒ）は、ＧａＡｓ基板の上にＧａＡｌＡｓを積層した厚さ１００μｍ、３５０μｍ角の赤色発光チップ３Ｒを有しており、その発光チップ３Ｒが載置されたリードフレーム２Ｒは透明なエポキシ樹脂でレンズ状にモールドされてモールドレンズ４を形成している。なお赤色発光チップ３Ｒの厚さはＧａＡｓ基板を研磨することにより、緑色発光チップ、および青色発光チップの厚さと同一になるように調整してある。またモールドレンズ４は、その指向特性の半値角がＢ、Ｇ、Ｒ全てレンズ中心から±３０゜になるような型を用いてモールドされている。この赤色ＬＥＤ（Ｒ）の光度は１０ｍＡ、２Ｖにおいて２ｃｄ、発光波長６４０ｎｍを有している。

【００１８】次に緑色ＬＥＤ（Ｇ）は、サファイア基板の上に窒化ガリウム系化合物半導体を積層した厚さ１００μｍ、３５０μｍ角の緑色発光チップ３Ｇを有しており、緑色発光チップはＩｎＧａＮを活性層とし、ＧａＡｌＮをクラッド層とするダブルヘテロ構造とされている。この緑色発光チップ３Ｇもリードフレーム２Ｒと同一形状のリードフレーム２Ｇ上に載置され、同じく透明なエポキシ樹脂４で赤色ＬＥＤ（Ｒ）と同一のレンズ形状でモールドされている。この緑色ＬＥＤ（Ｇ）の光度は２０ｍＡ、３．６Ｖにおいて４ｃｄ、発光波長４２０ｎｍを有している。

【００１９】次に青色ＬＥＤ（Ｂ）は、緑色発光チップ３Ｇと活性層のＩｎＧａＮの組成が異なるだけで、厚

さ、サイズ全て同一であり、青色ＬＥＤの光度は２０ｍＡ、３．６Ｖにおいて１ｃｄ、発光波長３６０ｎｍを有している。

【００２０】さらに、指向特性を調整するために、前記赤色ＬＥＤ（Ｒ）の赤色発光チップ３Ｒの基板を研磨することにより、そのチップの表面から、モールドレンズ４Ｒの頂点迄の距離（ｌｒ）を、前記緑色ＬＥＤ（Ｇ）の緑色発光チップ３Ｇの表面から、モールドレンズ４Ｇの頂点迄の距離（ｌｇ）とほぼ等しくしている。なお、緑色ＬＥＤ（Ｇ）と青色ＬＥＤ（Ｂ）とは同一であることはいうまでもない。

【００２１】さらに、図３にモールドレンズ４Ｒ側から見た赤色発光チップ３Ｒの形状を示す平面図と、同じくモールドレンズ４Ｇ側から見た緑色発光チップ３Ｇの形状を示す平面図を比較して示す。図３の斜線部は発光チップの発光部を示している。なお緑色発光チップ３Ｇと青色発光チップ３Ｂの形状は同一であることはいうまでもない。前記のように緑色発光チップ３Ｇはサファイアを基板としているため、この図に示すように同一面側から正、負の両電極が形成される。さらに両電極をワイヤーボンドする際のボールの位置を対角線上に配置することにより、チップ中央部を発光させている。一方赤色発光チップのボールは通常は矩形チップの中央部に設けられるのが、本発明においては隅部にそのボールを配することにより、赤色発光チップ３Ｒの発光部を中央にしている。このように、赤色発光チップ３Ｒの発光部の位置を緑色発光チップ３Ｇ、青色発光チップ３Ｂと合わせることにより、さらにＬＥＤディスプレイの指向性を高めることが可能となる。

【００２２】以上のようにして、Ｒ、Ｇ、ＢのＬＥＤが各一個づつΔ配列された画素を、縦４８０、横６４０づつ並べることにより本発明のフルカラーＬＥＤディスプレイを得たところ、明るさは従来の緑色ＬＥＤ、および青色ＬＥＤを使用したものに比べて数十倍も明るく、十＊＊分屋外で使用可能であった。さらにこのディスプレイはホワイトバランスが非常に良く調整され、ディスプレイ正面から±３０°の角度内において、同じ色調の白色を有していた。

【００２３】

【発明の効果】以上説明したように本発明によると、赤色ＬＥＤ、緑色ＬＥＤ、青色ＬＥＤそれぞれ一個づつでフルカラーディスプレイが実現可能となるので、一画素を従来のディスプレイに比べて小さくでき、解像度が格段に向上する。また指向特性においても、緑色ＬＥＤと青色ＬＥＤとが同一材料であるので、ディスプレイで３色並べたときに赤色ＬＥＤのみを調整すれば良く、非常にメインテナンスも楽である。

【００２４】さらにまた、副次的な効果として、従来の赤色ＬＥＤの発光チップのチップサイズは、通常２００μｍ角以下と非常に小さいのに対し、本発明では赤色発光チップの大きさを、緑色発光チップおよび青色発光チップと同じ大きさの３５０μｍ角としていることにより、指向特性をさらに合わせやすくできると共に、赤色ＬＥＤ自体の寿命が良くなり、ディスプレイの信頼性が向上する。

【図面の簡単な説明】

【図１】　本発明のフルカラーＬＥＤディスプレイの一実施例を示す平面図。

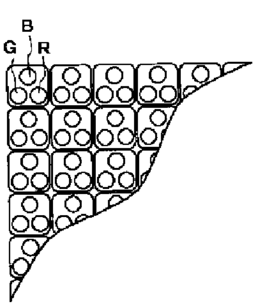
【図２】　図１のディスプレイの一画素の構造を示す模式断面図。

【図３】　モールドレンズ側から見た赤色発光チップ３Ｒの形状と、緑色発光チップ３Ｇの形状を比較して示す平面図。

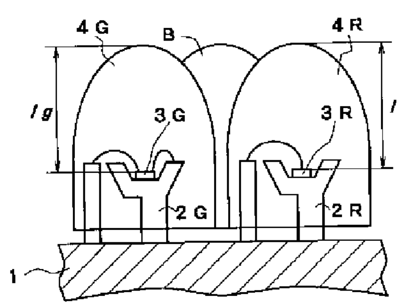
【符号の説明】

1・・・・基板
2・・・・リードフレーム
3・・・・発光チップ
4・・・・モールドレンズ

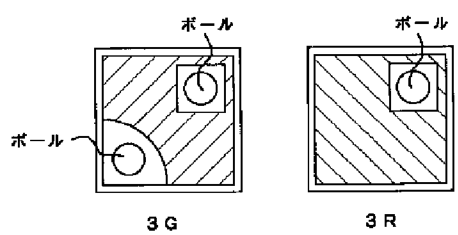
【図１】



【図２】



【図３】



PATENT ABSTRACTS OF JAPAN

(11)Publication number : 07-099345
(43)Date of publication of application : 11.04.1995

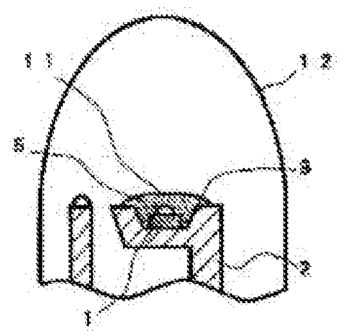
(51)Int.Cl. H01L 33/00
H01L 23/29
H01L 23/31

(21)Application number : 05-241449
(22)Date of filing : 28.09.1993

(71)Applicant : NICHIA CHEM IND LTD
(72)Inventor : MATOBA KOSUKE
KISHI AKITO
NAKAMURA SHUJI

(54) LIGHT EMITTING DIODE

(57)Abstract:
PURPOSE: To provide a LED capable of avoiding color mixture even if the LEDs in different wavelength are closely arranged when a fluorescent pigment is used while the focussing of converted and emitted light is enhanced for increasing the brightness of the LED when a wavelength conversion material is contained in a resin of LED for wavelength conversion of light emitting chip.
CONSTITUTION: A sealing resin of LED comprises the first resin 11 filling up the inside of a cup 3 and the second resin 12 encircling the first resin 11 while the first resin 11 contains the fluorescent material converting the light emitting wavelength of a light emitting chip to the other wavelength or a wavelength converting material 5 such as a filter material, etc., partly absorbing the light emitting wavelength thereby increasing the brightness, focussing efficiency due to the wavelength conversion light reflected on the cup 3.



CLAIMS

[Claim(s)]
[Claim 1]A light emitting diode which is provided with the following and characterized by a fluorescent substance which converts a luminous wavelength of a light emitting chip to other wavelength, or a filter substance which absorbs a part of luminous wavelength of a light emitting chip containing to said first resin.
First resin in which it is a light emitting diode which seals the whole light emitting device by which a light emitting chip was placed on a bottom part of a cup which reflects luminescence of a light emitting chip in the luminescence observation surface side by resin, and the aforementioned resin is filled up with the aforementioned inside of a cup.
Second resin which surrounds the first resin.

[Claim 2]The light emitting diode according to claim 1 which a substance contained in resin of said first resin is a fluorescent substance, and is characterized by filling up with said first resin so that it may become lower than the level surface of an edge of the aforementioned cup.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]The present invention is converted to wavelength which is applied to a light emitting diode (henceforth LED), especially is different in the luminous wavelength of a light emitting chip, or relates to LED which absorbs a part of luminescence of a light emitting chip.
[0002]
[Description of the Prior Art]Fig.2 is a schematic cross section showing one structure of the conventional LED, and the cup provided in order to reflect in a leadframe the light emitting chip in which 1 consists of compound semiconductors, and 2 and for 3 to reflect luminescence of a light emitting chip in the luminescence observation surface side, and 4 are resin which seals the whole light emitting device. Usually, highly transparent resin is chosen in order for the resin 4 to emit luminescence of a light emitting chip efficiently into the air, but. It is the purpose of converting the luminescent color of the light emitting chip to others, or the fluorescent substance which converts luminescence of a light emitting chip to other wavelength, or the filter substance 5 (henceforth the wavelength conversion material 5) which absorbs a part of luminous wavelength of a luminous wavelength may be mixed into the resin 4 in order to correct a color. In this case, usually it is mixed so that the wavelength conversion material 5 may be uniformly distributed to the resin 4.
[0003]
[Problem to be solved by the invention]However, when the wavelength conversion material 5 is uniformly distributed in the resin 4 for the above-mentioned purpose, as shown in this figure, the light by which wavelength changing was carried out, or the lights into which unnecessary wavelength was cut are scattered about in all directions in the resin 4, and there is a problem that condensing worsens. The arrow of Fig.2 is a figure showing typically signs that the light of a light emitting chip strikes upon the wavelength conversion material 5, and the lights by which wavelength changing was carried out are scattered about. That is, when the lights by which wavelength changing was carried out are scattered about, the light volume by the side of a luminescence observation surface decreases, and luminosity becomes low.
[0004]When the wavelength conversion material 5 is limited to a fluorescent substance, it approaches and LED of the different luminescent color is installed as a new problem, there is a problem of excessive luminescence of the fluorescent substance by other LED luminescence. For example, green LED which contains the fluorescent substance in which green emission is obtained with a blue light chip, If green LED is switched off and blue LED is turned on when it approaches horizontally on the same flat surface and the blue LED which consists only of a mere blue light chip is put in order, by the light which leaks and comes out of blue LED, and the light got blocked and scattered about, The fluorescent substance of green LED is excited, it will be in the state where green LED which went out lit up, and the mixed colors of both LED will occur.
[0005]Therefore, when the place made into the object of this invention makes resin of LED contain a wavelength conversion material and wavelength changing of a light emitting chip is performed, When a fluorescent pigment is used [and] for the purpose of improving condensing

of luminescence converted first and raising the luminosity of LED, it sets it as another purpose to provide LED to which mixed colors do not happen even if it approaches and installs LED from which wavelength differs.

[0006]

[Means for solving problem]The first resin in which LED of the present invention is LED which seals the whole light emitting device by which the light emitting chip was placed on the bottom part of the cup which reflects luminescence of a light emitting chip in the luminescence observation surface side by resin, and the aforementioned resin is filled up with the aforementioned inside of a cup, It consists of second resin which surrounds the first resin, and the fluorescent substance which converts the luminous wavelength of a light emitting chip to other wavelength, or the filter substance which absorbs a part of luminous wavelength of a light emitting chip contains to the above-mentioned first resin.

[0007]

[Function]In first resin for luminescence of a light emitting chip, it converts to desired wavelength or LED of the present invention absorbs a part of unnecessary wavelength. Thus, although the lights by which wavelength changing was carried out are scattered about in all directions, it is reflected by the cup and most scattered lights are condensed at the luminescence observation surface side. that is, since the cup of an application concerned reflects the light by which wavelength changing was carried out with the wavelength conversion material and can be condensed within first resin, the condensing efficiency of converted light is markedly alike, and improves.

[0008]If it is filled up with first resin containing a fluorescent substance so that it may become lower than the level surface of the edge of a cup when a wavelength conversion material is used as a fluorescent substance, the mixed colors between LED can be prevented by interrupting an incident light on the edge of a cup from the exterior, and not reaching even a fluorescent substance. If it says simply, when keeping the first resin that makes the cup depth deep and contains a fluorescent substance from overflowing a cup, the excitation source of a fluorescent substance can be restricted only to the luminous wavelength of a light emitting chip.

[0009]

[Working example]Fig.1 is a schematic cross section showing the structure of LED of one working example of an application concerned, and is taken as the structure which sealed the whole light emitting device which placed like Fig.2 the light emitting chip 1 which consists of compound semiconductors on the leadframe 2 which has the cup 3 by resin.However, a different place from Fig.2, sealing resin consists of the first resin 11 filled up with cup 3 inside, and the second resin 12 which surrounds the first resin, to the first resin 11, it converts to other wavelength or the wavelength conversion material 5 which is absorbed in part and to convert contains the luminous wavelength of the light emitting chip.

[0010]An identical material may be sufficient as the material of the first resin 11 and second resin, for example, it constitutes both from an epoxy resin, and should just make only first resin contain the fluorescent substance 5 in LED of the present invention. It cannot be overemphasized that it may be the same as that of the resin 4 of Fig.2. If the wavelength conversion material 5 is a fluorescent substance, fluorescent dye, a fluorescent pigment, a fluorescent substance, etc., As long as it is the material which can convert the luminous wavelength of a light emitting chip to other wavelength, what kind of thing may be used, If it is a filter substance, the unnecessary wavelength of luminescence of a light emitting chip will be absorbed, the material which receives color purity is chosen, and the inorganic and organic filter paints which usually have the same color as the luminescent color of a light emitting chip are used.

[0011]In order to obtain LED of such a structure, for example in an LED manufacturing process, pre dip the inside of a cup which placed the light emitting chip 1 previously by resin in order to usually drive out the air of the cup 3, but. It can obtain by making the first resin 11 contain the wavelength conversion material 5, when pre dipping, and sealing by the second resin 12, after the first resin 11 containing the wavelength conversion material 5 hardens. The first resin 11 that includes the wavelength conversion material 5 previously may be injected into cup 3 inside. thus, the inside of 3 of a cup is filled up with the first resin 11 containing the wavelength conversion material 5, most lights by which wavelength changing was carried out by the first resin 11 return in the reflector of the cup 3, and by reflecting in a luminescence observation surface, condensing of LED is markedly alike and improves.

[0012]The first resin 11 and the second resin 12 are used as a different material, and the external quantum efficiency of the light by which wavelength changing was carried out improves by setting up to make small the refractive index of the first resin 11 and the second resin 12 in order, and become close to the refractive index 1 of air. It cannot be overemphasized that a material smaller than the refractive index of the light emitting chip 1 is selected into the material of the first resin 11 in this case.

[0013]Fig.3 and Fig.4 are the schematic cross sections expanding and showing the portion of the cup 3 of LED concerning other working examples of the present invention, and the state with which Fig.3 became convex, the surface of the first resin 11 hardened it, and the cup 3 was filled up, and the state where Fig.4 became a concave conversely, and it hardened and filled up are shown.Since it fills up so that the first resin 11 containing the fluorescent substance may become lower than the level surface of the edge of the cup 3 and the cup 3 is not overflowed in which state when the wavelength conversion material 5 is used as a fluorescent substance, The extraneous light which excites a fluorescent substance by the edge of the cup 3 can be intercepted, and the mixed colors of LED can be prevented.

[0014]

[Effect of the Invention]As described above, since converted light reflects inside a cup since LED of the present invention has filled up the inside of a cup with first resin containing a wavelength conversion material, and it is condensed, luminosity improves more than double. When making first resin contain a fluorescent pigment, performing wavelength changing, making the cup depth deep and keeping first resin from overflowing a cup, When the mixed colors between LED do not occur, for example, a planar display is realized by LED, an image with dramatically sufficient resolution can be acquired.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]The schematic cross section showing the structure of 1LED of the present invention.
[Drawing 2]The schematic cross section showing the structure of the conventional LED.
[Drawing 3]The schematic cross section expanding and showing the portion of the cup 3 of LED concerning other working examples of the present invention.
[Drawing 4]The schematic cross section expanding and showing the portion of Kapp 3 of LED concerning other working examples of the present invention.
[Explanations of letters or numerals]
1 ... Light emitting chip 2 ... Leadframe
3 ... Kapp 5 ... Wavelength conversion material
11 ... First resin 12 ... Second resin

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12) 公開特許公報（Ａ）　(11)特許出願公開番号

特開平7－99345

(43)公開日　平成７年(1995)４月11日

(51)Int.Cl.[6]	識別記号	庁内整理番号	ＦＩ	技術表示箇所
Ｈ０１Ｌ　33/00	Ｎ			
	Ａ			
	Ｈ			
		8617－4M	Ｈ０１Ｌ　23/ 30	Ｂ
		8617－4M		Ｃ

審査請求　未請求　請求項の数２　ＯＬ　（全　４　頁）　最終頁に続く

(21)出願番号　特願平5－241449

(22)出願日　平成５年(1993)９月28日

(71)出願人　000226057
日亜化学工業株式会社
徳島県阿南市上中町岡491番地100

(72)発明者　的場　功祐
徳島県阿南市上中町岡491番地100　日亜化学工業株式会社内

(72)発明者　岸　明人
徳島県阿南市上中町岡491番地100　日亜化学工業株式会社内

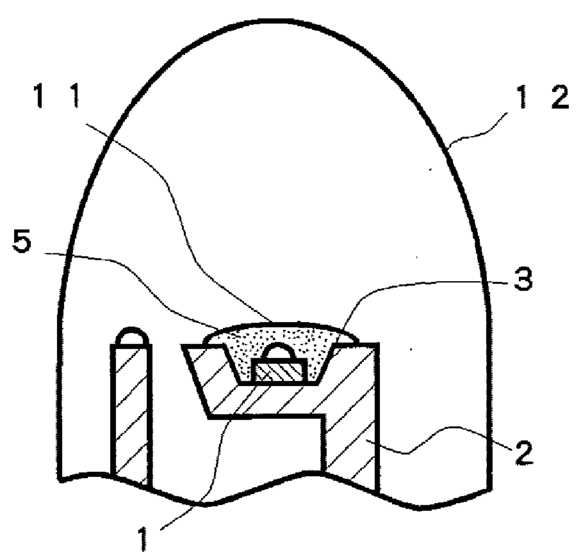
(72)発明者　中村　修二
徳島県阿南市上中町岡491番地100　日亜化学工業株式会社内

(54)【発明の名称】　発光ダイオード

(57)【要約】

【目的】　ＬＥＤの樹脂に波長変換材料を含有させて発光チップの波長変換を行う際、まず変換された発光の集光をよくしてＬＥＤの輝度を高めることを目的とし、また蛍光顔料を使用した際、波長の異なるＬＥＤを近接して設置しても混色の起こらないＬＥＤを提供する。

【構成】　ＬＥＤの封止樹脂が、カップ３内部を充填する第一の樹脂１１と、その第一の樹脂を包囲する第二の樹脂１２とからなり、第一の樹脂１１には発光チップの発光波長を他の波長に変換する蛍光物質、または発光波長を一部吸収するフィルター物質等の波長変換材料５が含有されていることにより、波長変換光がカップ３に反射されるため輝度、集光効率が向上する。



【特許請求の範囲】

【請求項１】　発光チップの発光を発光観測面側に反射するカップの底部に発光チップが載置された発光素子全体を、樹脂で封止してなる発光ダイオードであって、前記樹脂は前記カップ内部を充填する第一の樹脂と、その第一の樹脂を包囲する第二の樹脂とからなり、前記第一の樹脂には発光チップの発光波長を他の波長に変換する蛍光物質、または発光チップの発光波長を一部吸収するフィルター物質が含有されていることを特徴とする発光ダイオード。

【請求項２】　前記第一の樹脂の樹脂に含まれる物質が蛍光物質であって、前記第一の樹脂は前記カップの縁部の水平面よりも低くなるように充填されていることを特徴とする請求項１に記載の発光ダイオード。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は発光ダイオード（以下ＬＥＤという。）に係り、特に発光チップの発光波長を異なる波長に変換する、または発光チップの発光を一部吸収するＬＥＤに関する。

【０００２】

【従来の技術】図２は従来のＬＥＤの一構造を示す模式断面図であり、１は化合物半導体よりなる発光チップ、２はリードフレーム、３は発光チップの発光を発光観測面側に反射させる目的で設けられたカップ、４は発光素子全体を封止する樹脂である。通常、樹脂４は発光チップの発光を空気中に効率よく放出する目的で透明度の高い樹脂が選択されるが、他にその発光チップの発光色を変換する目的で、あるいは色を補正する目的で、その樹脂４の中に発光チップの発光を他の波長に変換する蛍光物質、または発光波長の発光波長を一部吸収するフィルター物質５（以下、波長変換材料５という。）が混入される場合がある。この場合、波長変換材料５は樹脂４に均一に分散するように混入されるのが通常である。

【０００３】

【発明が解決しようとする課題】しかしながら、上記の目的で波長変換材料５を樹脂４中に均一に分散させると、この図に示すように、波長変換された光、または不要な波長がカットされた光は樹脂４中で四方八方に散乱してしまい、集光が悪くなるという問題がある。図２の矢印は発光チップの光が波長変換材料５にあたり、波長変換された光が散乱する様子を模式的に示した図である。つまり、波長変換された光が散乱されることにより、発光観測面側の光量が減少して輝度が低くなるのである。

【０００４】また、波長変換材料５を蛍光物質に限定した場合、新たな問題点として、異なる発光色のＬＥＤを接近して設置した際に、他のＬＥＤ発光による蛍光物質のよけいな発光の問題がある。例えば、青色発光チップで緑色発光が得られる蛍光物質を含む緑色ＬＥＤと、単なる青色発光チップのみからなる青色ＬＥＤとを同一平面上に水平に近接して並べた場合、緑色ＬＥＤを消灯して、青色ＬＥＤを点灯すると、青色ＬＥＤから洩れ出る光、つまり散乱する光により、緑色ＬＥＤの蛍光物質が励起され、消灯した緑色ＬＥＤがあたかも点灯したような状態となり、両ＬＥＤの混色が発生する。

【０００５】従って本発明の目的とするところは、ＬＥＤの樹脂に波長変換材料を含有させて発光チップの波長変換を行う際、まず変換された発光の集光をよくしてＬＥＤの輝度を高めることを目的とし、また蛍光顔料を使用した際、波長の異なるＬＥＤを近接して設置しても混色の起こらないＬＥＤを提供することをもう一つの目的とする。

【０００６】

【課題を解決するための手段】本発明のＬＥＤは、発光チップの発光を発光観測面側に反射するカップの底部に発光チップが載置された発光素子全体を、樹脂で封止してなるＬＥＤであって、前記樹脂は前記カップ内部を充填する第一の樹脂と、その第一の樹脂を包囲する第二の樹脂とからなり、前記第一の樹脂には発光チップの発光波長を他の波長に変換する蛍光物質、または発光チップの発光波長を一部吸収するフィルター物質が含有されていることを特徴とする。

【０００７】

【作用】本発明のＬＥＤは、発光チップの発光を第一の樹脂内において所望の波長に変換、または不要な波長を一部吸収する。このようにして波長変換された光は四方八方に散乱するが、散乱した光のほとんどはカップにより反射され、発光観測面側に集光される。つまり本願のカップは第一の樹脂内で波長変換材料により波長変換された光を反射して集光できるので、変換光の集光効率が格段に向上する。

【０００８】さらに、波長変換材料を蛍光物質とした場合、蛍光物質を含む第一の樹脂をカップの縁部の水平面よりも低くなるように充填すると、外部から入射する光がカップの縁で遮られ、蛍光物質にまで到達しないことにより、ＬＥＤ間の混色を防止することができる。簡単にいうと、カップ深さを深くして蛍光物質を含む第一の樹脂がカップからはみ出さないようにすることにより、蛍光物質の励起源を発光チップの発光波長のみに制限できる。

【０００９】

【実施例】図１は本願の一実施例のＬＥＤの構造を示す模式断面図であり、図２と同様に、カップ３を有するリードフレーム２上に化合物半導体よりなる発光チップ１を載置した発光素子全体を、樹脂で封止した構造としている。しかし、図２と異なるところは、封止樹脂がカップ３内部を充填する第一の樹脂１１と、その第一の樹脂を包囲する第二の樹脂１２とからなり、第一の樹脂１１には発光チップの発光波長を他の波長に変換、または一

部吸収する変換する波長変換材料５が含有されている。

【００１０】本発明のＬＥＤにおいて、第一の樹脂１１と第二の樹脂の材料は同一材料でもよく、例えば両方ともエポキシ樹脂で構成し、第一の樹脂にのみ蛍光物質５を含有させればよい。さらに、第二の樹脂１２の材料は図２の樹脂４と同一でもよいことはいうまでもない。また、波長変換材料５は蛍光物質であれば蛍光染料、蛍光顔料、蛍光体等、発光チップの発光波長を他の波長に変換できる材料であればどのようなものを使用してもよく、またフィルター物質であれば発光チップの発光の不要な波長を吸収し、色純度をよくする材料が選択され、通常発光チップの発光色と同一色を有する無機、有機のフィルター顔料が使用される。

【００１１】このような構造のＬＥＤを得るには、例えばＬＥＤ製造工程において、通常カップ３の空気を追い出す目的で、予め発光チップ１を載置したカップ内部を樹脂でプレディップするのであるが、プレディップする際に第一の樹脂１１に波長変換材料５を含有させておき、波長変換材料５を含む第一の樹脂１１が硬化した後、第二の樹脂１２で封止することにより得ることができる。また予め波長変換材料５を含む第一の樹脂１１をカップ３内部に注入してもよい。このようにして、波長変換材料５を含む第一の樹脂１１をカップの３の内部に充填し、第一の樹脂１１で波長変換された光のほとんどがカップ３の反射鏡内に戻り、発光観測面に反射することによりＬＥＤの集光が格段に向上する。

【００１２】また第一の樹脂１１と第二の樹脂１２とを異なる材料とし、第一の樹脂１１、第二の樹脂１２の屈折率を順に小さくして空気の屈折率１に近くなるように設定することにより波長変換された光の外部量子効率が向上する。なおこの場合、第一の樹脂１１の材料には、発光チップ１の屈折率よりも小さい材料を選定することは言うまでもない。

【００１３】図３、および図４は本発明の他の実施例に係るＬＥＤのカップ３の部分を拡大して示す模式断面図であり、図３は第一の樹脂１１の表面が凸状になって硬化してカップ３に充填された状態、図４は逆に凹状となって硬化して充填された状態を示している。いずれの状態においても、波長変換材料５を蛍光物質とした場合、その蛍光物質を含む第一の樹脂１１がカップ３の縁部の水平面よりも低くなるように充填されており、カップ３からはみ出していないので、カップ３の縁部により蛍光物質を励起する外部光を遮断でき、ＬＥＤの混色を防止することができる。

【００１４】

【発明の効果】以上説明したように、本発明のＬＥＤはカップ内部に波長変換材料を含有する第一の樹脂を充填しているため、変換光がカップ内部で反射して集光されるため、輝度は倍以上に向上する。また、蛍光顔料を第一の樹脂に含有させて波長変換を行う場合、カップ深さを深くして、第一の樹脂がカップからはみ出さないようにすることにより、ＬＥＤ間の混色が発生せず、例えばＬＥＤで平面ディスプレイを実現した際には、非常に解像度のよい画像を得ることができる。

【図面の簡単な説明】

【図１】　本発明の一ＬＥＤの構造を示す模式断面図。

【図２】　従来のＬＥＤの構造を示す模式断面図。

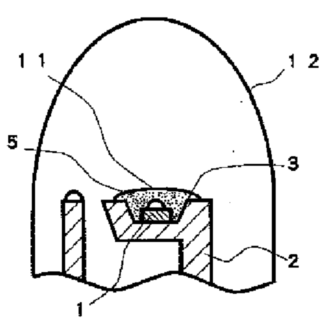
【図３】　本発明の他の実施例に係るＬＥＤのカップ３の部分を拡大して示す模式断面図。

【図４】　本発明の他の実施例に係るＬＥＤのカップ３の部分を拡大して示す模式断面図。

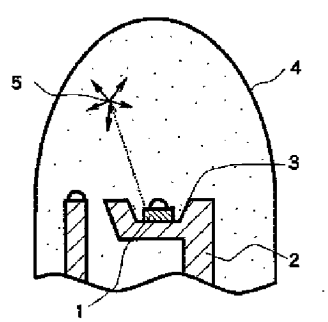
【符号の説明】

１・・・発光チップ　　２・・・リードフレーム
３・・・カップ　　５・・・波長変換材料
１１・・・第一の樹脂　　１２・・・第二の樹脂

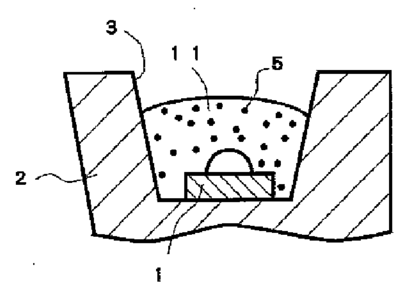
【図１】



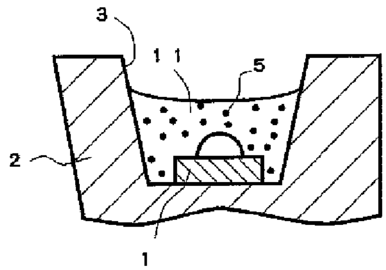
【図２】



【図３】



【図４】



フロントページの続き

(51)Int.Cl.[6]	識別記号	庁内整理番号	F I	技術表示箇所
H01L　23/29				
23/31				

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 07-176794
(43)Date of publication of application : 14.07.1995

(51)Int.Cl. H01L 33/00
G09F 9/00

(21)Application number : 05-318276
(22)Date of filing : 17.12.1993

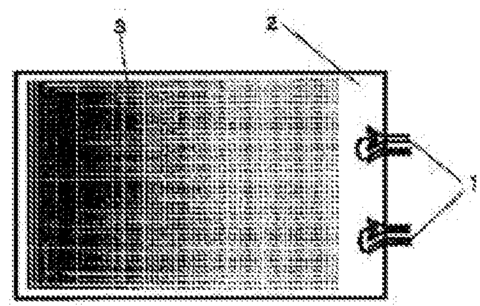
(71)Applicant : NICHIA CHEM IND LTD
(72)Inventor : SHIMIZU YOSHINORI

(54) PLANAR LIGHT SOURCE

(57)Abstract:

PURPOSE: To provide a planar light source wherein a blue light emitting diode is used and white luminescence is feasible, and wherein uniform white luminescence can be observed.

CONSTITUTION: Light emitting diodes 1 are optically connected with the end of a transparent light transmitting plate 2. A fluorescent substance that emits light when energized by the luminescence of the blue light emitting diodes 1 and white powder that scatters fluorescence, are mixed. The resultant mixture is applied to either of the major surfaces of the light transmitting plate 2 to form a fluorescence scattering layer 3. The wavelength of the luminescence of the blue light emitting diodes 1 is changed through the fluorescence scattering layer 3.



CLAIMS

[Claim(s)]
[Claim 1]A fluorescent substance which a blue light-emitting diode is optically connected to at least one place of an end face of a transparent light guide plate, is further excited by luminescence of the aforementioned blue light-emitting diode by either of the main surfaces of the aforementioned light guide plate, and shows a fluorescence, A source of sheet-like light which having the fluorescence scattering layer applied where white powder over which fluorescence is scattered is mixed, carrying out wavelength changing of the luminescence of the aforementioned blue light-emitting diode by the aforementioned fluorescence scattering layer, and observing from the main surface side of a light guide plate of the aforementioned fluorescence scattering layer and an opposite hand.
[Claim 2]The source of sheet-like light according to claim 1, wherein the main-light-emission wavelength of the aforementioned blue light-emitting diode is shorter than 500 nm and a radiant power output is not less than 500 microwatts.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]The present invention relates to the source of sheet-like light which starts the light source of the surface state used for the backlight of a display, an illuminated operation switch, etc., especially can be preferably used as a backlight of a liquid crystal display.

[0002]
[Description of the Prior Art]EL and a cold cathode tube are used for the source of sheet-like light for the backlights of the liquid crystal display generally used for a notebook sized personal computer, a word processor, etc., for example. Itself of EL is a source of sheet-like light, a cold cathode tube is made into the source of sheet-like light using a diffusion board, and the luminescent color of the backlight of them is made white [most] now.
[0003]On the other hand, the light emitting diode (it is described as LED below.) is also used in part as a light source for backlights. However, by the former, when obtaining white light using LED, since there is only an about tens of microwatts radiant power output of blue LED, in order to realize white light using other red LED and green LED, there is a fault that a color change is large that it is hard to make the characteristic of these each color luminescence LED agree. Since those LED was recognized visually in the near position as a backlight even if trichromatic LED is gathered and it arranges in the same position geometrically on the same flat surface, it was impossible to have used a uniform white light source. Therefore, if large-sized, the actual condition is properly used with EL, and most backlights of white light using LED are not known by a cold cathode tube, small size - the medium size now at the white source of sheet-like light of the liquid crystal back light.
[0004]Although the trial which surrounds and carries out the convert colors of the circumference of a blue LED chip by resin containing a fluorescent substance also occurs partly as a light source of white light or monochrome, since a chip periphery is exposed to the beam of light of radiant intensity stronger than sunlight, degradation of a fluorescent substance poses a problem, especially it is remarkable at an organic fluorescent pigment. Organic dye of ionicity may cause an electrophoresis by direct-current electric field near the chip, and a color tone may change. Even if the conventional blue LED does not have sufficient output to carry out convert colors but carries out convert colors with a fluorescent substance, it is unusable.
[0005]
[Problem to be solved by the invention]The place which was accomplished in order that the present invention might solve such a fault, and is made into the purpose, Realize the source of sheet-like light which can be used mainly as a backlight and in which white light is possible using LED, and. It is in providing the source of sheet-like light which can observe uniform white light, and is in providing the source of sheet-like light which can emit light for arbitrary colors other than white further, using the characteristic of LED excellent in reliability, and using for various operation switches etc.
[0006]
[Means for solving problem]The fluorescent substance which blue LED is optically connected to

at least one place of the end face of a transparent light guide plate, and the source of sheet-like light of the present invention is further excited by luminescence of the aforementioned blue light-emitting diode by either of the main surfaces of the aforementioned light guide plate, and shows a fluorescence, The fluorescence scattering layer applied where the white powder over which light is scattered is mixed. (the main surface by the side of a fluorescence scattering layer is hereafter called second main surface.) -- it has, wavelength changing of a part of luminescence of the aforementioned blue light-emitting diode is carried out by the aforementioned fluorescence scattering layer, and it is observed from the main surface (main surface by the side of luminescence observation is called first main surface below.) side of the light guide plate of the aforementioned fluorescence scattering layer and an opposite hand

[0007]Fig.1 is the plan view which looked at the light guide plate 2 of the source of sheet-like light of the present invention from the fluorescence scattering layer 3 side. The light guide plate 2 consists of transparent materials, such as an acrylic and glass, and the light guide plate 2 and the blue LED 1 are optically connected by embedding the blue LED 1 under the end face of the light guide plate 2. that the blue LED 1 and the end face of the light guide plate 2 are connected optically in the present invention, Not to mention embedding the blue LED 1, as it says introducing the light of blue LED from the end face of the light guide plate 2, for example, is shown in this figure, if it says simply, It is realizable by adhering blue LED and leading luminescence of blue LED to the end face of the light guide plate 2 using an optical fiber etc.

[0008]Next, the fluorescence scattering layer 3 is scattering the fluorescence in the light guide plate 2 with the white pigment at the same time it comes to apply the ink which prepared the fluorescent substance and the white pigment and it carries out wavelength changing of the luminescence of the blue LED 1 with a fluorescent substance so that a desired color can be observed. So that the aforementioned fluorescence scattering layer 3 may especially be made into dot form by Fig.1 and the surface brightness by the side of a first main surface may become fixed. It is considered as a pattern which reduces the area of the fluorescence scattering layer 3 per unit area by the side of a second main surface, and area of the end of LED1 and the most distant second main surface is further made small a little slightly as compared with the maximum area as LED1 is approached. Here, ** in Fig.1 expresses the pattern of the fluorescence scattering layer 3. Although blue LED is made into the structure allotted to one end face two pieces in Fig.1, if a light guide plate is a quadrangle, to say nothing of connecting LED, the number of LED will not be limited to all end faces on all sides. The coating form of a fluorescence scattering layer and an application state can be suitably changed so that luminescence observed from the first main surface side may be made into surface state homogeneity according to the arrangement situation of LED.

[0009]

[Function]Fig.2 is a schematic cross section at the time of mounting the source of sheet-like light of the present invention as a backlight of a liquid crystal panel. The scatter reflection layer 6 which is on the second main surface side of the source of sheet-like light which this shows to Fig.1, for example from barium titanate, titanium oxide, an aluminum oxide, etc., For example, the light reflector with which the base 7 which consists of aluminum was laminated is installed, the optical diffuser 5 by which the surface is considered as unevenness at the first main surface side is installed, and these composition is not different from the backlight in particular that uses a light source as a cold cathode tube.

[0010]As the arrow of Fig.2 shows first, the light which came out of the blue LED 1 is emitted to the exteriors other than a light guide plate in part near the chip, but a great portion of light reaches the end face of a light guide plate in the inside of the light guide plate 2, repeating total internal reflection. It is reflected by the reflecting film 4 formed in all end faces, and the light which reached the end face repeats total internal reflection. At this time, a part of lights are absorbed with a fluorescent substance, and wavelength changing of them is carried out simultaneously, they are emitted [a part of lights are scattered about by the fluorescence scattering layer 3 provided at the second main surface side of the light guide plate 2 and], and the luminescent color observed from the first main surface side of the light guide plate 2 can observe the light which synthesized such lights. For example, in the source of sheet-like light which provided the fluorescence scattering layer 3 which consists of an orange fluorescent pigment and white pigment, by the operation described previously, the luminescent color from blue LED becomes white, and it can observe. A color tone can be arbitrarily adjusted with the kind of fluorescent substance, and the mixture ratio of a white pigment. At the present invention, the main-light-emission peak of especially the luminous wavelength of one blue LED is shorter than 500 nm, and the radiant power output needs not less than 200 microwatts of outputs of not less than 300 microwatts still more preferably. It is because it is in the tendency for the light source of surface state luminescence with sufficient uniform luminosity to be hard to be obtained even if it increases the number of blue LED which connects with the end face of a light guide plate optically even if when it becomes it difficult to realize all the colors that a luminous wavelength is not less than 500 nm and there are few the radiant power outputs than 200 microwatts.

[0011]

[Working example]

[Working example 1] The fluorescence scattering layer 3 was formed in one side of an acrylic board about 2 mm thick by screen-stencil by the dot form pattern shown in Fig.1. The fluorescent pigment which mixed ana product FAmade from SHINROIHI chemistry-001 whose fluorescence scattering layer 3 is a red fluorescent pigment, and the company's FA-005 which are green fluorescence paints, Barium titanate was mixed at a ratio of 1:5 by the weight ratio as white powder, and what distributed it in the acrylic binder was printed and formed.

[0012]Next, after cutting the acrylic board with which the fluorescence scattering layer was formed as mentioned above according to the desired pattern and grinding all the end faces (cutting plane) of an acrylic board, the light guide plate 2 with which the fluorescence scattering layer 3 was formed was obtained by forming the reflecting layer 4 which becomes a polished surface from aluminum.

[0013]Two places and a hole are provided to the end face of the aforementioned light guide plate 2, and it is a luminous wavelength of 480 nm to the hole. By embedding at a time one blue LED which consists of a gallium nitride system compound semiconductor which has 1200 microwatts of radiant power outputs, respectively, the source of sheet-like light of the present invention was acquired. When the blue LED of this source of sheet-like light was made to turn on simultaneously, substantially uniform white surface state luminescence which is a little tinged with yellowness was obtained from the luminescence observation surface side of the light guide plate 2. the place which installed the optical diffuser 5 by which mat processing was previously performed to the luminescence observation surface side, and the light reflector with which the barium titanate layer 6 was applied on the aluminum base 7 at the fluorescence scattering layer 3 side, and was used as the light source for backlights -- from the optical diffuser 5 side -- completely -- surface state -- uniform white light was obtained. Luminosity was 55cd/m^2.

[0014][Working example 2] Mix the fluorescence scattering layer 3 as yellow fluorescent dye, and the company's Orenge-240 is substantially mixed in equivalent amount as LumogenF Yellow-083 of BASF A.G., and orange fluorescent dye, When barium titanate was formed using the thing mixed at a ratio of 1(color):200 by the weight ratio as the fluorescent dye which dissolved them in butylcarbitol acetate, and a white substance and also the source of sheet-like light of the present invention was acquired like the working example 1, substantially uniform surface state luminescence was observed. When it was considered as the light source for backlights still more nearly similarly, completely uniform surface state luminescence was observed.

[0015]

[Effect of the Invention]As described above, the source of sheet-like light of the present invention became possible [realizing the source of sheet-like light by LED excellent in reliability] by having a fluorescence scattering layer containing the fluorescent substance which can moreover carry out wavelength changing to the surface of one of the two of a light guide plate by blue LED, and white powder using blue LED. And since the white powder of a

fluorescence scattering layer has the operation which reflects the light by which wavelength changing was carried out with the fluorescent substance, and makes it spread, there is little amount of the fluorescent substance used to be used, and it ends. Since an LED chip and a fluorescent substance do not meet with a convenient thing directly, there is little degradation of a fluorescent substance and it does not cause the tone change of the source of sheet-like light over a long period of time. Any color tones including white can be provided by changing the kind of a fluorescent substance and white powder, a mixed amount, etc. about a color tone.
[0016]When the radiant power output of the blue LED most preferably used as a side which excites a fluorescence scattering layer on the other hand considers it as a not less than 200-microwatt thing, wavelength changing can be efficiently carried out with a fluorescent substance, and the source of sheet-like light with a bright big area can be realized. Thus, the source of sheet-like light of an application concerned can also be used for the illuminated operation switch not only using the light source for backlights but a fluorescent substance, etc.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]The plan view which looked at the light guide plate 2 of the source of sheet-like light of one working example of the present invention from the fluorescence scattering layer 3 side.
[Drawing 2]The schematic cross section at the time of mounting the source of sheet-like light of one working example of the present invention as a backlight.
[Explanations of letters or numerals]
1 ..... Blue LED
2 ..... Light guide plate
3 ..... Fluorescence scattering layer
4 ..... Reflecting layer
5 ..... Optical diffuser
6 ..... Scatter reflection layer
7 ..... aluminum base

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12) 公開特許公報（Ａ）　(11)特許出願公開番号

特開平7－176794

(43)公開日　平成７年(1995)７月14日

(51)Int.Cl.[6]	識別記号	庁内整理番号	ＦＩ	技術表示箇所
Ｈ０１Ｌ　33/00	Ｎ			
Ｇ０９Ｆ　9/00	３３６　Ｈ	7610－5G		

審査請求　未請求　請求項の数２　ＯＬ　（全４頁）

(21)出願番号　特願平5－318276

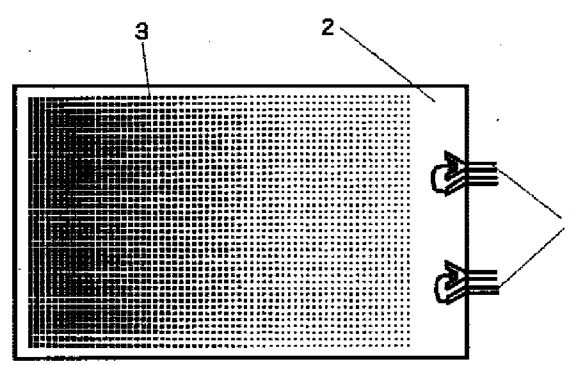
(22)出願日　平成５年(1993)12月17日

(71)出願人　000226057
日亜化学工業株式会社
徳島県阿南市上中町岡491番地100

(72)発明者　清水　義則
徳島県阿南市上中町岡491番地100　日亜化学工業株式会社内

(54)【発明の名称】　面状光源

(57)【要約】
【目的】　青色発光ダイオードを用いた白色可能な面状光源を実現し、均一な白色発光を観測できる面状光源を提供する。
【構成】　透明な導光板の端面に発光ダイオードが光学的に接続されており、さらに前記導光板の主面のいずれか一方に、前記青色発光ダイオードの発光により励起されて蛍光を発する蛍光物質と、蛍光を散乱させる白色粉末とが混合された状態で塗布された蛍光散乱層を有し、前記青色発光ダイオードの発光が前記蛍光散乱層で波長変換される。



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【特許請求の範囲】

【請求項１】　透明な導光板の端面の少なくとも一箇所に青色発光ダイオードが光学的に接続されており、さらに前記導光板の主面のいずれか一方に、前記青色発光ダイオードの発光により励起されて蛍光を発する蛍光物質と、蛍光を散乱させる白色粉末とが混合された状態で塗布された蛍光散乱層を有し、前記青色発光ダイオードの発光が前記蛍光散乱層で波長変換され、前記蛍光散乱層と反対側の導光板の主面側から観測されることを特徴とする面状光源。

【請求項２】　前記青色発光ダイオードは、その主発光波長が５００ｎｍよりも短く、発光出力が５００μＷ以上であることを特徴とする請求項１に記載の面状光源。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明はディスプレイのバックライト、照光式操作スイッチ等に使用される面状の光源に係り、特に液晶ディスプレイのバックライトとして好適に用いることができる面状光源に関する。

【０００２】

【従来の技術】一般にノート型パソコン、ワープロ等に使用される液晶ディスプレイのバックライト用の面状光源には、例えばＥＬ、冷陰極管が使用されている。ＥＬはそれ自体が面状光源であり、冷陰極管は拡散板を用いて面状光源とされ、現在それらのバックライトの発光色はほとんどが白色とされている。

【０００３】一方発光ダイオード（以下ＬＥＤと記す。）もバックライト用光源として一部利用されている。しかしＬＥＤを用いて白色発光を得る場合、従来では青色ＬＥＤの発光出力が数十μＷほどしかないため、他の赤色ＬＥＤ、緑色ＬＥＤを用いて白色発光を実現させるには、それら各色発光ＬＥＤの特性を合致させにくく色変化が大きいという欠点がある。また、三原色のＬＥＤを集合させて、同一平面上に幾何学的に同じ位置に配置しても、バックライトとしてはそれらのＬＥＤを接近した位置で視認するため、均一な白色光源にすることは不可能であった。従って現在白色の液晶バックライトの面状光源には、大型では冷陰極管、小型～中型にはＥＬと使い分けられているのが現状で、ＬＥＤを用いた白色発光のバックライトはほとんど知られていない。

【０００４】また白色発光、あるいはモノクロの光源として、一部では青色ＬＥＤチップの周囲を蛍光物質を含む樹脂で包囲して色変換する試みもあるが、チップ周辺は太陽光よりも強い放射強度の光線にさらされるため、蛍光物質の劣化が問題となり、特に有機蛍光顔料で顕著である。更にイオン性の有機染料はチップ近傍では直流電界により電気泳動を起こし、色調が変化する可能性がある。また従来の青色ＬＥＤは蛍光物質で色変換するには十分な出力を有しておらず、たとえ色変換したとしても実用できるものではなかった。

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【０００５】

【発明が解決しようとする課題】本発明はこのような欠点を解決するために成されたもので、その目的とするところは、ＬＥＤを用い、主としてバックライトとして利用できる白色発光可能な面状光源を実現すると共に、均一な白色発光を観測できる面状光源を提供することにあり、さらには白色以外の任意色の発光が可能な面状光源を提供し、信頼性に優れたＬＥＤの特性を利用し、各種操作スイッチ等に利用することにある。

【０００６】

【課題を解決するための手段】本発明の面状光源は、透明な導光板の端面の少なくとも一箇所に青色ＬＥＤが光学的に接続されており、さらに前記導光板の主面のいずれか一方に、前記青色発光ダイオードの発光により励起されて蛍光を発する蛍光物質と、光を散乱させる白色粉末とが混合された状態で塗布された蛍光散乱層（以下、蛍光散乱層側の主面を第二の主面という。）を有し、前記青色発光ダイオードの発光の一部が前記蛍光散乱層で波長変換され、前記蛍光散乱層と反対側の導光板の主面（以下発光観測側の主面を第一の主面という。）側から観測されることを特徴とする。

【０００７】図１は本発明の面状光源の導光板２を蛍光散乱層３側から見た平面図である。導光板２は例えばアクリル、硝子等の透明な材料よりなり、その導光板２の端面に青色ＬＥＤ１が埋設されることにより、導光板２と青色ＬＥＤ１とが光学的に接続されている。なお本発明において、青色ＬＥＤ１と導光板２の端面とが光学的に接続されているとは、簡単に言えば、導光板２の端面から青色ＬＥＤの光を導入することをいい、例えばこの図に示すように青色ＬＥＤ１を埋設することはもちろんのこと、青色ＬＥＤを接着したり、また、光ファイバー等を用いて導光板２の端面に青色ＬＥＤの発光を導くことによって実現可能である。

【０００８】次に、蛍光散乱層３は、所望の色が観測できるように、蛍光物質と白色顔料とを調合したインクが塗布されてなり、青色ＬＥＤ１の発光を蛍光物質で波長変換すると同時に、白色顔料でその蛍光を導光板２内に散乱させている。特に図１では前記蛍光散乱層３をドット状とし、第一の主面側の表面輝度が一定となるように、ＬＥＤ１に接近するにつれて、第二の主面側の単位面積あたりの蛍光散乱層３の面積を減じるようなパターンとし、さらにはＬＥＤ１と最も離れた第二の主面の端部の面積はやや最大面積に比して若干小さくしている。ここで、図１中の■は蛍光散乱層３のパターンを表している。図１では青色ＬＥＤを一つの端面に２個配した構造としているが、導光板が四角形であれば四方の端面全てにＬＥＤを接続してもよいことはいうまでもなく、ＬＥＤの個数も限定するものではない。さらに、ＬＥＤの配置状況により、第一の主面側から観測する発光を面状均一とするように蛍光散乱層の塗布形状、塗布状態を適

宜変更することができる。

【０００９】

【作用】図２は本発明の面状光源を例えば液晶パネルのバックライトとして実装した場合の模式断面図である。これは図１に示す面状光源の第二の主面側に、例えばチタン酸バリウム、酸化チタン、酸化アルミニウム等よりなる散乱反射層６と、例えばＡｌよりなるベース７とが積層された反射板を設置し、第一の主面側に表面が凹凸とされている光拡散板５を設置しており、これらの構成は光源を冷陰極管とするバックライトと特に変わるものではない。

【００１０】まず図２の矢印で示すように、青色ＬＥＤ１から出た光は、チップ近傍で一部導光板以外の外部に放射されるが、大部分の光は導光板２の中を全反射を繰り返しながら、導光板の端面に達する。端面に達した光は端面全てに形成された反射膜４に反射されて、全反射を繰り返す。この時、導光板２の第二の主面側に設けられた蛍光散乱層３により一部の光は散乱され、また一部の光は蛍光物質により吸収され同時に波長変換されて放射され、導光板２の第一の主面側から観測する発光色はこれらの光を合成した光が観測できる。例えば橙色の蛍光顔料と白色顔料からなる蛍光散乱層３を設けた面状光源では、先に述べた作用により、青色ＬＥＤからの発光色が白色となって観測できる。また色調は蛍光物質の種類と白色顔料の混合比により任意に調整できる。特に本発明では一つの青色ＬＥＤの発光波長はその主発光ピークが５００ｎｍよりも短く、その発光出力は２００μＷ以上、更に好ましくは３００μＷ以上の出力が必要である。なぜなら発光波長が５００ｎｍ以上であると全ての色が実現しにくくなり、またその発光出力が２００μＷよりも少ないと、たとえ導光板の端面に光学的に接続する青色ＬＥＤの数を増やしても、充分な明るさの均一な面状発光の光源が得られにくい傾向にあるからである。

【００１１】

【実施例】

［実施例１］厚さ約２ｍｍのアクリル板の片面に、図１に示すドット状のパターンで、蛍光散乱層３をスクリーン印刷により形成した。蛍光散乱層３は、赤色蛍光顔料であるシンロイヒ化学製ＦＡ－００１と緑色蛍光顔料である同社製ＦＡ－００５とを等量に混合した蛍光顔料と、白色粉末としてチタン酸バリウムとを重量比で１：５の割合で混合し、それをアクリル系バインダー中に分散したものを印刷して形成した。

【００１２】次に上記のようにして蛍光散乱層が形成されたアクリル板を、所望のパターンに従って切断し、アクリル板の端面（切断面）を全て研磨した後、研磨面にＡｌよりなる反射層４を形成することにより、蛍光散乱層３が形成された導光板２を得た。

【００１３】前記導光板２の端面に二箇所、穴を設け、その穴に発光波長４８０ｎｍ。発光出力１２００μＷを有する窒化ガリウム系化合物半導体よりなる青色ＬＥＤをそれぞれ１個づつ埋め込むことにより、本発明の面状光源を得た。この面状光源の青色ＬＥＤを同時に点灯させたところ、導光板２の発光観測面側からはやや黄色みを帯びた白色のほぼ均一な面状発光が得られた。さらに、発光観測面側に予めマット加工が施された光拡散板５と、蛍光散乱層３側にＡｌベース７上にチタン酸バリウム層６が塗布された反射板を設置して、バックライト用光源としたところ、光拡散板５側から完全に面状均一な白色発光が得られた。輝度は５５ｃｄ／ｍ^{2}であった。

【００１４】［実施例２］蛍光散乱層３を、黄色蛍光染料としてＢＡＳＦ社のＬｕｍｏｇｅｎＦ　Ｙｅｌｌｏｗ－０８３と橙色蛍光染料として同社製Ｏｒｅｎｇｅ－２４０とをほぼ等量混合し、それらをブチルカルビトールアセテートに溶解した蛍光染料と、白色物質としてチタン酸バリウムとを重量比で１（染料）：２００の割合で混合したものを用いて形成する他は、実施例１と同様にして本発明の面状光源を得たところ、ほぼ均一な面状発光が観測された。さらに同様にしてバックライト用光源としたところ、完全に均一な面状発光が観測された。

【００１５】

【発明の効果】以上説明したように、本発明の面状光源は、青色ＬＥＤを用い、しかも導光板の片方の面に青色ＬＥＤにより波長変換できる蛍光物質と白色粉末とを含有した蛍光散乱層を有していることにより、信頼性に優れたＬＥＤによる面状光源を実現することが可能となった。しかも蛍光散乱層の白色粉末は、蛍光物質により波長変換された光を反射、拡散させる作用があるため、使用する蛍光物質の使用量が少なくて済む。更に好都合なことには、ＬＥＤチップと蛍光物質とが直接接することがないので、蛍光物質の劣化が少なく、長期間に渡って面状光源の色調変化を起こすことがない。さらに、色調に関しては、蛍光物質、白色粉末の種類、混合量等を変更することにより、白色を含め任意の色調を提供することができる。

【００１６】一方蛍光散乱層を励起する側として、最も好ましくは使用する青色ＬＥＤの発光出力が２００μＷ以上のものとすることにより、蛍光物質により効率的に波長変換して大きな面積の明るい面状光源を実現することができる。このように、本願の面状光源は、バックライト用光源とだけでなく、蛍光物質を利用した照光式操作スイッチ等に利用することもできる。

【図面の簡単な説明】

【図１】　本発明の一実施例の面状光源の導光板２を蛍光散乱層３側から見た平面図。

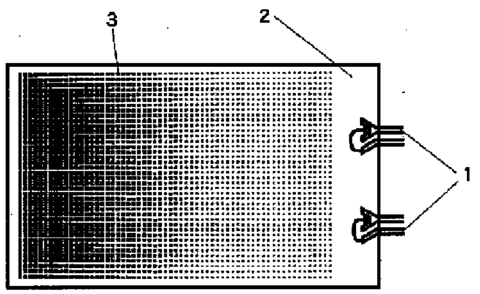
【図２】　本発明の一実施例の面状光源をバックライトとして実装した場合の模式断面図。

【符号の説明】

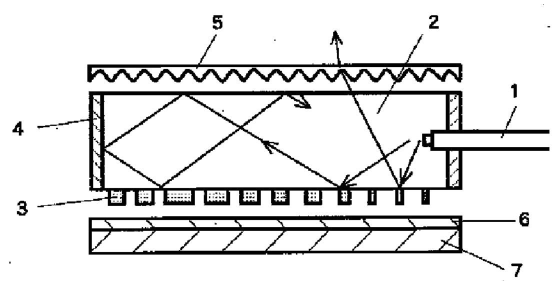
１・・・・・青色ＬＥＤ

2・・・・・導光板
3・・・・・蛍光散乱層
4・・・・・反射層
＊5・・・・・光拡散板
6・・・・・散乱反射層
＊7・・・・・Ａｌベース

【図1】



【図2】



Electronic Patent Application Fee Transmittal

Application Number:	12942792
Filing Date:	09-Nov-2010
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimizu
Filer:	Corina E. Tanasa/Patti Young
Attorney Docket Number:	0020-5147PUS12

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
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Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	13448296
Application Number:	12942792
International Application Number:	
Confirmation Number:	2357
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimizu
Customer Number:	2292
Filer:	Corina E. Tanasa/Patti Young
Filer Authorized By:	Corina E. Tanasa
Attorney Docket Number:	0020-5147PUS12
Receipt Date:	08-AUG-2012
Filing Date:	09-NOV-2010
Time Stamp:	15:26:53
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$180
RAM confirmation Number	1766
Deposit Account	022448
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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

FEE TRANSMITTAL

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 180.00

Complete if Known	
Application Number	12/942,792 Conf. No.: 2357
Filing Date	November 09, 2010
First Named Inventor	Yoshinori SHIMIZU
Examiner Name	A.B. MUSTAPHA
Art Unit	2812
Attorney Docket No.	0020-5147PUS12

METHOD OF PAYMENT (check all that apply)

☐ Check ☑ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): ______

☑ Deposit Account Deposit Account Number: 02-2448 Deposit Account Name: Birch, Stewart, Kolasch & Birch, LLP

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☐ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☑ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☑ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
Application Type	**Fee ($)**	**Small Entity Fee ($)**	**Fee ($)**	**Small Entity Fee ($)**	**Fee ($)**	**Small Entity Fee ($)**	**Fees Paid ($)**
Utility	380	190	620	310	250	125	
Design	250	125	120	60	160	80	
Plant	250	125	380	190	200	100	
Reissue	380	190	620	310	750	375	
Provisional	250	125	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	**Fee ($)**	**Small Entity Fee ($)**
Each claim over 20 (including Reissues)	60	30
Each independent claim over 3 (including Reissues)	250	125
Multiple dependent claims	450	225

Total Claims ______ - 20 or HP = **Extra Claims** 0 x **Fee ($)** ______ = **Fee Paid ($)** 0.00

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims ______ - 3 or HP = **Extra Claims** 0 x **Fee ($)** ______ = **Fee Paid ($)** 0.00

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims — **Fee ($)** ______ **Fee Paid ($)** ______

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets ______ - 100 = **Extra Sheets** 0 / 50 = **Number of each additional 50 or fraction thereof** 0 (round **up** to a whole number) x **Fee ($)** ______ = **Fee Paid ($)** 0.00

4. OTHER FEE(S) **Fees Paid ($)**

Non-English Specification, $130 fee (no small entity discount) ______

Other (e.g., late filing surcharge): 1806 - IDS Fee 180.00

SUBMITTED BY

Signature	Corina Tanasa Reg No. 64042	Registration No. (Attorney/Agent) 40,439	Telephone 703-205-8000
Name (Print/Type)	D. Richard Anderson CORINA TANASA		Date August 8, 2012

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application of:	Yoshinori SHIMIZU et al.		
Application No.:	12/942,792	Confirmation No.:	2357
Filed:	November 09, 2010	Art Unit:	2812
For:	LIGHT EMITTING DEVICE AND DISPLAY	Examiner:	A. B. MUSTAPHA

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Applicant(s) hereby submit(s) an Information Disclosure Statement for consideration by the Examiner.

I. LIST OF PATENTS, PUBLICATIONS OR OTHER INFORMATION

The patents, publications, or other information submitted for consideration by the Office are listed on the attached PTO/SB/08.

II. COPIES

☑ a. Copies of foreign patent documents, non-patent literature and other information are provided.

☐ b. REFERENCES PREVIOUSLY CITED OR SUBMITTED: Copies of any information not provided can be found in one or more of the following applications which has been relied upon for an earlier filing date under 35 U.S.C. § 120:

U.S. Application No. and U.S. Filing Date

12/548,614 filed August 27, 2009

III. CONCISE EXPLANATION OF THE RELEVANCE/OTHER INFORMATION

☑ a. NON-ENGLISH LANGUAGE DOCUMENTS: A concise explanation of the relevance of all non-English language patents, publications, or other information listed is as follows:

An English language abstract and a full English machine translation is provided (as a partial translation) for the following reference(s): JP 7-99345, JP 7-335942 and JP 7-176794.

☑ b. ENGLISH LANGUAGE SEARCH REPORT OR FOREIGN PATENT OFFICE COMMUNICATION:

An English language version of a Singaporean Examination and Search Report issued on July 2, 2012 in foreign counterpart application No. 201007151-2 that indicates the degree of relevance is attached.

An English language version of a Singaporean Examination and Search Report issued on July 5, 2012 in foreign counterpart application No. 201007150-4 that indicates the degree of relevance is attached.

☑ c. OTHER: The following additional information is provided.

JP 7-99345 and US 5,247,533 were cited in the Singaporean Examination and Search Report issued on July 2, 2012. US 3,691,482 cited in the Singaporean Examination and Search Report was previously cited in an IDS in USPTO.

JP 7-335942, JP 7-176794 and US 5,408,120 were cited in the Singaporean Examination and Search Report issued on July 5, 2012.

Both JP 7-99345 and JP 7-176794 were previously cited in an IDS filed in the USPTO on November 9, 2010. The full English machine translations for JP 7-99345 and JP 7-176794 are now submitted for Examiner's consideration.

IV. STATEMENT UNDER 37 C.F.R. § 1.97(e)

The undersigned hereby states that:

☐ a. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **30 days** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☑ b. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☐ c. No item of information contained in the IDS was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of IDS was known to any individual designated in 37 C.F.R. § 1.56(c) more than **three months** prior to the filing of the IDS; or

☐ d. Some of the items of information in the IDS were cited in a communication from a foreign patent office. Such items were first cited in a communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office. As to the remaining items of information, to the knowledge of the person signing the certification after making reasonable inquiry, such remaining items were not known to any individual designated in 37 C.F.R. § 1.56(c) more than **three months** prior to the filing of this statement.

V. STATEMENT UNDER 37 C.F.R. § 1.704(d)(1)

Patent Term Adjustment Reduction Should Not Apply

☐ The undersigned hereby states:

This Information Disclosure Statement is in compliance with 37 C.F.R. §§ 1.97 and 1.98 and will not be considered a failure to engage in reasonable efforts to conclude prosecution (processing or examination) of the present application under 37 C.F.R. § 1.704(c)(6), (c)(8), (c)(9), or (c)(10), because each item of information contained in the Information Disclosure Statement:

☐ (i) Was first cited in any communication from a patent office in a counterpart foreign or international application or from the Office, and this communication was not received by any individual designated in § 1.56(c) more than thirty days prior to the filing of the information disclosure statement; or

☐ (ii) Is a communication that was issued by a patent office in a counterpart foreign or international application or by the Office, and this communication was not received by any individual designated in § 1.56(c) more than thirty days prior to the filing of the information disclosure statement.

VI. FEES

☐ a. This Information Disclosure Statement is being filed concurrently with the filing of a new patent application or Request for Continued Examination. No fee is required.

☐ b. This Information Disclosure Statement is being filed within three months of the filing date of an application. No fee is required.

☐ c. This Information Disclosure Statement is being filed before the mailing date of a first Action on the merits. No fee is required. If a first Office Action on the merits has issued, please consider this IDS under 37 C.F.R. § 1.97(c) and see the statement under 37 C.F.R. § 1.97(e) above. If no statement has been made, charge our deposit account for the required fee.

☐ d. This Information Disclosure Statement is being filed <u>before</u> the mailing date of a Final Office Action or <u>before</u> the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(c)(1)).

☐ No statement. The fee as required by 37 C.F.R. § 1.17(p) is provided.

or

☐ See the above statement. No fee is required.

☑ e. This Information Disclosure Statement is being filed <u>after</u> the mailing date of a Final Office Action or <u>after</u> the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(d)), see the statement above. The fee as required by 37 C.F.R. § 1.17(p) is provided.

VII. <u>PAYMENT OF FEES</u>

☑ The required fee is listed on the attached Fee Transmittal.

☐ No fee is required.

If the Examiner has any questions concerning this IDS, please contact the undersigned. If it is determined that this IDS has been filed under the wrong rule, the USPTO is requested to consider this IDS under the proper rule and charge the appropriate fee to Deposit Account No. 02-2448.

Dated: August 8, 2012

Respectfully submitted,

Reg. No.
By Corina Tanasa 64042
for D. Richard Anderson
Registration No.: 40,439 CORINA TANASA
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road, Suite 100 East
P.O. Box 747
Falls Church, VA 22040-0747
703-205-8000

Attachment(s):
- ☑ PTO/SB/08
- ☑ Document(s)
- ☐ Foreign Patent Office Communication
- ☑ Foreign Search Report
- ☑ Fee
- ☑ Other: Full English machine translations for JP 7-99345 and JP 7-176794.

Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Complete if Known	
Application Number	12/942,792
Filing Date	11-09-10
First Named Inventor	Yoshinori Shimizu
Art Unit	2812
Examiner Name	A.B. MUSTAPHA
Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

Examiner Initial *	Cite No.	Document Number Number - Kind Code [2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	US-3,560,649	02-02-1971	Anderson	

FOREIGN PATENT DOCUMENTS

Examiner Initial *	Cite No. [1]	Foreign Patent Document Country Code [3] Number [4] Kind Code (if known) [5]	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear	T

Examiner Signature		Date Considered	

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not Considered. Include copy of this form with next communication to applicant. 1. Applicant's unique citation design number (optional) 2 See Kinds Codes of USPTO patent Documents, at www.uspto.gov or MPEP 901.04 3. Enter Office that issued the document, by the two-letter code (WIPO Standard ST 3). 4 For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5 Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. 6 Applicant is to place a check mark here if English language Translation is attached.

PTO/SB/08b (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449B/PTO	Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number	12/942,792
	Filing Date	11-09-10
	First Named Inventor	Yoshinori Shimizu
	Art Unit	2812
(Use as many sheets as necessary)	Examiner Name	A.B. MUSTAPHA
Sheet 2 of 2	Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

Examiner Initial *	Cite No. [1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T [2]
	2	U.S. Office Action issued in co-pending U.S. application no. 12/689,681 on May 10, 2012.	

Examiner Signature		Date Considered	

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.
1. Applicants unique citation designation number. (optional) 2. Applicant is to place a check mark here if English language Translation is attached.
This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Cheif Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450 Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS.
SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Patent Application Fee Transmittal

Application Number:	12942792
Filing Date:	09-Nov-2010
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimizu
Filer:	Corina E. Tanasa/Patti Young
Attorney Docket Number:	0020-5147PUS12

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Submission- Information Disclosure Stmt	1806	1	180	180
		Total in USD ($)		**180**

Electronic Acknowledgement Receipt

EFS ID:	13313680
Application Number:	12942792
International Application Number:	
Confirmation Number:	2357
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimizu
Customer Number:	2292
Filer:	Corina E. Tanasa/Patti Young
Filer Authorized By:	Corina E. Tanasa
Attorney Docket Number:	0020-5147PUS12
Receipt Date:	23-JUL-2012
Filing Date:	09-NOV-2010
Time Stamp:	14:39:24
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$180
RAM confirmation Number	1091
Deposit Account	022448
Authorized User	ARMSTRONG,MARYANNE

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		20120723IDS.pdf	4404919 60d43ed4380a0241ada91c8faf74e47e710edd25	yes	9

Multipart Description/PDF files in .zip description

Document Description	Start	End
Miscellaneous Incoming Letter	1	1
Transmittal Letter	2	7
Information Disclosure Statement (IDS) Form (SB08)	8	9

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
2	Non Patent Literature	20120510NonfinalRejection.pdf	483853 e217f267002443e0a31af9c851620f4a54329d78	no	11

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
3	Fee Worksheet (SB06)	fee-info.pdf	30215 3372f0eda2b15575297a7f792a0b5a84225df57c	no	2

Warnings:

Information:

Total Files Size (in bytes):	4918987

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

FEE TRANSMITTAL

Complete if Known	
Application Number	12/942,792 Conf. No.: 2357
Filing Date	November 09, 2010
First Named Inventor	Yoshinori SHIMIZU
Examiner Name	A.B. MUSTAPHA
Art Unit	2812
Attorney Docket No.	0020-5147PUS12

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 180.00

METHOD OF PAYMENT (check all that apply)

☐ Check ☑ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): ____

☑ Deposit Account Deposit Account Number: 02-2448 Deposit Account Name: Birch, Stewart, Kolasch & Birch, LLP

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☐ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☑ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☑ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

Application Type	FILING FEES Fee ($)	FILING FEES Small Entity Fee ($)	SEARCH FEES Fee ($)	SEARCH FEES Small Entity Fee ($)	EXAMINATION FEES Fee ($)	EXAMINATION FEES Small Entity Fee ($)	Fees Paid ($)
Utility	380	190	620	310	250	125	
Design	250	125	120	60	160	80	
Plant	250	125	380	190	200	100	
Reissue	380	190	620	310	750	375	
Provisional	250	125	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	Fee ($)	Small Entity Fee ($)
Each claim over 20 (including Reissues)	60	30
Each independent claim over 3 (including Reissues)	250	125
Multiple dependent claims	450	225

Total Claims	Extra Claims	Fee ($)	Fee Paid ($)
____ - 20 or HP =	0	x ____	= 0.00

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims	Extra Claims	Fee ($)	Fee Paid ($)
____ - 3 or HP =	0	x ____	= 0.00

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims

Fee ($)	Fee Paid ($)

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof	Fee ($)	Fee Paid ($)
____ - 100 =	0 / 50 =	0 (round up to a whole number) x	____	= 0.00

4. OTHER FEE(S)

Fees Paid ($)

Non-English Specification, $130 fee (no small entity discount) ____

Other (e.g., late filing surcharge): 1806 - IDS Fee 180.00

SUBMITTED BY

Signature	Corina Tanasa Reg. No. 64042	Registration No. (Attorney/Agent) 40,439	Telephone 703-205-8000
Name (Print/Type)	D. Richard Anderson CORINA TANASA		Date July 23, 2012

Docket No.: 0020-5147PUS12
(Patent)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application of:
Yoshinori SHIMIZU et al.

Application No.: 12/942,792 Confirmation No.: 2357

Filed: November 09, 2010 Art Unit: 2812

For: LIGHT EMITTING DEVICE AND DISPLAY Examiner: A.B. MUSTAPHA

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Applicant(s) hereby submit(s) an Information Disclosure Statement for consideration by the Examiner.

I. LIST OF PATENTS, PUBLICATIONS OR OTHER INFORMATION

The patents, publications, or other information submitted for consideration by the Office are listed on the attached PTO/SB/08.

II. COPIES

☑ a. Copies of foreign patent documents, non-patent literature and other information are provided.

☐ b. REFERENCES PREVIOUSLY CITED OR SUBMITTED: Copies of any information not provided can be found in one or more of the following applications which has been relied upon for an earlier filing date under 35 U.S.C. § 120:

U.S. Application No. and U.S. Filing Date

12/028,062 filed February 8, 2008

III. CONCISE EXPLANATION OF THE RELEVANCE/OTHER INFORMATION

☐ a. NON-ENGLISH LANGUAGE DOCUMENTS: A concise explanation of the relevance of all non-English language patents, publications, or other information listed is as follows:

☐ b. ENGLISH LANGUAGE SEARCH REPORT OR FOREIGN PATENT OFFICE COMMUNICATION: An English language version of the search report or Foreign Patent Office communication that indicates the degree of relevance is attached.

☑ c. OTHER: The following additional information is provided.

A U.S. Office Action (submitted herein) issued in co-pending U.S. application No. 12/689,681 on May 10, 2012 cited US 3,560,649 submitted herein.

IV. STATEMENT UNDER 37 C.F.R. § 1.97(e)

The undersigned hereby states that:

☐ a. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **30 days** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☐ b. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☑ c. No item of information contained in the IDS was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of IDS was known to any individual designated in 37 C.F.R. § 1.56(c) more than **three months** prior to the filing of the IDS; or

☐ d. Some of the items of information in the IDS were cited in a communication from a foreign patent office. Such items were first cited in a communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office. As to the remaining items of information, to the knowledge of the person signing the certification after making reasonable inquiry, such remaining items were not known to any individual designated in 37 C.F.R. § 1.56(c) more than **three months** prior to the filing of this statement.

V. STATEMENT UNDER 37 C.F.R. § 1.704(d)(1)

Patent Term Adjustment Reduction Should Not Apply

☐ The undersigned hereby states:

This Information Disclosure Statement is in compliance with 37 C.F.R. §§ 1.97 and 1.98 and will not be considered a failure to engage in reasonable efforts to conclude prosecution (processing or examination) of the present application under 37 C.F.R. § 1.704(c)(6), (c)(8), (c)(9), or (c)(10), because each item of information contained in the Information Disclosure Statement:

☐ (i) Was first cited in any communication from a patent office in a counterpart foreign or international application or from the Office, and this communication was not received by any individual designated in § 1.56(c) more than thirty days prior to the filing of the information disclosure statement; or

☐ (ii) Is a communication that was issued by a patent office in a counterpart foreign or international application or by the Office, and this communication was not received by any individual designated in § 1.56(c) more than thirty days prior to the filing of the information disclosure statement.

VI. FEES

☐ a. This Information Disclosure Statement is being filed concurrently with the filing of a new patent application or Request for Continued Examination. No fee is required.

☐ b. This Information Disclosure Statement is being filed within three months of the filing date of an application. No fee is required.

☐ c. This Information Disclosure Statement is being filed before the mailing date of a first Action on the merits. No fee is required. If a first Office Action on the merits has issued, please consider this IDS under 37 C.F.R. § 1.97(c) and see the statement under 37 C.F.R. § 1.97(e) above. If no statement has been made, charge our deposit account for the required fee.

☐ d. This Information Disclosure Statement is being filed before the mailing date of a Final Office Action or before the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(c)(1)).

☐ No statement. The fee as required by 37 C.F.R. § 1.17(p) is provided.

or

☐ See the above statement. No fee is required.

☑ e. This Information Disclosure Statement is being filed after the mailing date of a Final Office Action or after the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(d)), see the statement above. The fee as required by 37 C.F.R. § 1.17(p) is provided.

VII. PAYMENT OF FEES

☑ The required fee is listed on the attached Fee Transmittal.

☐ No fee is required.

If the Examiner has any questions concerning this IDS, please contact the undersigned. If it is determined that this IDS has been filed under the wrong rule, the USPTO is requested to consider this IDS under the proper rule and charge the appropriate fee to Deposit Account No. 02-2448.

Dated: July 23, 2012

Respectfully submitted,

By Corina Tanasa Reg. No. 64042

for D. Richard Anderson CORINA TANASA
Registration No.: 40,439
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road, Suite 100 East
P.O. Box 747
Falls Church, VA 22040-0747
703-205-8000

Attachment(s):
☑ PTO/SB/08
☑ Document(s)
☐ Foreign Patent Office Communication
☐ Foreign Search Report
☑ Fee
☐ Other:

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

2292 7590 07/12/2012

BIRCH STEWART KOLASCH & BIRCH
PO BOX 747
FALLS CHURCH, VA 22040-0747

EXAMINER	
MUSTAPHA, ABDULFATTAH B	
ART UNIT	PAPER NUMBER
2812	

DATE MAILED: 07/12/2012

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/942,792	11/09/2010	Yoshinori Shimizu	0020-5147PUS12	2357

TITLE OF INVENTION: LIGHT EMITTING DEVICE AND DISPLAY

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1740	$300	$0	$2040	10/12/2012

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

2292 7590 07/12/2012

BIRCH STEWART KOLASCH & BIRCH
PO BOX 747
FALLS CHURCH, VA 22040-0747

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/942,792	11/09/2010	Yoshinori Shimizu	0020-5147PUS12	2357

TITLE OF INVENTION: LIGHT EMITTING DEVICE AND DISPLAY

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1740	$300	$0	$2040	10/12/2012

EXAMINER	ART UNIT	CLASS-SUBCLASS
MUSTAPHA, ABDULFATTAH B	2812	438-021000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
   - ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
   - ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
   (1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
   (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
   1____________________
   2____________________
   3____________________

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
- ☐ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies ______________

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _________ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)
   - ☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.
   - ☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature ____________________ Date ____________________

Typed or printed name ____________________ Registration No. ____________________

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/942,792	11/09/2010	Yoshinori Shimizu	0020-5147PUS12	2357

2292 7590 07/12/2012

BIRCH STEWART KOLASCH & BIRCH
PO BOX 747
FALLS CHURCH, VA 22040-0747

EXAMINER	
MUSTAPHA, ABDULFATTAH B	
ART UNIT	**PAPER NUMBER**
2812	

DATE MAILED: 07/12/2012

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)

(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 0 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 0 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	**Application No.** 12/942,792	**Applicant(s)** SHIMIZU ET AL.	
	Examiner ABDULFATTAH MUSTAPHA	**Art Unit** 2812	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 05/30/2012.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are 1-19.
4. ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☒ All b) ☐ Some* c) ☐ None of the:
   1. ☒ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
   1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 04/05/2012 and 01/20/2012
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☐ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

/Charles D. Garber/
Supervisory Patent Examiner, Art Unit 2812

DETAILED ACTION

Response to Arguments

Applicant's arguments, see Applicant Arguments/ Remarks, filed 05/30/2012, with respect to Non-Final Rejection have been fully considered and are persuasive. The Non-Final Rejection of 01/30/2012 has been withdrawn.

Allowable Subject Matter

Claims 1 – 19 are allowed.

The following is an examiner's statement of reasons for allowance:

The closest prior art known by the Examiner are listed on the PTO 892, IDS forms of record.

None of the prior art found by the examiner anticipate or make obvious the claimed;

"preparing a light emitting component having an active layer of a semiconductor, said active layer comprising a gallium nitride based semiconductor containing indium and being capable of emitting a blue color light having a spectrum with a peak wavelength within the range from 420 to 490 nm; preparing a phosphor capable of absorbing a part of the blue color light emitted from said light emitting component and emitting a yellow color light having a broad emission spectrum comprising a peak wavelength existing around the range from 510 to 600 nm and a tail continuing beyond 700 nm, wherein selection of said phosphor is controlled based on an emission wavelength of said light emitting component and combining said light emitting component and said phosphor so that the blue color light from said light emitting component and the yellow color light from said phosphor are mixed to make a white color light", as required by Claim 1 and dependent Claims thereof.

Since the reference either singly or in combination do not show all elements of the claims, the subject matter of the claims is properly allowable.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ABDULFATTAH MUSTAPHA whose telephone number is (571)272-9736. The examiner can normally be reached on Monday, Tuesday, Wednesday, and Friday. (06:00am - 4:00pm).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Charles Garber can be reached on 571-272-2194. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Abdulfattah Mustapha/
Examiner, Art Unit 2812

/Charles D. Garber/
Supervisory Patent Examiner, Art Unit 2812

PTO/SB/08a (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	1	of	12

Complete if Known	
Application Number	~~NEW~~ 12/942792
Filing Date	~~Concurrently Herewith~~ 11/09/2010
First Named Inventor	Yoshinori SHIMIZU
Art Unit	~~N/A~~ 2812
Examiner Name	~~Not Yet Assigned~~ Mustapha
Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
/A.M./	AA*	US-5,700,713-A	12-23-1997	Yamazaki et al.	
	AB*	US-5,257,049	10-26-1993	Van Peteghem	
	AC*	US-6,812,500	11-02-2004	Reeh et al.	
	AD*	US-2001-0030326-A1	10-18-2001	Reeh et al.	
	AE*	US-6,576,930	06-10-2003	Reeh et al.	
	AF*	US-6,784,511	08-31-2004	Kunihara et al.	
	AG*	US-6,066,861	05-23-2000	Hohn et al.	
	AH*	US-5,959,316	09-28-1999	Lowery	
	AI*	US-5,118,985-A	06-02-1992	Patton et al.	
	AJ*	US-4,644,223	02-17-1987	de Hair et al.	
	AK*	US-6,538,371	03-25-2003	Duggal et al.	
	AL*	US-3,875,456	04-01-1975	Kano et al.	
	AM*	US-3,510,732	05-05-1970	R.L. Amans	
	AN*	US-5,550,657	08-27-1996	Tanaka et al.	
	AO*	US-5,578,839	11-26-1996	Nakamura et al.	
	AP*	US-6,004,001-A	12-21-1999	Noll	
	AQ*	US-4,905,060	02-27-1990	Chinone et al.	
	AR*	US-3,652,956	03-28-1972	Pinnow et al.	
/A.M./	AS*	US-4,314,910	02-09-1982	Barnes	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
/A.M./	BA	JP-2002-270020-A	09-20-2002	CASIO COMPUTER CO LTD		
	BB	JP-7-321407	12-08-1995	FUJI ELECTRIC CO LTD.		
	BC	JP-6-115158	04-26-1994	AGFA GEVAERT NV		
	BD	JP-61-158606	07-18-1986			
	BE	JP-2000-512806-A	09-26-2000			
/A.M./	BF	JP-07-288341	10-31-1995	NICHIA CHEM IND LTD		

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	07/02/2012

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. * CITE NO.: Those application(s) which are marked with an single asterisk (*) next to the Cite No. are not supplied (under 37 CFR 1.98(a)(2)(iii)) because that application was filed after June 30, 2003 or is available in the IFW. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

ot

Birch, Stewart, Kolasch & Birch, LLP

DRA/CET/py

Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 2 of 12

Complete if Known	
Application Number	NEW 12/942792
Filing Date	~~Concurrently Herewith~~ 11/09/2010
First Named Inventor	Yoshinori SHIMIZU
Art Unit	~~N/A~~ 2812
Examiner Name	~~Not Yet Assigned~~ Mustapha
Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number: Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
/A.M./	AT*	US-5,006,908	04-09-1991	Matsuoka et al.	
	AU*	US-5,369,289	11-29-1994	Tamaki et al.	
	AV*	US-4,727,283	02-23-1988	van Kemenade et al.	
	AW*	US-4,298,820	11-03-1981	Bongers et al.	
	AX*	US-3,699,478	10-17-1972	Pinnow et al.	
	AY*	US-5,798,537	08-25-1998	Nitta	
	AZ*	US-5,202,777	04-13-1993	Sluzky et al.	
	AA1*	US-3,819,974	06-25-1974	Stevenson et al.	
	AB1*	US-5,847,507	12-08-1998	Butterworth et al.	
	AC1*	US-3,691,482	09-12-1972	Pinnow et al.	
	AD1*	US-4,550,256	10-29-1985	Berkstesser et al.	
	AE1*	US-4,716,337	12-29-1987	Huiskes et al.	
	AF1*	US-5,471,113	11-28-1995	De Backer et al.	
	AG1*	US-5,825,125-A	10-20-1998	Ligthart et al.	
	AH1*	US-5,602,418-A	02-11-1997	Imai et al.	
	AI1*	US-5,998,925-A	12-07-1999	Shimizu et al.	
	AJ1*	US-6,069,440-A	05-30-2000	Shimizu et al.	
	AK1*	US-6,608,332-B2	08-19-2003	Shimizu et al.	
/A.M./	AL1*	US-6,614,179-B1	09-02-2003	Shimizu et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document: Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
/A.M./	BG	JP-5-226676	03-09-1993	SHARP CORP.		
	BH	JP-49-122292	11-22-1974			
	BI	JP-11-500584	01-12-1999			
	BJ	JP-8-78727-A	03-22-1996			
	BK	JP-03-152898-A	06-28-1991			
/A.M./	BL	JP-06-139973-A	05-20-1994			

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	07/02/2012

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Complete if Known	
Application Number	~~NEW~~ 12/942792
Filing Date	~~Concurrently Herewith~~ 11/09/2010
First Named Inventor	Yoshinori SHIMIZU
Art Unit	~~N/A~~ 2812
Examiner Name	~~Not Yet Assigned~~ Mustapha
Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
/A.M./	AM1*	US-7,329,988-B2	02-12-2008	Shimizu et al.	
	AN1*	US-7,126,274-B2	10-24-2006	Shimizu et al.	
	AO1*	US-7,026,756-B2	04-11-2006	Shimizu et al.	
	AP1*	US-7,215,074-B2	05-08-2007	Shimizu et al.	
	AQ1*	US-7,071,616-B2	07-04-2006	Shimizu et al.	
	AR1*	US-7,531,960-B2	05-12-2009	Shimizu et al.	
	AS1*	US-7,362,048-B2	04-22-2008	Shimizu et al.	
	AT1*	US-5,949,182	09-07-1999	Shealy et al.	
	AU1*	US-3,748,548	07-24-1973	Haisty et al.	
	AV1*	US-5,512,210	04-30-1996	Sluzky et al.	
	AW1*	US-5,630,741	05-20-1997	Potter	
	AX1*	US-4,857,228	08-15-1989	Kabay et al.	
	AY1*	US-6,340,824	01-22-2002	Komoto et al.	
	AZ1*	US-4,001,628	01-04-1977	Ryan	
	AA2*	US-5,208,462	05-04-1993	O'Connor et al.	
	AB2*	US-5,706,022	01-06-1998	Hato	
	AC2*	US-5,743,629	04-28-1998	Helstern et al.	
	AD2*	US-6,600,175	07-29-2003	Baretz et al.	
/A.M./	AE2*	US-20100001258	01-07-2010	Shimizu et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
/A.M./	BM	EP-0 500 937-A1	09-02-1992			
	BN	JP-2001-320094-A	11-16-2001			
	BO	DE-3804293-A1	08-24-1989			
	BP	JP-06-231605-A	08-19-1994			
	BQ	GB-2 000 173	01-04-1979			
/A.M./	BR	EP-0 383 215-A	08-22-1990			

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	07/02/2012

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Sheet	4	of	12

Complete if Known	
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Filing Date	~~Concurrently Herewith~~ 11/09/2010
First Named Inventor	Yoshinori SHIMIZU
Art Unit	~~N/A~~ 2812
Examiner Name	~~Not Yet Assigned~~ Mustapha
Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

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	AF2*	US-20090315015	12-24-2009	SHIMIZU et al.	
	AG2*	US-5,221,984	06-22-1993	Furuyama et al.	
	AH2*	US-5,594,751	01-14-1997	Scott	
	AI2*	US-5,801,435	09-01-1998	Otsuki	
	AJ2*	US-6,015,200	01-18-2000	Ogura	
	AK2*	US-7,682,848-A1	03-23-2010	Shimizu et al.	

FOREIGN PATENT DOCUMENTS

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/A.M./	BS	DE-9013615-U	01-24-1991			
	BT	JP-59-30107-U	02-24-1984			
	BU	JP-7-32638-U	06-16-1995			
	BV	JP-01-257993-A	10-16-1989			
	BW	JP-01-260707-A	10-18-1989			
/A.M./	BX	JP-02-111922-A	04-24-1990			

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	07/02/2012

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Application Number	~~NEW~~ 12/942792
Filing Date	~~Concurrently Herewith~~ 11/09/2012
First Named Inventor	Yoshinori SHIMIZU
Art Unit	~~N/A~~ 2812
Examiner Name	~~Not Yet Assigned~~ Mustapha
Attorney Docket Number	0020-5147PUS12

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/A.M./	BY	JP-05-142424-A	06-11-1993			
	BZ	JP-06-160635-A	06-07-1994			
	BA1	JP-06-027327-A	02-04-1994			
	BB1	JP-06-82633-A	03-25-1994			
	BC1	JP-07-114904-A	05-02-1995			
	BD1	JP-07-235207-A	09-05-1995			
	BE1	JP-53-7153	01-21-1978			
	BF1	JP-7-42152-A	07-21-1995			
	BG1	JP-55-4898-A	01-14-1980			
	BH1	JP-55-005533-A	01-16-1990			
	BI1	JP-60-185457	09-20-1985			
	BJ1	JP-62-20237-A	01-28-1987			
	BK1	JP-62-232827-A	10-13-1987			
	BL1	JP-01-189695-A	07-28-1989			
	BM1	JP-07-120754-A	05-12-1995			
	BN1	JP-06-177423-A	06-24-1994			
	BO1	JP-7-99345-A	04-11-1995			
	BP1	JP-09-027642-A	01-28-1997			
	BQ1	JP-05-63068-U	08-20-1993			
	BR1	EP-0 209 942-A1	01-28-1987			
	BS1	EP-0 541 373-A2	11-05-1992			
	BT1	JP-0 599 224-A1	06-01-1994			
	BU1	JP-01179471-A	07-17-1989			
	BV1	JP-5043913-C1	04-21-1975			
	BW1	JP-554898-A	01-14-1980			
	BX1	JP-09027642-A	01-28-1997			
	BY1	JP-08007614-A	01-12-1996			
	BZ1	JP-07176794-A	07-14-1995			
	BA2	JP-07099345-A	04-11-1995			
	BB2	JP-05152609	06-18-1993			
	BC2	JP-6220237-A	01-28-1987			
	BD2	WO-97/50132-A1	12-31-1997			
	BE2	WO-98/12757-A1	03-26-1998			
	BF2	JP-5079379	11-24-1973			
	BG2	JP-742152	07-21-1995			
	BH2	JP-4717684	09-09-1972			
	BI2	JP-491221	01-12-1974			
	BJ2	JP-49112577	10-26-1974			
	BK2	JP-62189770	02-15-1986			
	BL2	JP-291980	09-29-1988			
	BM2	JP-5152609-A	06-18-1993			
/A.M./	BN2	JP-5-183189-A	07-23-1993	Nichia Kagaku Kogyo Kk		

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	~~NEW~~ 12/942792
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				First Named Inventor	Yoshinori SHIMIZU
(Use as many sheets as necessary)				Art Unit	~~N/A~~ 2812
				Examiner Name	~~Not Yet Assigned~~ Mustapha
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/A.M./	BO2	JP-863119	03-08-1996			
	BP2	JP-10036835-A	02-10-1998			
	BQ2	JP-49106283	12-27-1972			
	BR2	JP-5245181	10-14-1977			
	BS2	GB-1589964	05-20-1981			
	BT2	JP-5441660	12-05-1979			
	BU2	JP-5472484	11-07-1978			
	BV2	JP-5950445	04-01-1984			
	BW2	JP-324692	03-14-1991			
	BX2	JP-463162	05-29-1992			
	BY2	JP-463163	05-29-1992			
	BZ2	JP-563068	08-20-1993			
	BA3	JP-8170077	07-02-1996			
	BB3	JP-5331584	03-24-1978			
	BC3	JP-60144381	07-30-1985			
	BD3	JP-62167387	07-23-1987			
	BE3	JP-6208845	07-26-1994			
	BF3	JP-06177423	06-24-1994			
	BG3	JP-06260680	09-16-1994			
	BH3	JP-06268257	09-22-1994			
	BI3	JP-4-234481-A	08-24-1992			
	BJ3	JP-4-80286-A	03-13-1992			
	BK3	GB-1 305 111	01-31-1973			
	BL3	EP-0 667 383-A2	08-16-1995			
	BM3	JP-6-296043-A	10-21-1994			
/A.M./	BM4	EP-0-550-937-A1	09-02-1992			

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First Named Inventor	Yoshinori SHIMIZU
Art Unit	~~N/A~~ 2812
Examiner Name	~~Not Yet Assigned~~ Mustapha
Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

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/A.M./	CA	"White LED lamp: Efficient light-emitting; Manufacture cost half", Nikkei Sangyo Shimbun, September 13, 1996, Published by Nihon Keizai Shimbunsha.	
	CB	"SIMENS SMT-TOPLED fur die Oberflachenmontage" Frank Mollmer et al. Simens Components, 29 (1991) Hfet 4. Assume December, 1991	
	CC	"Proceedings of the Institute of Phosphor Society", Translation of pages 1, 5 to 14 of the 264th Proceedings of the Institute of Phosphor Society, Nov. 29, 1996.	
	CD	"Nichia Chemical starts the sample shipment of white light emitting diode", News Report, translation of page 15 of Nikkei Electronics 1996.9.23 (No. 671).	
	CE	"GaNpn Contact Blue/Ultraviolet light Emitting Diode", H. Amano et al., Applied Physics, Vol. 20, No. 2, pp. 163-166 (1991) December, 1991	
	CF	"Phosphors Based on Rare-Earths, A New Era in Fluorescent Lighting", B.M.J. Smets, Materials Chemistry and Physics, 16 pp. 283-299 (1987) Assume December, 1987	
	CG	"Proceedings of the Institute of Phosphor Society", Translation of pages 1, 5 to 14 of the 264th Proceedings of the Institute of Phosphor Society. Nov. 29, 1996	
	CH	"A New Phosphor for Flying-Spot Cathode-Ray Tubes for Color Television: Yellow Emitting..", G. Blasse et al., App. Phys. Lett. Vol. 11, No. 2, pp. 53-55 (1967) Assume 12/1967	
	CI	Y. Nayatani, Color Research & Application, Vol. 20, No. 3, June 1995, pp. 143-155.	
/A.M./	CJ	WUSTLICH MIKRO-/OPTO-ELEKTRONIK GMBH (1994/1995) ~~Assume 12/1995~~	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	07/02/2012

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				First Named Inventor	Yoshinori SHIMIZU
(Use as many sheets as necessary)				Art Unit	~~N/A~~ 2812
				Examiner Name	~~Not Yet Assigned~~ Mustapha
Sheet	8	of	12	Attorney Docket Number	0020-5147PUS12

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/A.M./	CK	W.W. Holloway, Jr. et at., "Optical Properties of Cerium-Activated Garnet Crystals", 1969 Journal of the Optical Society of America, Vol. 59, No. 1, pp. 60-63 Assume 12/1969	
	CL	W.W. HOLLOWAY, Jr. et al., "On The Fluorescence of Cerium - Activated Garnet Crystals", Physics Letters, Vol. 25A, No. 8, 23 October 1967, pp. 614-615.	
	CM	W.J. MINISCALCO et al., "Measurements of Excited-State Absorption in Ce3+:YAGa)", J. Appl. Phys. Vol. 49, No. 12, December 1978, pp. 6109-6111.	
	CN	Takashi MATSUOKA et al., "Growth and Properties of a Wide-Gap Semiconductor InGaN", Optoelectronics-Devices and Technologies, Vol. 5, No. 1, pp.53-64, June 1990.	
	CO	Tadao MIURA, ELECTRONICS ENGINEERING, "High-intensity White Backlighting for LCD of Car Audios", July 1996, Vol. 38, No. 7, pp. 55-58	
	CP	T. NAGATOMO et al., "Ga1-xInxN Blue Light-Emitting Diodes", Proc. Electrochem. Soc., 1993, Vol. 93-10, pp. 136-141. Assume 12/1993	
	CQ	Shuji NAKAMURA, "Zn-doped InGaN growth and InGaN/AlGaN double-heterostructure blue-light-emitting diodes", Journal of Crystal Growth, 145 (1994), pp. 911-917. Assume 12/1994	
	CR	Shuji NAKAMURA, "InGaN/AlGaN blue-light-emitting diodes", J. Vac. Sci. Technol. A 13(3), May/Jun 1995, pp.705-710.	
	CS	Shuji NAKAMURA, "High-Power InGaN/AlGaN Double-Heterostructure Blue-Light-Emitting Diodes", IEDM 94 (1994), IEEE, pp. 567-570. Assume 12/1994	
/A.M/	CT	Shuji NAKAMURA et al., "Si-Doped InGaN Films Grown on GaN Films", Jpn. J. Appl. Phys. Vol. 32 (1993), pp. L16-L19, Part 2, No. 1A/B, 15 January 1993.	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	07/02/2012

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/A.M./	CU	Shuji NAKAMURA et al., "P-GaN/N-InGaN/N-GaN Double-Heterostructure Blue-Light-Emitting Diodes", Jpn. J. Appl. Phys. Vol. 32 (1993), pp. L8-L11, Part 2, No. 1A/B, 15, January 1993.	
	CV	Shigeo SHIONOYA et al. (editors), "Phosphor Handbook", pp. 505-508, CRC Press, 1999. Assume 12/1999	
	CW	Shigeo SHIONOYA et al. (editors), "Phosphor Handbook", pp. 505-508, CRC Press. Assume 12/1999	
	CX	Sato et al., Japanese Journal of Applied Physics, Vol. 35, July 1, 1996, pp. L838-L839.	
	CY	S. Nakaura et al., Japanese Journal of Applied Physics Part 2, Vol. 31, No. 10B, 1992, pp. L1457-1459. Assume 12/1992	
	CZ	R. W. G. Hunt, Color Research & Application, Vol. 16, No. 3, 1991, pp. 146-165. Assume 12/1991	
	CA1	Proceedings of Illumination National Convention in 1983, page 12. Assume 12/1983	
	CB1	Phosphor Handbook, 1st Edition, 1987, pp. 233-240 and 275-277. Assume 12/1987	
	CC1	P. Schlouer et al. "Luminescence Conversion of Blue Light Emitting Diodes", Applied Physics Letter, vol. 46, p. 417-418, February 1997	
	CD1	Nikkei Sangyo Shin-bun of September 13, 1996.	
	CE1	Nakamura, SPIE, Vol. 3002, pp. 26-35 (1997) assume 12/1997	
	CF1	Mitsubishi Electric Company Technical Report, Vol. 48, No. 9, 1974, pp. 1121-1124. Assume 12/1974	
	CG1	M.F. YAN et al., "Preparation of Y3Al5O12-Based Phosphor Powders, J. Electrochem. Soc., Vol. 134, No. 2. 02/1987	
	CH1	M.F. YAN et al., "Preparation of Y3Al5O12-Based Phosphor Powders, J. Electrochem. Soc., Vol. 134, No. 2, Feb. 1987.	
	CI1	M. Ikeda, Journal of the Illumination Society, Vol. 71, No. 10, 1987, pp. 612-617 and English Abstract. Assume 12/1987	
	CJ1	M. Ikeda et al., Color Research & Application, Vol. 16, No. 2, April 1991, pp. 72-80.	
	CK1	M. Ikeda et al., Color Research & Application, Vol. 14, No. 4, August 1989, pp. 198-206.	
	CL1	Kozo OSAMURA et al., "Preparation and optical properties of Ga1-xInxN thin films", Journal of Applied Physics, Vol. 46, No. 8, August 1975, pp. 3432-3437.	
	CM1	Journal of the Television Society, Vol. 47, No. 5, 1993, pp. 753-764. Assume 12/1993	
/A.M./	CN1	J.M. Robertson, et al., "Colourshift of the Ce3+ Emission in Monocrystalline Epitaxially Grown Garnet Layers", 1981 Philips J. Res. 36, pp. 15-30 Assume 12/1981	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	07/02/2012

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English language Translation is attached.

ce+

Substitute for form 1449/PTO	Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number	~~NEW~~ 12/942792
	Filing Date	~~Concurrently Herewith~~ 11/09/2010
	First Named Inventor	Yoshinori SHIMIZU
(Use as many sheets as necessary)	Art Unit	~~N/A~~ 2812
	Examiner Name	~~Not Yet Assigned~~ Mustapha
Sheet 10 of 12	Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
/A.M./	CI2	Office Action issued February 28, 2006, in U.S. Application No. 10/677,382 (U.S. Patent 7,026,756).	
	CJ2	Notice of Allowance and Examiner's Comments on Allowance issued February 13, 2008, in connection with U.S. Application No. 10/609,402 (U.S. Patent 7,362,048).	
	CK2	Notice of Allowance and Examiner's Comments on Allowance issued February 11, 2009, in U.S. Application No. 11/682,014 (U.S. Patent 7,531,960).	
	CL2	Notice of Allowance and Examiner's Comments on Allowance issued March 10, 2006, in U.S. Application No. 10/864,544 (U.S. Patent 7,126,274).	
	CM2	Notice of Allowance and Examiner's Comments on Allowance issued September 7, 2006, in U.S. Application No. 11/208,729 (U.S. Patent 7,215,074).	
	CN2	Notice of Allowance and Examiner's Comments on Allowance issued May 4, 2005, in U.S. Application No. 10/609,503 (U.S. Patent 7,071,616).	
	CO2	Notice of Allowance and Examiner's Comments on Allowance issued March 25, 2003, in U.S. Application No. 09/736,425 (U.S. Patent 6,608,332).	
	CP2	Notice of Allowance and Examiner's Comments on Allowance issued March 26, 2003, in U.S. Application No. 09/458,024 (U.S. Patent 6,614,179).	
	CQ2	Notice of Allowance and Examiner's Comments on Allowance issued September 25, 2007, in U.S. Application No. 11/653,275 (U.S. Patent 5,998,925).	
/A.M./	CR2	Notice of Allowance and Examiner's Comments on Allowance issued March 8, 1999, in U.S. Application No. 09/300,315 (U.S. Patent 6,069,440).	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	07/02/2012

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[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English language Translation is attached.

Cot

Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	11	of	12

Complete if Known	
Application Number	NEW
Filing Date	Concurrently Herewith
First Named Inventor	Yoshinori SHIMIZU
Art Unit	N/A
Examiner Name	Not Yet Assigned
Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
/A.M./	CS2	Notice of Allowance and Examiner's Comments on Allowance issued January 28, 1999, in U.S. Application No. 08/902,725 (U.S. Patent 5,998,925).	
	CT2	Office Action issued November 17, 2000, in U.S. Application No. 08/902,725 (U.S. Patent 5,998,925).	
	CU2	Notice of Allowance and Examiner's Comments on Allowance issued September 22, 2005, in U.S. Application No. 10/677,382 (U.S. Patent 7,026,756).	
	CV2	Office Action issed October 20, 2009, in Japanese Patent Application No. 2009-065948 with partial English translation.	
	CW2	Office Action issued April 4, 2007, in U.S. Application 11/653,275 (U.S. Patent 7,329,988 B2).	
	CX2	Notice of Allowance and Examiner's Comments on Allowance issued February 13, 2008, in U.S. Application No. 10/609,402 (U.S. Patent 7,362,048).	
	CY2	Notice of Allowance and Examiner's Comments on Allowance issued September 25, 2007, in U.S. Application No. 11/653,275 (U.S. Patent 7,329,988).	
	CZ2	Notice of Allowance and Examiner's Comments on Allowance issued October 8, 1999, in U.S. Application No. 09/300,315 (U.S. Patent 6,069,440).	
	CA3	Office Action issUed October 20, 2009, in Japanese Patent Application No. 2009-065948 with partial English translation.	
/A.M./	CB3	Hide et al., "White light from InGaN/conjugated polymer hybrid light-emitting diodes," Appl. Phys. Lett., Vol. 70 (20), May 19, 1997, http://apl.aip.org/apl/copyright.jsp, pp. 2664-2666.	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	07/02/2012

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[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English language Translation is attached.

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Substitute for form 1449/PTO	Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number	~~NEW~~ 12/942792
(Use as many sheets as necessary)	Filing Date	~~Concurrently Herewith~~ 11/09/2010
	First Named Inventor	Yoshinori SHIMIZU
	Art Unit	~~N/A~~ 2812
	Examiner Name	~~Not Yet Assigned~~ Mustapha
Sheet 12 of 12	Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
/A.M/	CC3	NAKAMURA et al., "High-Brightness InGaN Blue, Green and Yellow Light-Emitting Diodes with Quantum Well Structures", Japanese Journal of Applied Physics, Vol. 34, No. 7A, Part 2, July 1, 1995, pp. L797-L799 XP000702022	
	CD3	Non-Final Office Action issued August 2, 2010, in co-pending U.S. Application Serial No. 12/559,042.	
	CD4	Hoffman, Journal of les, pp. 89-91 (1977).	
	CD5	H. Shinoda et al., Color Research & Application, Vol. 18, No. 5, October 1993, pp. 326-333.	
	CD6	G. BLASSE et al., "Investigation of Some Ce3+-Activated Phosphors", Journal of Chemical Physics, Vol. 47, No. 12, 15 December 1967.	
	CD7	E.F. GIBBONS et al., "Some Factors Influencing the Luminous Decay characteristics of Y3Al5O12:Ce3+", J. Electrochem. Soc., Vol. 120, No. 6, June 1973.	
	CD8	D.J. ROBBINS et al., "Lattice Defects and Energy Transfer Phenomena in Y3Al5O12:Ce3+", pp. 1004-1013, printed June 19, 2001.	
	CD9	Bando et al., Development and applications of highbright white LED lamps, November 29, 1996, The 264th Proceedings of the Institute of Phosphor Society, pages 4-16 of the English translation.	
	CD10	Office Action issued December 13, 2005, in U.S. Application No. 11/208,729 (U.S. Patent No. 7,215,074).	
	CD11	Office Action issued March 13, 2001, in U.S. Application No. 09/458,024 (U.S. Patent No. 6,614,179).	
	CD12	Office Action issued August 14, 2002, in U.S. Application No. 09/736,425 (U.S. Patent No. 6,608,332).	
	CD13	Office Action issued August 19, 2005, in U.S. Application No. 10/609,402 (U.S. Patent No. 7,362,048).	
	CD14	Office Action issued July 27, 2007, in U.S. Application No. 10/609,402 (U.S. Patent No. 7,362,048).	
	CD15	Office Action issued January 2, 2008, in U.S. Application No. 10/609,402 (U.S. Patent No. 7,362,048).	
	CD16	Office Action issued April 8, 2005, in U.S. Application No. 10/677,382 (U.S. Patent No. 7,026,756).	
/A.M./	CD17	Office Action issued September 7, 2005, in U.S. Application No. 10/864,544 (U.S. Patent No. 7,126,274).	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	07/02/2012

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English language Translation is attached.

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12942792	SHIMIZU ET AL.
	Examiner	**Art Unit**
	ABDULFATTAH MUSTAPHA	2812

SEARCHED

Class	Subclass	Date	Examiner
438	21-27	12/16/2011	MBA
257	98,E33.044, E33.059	12/16/2011	MBA
349	69-105	12/16/2011	MBA
438	Search updated	6/14/2012	MBA
257	Search updated	6/14/2012	MBA
349	Search updated	6/14/2012	MBA

SEARCH NOTES

Search Notes	Date	Examiner
East search	12/16/2011	MBA
References and suggestions provided by SPE C. Garber.	12/30/2011	MBA
Search updated.	6/14/2012	MBA

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner
	See report.	12/16/2011	MBA
	Report updated.	6/14/2012	MBA

Index of Claims	Application/Control No. 12942792	Applicant(s)/Patent Under Reexamination SHIMIZU ET AL.
	Examiner ABDULFATTAH MUSTAPHA	Art Unit 2812

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/29/2011	06/14/2012							
	1	✓	=							
	2	✓	=							
	3	✓	=							
	4	✓	=							
	5	✓	=							
	6	✓	=							
	7	✓	=							
	8	✓	=							
	9	✓	=							
	10	✓	=							
	11	✓	=							
	12	✓	=							
	13	✓	=							
	14	✓	=							
	15	✓	=							
	16	✓	=							
	17	✓	=							
	18	O	=							
	19	✓	=							

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12942792	SHIMIZU ET AL.
	Examiner	**Art Unit**
	ABDULFATTAH MUSTAPHA	2812

ORIGINAL		INTERNATIONAL CLASSIFICATION									
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED				
438	21	H	0	1	L	21 / 00 (2006.0)					

CROSS REFERENCE(S)

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
438	21	27			
257	E33.044	E33.059	99		

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		17												
	2		18												
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	14														
	15														
	16														

/ABDULFATTAH MUSTAPHA/ Examiner.Art Unit 2812 (Assistant Examiner)	06/14/2012 (Date)	**Total Claims Allowed:** 19	
/CHARLES GARBER/ Supervisory Patent Examiner.Art Unit 2812 (Primary Examiner)	06/18/2012 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	488	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:32
S2	17750983	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:33
S3	47	S1 and S2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:34
S4	53731	stoichiometri$3 and (coprecipitat$3 or precipitat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:35
S5	0	S3 and S4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:35
S6	464	stoichiometri$3 and (coprecipitat$3 or precipitat$3) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:36
S7	13	S1 and S6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:37
S8	36	("20010030326" | "3510732" |	US-PGPUB;	ADJ	ON	2009/03/09

		"3652956" | "3691482" | "3699478" | "3819974" | "3875456" | "4298820" | "4314910" | "4550256" | "4644223" | "4716337" | "4727283" | "4905060" | "5006908" | "5118985" | "5202777" | "5257049" | "5369289" | "5471113" | "5550657" | "5578839" | "5602418" | "5700713" | "5825125" | "5847507" | "5959316" | "6004001" | "6066861" | "6340824" | "6538371" | "6576930" | "6784511" | "6798537" | "6812500").PN.	USPAT; USOCR			09:40
S9	0	S1 and S8	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:41
S10	2	S6 and S8	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:41
S11	1	"20080138918".pn.	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/03/09 09:43
S12	33641	((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:44
S13	159	S12 and S6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:44
S14	11	S13 and S2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:44
S15	3726370	(oxide or ammonium or fluoride or aluminum)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:47
S16	2125	(ammonium adj3 fluoride) and (aluminum adj3 oxide)	US-PGPUB; USPAT;	ADJ	ON	2009/03/09 09:48

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S17	2125	S15 and S16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:48
S18	47	S6 and S17	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:49
S19	2	S1 and S18	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:49
S20	35	("20010030326" | "3510732" | "3652956" | "3691482" | "3699478" | "3819974" | "3875456" | "4298820" | "4314910" | "4550256" | "4644223" | "4716337" | "4727283" | "4905060" | "5006908" | "5118985" | "5202777" | "5257049" | "5369289" | "5471113" | "5550657" | "5578839" | "5602418" | "5798537" | "5825125" | "5847507" | "5959316" | "6004001" | "6066861" | "6340824" | "6538371" | "6576930" | "6784511" | "6812500").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/03/09 09:55
S21	1	"4644223".pn.	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/03/09 09:56
S22	24	("2143077" | "3294699" | "3595802" | "3925239" | "4174294" | "4319161").PN. OR ("4644223").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/03/09 09:56
S23	334	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 10:00
S24	13	S6 and S23	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 10:00

S25	0	S24 and S2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 10:00
S26	17750983	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:40
S27	464	stoichiometri$3 and (coprecipitat$3 or precipitat$3) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:40
S28	334	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:40
S29	13	S27 and S28	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:40
S30	0	S26 and S29	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:40
S31	13476	((light adj3 emit$3) or LED) same nitride	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:42
S32	1482	S26 and S31	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:42
S33	0	S32 and S27	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	ON	2009/03/09 19:43

			DERWENT; IBM_TDB			
S34	53731	stoichiometri$3 and (coprecipitat$3 or precipitat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:43
S35	7	S32 and S34	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:43
S36	7	S35 and S35	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:45
S37	7	S35 and S31	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:45
S38	0	S37 and S33	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:45
S39	15	("56016584" "60011069" "3748548" "105061" "4857228" "4991941" "19910307").pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/03/09 19:49
S40	1833	((light adj3 emit$3) or LED) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:51
S41	32	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:04
S42	32	S40 and S41	US-PGPUB; USPAT; USOCR;	ADJ	ON	2009/03/09 20:05

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S43	0	S26 and S42	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:05
S44	696	(light adj3 emit$3) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:08
S45	9	S26 and S44	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:08
S46	3726370	(oxide or ammonium or fluoride or aluminum)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:58
S47	2125	(ammonium adj3 fluoride) and (aluminum adj3 oxide)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:58
S48	2125	S46 and S47	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:58
S49	47	S27 and S48	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:58
S50	86160	fir$3 near3 (oxide or (ammonium adj3 fluoride) or (aluminum adj3 oxide))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:00
S51	45	S49 and S50	US-PGPUB;	ADJ	ON	2009/03/09

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			21:01
S52	0	S26 and S51	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:01
S53	27176	S26 and S50	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:02
S54	89	S53 and S48	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:03
S55	25	fir$3 near3 (oxide and (ammonium fluoride) and (aluminum oxide))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:05
S56	1	S26 and S55	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:06
S57	1945	dissolv$3 near5 stoichiometric$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:08
S58	1279	S34 and S57	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:08
S59	674	S26 and S58	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2009/03/09 21:08

			IBM_TDB			
S60	11	S53 and S59	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:09
S61	49	("4924612" "6139162" "5907373" "6014489" "4772780" "5729024" "5786665" "5818062" "5929436" "6036328" "6094404" "5462164" "5519519" "5671028" "5828302" "6102545" "6215535" "6215535" "4405858" "4807026" "4840137" "4864144" "4865196" RE34411 "5266811" "5398170" "5410212" "5467216" "5573107" "5757447" "5841154" "6048071" "6231200" "6249370" "4250575" "4251142" "4259963" "4340292" "4494874" "4616293" "4814948" "4875074" "4916478" "5219418" "5319414" "5408296" "5459000" "5459505" "5471050" "5510869").pn.	US-PGPUB; USPAT; USOCR	OR	ON	2009/03/09 21:44
S62	0	blue color near5 (420-490) adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 18:58
S63	210	blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 18:59
S64	184	blue color near5 ("510" or "515" or "520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:01
S65	5	S63 and S64	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:02
S66	2	phosphor near5 blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:28
S67	788	(light adj3 emit$3) same (phosphor	US-PGPUB;	ADJ	ON	2009/10/12

		and nitri$3)	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			19:30
S68	14	S63 and S67	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:30
S69	16927698	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:33
S70	0	S68 and S69	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:33
S71	14	S68 and S67	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:34
S72	41	S63 and S69	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:35
S73	0	S64 and S72	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:35
S74	733	NICHIA CORPORATION.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:43
S75	12	NICHIA KAGAKU KOGYO KABUSHIKI KAISHA.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2009/10/12 19:43

			IBM_TDB			
S76	745	S74 or S75	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:44
S77	0	S72 and S76	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:44
S78	0	Yoshinori Shimizu.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:46
S79	0	Kensho Sakano.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:46
S80	0	Yasunobu Noguchi.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:47
S81	0	Toshio Moriguchi.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:47
S89	12	("5798537" "5998925" "6069440" "6608332" "6614179" "7026756" "7071616" "7126274" "7215074" "7329988" "7362048" "7531960").pn.	US-PGPUB; USPAT; USOCR	OR	ON	2009/11/23 09:03
S90	36867	((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:09
S91	12	S90 and S89	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2009/11/23 09:09

			IBM_TDB			
S92	2163	((light adj3 emit$3) or LED) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:10
S93	40	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:10
S94	40	S92 and S93	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:10
S95	0	S94 and S91	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:10
S96	188	blue color near5 ("510" or "515" or "520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:11
S97	0	S96 and S91	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:11
S98	212	blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:13
S99	0	S98 and S91	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:13
S100	321	blue color near5 (wavelength or wave length) same ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480"	US-PGPUB; USPAT; USOCR; FPRS;	ADJ	ON	2009/11/23 09:14

		or "485" or "490") adj (nm or nanometre or nano meter or ANG)	EPO; JPO; DERWENT; IBM_TDB			
S101	358	blue color near5 (wavelength or wave length) same ("510" or "515" or "520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:15
S102	1	S100 and S91	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:15
S103	1	S101 and S91	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:15
S104	16928194	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:33
S105	0	S94 and S104	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:33
S106	745	NICHIA CORPORATION.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:39
S107	12	NICHIA KAGAKU KOGYO KABUSHIKI KAISHA.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:39
S108	757	S106 or S107	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:39
S109	757	S106 or S107	US-PGPUB;	ADJ	ON	2009/11/23

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			09:40
S110	9	S100 and S109	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:40
S111	5	S101 and S109	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:40
S112	10	S110 or S111	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:40
S113	0	S112 and S104	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:41
S114	17759950	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:20
S115	520	stoichiometri$3 and (coprecipitat$3 or precipitat$3) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:21
S116	460	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:21
S117	13	S115 and S116	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2010/05/31 14:21

			IBM_TDB			
S118	0	S117 and S114	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:21
S119	104	(LED or light emit$3) near5 spectrum near3 ("420" or "430" or "440" or "450" or "460" or "470" or "480" or "490" or "500" or "510" or "520" or "530" or "540" or "550" or "560" or "570" or "580" or "590" or "600" or "610" or "620" or "630" or "640" or "650" or "660" or "670" or "680" or "690" or "700") adj (nm or nano meter or nano metre)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:28
S120	15	S114 and S119	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:29
S121	2506	spectrum near3 phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:29
S122	2	S120 and S121	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:29
S123	108	("20010030326" | "3510732" | "3652956" | "3691482" | "3699478" | "3748548" | "3819974" | "3875456" | "4298820" | "4314910" | "4550256" | "4644223" | "4716337" | "4727283" | "4857228" | "4905060" | "5006908" | "5118985" | "5202777" | "5257049" | "5369289" | "5471113" | "5512210" | "5550657" | "5578839" | "5602418" | "5630741" | "5700713" | "5798537" | "5825113" | "5847507" | "5949182" | "5959316" | "5998925" | "6004001" | "6066511" | "6069440" | "6340824" | "6538371" | "6576930" | "6608332" | "6614179" | "6784511" | "6798537" | "6812500" | "7026756" | "7071616" | "7126274" | "7215074" | "7329988" | "7362048" | "7531960").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:32
S124	504	((light adj3 emit$3) or LED) near5 transparent material	US-PGPUB; USPAT;	ADJ	ON	2010/05/31 14:34

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S125	0	S123 and S124	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:34
S126	5	S124 and S121	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:35
S127	0	S120 and S126	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:35
S128	2458	((light adj3 emit$3) or LED) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:36
S129	46	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:36
S130	46	S128 and S129	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:36
S131	49415	(LCD or liquid crystal display) same color filter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:37
S132	4	S119 and S131	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:37

S133	236146	"257"/$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:38
S134	195807	"438"/$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:38
S135	115041	S133 and S134	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:39
S136	46352	"349"/$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:39
S137	3373	S135 and S136	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:39
S138	125801	"359"/$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:39
S139	64206	"313"/$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:39
S140	3125	S138 and S139	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:40
S141	186	S131 and S140	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	ON	2010/05/31 14:40

			DERWENT; IBM_TDB			
S142	18	S137 and S141	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:40
S143	111	S128 and S131	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:40
S144	1	S142 and S143	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:41
S145	8649	349/69-105.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:07
S146	1822	S131 and S145	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:07
S147	17	S119 and S121	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:08
S148	0	S146 and S147	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:08
S149	5106	(LCD or liquid crystal display) near3 (glass or transparent) adj (wafer or substrate)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:11
S150	872	liquid crystal near3 (inject$3 or introduc$3 or dispens$3) near5 (glass or transparent) adj (wafer or	US-PGPUB; USPAT; USOCR;	ADJ	ON	2010/05/31 15:14

		substrate)	FPRS; EPO; JPO; DERWENT; IBM_TDB			
S151	129	S149 and S150	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:14
S152	0	S119 and S151	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:15
S153	0	("10677382" "12548614" "12548620" "12559042").ap.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 17:39
S154	0	("10/677382" "12/548614" "12/548620" "12/559042").ap.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 17:40
S155	24	("677382" "548614" "548620" "559042").ap.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 17:40
S156	4	("20090315015" "20100001258" "20090315014" "7026756" "7026756").pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 17:45
S157	0	"7362048.pn"	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 19:46
S158	0	"7362048.pn."	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 19:46
S159	1	"7362048".pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 19:47
S160	894622	phosphor near5 transparent material same (LED or light emit$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 19:56
S161	227	blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 19:56
S162	198	blue color near5 ("510" or "515" or "520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 19:56
S163	7	S161 and S162	US-PGPUB; USPAT; USOCR;	ADJ	ON	2010/06/07 19:56

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S164	67510	("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:02
S165	137544	("510" or "515" or "520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:02
S166	31514	S164 and S165	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:02
S167	13207	S160 and S166	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:02
S168	17760117	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:03
S169	16666	((light adj3 emit$3) or LED) same nitride	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:03
S170	1488	S168 and S169	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:03
S171	5111	(LCD or liquid crystal display) near3 (glass or transparent) adj (wafer or substrate)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:03
S172	873	liquid crystal near3 (inject$3 or	US-PGPUB;	ADJ	ON	2010/06/07

		introduc$3 or dispens$3) near5 (glass or transparent) adj (wafer or substrate)	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			20:03
S173	129	S171 and S172	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:03
S174	0	S170 and S173	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:04
S175	61	S170 and S167	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:04
S176	0	transparent adj mateial near5 (LED or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:05
S177	1555	transparent adj material near5 (LED or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:05
S178	0	S175 and S177	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:05
S179	2	"5700713".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/08 13:30
S180	0	bck light near5 (LED or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	OFF	2010/06/08 19:27

			IBM_TDB			
S181	2980	back light near5 (LED or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/08 19:27
S182	5397	liquid crystal near5 glass substrate	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/08 19:28
S183	40	S181 and S182	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/08 19:28
S184	17760148	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/08 19:29
S185	16932587	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/08 19:29
S186	3	S183 and S185	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/08 19:30
S187	56	("20010030326" | "20090315014" | "20090315015" | "20100001258" | "3510732" | "3652956" | "3691482" | "3699478" | "3748548" | "3819974" | "3875456" | "4298820" | "4314910" | "4550256" | "4644223" | "4716337" | "4727283" | "4857228" | "4905060" | "5006908" | "5118985" | "5202777" | "5257049" | "5369289" | "5471113" | "5512210" | "5550657" | "5578839" | "5602418" | "5630741" | "5700713" | "5798537" | "5825125" | "5847507" | "5949182" | "5959316" | "5998925" | "6004001" | "6066861" | "6069440" | "6340824" | "6538371" | "6575930" | "6608332" | "6614179" | "6784511" | "6798537"	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/06/19 13:54

		| "6812500" | "7026756" | "7071616" | "7126274" | "7215074" | "7329988" | "7362048" | "7531960").PN.				
S188	24	(diameter or radi$3) near3 (conduct$3 or wire) near3 ("10" or "15" or "20" or "25" or "30" or "35" or "40" or "45") adj (mu or micro or meter)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 13:59
S189	0	S187 and S188	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 14:02
S190	1	"20090315014".pn.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/06/19 14:04
S191	55	S187 and (diameter or radi$3 or conduct$3 or wire or ".mu.m" or "10" or "15" or "20" or "25" or "30" or "35" or "40" or "45")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 14:08
S192	75	(LED or Light emit$3) adj3 chip near5 conduct$3 adj wire	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 14:44
S193	1	S187 and S192	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 14:44
S194	11	("1305111" or "6340824").pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:13
S195	951	diameter near5 conduct$3 adj wire	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:16
S196	14	S191 and S195	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	OFF	2010/06/19 15:17

			DERWENT; IBM_TDB			
S197	168	phosphor near3 transparent material	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:18
S198	3	S196 and S197	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:18
S199	178048	shimizu.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:19
S200	161	S197 NOT S199	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:20
S201	2	("5949182" "3748548").pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/19 15:28
S202	34	("2913632" | "3173101" | "3179542" | "3209214" | "3229104" | "3234057" | "3260902" | "3270235" | "3283160" | "3372069").PN. OR ("3748548").URPN.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/06/19 15:28
S203	21	("3665241" | "3755704" | "3812559" | "4513308" | "5064396" | "5186670" | "5199917" | "5229331" | "5232549" | "5316979" | "5329207" | "5363021" | "5438240" | "5448132" | "5615143").PN. OR ("5949182").URPN.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/06/19 15:30
S204	2	("5630741" "4857228").pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/19 15:34
S205	2	S192 and S197	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:38
S206	16932745	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	ON	2010/06/19 15:41

			DERWENT; IBM_TDB			
S207	2	S192 and S206	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:42
S208	318	S195 and S206	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:42
S209	0	S208 and S197	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:43
S210	6	("3699478" | "5221984" | "5594751" | "5801435" | "6015200" | "6600175").PN.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/21 16:00
S211	5	("4001628" | "5208462" | "5706022" | "5743629" | "6600175").PN.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/21 16:09
S212	2	"6600175".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/10/24 13:21
S213	6	("3699478" | "5221984" | "5594751" | "5801435" | "6015200" | "6600175").PN.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/24 13:25
S214	3	"3699478".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/04/21 16:56
S215	3	("4992704" "20090315014" "5045867").pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2011/04/22 14:59
S216	2	("2009/0315014").URPN.	USPAT	ADJ	OFF	2011/04/22 14:59
S217	581	(conduct$3 or electric$3) adj5 (wire or cable) with (diameter or radius or size) with (("10" "15" "20" "25" "30" "35" "40" "45") adj(".mu.m" or micro or micron or meter or metre))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/04/22 15:19
S218	16934970	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT;	ADJ	ON	2011/04/22 15:20

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S219	82	S217 and S218	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:20
S220	19216	((light adj3 emit$3) or LED) same nitride	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:21
S221	1245	S218 and S220	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:22
S222	0	S219 and S221	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:22
S223	7	((light adj3 emit$3) or LED) and S219	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:22
S224	0	(transparent$3 or visibl$3) adj5 material with (LED or light emit$3 diode or light emit$3) and S219	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:24
S225	0	(transparent$3 or visibl$3) adj5 material with phosphor and S219	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:25
S226	2	"4992704".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/13 16:16

S227	2	"20090315015".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 11:44
S228	3	("2009/0315015").URPN.	USPAT	ADJ	OFF	2011/05/17 11:51
S229	550	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius) with (("10" or "15" or "20" or "25" or "30" or "35" or "40" or "45") adj (".mu.m" or micron or nm or mm))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 15:40
S230	2267282	((LCD or liquid crystal display or liquid crystal) or (LED or light emitting diode or light emit$3) or (bak light))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 15:48
S231	227	S229 and S230	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 15:48
S232	16935137	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/05/17 15:49
S233	18	S232 and S231	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/05/17 15:50
S234	47	phosphor near3 transparent material with (light emit$3 or LED)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 15:54
S235	0	S233 and S234	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 15:54
S236	12	S234 and S231	US-PGPUB; USPAT; USOCR;	ADJ	ON	2011/05/17 15:54

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S237	950368	phosphor near5 transparent material same (LED or light emit$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2011/05/17 16:55
S238	40	S234 and S237	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/05/17 16:56
S239	0	S233 and S238	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 16:57
S240	195589	S232 and S237	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/05/17 16:57
S241	6	S231 and S240	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/05/17 16:58
S242	283	(wir$3 or (conduct$3 adj wire)) near3 (diameter or radius) with (LED or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 13:15
S243	74	(wir$3 or (conduct$3 adj wire)) near3 (diameter or radius) with (LED or light emit$3) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 13:15
S244	74	(wir$3 or (conduct$3 adj wire)) near3 (diameter or radius) with (LED or light emit$3) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 14:44
S245	13	S244 and (light emit$3 or light emit$3 diode or light emit$3 display)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	OFF	2011/06/03 14:44

			DERWENT; IBM_TDB			
S246	74	S244 and (LED or light emit$3 or light emit$3 diode or light emit$3 display)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 14:47
S247	16	(wir$3 or (conduct$3 adj wire)) with (diameter or radius) with (light emit$3 or light emit$3 diode or light emit$3 display) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 15:22
S248	93	(wir$3 or (conduct$3 adj wire) or conduct$3) near3 (diameter or radius) with (LED or light emit$3) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 16:05
S249	122	(wir$3 or (conduct$3 adj wire) or conduct$3) near3 (diameter or radi$3) with (LED or light emit$3) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 16:05
S250	20	(wir$3 or (conduct$3 adj wire) or conduct$3) near3 (diameter or radi$3) with (light emit$3 or light emit$3 diode or light emit$3 display) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 16:06
S251	20	(wir$3 or (conduct$3 adj wire) or conduct$3) near3 (diameter or radi$3) with (light emit$3 or light emit$3 diode or light emit$3 display) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 16:06
S252	20	S250 and S251	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 16:06
S253	6501	257/98.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 10:27
S254	6501	(257/98).CCLS.	US-PGPUB; USPAT; USOCR;	OR	OFF	2011/06/08 10:27

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S255	4900	(257/99).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/06/08 10:27
S256	1730	(257/100).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/06/08 10:29
S257	78	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius or thick$3) and S253	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 10:30
S258	6	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius or thick$3) and S253 and @ad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 10:30
S259	6	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius or thick$3) and S254 and @ad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 10:33
S260	7	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius or thick$3) and S255 and @ad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 10:34
S261	1	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius or thick$3) and S256 and @ad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 10:35
S262	0	438/106-127.ccls. and light near2 emitting near2 diode and (lead wire wiring conductor) near4 (thickness thick diameter)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 13:33
S263	56	438/106-127.ccls. and light near2	US-PGPUB;	OR	OFF	2011/06/08

		emitting near2 diode and (lead wire wiring conductor) near4 (thickness thick diameter)	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			13:33
S264	3	("4347655" "5125153" "5885893").pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2011/06/08 13:34
S265	1730	(257/100).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/06/08 13:35
S266	0	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius or thick$3) and S265 and S264	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 13:35
S267	3	S264 and (wir$3 or LED or light or emit$3 or diameter or thick$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2011/06/08 13:38
S268	6501	257/98.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 13:46
S269	6501	257/98.ccls. and S268	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 13:46
S270	119519	quantum well and S268	US-PGPUB; USPAT; USOCR	OR	OFF	2011/06/08 13:47
S271	1489	quantum well and S268	US-PGPUB; USPAT; USOCR	ADJ	OFF	2011/06/08 13:47
S272	50	quantum well and S268 and @ad<"19970331"	US-PGPUB; USPAT; USOCR	ADJ	OFF	2011/06/08 13:48
S273	25	((single or multi$3) adj quantum well) and S268 and @ad<"19970331"	US-PGPUB; USPAT; USOCR	ADJ	OFF	2011/06/08 13:55
S274	27356	liquid crystal with (glass adj substrate)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:10
S275	17763698	@ad<"19970331" or	US-PGPUB;	ADJ	ON	2011/06/09

		@rlad<"19970331"	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			12:10
S276	4812	S274 and S275	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:11
S277	6515	257/98.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:11
S278	1493	quantum well and S277	US-PGPUB; USPAT; USOCR	ADJ	OFF	2011/06/09 12:11
S279	0	S278 and S276	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:11
S280	3	S277 and S276	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:11
S281	1071	(inject$3 or introduc$3 or insert$3) with liquid crystal with (glass adj substrate)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:16
S282	0	S281 and S275 and S277	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:16
S283	505	(inject$3 or introduc$3 or insert$3) with liquid crystal with (glass adj substrate) and color filter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:19
S284	123	S275 and S283	US-PGPUB; USPAT; USOCR;	ADJ	ON	2011/06/09 12:20

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S285	0	S277 and S284	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:20
S286	3	(inject$3 or introduc$3 or insert$3) with liquid crystal with (glass adj substrate) and color filter with (LED or light emitting diode or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:22
S287	144	(inject$3 or introduc$3 or insert$3) with liquid crystal with (glass adj substrate) and color filter and (LED or light emitting diode or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:22
S288	55	S275 and S287	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:25
S289	7280	liquid crystal with (glass adj substrate) and color filter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:25
S290	55	S288 and S289	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:25
S291	0	S277 and S290	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:26
S292	2596	liquid crystal with (glass adj substrate) with color filter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:33
S293	19	S290 and S292	US-PGPUB;	ADJ	OFF	2011/06/09

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			12:33
S294	17764738	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/04 17:14
S295	4	("3623867" | "3842306" | "5816677").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/11/04 17:17
S296	17764740	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 13:05
S297	4	("3623867" | "3842306" | "5816677").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/11/05 13:06
S298	1	("3875456").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/11/05 13:13
S299	17764740	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 13:51
S300	568	stoichiometri$3 and (coprecipitat$3 or precipitat$3) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 13:51
S301	47842	((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 13:51
S302	239	S301 and S300	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 13:51
S303	11	S302 and S299	US-PGPUB; USPAT; USOCR;	ADJ	ON	2011/11/05 13:51

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S304	11176	phosphor with (concentrat$3 or quatity or quality or different or mix$3) with (LED or light or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:04
S305	1869	S296 and S304	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:04
S306	773	S301 and S305	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:04
S307	21084	((light adj3 emit$3) or LED) same nitride	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:04
S308	984	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S309	4468235	(oxide or ammonium or fluoride or aluminum)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S310	2933	(ammonium adj3 fluoride) and (aluminum adj3 oxide)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S311	2933	S309 and S310	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S312	80	S300 and S311	US-PGPUB;	ADJ	ON	2011/11/05

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			14:05
S313	3	S308 and S312	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S314	12	("5798537" "5998925" "6069440" "6608332" "6614179" "7026756" "7071616" "7126274" "7215074" "7329988" "7362048" "7531960").pn.	US-PGPUB; USPAT; USOCR	OR	ON	2011/11/05 14:05
S315	47842	((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S316	12	S315 and S314	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S317	260	blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S318	961	NICHIA CORPORATION.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S319	12	NICHIA KAGAKU KOGYO KABUSHIKI KAISHA.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S320	973	S318 or S319	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S321	4	("6600175" "3842306" "3875456"	US-PGPUB;	OR	OFF	2011/12/16

		"5126214").pn.	USPAT; USOCR			18:21
S322	12	("6600175" "3842306" "3875456" "5126214").pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/12/16 18:30
S323	5002	phosphor with (blue and yellow) with (LED or light or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/16 18:52
S324	16936281	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/16 18:53
S325	110	S323 and S324	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/16 18:53
S326	1681	(light emit$3 or LED) with (gallium nitride or GaN) with wavelength	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/16 18:54
S327	7	S325 and S326	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/16 18:54
S328	12	("5798537" "5998925" "6069440" "6608332" "6614179" "7026756" "7071616" "7126274" "7215074" "7329988" "7362048" "7531960").pn.	US-PGPUB; USPAT; USOCR	OR	ON	2011/12/16 18:58
S329	48488	((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/16 18:58
S330	12	S329 and S328	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	ON	2011/12/16 18:58

			DERWENT; IBM_TDB			
S331	0	S325 and S330	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/16 18:59
S332	139566	("5847507" "5966393")".pn"	US-PGPUB; USPAT; USOCR	OR	ON	2011/12/28 12:24
S333	49511	("5847507" "5966393")".pn"	USPAT	OR	ON	2011/12/28 12:34
S334	47932	("5847507" "5966393")".pn"	USPAT	OR	OFF	2011/12/28 12:34
S335	0	("("5847507""5966393")").PN.	USPAT; USOCR	OR	OFF	2011/12/28 12:34
S336	0	("(58475075966393)").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2011/12/28 12:35
S337	0	("(58475075966393)").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2011/12/28 12:35
S338	2	(("5966393") or ("5847507")).PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2011/12/28 12:35
S340	1	("20110053299").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2011/12/28 13:38
S341	55	phosphor with crystal structure with (LED or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 13:51
S342	0	S341 and @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 13:52
S343	0	S341 and @ad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 13:52
S344	1281	phosphor with crystal structure	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 13:54
S345	3622	((light adj3 emit$3) or LED) same	US-PGPUB;	ADJ	ON	2011/12/28

		(phosphor and nitri$3)	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			13:54
S346	281	S344 and S345	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 13:54
S347	622723	@rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 13:55
S348	16808771	@ad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 13:55
S349	16936334	S347 or S348	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 13:55
S350	0	S346 and S349	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 13:55
S351	0	S346 and S347	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 13:56
S352	0	S346 and S348	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 13:56
S353	3285	quantum well with (LED or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2011/12/28 15:06

			IBM_TDB			
S354	538	white light with black body	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 15:18
S355	75	S353 and S354	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 15:19
S356	0	S355 and @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 15:19
S357	0	S355 and @ad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 15:19
S358	140	white light with black body with (LED or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 15:20
S359	0	S358 and @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 15:20
S360	1	S358 and @ad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/28 15:20
S361	222	mustapha.xa.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/29 10:44
S362	222	mustapha.xa.	US-PGPUB; USPAT; USOCR; FPRS;	ADJ	ON	2011/12/29 11:55

			EPO; JPO; DERWENT; IBM_TDB			
S363	190021	Shimizu.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/29 11:56
S364	3	S362 and S363	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/29 11:56
S365	5	(("5998925") or ("6069440") or ("6614179") or ("7362048") or ("7682848")).PN.	USPAT; USOCR	OR	OFF	2011/12/29 11:59
S366	0	("L03orL4").PN.	USPAT; USOCR	OR	OFF	2011/12/29 12:00
S367	7	S364 or S365	USPAT	OR	OFF	2011/12/29 12:00
S368	0	phosphor with ("Al.sub.S3" adj3 "Ga.sub."$3 adj5 "O.sub."$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/29 13:08
S369	0	phosphor with ("Al.sub.S3" near3 "Ga.sub."$3 near3 "O.sub."$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/29 13:09
S370	0	(fluorescent adj3 material) with ("Al.sub.S3" near3 "Ga.sub."$3 near3 "O.sub."$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/29 13:10
S371	0	fluore$5 with ("Al.sub.S3" near3 "Ga.sub."$3 near3 "O.sub."$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/29 13:10
S372	0	("Al.sub.S3" near3 "Ga.sub."$3 near3 "O.sub."$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/29 13:10
S373	0	("Al.sub.S3" near3 "Ga.sub."$3)	US-PGPUB;	ADJ	ON	2011/12/29

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			13:11
S374	43	("Al.sub.$3" near3 "Ga.sub."$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/29 13:11
S375	26	("Al.sub.$3" near3 "Ga.sub."$3 near3 "O.sub."$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/29 13:11
S376	15	phosphor with ("Al.sub.$3" near3 "Ga.sub."$3 near3 "O.sub."$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/29 13:11
S377	579	stoichiometri$3 and (coprecipitat$3 or precipitat$3) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/29 13:12
S378	48767	((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/29 13:12
S379	249	S378 and S377	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/29 13:12
S380	0	S379 and S376	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/29 13:12
S381	6	S376 and S378	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2011/12/29 13:12

			IBM_TDB			

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S82	469	NICHIA CORPORATION.as.	USPAT; UPAD	ADJ	ON	2009/10/12 19:51
S83	7	NICHIA KAGAKU KOGYO KABUSHIKI KAISHA.as.	USPAT; UPAD	ADJ	ON	2009/10/12 19:51
S84	99	blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	USPAT; UPAD	ADJ	ON	2009/10/12 19:51
S85	94	blue color near5 ("510" or "515" or "520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or nano meter or ANG)	USPAT; UPAD	ADJ	ON	2009/10/12 19:51
S86	0	S82 and S83	USPAT; UPAD	ADJ	ON	2009/10/12 19:52
S87	1	S84 and S85	USPAT; UPAD	ADJ	ON	2009/10/12 19:52
S88	0	phosphor near5 blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	USPAT; UPAD	ADJ	ON	2009/10/12 19:57
S339	49938	("5847507" "5966393")".pn"	USPAT; UPAD	OR	ON	2011/12/28 12:34

12/29/2011 3:28:13 PM
C:\Users\amustapha\Documents\EAST\Workspaces\12_942792.wsp

Receipt date: 04/05/2012

Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	12/942,792
Filing Date	11-09-10
First Named Inventor	Yoshinori Shimizu
Art Unit	2812
Examiner Name	A.B. MUSTAPHA
Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

Examiner initial *	Cite No.	Document Number Number - Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear
/A.M./	1	US-2006/0067668 - A1	03-30-2006	KITA	
/A.M./	2	US-2008/0128735 - A1	06-05-2008	YOO et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial *	Cite No. 1	Foreign Patent Document Country[3] Code Number[4] Kind Code (if known)[5]	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear	T
/A.M./	3	JP 9-116225 - A	05-02-1997			✓

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	06/14/2012

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Receipt date: 04/05/2012

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	2	of	2

Complete if Known	
Application Number	12/942,792
Filing Date	11-09-10
First Named Inventor	Yoshinori Shimizu
Art Unit	2812
Examiner Name	A.B. MUSTAPHA
Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

Examiner initial *	Cite No. [1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T [2]
/A.M./	4	U.S. Office Action, dated January 9, 2012, for U.S. Application No. 12/947,470.	
/A.M./	5	U.S. Office Action, dated March 13, 2012, for U.S. Application No. 13/210,027.	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	06/14/2012

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.
1. Applicants unique citation designation number. (optional) 2. Applicant is to place a check mark here if English language Translation is attached.

Substitute for form 1449B/PTO	Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number	12/942,792
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(Use as many sheets as necessary)	Art Unit	2812
	Examiner Name	A. Mustapha
Sheet 1 of 1	Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

Examiner Initial *	Cite No. [1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T [2]
/A.M./	1	U.S. Office Action issued in co-pending application 12/689,681 on December 5, 2011.	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	06/14/2012

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

1. Applicants unique citation designation number. (optional) 2. Applicant is to place a check mark here if English language Translation is attached.

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BIB DATA SHEET

CONFIRMATION NO. 2357

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
12/942,792	11/09/2010 **RULE**	257	2812	0020-5147PUS12

APPLICANTS

Yoshinori Shimizu, Naka-gun, JAPAN;
Kensho Sakano, Anan-shi, JAPAN;
Yasunobu Noguchi, Naka-gun, JAPAN;
Toshio Moriguchi, Anan-shi, JAPAN;

** **CONTINUING DATA** *************************

This application is a DIV of 12/548,614 08/27/2009 PAT 8,148,177
which is a DIV of 12/028,062 02/08/2008 PAT 7,682,848
which is a DIV of 10/609,402 07/01/2003 PAT 7,362,048
which is a DIV of 09/458,024 12/10/1999 PAT 6,614,179
which is a DIV of 09/300,315 04/28/1999 PAT 6,069,440
which is a DIV of 08/902,725 07/29/1997 PAT 5,998,925

** **FOREIGN APPLICATIONS** *************************

JAPAN P 08-198585 07/29/1996
JAPAN P 08-244339 09/17/1996
JAPAN P 08-245381 09/18/1996
JAPAN P 08-359004 12/27/1996
JAPAN P 09-081010 03/31/1997

** **IF REQUIRED, FOREIGN FILING LICENSE GRANTED** **

11/19/2010

Foreign Priority claimed / 35 USC 119(a-d) conditions met / Verified and Acknowledged	Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
Foreign Priority claimed ☑ Yes ☐ No 35 USC 119(a-d) conditions met ☑ Yes ☐ No Verified and Acknowledged /ABDULFATTAH B MUSTAPHA/ Examiner's Signature	☐ Met after Allowance Initials	JAPAN	19	19	1

ADDRESS

BIRCH STEWART KOLASCH & BIRCH
PO BOX 747
FALLS CHURCH, VA 22040-0747
UNITED STATES

TITLE

LIGHT EMITTING DEVICE AND DISPLAY

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BIB (Rev. 05/07).

Docket No.: 0020-5147PUS12
(PATENT)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:
Yoshinori Shimizu et al.

Application No.: 12/942,792 — Confirmation No.: 2357

Filed: November 9, 2010 — Art Unit: 2812

For: LIGHT EMITTING DEVICE AND DISPLAY — Examiner: Abdulfattah B MUSTAPHA

RESPONSE UNDER 37 C.F.R. § 1.111

MS Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

INTRODUCTORY COMMENTS

In response to the Office Action dated January 30, 2012, the following remarks are submitted in connection with the above-identified U.S. patent application:

A Listing of Claims begins on page 2 of this paper.

Remarks/Arguments begin on page 6 of this paper.

LISTING OF CLAIMS

1. (Original) A method for manufacturing a light emitting device comprising:

preparing a light emitting component having an active layer of a semiconductor, said active layer comprising a gallium nitride based semiconductor containing indium and being capable of emitting a blue color light having a spectrum with a peak wavelength within the range from 420 to 490 nm;

preparing a phosphor capable of absorbing a part of the blue color light emitted from said light emitting component and emitting a yellow color light having a broad emission spectrum comprising a peak wavelength existing around the range from 510 to 600 nm and a tail continuing beyond 700 nm, wherein selection of said phosphor is controlled based on an emission wavelength of said light emitting component; and

combining said light emitting component and said phosphor so that the blue color light from said light emitting component and the yellow color light from said phosphor are mixed to make a white color light, wherein a chromaticity point of the white color light is on a straight line connecting a point of chromaticity of the blue color light and a point of chromaticity of the yellow color light, and

wherein a content of said phosphor in said light emitting device is selected to obtain a desired chromaticity of the white color light.

2. (Original) The method for manufacturing a light emitting device according to claim 1, wherein said phosphor comprises a garnet fluorescent material activated with cerium.

3. (Original) The method for manufacturing a light emitting device according to claim 1, wherein said phosphor comprises two or more kinds of fluorescent materials.

4. (Original) The method for manufacturing a light emitting device according to claim 1, wherein the emission spectrum of said phosphor comprises a peak wavelength existing around the range from 530 to 570 nm and a tail continuing beyond 700 nm.

5. (Original) The method for manufacturing a light emitting device according to claim 1, wherein said phosphor comprises an yttrium-aluminum-garnet fluorescent material containing Y and Al.

6. (Original) The method for manufacturing a light emitting device according to claim 1, wherein said phosphor has a crystal structure.

7. (Original) The method for manufacturing a light emitting device according to claim 1, wherein the active layer of said light emitting component has a single quantum well or multi quantum well structure.

8. (Original) The method for manufacturing a light emitting device according to claim 1, wherein the active layer of said light emitting component comprises InGaN.

9. (Original) The method for manufacturing a light emitting device according to claim 1, wherein said light emitting device is capable of emitting white light substantially along the black body radiation locus.

10. (Original) The method for manufacturing a light emitting device according to claim 1, further comprising:

controlling emission color of said light emitting device by changing a content of said phosphor with respect to a content of a resin in a coating material.

11. (Original) The method for manufacturing a light emitting device according to claim 1, wherein said step of controlling selection of said phosphor is used to reduce variation in the

emission wavelength of said light emitting device, by compensating for a variation of the emission wavelength of said light emitting component.

12. (Original) The method for manufacturing a light emitting device according to claim 3, further comprising:

controlling compositions or quantities of light emitting components and fluorescent materials included in said light emitting device, to control color emitted by said light emitting device.

13. (Original) The method for manufacturing a light emitting device according to claim 3, wherein the emission wavelength of the fluorescent materials are selected so that said light emitting device produces RGB components with high luminance.

14. (Original) The method for manufacturing a light emitting device according to claim 13, wherein

the emission spectrum of one fluorescent material comprises a peak wavelength around 510 nm, and the emission spectrum tails out to around 700 nm, and

the emission spectrum of a second fluorescent material comprises a peak wavelength around 600 nm, and the emission spectrum tails out to around 750 nm,

so that said light emitting device produces RGB components with high luminance.

15. (Original) The method for manufacturing a light emitting device according to claim 3, further comprising mixing said two or more kinds of fluorescent materials.

16. (Original) The method for manufacturing a light emitting device according to claim 3, wherein said two or more kinds of fluorescent materials are arranged independently to adjust color by laminating the layers of fluorescent materials.

17. (Original) The method for manufacturing a light emitting device according to claim 3, wherein one of said fluorescent materials absorbs light of a shorter wavelength and another of said fluorescent materials absorbs light of a longer wavelength, and said fluorescent material that absorbs light of a longer wavelength is arranged away from said light emitting component, while said fluorescent material that absorbs light of a shorter wavelength is arranged near said light emitting component.

18. (Original) The method for manufacturing a light emitting device according to claim 1, wherein said phosphor is a fluorescent material represented by formula $(Re_{1-r}Sm_r)_3(Al_{1-s}Ga_s)_5O_{12}$:Ce where $0 \leq r < 1$, $0 \leq s \leq 1$ and Re is at least one element selected from Y, Gd and La.

19. (Original) The method for manufacturing a light emitting device according to claim 1, further comprising:

controlling compositions or quantities of light emitting components included in said light emitting device and controlling composition of said phosphor, to control color emitted by said light emitting device.

REMARKS

Claims 1-19 are currently pending in the application. Claim 1 is independent. Claims 1-19 were pending prior to the Office Action.

The Examiner is respectfully requested to reconsider the rejections in view of the remarks set forth herein. Applicants respectfully request favorable consideration thereof in light of the comments contained herein, and earnestly seek timely allowance of the pending claims.

Request for Acknowledgement of Domestic Priority and Foreign Priority

In the Office Action (page 2), the Examiner alleged that a light emitting component having an active semiconductor layer, and a fluorescent material as recited in claim 18 are not described in the foreign priority documents and in the specification of the parent US application of the present application.

Applicants respectfully disagree with Examiner's assertions, and point out that these features are fully supported by the domestic parent document which is US Patent 5,998,925. Here, it is noted that the present application is a divisional application in a chain of divisional applications starting with US Patent 5,998,925, and thus the specifications of US Patent 5,998,925 and all patent applications in the divisional chain of the present application are identical. Therefore, support is presented below in the text of US Patent 5,998,925.

Specifically, the feature of a light emitting component having an active layer of a semiconductor (as in claim 1) is described at, e.g., col. 13 lines 51- col. 14 line 6, and col. 23 line 65 - col. 24 line 3 in US Patent 5,998,925. The feature of claim 18 is identically described at col. 18 lines 3-7 in US Patent 5,998,925.

These above-mentioned claim features are also described in foreign priority document JP 09-081010 (see below). With respect to claim 18, it is noted that it is supported by at least claim 2 of JP 09-081010 and paragraph [0011] in the English translation.

Claim Rejections – 35 USC §103

The Examiner rejected claims 1-17 and 19 under 35 U.S.C. § 103(a) as being made obvious by US 5,847,507 ("Butterworth") in view of US 5,966,393 ("Hide").

DRA/CET

Applicants respectfully submit the Examiner has failed to establish a *prima facie* case of obviousness.

The present application was filed in the USPTO on November 9, 2010, and is a divisional of U.S. Application No. 12/548,614 (now U.S. Patent 8,148,177) which is a divisional of U.S. Application No. 12/028,062 (now U.S. Patent 7,682,848) which is a divisional of U.S. Application No. 10/609,402 (now U.S. Patent 7,362,048), which is a divisional of U.S. Application No. 09/458,024 (now U.S. Patent 6,614,179), which is a divisional of U.S. Application No. 09/300,315 (now U.S. Patent 6,069,440), which is a divisional of U.S. Application No. 08/902,725 (now U.S. Patent 5,998,925) filed on July 29, 1997 and which claims priority under 35 U.S.C. §119 based on prior foreign applications JP 08-198585 filed July 29, 1996, JP 08-244339 filed September 17, 1996, JP 08-245381 filed September 18, 1996, JP 08-359004 filed December 27, 1996, and JP 09-081010 filed March 31, 1997.

Applicants submit herein a verified English translation of foreign priority application JP 09-081010 to perfect the priority claim. Foreign priority application JP 09-081010 explicitly supports claims 1-3, 5, 7, 8, and 10-19 of the present application.

In connection with claim 1, the verified English translation of JP 09-081010 describes the following features:

- preparing a light emitting component having an active layer of a semiconductor, said active layer comprising a gallium nitride based semiconductor containing indium and being capable of emitting a blue color light having a spectrum with a peak wavelength within the range from 420 to 490 nm - at least paragraphs [0021], [0032], [0051];

- preparing a phosphor capable of absorbing a part of the blue color light emitted from said light emitting component and emitting a yellow color light - at least paragraphs [0021], [0022], [0025], [0054], [0055], [0058], [0059], [0064], [0065];

- the phosphor having a broad emission spectrum comprising a peak wavelength existing around the range from 510 to 600 nm and a tail continuing beyond 700 nm - at least paragraph [0025] and Fig. 4B;

- wherein selection of said phosphor is controlled based on an emission wavelength of said light emitting component - at least paragraphs [0016], [0020];

- combining said light emitting component and said phosphor so that the blue color light from said light emitting component and the yellow color light from said phosphor are mixed to make a white color light - at paragraphs [0021], [0022], [0074];

- wherein a chromaticity point of the white color light is on a straight line connecting a point of chromaticity of the blue color light and a point of chromaticity of the yellow color light - at least paragraphs [0016], [0020], and Fig. 8;

- wherein a content of said phosphor in said light emitting device is selected to obtain a desired chromaticity of the white color light -at least paragraphs [0016], [0020], [0022].

JP 09-081010 also supports dependent claims 2, 3, 5, 7, 8, and 10-19 (see, e.g., paragraphs [0010], [0011], [0016], [0019], [0020], [0021], [0022], [0023], [0025], [0028], [0029], [0032], [0045], [0051], [0055], [0058], [0059], [0064], [0065], [0066], [0067], [0074]).

Since foreign priority application JP 09-081010 was filed on March 31, 1997 which is before the reference date (U.S. filing date) of July 14, 1997 of Butterworth, Butterworth is not a prior art reference against claims 1, 2, 3, 5, 7, 8, and 10-19 of the present application.

With respect to claim 4 which recites that the emission spectrum of the phosphor comprises a peak wavelength existing around the range from 530 to 570 nm and a tail continuing beyond 700 nm, the Examiner cited to Butterworth, col. 3 lines 58-64 and to the case of *In re Aller*. However, col. 3 lines 58-64 of Butterworth merely describe shifting of wavelength from 488 nm to 605 nm, or to 645 nm or to 685 nm, but do not describe the range of 530 to 570 nm. Furthermore, even though *In re Aller* provides that "[W]here the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation", it is respectfully submitted that the Examiner has not shown that 1) one of ordinary skill would realize that a phosphor as in claim 4 would be an optimum phosphor for, e.g., Butterworth, or that 2) one of ordinary skill could arrive to a phosphor as in claim 4 by merely routine experimentation. Therefore, Butterworth does not make obvious the feature of claim 4.

With respect to claim 6 which recites that the phosphor has a crystal structure, the Examiner has not provided a discussion of this claim in the Office Action, but merely listed it as rejected on page 2 of the Office Action. Here, it is noted that Butterworth and Hide do not mention a crystal structure.

With respect to claim 9 which recites that the light emitting device is capable of emitting white light substantially along the black body radiation locus, the Examiner has not provided a discussion of this claim in the body of the Office Action, but merely listed it as rejected on page 2 of the Office Action. Here, it is noted that Butterworth and Hide do not discuss a black body radiation locus or a white light along a black body radiation locus.

For all of the above reasons, taken alone or in combination, Applicants respectfully request reconsideration and withdrawal of the 35 U.S.C. § 103(a) rejection of claims 1-17 and 19.

DRA/CET

Conclusion

In view of the above remarks, this application appears to be in condition for allowance and the Examiner is, therefore, requested to reexamine the application and pass the claims to issue.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Corina Tanasa, Registration No. 64,042, at telephone number (703) 208-4003, located in the Washington, DC area, to conduct an interview in an effort to expedite prosecution in connection with the present application.

If necessary, the Director is hereby authorized in this, concurrent, and future replies to charge any fees required during the pendency of the above-identified application or credit any overpayment to Deposit Account No. 02-2448.

Dated: May 30, 2012

Respectfully submitted,

By ______________________

D. Richard Anderson
Registration No.: 40,439
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road
Suite 100 East
P.O. Box 747
Falls Church, Virginia 22040-0747
(703) 205-8000
Attorney for Applicant

Enclosures: Verified English translation of JP 09-081010.

ct

DRA/CET

VERIFICATION OF ENGLISH TRANSLATION

I, Hiroshi TAMURA, declare that I am conversant in both the Japanese and English languages and that the English translation as attached hereto is an accurate translation of Japanese Patent Application No. H9-081010 filed March 31, 1997.

Date: May 29, 2012
Name: Hiroshi TAMURA

Signature: ____________________

Address: c/o AOYAMA & PARTNERS, IMP Building,
1-3-7, Shiromi, Chuo-ku,
Osaka 540-0001 Japan

PATENT OFFICE
JAPANESE GOVERNMENT

This is to certify that the annexed is a true copy of the following application as filed with this Office.

Date of Application: March 31, 1997

Application Number: 081010/1997

Applicant(s): Nichia Chemical Industries, Ltd.

May 30, 1997

Commissioner,
Patent Office

Hisamitsu ARAI
(seal)

Document Name:	Application for Patent
Docket No.:	P96ST30-2
Date of Application:	March 31, 1997
Addressee:	Mr. Hisamitsu ARAI, Commissioner, Patent Office
International Patent Classification:	H01L 33/00
Title of the Invention:	LIGHT EMITTING DEVICE
Number of Claims:	8

Inventor:

Address: c/o Nichia Chemical Industries, Ltd., 491-100, Oka, Kaminakacho, Anan-shi, Tokushima, Japan
Name: Toshio MORIGUCHI

Inventor:

Address: c/o Nichia Chemical Industries, Ltd., 491-100, Oka, Kaminakacho, Anan-shi, Tokushima, Japan
Name: Yasunobu NOGUCHI

Applicant:

Identification No.:	000226057
Zip Code:	774
Address:	491-100, Oka, Kaminakacho, Anan-shi, Tokushima, Japan
Name:	Nichia Chemical Industries, Ltd.
Representative:	Eiji OGAWA
Telephone No.:	0884-22-2311

Priority Claim based on the Earlier Application:

Application No.:	244339/1996
Filing Date:	September 17, 1996

Payment of Fees:

Prepayment Book No.:	010526
Amount to be paid:	¥21,000

Attached document:

Item:	Specification	1 copy
Item:	Drawings	1 copy
Item:	Abstract	1 copy

Proof: Yes

[Document Name] Specification

[Title of the Invention] LIGHT EMITTING DEVICE

[What is claimed is]

[Claim 1] A light emitting device comprising a light emitting component whose light emitting layer is a nitride compound semiconductor and a phosphor which absorbs at least a part of light emitted by the light emitting component to emit light of a wavelength longer than that of the light emitted by the light emitting component, wherein

the phosphor is composed of two or more kinds of yttrium-aluminum oxide fluorescent materials activated with cerium having different compositions.

[Claim 2] The light emitting device according to claim 1, wherein the yttrium-aluminum oxide fluorescent material activated with cerium is $(Re_xSm_{1-x})_3(Al_yGa_{1-y})_5O_{12}:Ce$ where $0<x\leq1$ and $0\leq y\leq1$ and Re is at least one selected from Y, Gd and La.

[Claim 3] The light emitting device according to claim 1, wherein the yttrium-aluminum oxide fluorescent material activated with cerium comprises an yttrium-aluminum oxide fluorescent material activated with cerium which has a main emission wavelength shorter than that of $Y_3Al_5O_{12}:Ce$ and an yttrium-aluminum oxide fluorescent material activated with cerium has a main emission wavelength longer than that of $Y_3Al_5O_{12}:Ce$.

[Claim 4] The light emitting device according to claim

1, wherein the yttrium-aluminum oxide fluorescent material activated with cerium comprises a first fluorescent material of $Y_3(Al_yGa_{1-y})_5O_{12}$:Ce and a second fluorescent material of $Re_3Al_5O_{12}$:Ce having a main emission wavelength longer than that of the first fluorescent material, where $0 \leq y \leq 1$ and Re is at least one selected from Y, Gd and La.

[Claim 5] The light emitting device according to claim 1, wherein the two or more kinds of yttrium-aluminum oxide fluorescent materials activated with cerium having different compositions comprise a third fluorescent material containing Gd and a fourth fluorescent material having a composition ratio of Gd higher than that of the third fluorescent material.

[Claim 6] The light emitting device according to claim 1, wherein a main emission peak of the light emitting component is within the range from 400 nm to 530 nm.

[Claim 7] The light emitting device according to claim 1, which is capable of planar light emission by means of optical coupling of a light emitting component and an optical guide plate via a color converting material having a phosphor arranged on the optical guide plate which is optically coupled with the light emitting component or a color converting material having the phosphor.

[Claim 8] A light emitting device which is a light emitting diode comprising a light emitting component placed in a cup of a mount lead, an inner lead electrically connected with the light emitting component with a conductive wire, a coating material filling the cup and a molding material covering at least part of the coating material, the light emitting component, the conductive wire, the mount lead and the inner lead, wherein

a light emitting layer of the light emitting component is a nitride compound semiconductor and the coating material contains two or more kinds of yttrium-aluminum oxide fluorescent materials activated with cerium having different compositions which absorb at least a part of the light emitted by the light emitting component to emit light of a wavelength longer than that of the light emitted by the light emitting component.

[Detailed Description of the Invention]

[0001]

[Industrial Utilization Field]

The present invention relates to a light emitting device used in back light source, illuminating switch, signal, display, LED display, indicator, etc. More particularly, it relates to a light emitting device which emits lights of RGB (red, green, blue) colors with high luminance and high efficiency regardless of the operating environment.

[0002]

[Prior Art]

A light emitting device using a LED chip is compact and emits light of clear color with high efficiency. It is also free from such a trouble as burn-out because it is a semiconductor element. It has an excellent initial drive characteristic and such an advantage as durability to endure vibration and repetitive ON/OFF operations. Thus it has been used in such applications as various indicators and various light sources. Recently light emitting diodes for RGB (red, green and blue) colors having ultra-high luminance and high efficiency have been developed. Accordingly, planar light sources for full color, which can be used in a liquid crystal back-light, using the three primary colors of RGB have been greatly advancing by making most of the advantages such as low power consumption, long life and light weight.

[0003]

The LED chip can emit light of various wavelengths ranging from ultra violet to infrared, depending on the semiconductor material and conditions to form a light emitting layer to be used. It also has favorable emission spectrum to generate monochromatic light.

[0004]

Although because the light emitting diode has favorable emission spectrum to generate monochromatic light, making a light source for white light requires it to arrange the LED chips which are capable of emitting light of RGB colors closely to each other while diffusing and mixing the light emitted by them. Although these light emitting diodes are effective as light emitting devices for emitting various colors freely, a set of red green and blue light emitting diodes or a set of blue-green and yellow light emitting diodes must be used even when generating white light only. A LED chip is a semiconductor and still includes considerable variations in the color tone and luminance. The LED chip which can emit lights of RGB colors with high luminance has not been yet made from the same semiconductor material. In case the LED chips which are semiconductor light emitting component are made from different materials, different LED chips require different drive voltages which must be supplied from different power sources provided separately. Therefore, white light must be generated by adjusting the current for each semiconductor. Similarly, color tone is subject to variation due to the difference in temperature characteristics and chronological changes, because the LED chips are semiconductor light emitting components. Further, uneven color may result unless the light rays emitted by the LED chips are mixed evenly.

[0005]

Thus, the present applicant previously developed a light emitting diode which converts the color of light emitted by a LED chip by means of a fluorescent material and a planar light source disclosed in Japanese Patent Kokai Nos. 5-152609, 7-176794 and 8-8614. By using the light emitting diode and the planar light source, light of other colors such as white color can be emitted by using a LED chip of one type.

[0006]

Specifically, a LED chip capable of emitting blue light is connected to one end of a transparent optical guide plate and light emitted by the LED chip is converted by a layer containing a fluorescent material provided on the optical guide plate into green and red light, thereby to produce light of white color. These devices can be used as light emitting devices which emit light for an extended period of time with a sufficient luminance, even when used as light emitting device capable of emitting light of white color having RGB light components.

[0007]

[Problems to be solved by the Invention]

There are various fluorescent materials such as fluorescent dye, fluorescent pigment and organic or inorganic compounds which are excited by light emitted by a LED chip. Excitation wavelengths and emission wavelengths of fluorescent materials also range widely. Also there are fluorescent materials which convert light of shorter wavelength emitted by a light emitting component into light of longer wavelength and those which convert light of longer wavelength emitted by a light emitting component into light of shorter wavelength.

[0008]

However, efficiency of conversion of long-wavelength light into short-wavelength light is extremely low and is not practical. When a light emitting device is used in outdoor environment such as under direct sunlight, or when a fluorescent material is located in the vicinity of the LED chip, the fluorescent material remains to be irradiated by high-energy radiations such as ultra violet ray of strong intensities for a long period of time. In particular, energy of light emitted by a semiconductor light emitting component having a high energy band gap enough to excite a fluorescent material and emit secondary radiation is inevitably high. Therefore, the fluorescent material itself is subject to deterioration due also to the synergistic effect with the extraneous light such as sun light.

[0009]

There are such cases as the color tone changes as the fluorescent material deteriorates or the fluorescent material is blackened resulting in lowered efficiency of extracting light. Similarly, the fluorescent material is exposed to a high temperature such as rising temperature of the LED chip and from the external environment. Further, although a light emitting device is usually sealed in a plastic casing, it is impossible to completely prevent the entry of moisture from the outside or to completely remove moisture which was contained during production. In the case of some fluorescent materials, such moisture accelerates the deterioration of the fluorescent material due to the high-energy radiation or heat transmitted from the light emitting component.

When it comes to an organic dye of ionic property, direct current electric field in the vicinity of the chip may cause electrophoresis, resulting in a change in the color tone. Therefore, an object of the present invention is to solve the problems described above and provide a light emitting device which is subject only to extremely low degrees of deterioration in light emission efficiency and color shift over a long period of time even when used outdoors, and is capable of emitting light of desired color with a high luminance.

[0010]

[Means for Solving the Problems]

The light emitting device of the present invention provides a light emitting device comprising a light emitting component whose light emitting layer is a nitride compound semiconductor and a phosphor which absorbs at least a part of light emitted by the light emitting component to emit light of a wavelength longer than that of the light emitted by the light emitting component, wherein

the phosphor is composed of two or more kinds of yttrium-aluminum oxide fluorescent materials activated with cerium having different compositions.

[0011]

With respect to the light emitting device of claim 2 of the present invention, the yttrium-aluminum oxide fluorescent material activated with cerium is

$(Re_xSm_{1-x})_3(Al_yGa_{1-y})_5O_{12}$:Ce (where $0<x\leq1$ and $0\leq y\leq1$ and Re is at least one selected from Y, Gd and La).

With respect to the light emitting device of claim 3 of the present invention, the yttrium-aluminum oxide fluorescent material activated with cerium comprises an yttrium-aluminum oxide fluorescent material activated with cerium which has a main emission wavelength shorter than that of $Y_3Al_5O_{12}$:Ce and an yttrium-aluminum oxide fluorescent material activated with cerium has a main emission wavelength longer than that of Y3Al5O12:Ce.

[0012]

With respect to the light emitting device of claim 4 of the present invention, the yttrium-aluminum oxide fluorescent material activated with cerium comprises a first fluorescent material of $Y_3(Al_yGa_{1-y})_5O_{12}$:Ce and a second fluorescent material of Re3Al5O12:Ce having a main emission wavelength longer than that of the first fluorescent material (where $0\leq y\leq1$ and Re is at least one selected from Y, Gd and La).

With respect to the light emitting device of claim 5 of the present invention, the yttrium-aluminum oxide fluorescent materials activated with cerium having different compositions comprise a third fluorescent material containing Gd and a fourth fluorescent material having a composition ratio of Gd higher than that of the third fluorescent material.

[0013]

With respect to the light emitting device of claim 6 of the present invention, a main emission peak of the light emitting component is within the range from 400 nm to 530 nm.

[0014]

The light emitting device of claim 7 of the present invention is a light emitting device capable of planar light emission by means of optical coupling of a light emitting component and an optical guide plate via a color converting material having a phosphor arranged on the optical guide plate which is optically coupled with the light emitting component, or via a color converting material having the phosphor.

[0015]

A light emitting device of claim 8 of the present invention is a light emitting diode comprising a light emitting component placed in a cup of a mount lead, an inner lead electrically connected with the light emitting component by means of a conductive wire, a coating material filling the cup and a molding material covering at least part of the coating material, the light emitting component, the conductive wire, the mount lead and the inner lead, wherein

a light emitting layer of the light emitting component is a nitride compound semiconductor and the coating material includes at least two kinds of yttrium-aluminum oxide fluorescent materials activated with cerium of different compositions which absorb at least a part of light emitted by the light emitting component and emit light of a wavelength longer than that of the light emitted by the light emitting component.

[0016]

[Action]

The light emitting device of the present invention has a light emitting component and fluorescent materials which are excited by light emitted by the light emitting component to emit light of a wavelength longer than that of the light emitted by the light emitting component. As the fluorescent materials, two or more kinds of yttrium-aluminum oxide fluorescent materials having different compositions are used. This enables the light emitting device to emit light of a desired color with a high efficiency. That is, when the wavelength of the light emitted by the semiconductor light emitting component falls within the range from point A to point B in Fig. 8 depending on the semiconductor light emitting component, the device can emit light of any color within the shaded range enclosed by points C and D in Fig. 8 which are chromaticity points of at least two kinds of yttrium-aluminum oxide fluorescent materials of different compositions. The color can be controlled through the selection of composition or quantities of the light emitting component and the fluorescent materials. The light emitting device can be caused to produce light of a desired wavelength by selecting various fluorescent materials and absorbing the variations in emission of the light emitting component. Also the light emitting device can be caused to generate light which includes RGB components with high luminance, by selecting the wavelengths of light emitted by the fluorescent materials.

[0017]

Moreover, the yttrium-aluminum oxide fluorescent material can be used to make a light emitting device capable of emitting light with a high luminance for a long period of time. Also by using a fluorescent material which emits light of a wavelength longer than that of the light emitted by the light emitting component, light can be emitted with a high efficiency. Because the converted light has a wavelength longer than that of the light emitted by the light emitting chip, it is less than the band gap of the light emitting chip and is less likely to be absorbed by the light emitting component. Therefore, even when light is emitted in isotropic way by the fluorescent material and is directed toward the light emitting component, it is not absorbed by the light emitting component, making it possible to emit light with a high efficiency.

[0018]

[Mode for carrying out the Invention]

The present inventors have found, as a result of various experiments, that it is made possible to prevent the decrease in emission efficiency and color shift through operation with a high luminance over a long period of time by selecting a particular semiconductor and a fluorescent material in a light emitting diode which uses a phosphor to convert the color of light emitted by a LED chip having a relatively high radiation energy in visible region, and have achieved the present invention.

[0019]

The phosphor used in the light emitting device of the present invention must satisfy the following requirements:

1. Excellent resistance against light, particularly durability to endure direct sun light in which lights with various high energy are radiated for a long period. And durability to endure light of a radiation illuminance as high as $Ee=3Wcm^{-2}$ and more because the fluorescent material is exposed to intense radiation from a tiny region such as a semiconductor light emitting component when used as a light emitting diode.

2. Capability to emit light in blue region, not ultra violet, because mixing of colors with the light emitting elements is used.

3. Capability to emit light from green to red regions with high luminance in consideration of mixing with blue light.

4. Good temperature characteristic suitable for location in the outdoor and in the vicinity of the light emitting component.

5. Capability to continuously change the color tone

in terms of the proportion of composition or ratio of mixing a plurality of fluorescent materials.

6. Weatherability for the operating environment of the light emitting diode.

[0020]

As materials that satisfy the above requirements, the present invention uses a nitride compound semiconductor element having high-energy band gap in the light emitting layer as the light emitting component, and an yttrium-aluminum oxide fluorescent material activated with cerium where two or more kinds of phosphors of different compositions are activated with cerium as the phosphor. With this constitution, the light emitting device can emit light of a desired color tone by controlling two or more kinds of fluorescent materials, even when the wavelength of light emitted by the light emitting component deviates from the desired wavelength due to a problem in the production process of the light emitting component or other causes. More specifically, $(Re_xSm_{1-x})_3(Al_yGa_{1-y})_5O_{12}:Ce$ is used as the yttrium-aluminum oxide fluorescent material activated with cerium (where $0<x\leq1$ and $0\leq y\leq1$, and Re is at least one selected from Y, Gd and La). This makes it possible to make a light emitting component which experiences color shift of emitted light and a decrease in luminance of the emitted light, both of very low degrees, even when irradiated with high-energy radiation in the visible light region emitted by

the light emitting component in the vicinity thereof over a long period of time or used outdoors, and emits light of desired component with high luminance.

[0021]

As one embodiment of the light emitting device, a chip type LED is shown in Fig. 1. A LED chip 102 employing gallium nitrate semiconductor is fixed in the casing of the chip type LED by means of epoxy resin or the like. The LED chip 102 employs a light emitting component having a $In_{0.4}Ga_{0.6}N$ semiconductor light emitting layer with a thickness of 470 nm. The light emitting component has a contact layer which is a gallium nitride semiconductor having N type conductivity, a clad layer which is a gallium nitride semiconductor having P type conductivity and a contact layer which is a gallium nitride semiconductor having P type conductivity, formed on a sapphire substrate. Formed between the contact layer having N type conductivity and the clad layer having P type conductivity is a non-doped InGaN active layer of a single quantum well structure of thickness about 3 nm. (The sapphire substrate has a gallium nitride semiconductor formed thereon under a low temperature to make a buffer layer.) Electrodes of the light emitting component 102 and electrodes 105 provided on the casing are electrically connected by means of gold wires 103 which are conductive wires. The LED chip which is a light emitting component, made by mixing and dispersing $Y_3Al_5O_{12}$:Ce as phosphor of green color and $(Y_{0.8}Gd_{0.2})_3Al_5O_{12}$:Ce as phosphor of red color in an acrylic resin, and the conductive wires are protected from extraneous stresses by a molding material 101 which is uniformly applied and cured. The LED chip is caused to emit light by supplying electric power to the light emitting device. By mixing blue light emitted by the LED chip and light emitted by two or more kinds of phosphor capable of emitting light of high luminance when excited by the light emitted by the LED chip, the light emitting diode can emit light of white color. The light emitting diode formed as described above does not have the light emitting pattern normally observed during emission of a conventional light emitting diode which does not include fluorescent material. The emission pattern generated by electrodes formed on the light emitting surface of the LED chip causing shadows are eliminated by diffusion caused by the fluorescent material. Thus the light emitting diode can emit light with uniform luminance. Constituents of the present invention will now be described below.

[0022]

(Phosphor)

The phosphor used in this invention refers to a phosphor which emits light when excited by visible light or ultra violet light emitted by the semiconductor light emitting component. In the present invention, the phosphor uses two or more kinds of yttrium-aluminum oxide fluorescent materials activated with cerium of different compositions. Desired white color can be produced by mixing light of blue color emitted by a light emitting component employing nitride compound semiconductor in the light emitting layer, light of green color and light of red color emitted by the phosphor with yellow body color for absorbing blue light, or light of yellow color having greenish and reddish hue. In the light emitting device, in order to achieve this color mixture, it is preferable that the phosphor in the form or powder or bulk be contained in various resins such as epoxy resin, acrylic resin and silicone resin, or an inorganic substance such as silicon dioxide or aluminum oxide. Such a substance which includes phosphor can be used in various forms such as dot-shaped construction and a layer formed thin enough to transmit light from the LED chip. Various color colors containing white and incandescent lamp color can be produced by adjusting the mix proportion of phosphor and resin and the amount of coating or filling material and selecting the wavelength of light emitted by the light emitting device.

The light emitting device can be rendered weather-proof and other characteristics by changing the distribution of the phosphor. The distribution can be adjusted by changing the material which includes the phosphor, forming temperature and viscosity and the shape and particle size distribution of the phosphor. Therefore, desired concentration of the fluorescent material can be selected depending on the operating conditions.

[0023]

Also the light emitting device can be made capable of emitting light with a high efficiency by arranging two or more fluorescent materials in an order with respect to the incident light coming from the respective light emitting components. That is, reflected light can be utilized effectively by laminating a color converting material which includes a fluorescent material having an absorbing wavelength on longer wavelength side and capable of emitting light of a long wavelength, and a color converting material which has an absorbing wavelength on further longer wavelength side and capable of emitting light of a long wavelength, on the light emitting component which has a reflecting material.

[0024]

By using the phosphor of the present invention, the light emitting device can be given enough light resistance for high-efficient operation even when arranged adjacent to or in the vicinity of a LED chip of radiation illuminance (Ee) in a range from 3 Wcm^{-2} up to 10 Wcm^{-2}.

[0025]

YAG fluorescent material capable of emitting green light which is yttrium-aluminum oxide fluorescent material activated with cerium used in the present invention has garnet structure, and is therefore resistant to heat, light and moisture, thereby to be capable of absorbing excitation light having a peak at a wavelength near 450 nm as indicated by the solid line in Fig. 4(A). It emits light of broad spectrum having a peak near 510 nm tailing out to 700 nm as indicated by the solid line in Fig. 4(B). YAG fluorescent material capable of emitting red light which is yttrium-aluminum oxide fluorescent material activated with cerium used in the present invention, too, has garnet structure and is therefore resistant to heat, light and moisture, and is capable of absorbing excitation light having a peak near 450 nm as indicated by the wavy line in Fig. 4(A). It also emits light of broad spectrum having a peak near 600 nm tailing out to 750 nm as indicated by the wavy line in Fig. 4(B).

[0026]

Wavelength of the emitted light is shifted to a shorter wavelength by substituting part of Al, among the constituents of the YAG fluorescent material having garnet structure, with Ga, and the wavelength of the emitted light can be shifted to a longer wavelength by substituting part of Y with Gd and/or La. Proportion of substituting Al with Ga is preferably from Ga:Al=1:1 to 4:6 in consideration of the light emitting efficiency and the wavelength of emission. Similarly, proportion of substituting Y with Gd and/or La is preferably from Y:Gd and/or La=9:1 to 1:9, or more preferably from Y:Gd and/or La=1:4 to 2:3. Substitution of less than 20% results in an increase of green component and a decrease of red component. Substitution of 80% or greater part, on the other hand, increases red component but decreases the luminance steeply.

[0027]

Material for making such a phosphor is made by using oxides of Y, Gd, Ce, La, Al, Sm and Ga or compounds which can be easily converted into these oxides at high temperatures, and sufficiently mixing these materials in stoichiometrical proportions. Otherwise, mixture material is obtained by dissolving rare earth elements Y, Gd, Ce, La and Sm in stoichiometrical proportions in an acid, coprecipitating the solution oxalic acid and sintering the coprecipitate to obtain an oxide of the coprecipitate, which is then mixed with aluminum oxide and gallium oxide. This mixture is mixed with an appropriate quantity of a fluoride such as ammonium fluoride used as a flux, and sintered in a crucible at a temperature from 1350 to 1450 °C in air for 2 to 5 hours. Then the sintered material is ground by ball mill in water, washed, separated, dried and sieved thereby to obtain the desired material.

[0028]

The two or more kinds of yttrium-aluminum oxide fluorescent materials activated with cerium of different compositions may be either used by mixing or arranged independently. When arranging the fluorescent materials independently, it is preferable to arrange in the order of a fluorescent material that absorbs light from the light emitting component of a shorter wavelength, then a fluorescent material that absorbs light of a longer wavelength. This arrangement enables efficient absorption and emission of light.

[0029]

(Light emitting components 102, 202, 302)

As the light emitting component used in the present invention, a nitride compound semiconductor capable of efficiently exciting the two or more kinds of yttrium-aluminum oxide fluorescent materials activated with cerium of different compositions may be used. The LED chip which is the light emitting component can be made by forming light emitting layer of semiconductor such as AlN, InN, GaN, InGaN or InGaAl on a substrate in the MOCVD process. The semiconductor structure may be homostructure, heterostructure or double-heterostructure which have MIS junction, PIN junction or PN junction. It may also be made in a single quantum well structure or multiple quantum well structure where a semiconductor active layer is formed in a thin film where quantum effect can occur. While various wavelengths of emitted light can be selected depending on the property and structure of the semiconductor layer material and the mixed crystal ratio thereof, it is preferable to emit light of a wavelength shorter than the wavelength of light emitted by the phosphor, in order to excite the phosphor more efficiently.

[0030]

When a nitride compound semiconductor is used, sapphire, spinnel, SiC, Si, ZnO,GaN or the like is used as the semiconductor substrate. Use of sapphire substrate is preferable in order to form a nitride compound semiconductor of good crystalinity. A buffer layer of GaN, AlN, etc. is formed on the sapphire substrate, and a nitride semiconductor having PN junction is formed thereon. The gallium nitride semiconductor has N type conductivity under the condition of not doped with any impurity. In order to form an N type gallium nitride semiconductor having desired properties such as improved light emission efficiency, it is preferably doped with N type dopant such as Si, Ge, Se, Te, and C. In order to form a P type gallium nitride semiconductor, on the other hand, it is preferably doped with P type dopant such as Zn, Mg, Be, Ca, Sr and Ba. Because it is difficult to turn a gallium nitride compound semiconductor to P type simply by doping a P type dopant, it is preferable to anneal the gallium nitride compound semiconductor doped with P type dopant in such process as heating in a furnace, irradiation with low-speed electron beam, plasma irradiation, etc., thereby to turn it to P type. After exposing the surfaces of P type and N type semiconductor layers by etching or other process, electrodes of the desired shapes are formed on the semiconductor layers by sputtering or vapor deposition.

[0031]

Then the semiconductor wafer which has been formed is cut into pieces by means of a dicing saw which has a rotating blade having diamond cutting edge, or separated by an external force after cutting grooves (half-cut) which have width greater than the blade edge width. Or otherwise, the wafer is cut into chips by scribing grid pattern of extremely fine lines on the semiconductor wafer by means of a scriber having a diamond stylus which makes straight reciprocal movement. Thus the LED chips of gallium nitride compound semiconductor can be made.

[0032]

In order to emit white light with the light emitting device of the present invention, wavelength of main light emitted by the light emitting component is preferably from 400 nm to 530 nm inclusive in consideration of the mixing color with the phosphor, and more preferably from 420 nm to 490 nm inclusive. It is further more preferable that the wavelength be from 450 nm to 475 nm inclusive, so as to increase the emission efficiency of the LED chip and the phosphor, respectively.

[0033]

(Conductive wires 103, 303)

The conductive wires should have good electric conductivity, good thermal conductivity and good mechanical connection with the electrodes of the light emitting components

102, 302. Thermal conductivity is preferably 0.01 cal/cm^2/cm/°C or higher, and more preferably 0.5 cal/cm^2/cm/°C or higher. For workability and other reasons, the diameter of the conductive wire is preferably from Φ10 μm to Φ45 μm inclusive. The conductive wire may specifically be a metal such as gold, copper, platinum and aluminum or an alloy thereof. Such a conductive wire can be easily connected to the electrodes of the LED chips, the inner lead 306 and the mount lead 305 by means of a wire bonding device.

[0034]

(Mount lead 305)

The mount lead 305 is used for mounting of the light emitting component 302, and suffices to have a size enough to load the LED chip 302 with a die bonding equipment or the like. In case a plurality of LED chips are installed and the mount lead is used as common electrode of the LED chips, sufficient electric conductivity and good connecting characteristic with the bonding wires and the like are required. When the LED chip is installed in the cup of the mount lead and the cup is filled with the fluorescent material, erroneous illumination due to light from other light emitting diode mounted nearby can be prevented.

[0035]

Bonding of the LED chip 302 and the mount lead 305 with the cup can be achieved by means of a thermoplastic resin.

Specifically, epoxy resin, acrylic resin and imide resin can be used. When bonding a face-down LED chip and the mount lead and, at the same time, electrically connecting them, Ag paste, carbon paste, metallic bump or the like can be used.

[0036]

Further, in order to improve the efficiency of light utilization of the light emitting diode, surface of the mount lead whereon the LED chip 302 is mounted may be mirror-polished to give reflecting function to the surface. In this case, the surface roughness is preferably from 0.1S to 0.8S inclusive. Electric resistance of the mount lead is preferably within 300 $\mu\Omega$-cm and more preferably within 3 $\mu\Omega$ -cm.

[0037]

When mounting a plurality of LED chips on the mount lead, the LED chips generate significant amount of heat and therefore high thermal conductivity is required. Specifically, the thermal conductivity is preferably 0.01 cal/cm^2/cm/°C or higher, and more preferably 0.5 cal/cm^2/cm/°C or higher. Materials which satisfy these requirements include iron, copper, iron-containing copper, tin-containing copper and metallized ceramics.

[0038]

(Inner lead 306)

The inner lead 306 provides connection between the LED chip mounted on the mount lead 305 and the conductive wire.

When mounting a plurality of LED chips 302 on the mount lead, it is necessary to employ such a construction that the conductive wires can be arranged so as not to touch each other.

[0039]

Specifically, contact of the conductive wires with each other which connect the inner leads that are more distant from the mount lead can be prevented by increasing the area of the end face where the inner lead 306 is wire-bonded as the distance from the mount lead increases.

[0040]

Surface roughness of the end face connecting with the conductive wire is preferably from 1.6S to 10S inclusive in consideration of close contact. In order to form the tip of the inner lead in a desired shape, the shape may be formed by punching the lead frame with a die in advance, or by grinding off a part of inner leads at the top after forming all inner leads. Further, after forming by punching the inner leads, desired end face area and height can be formed simultaneously by applying pressure in the direction of end face.

[0041]

The inner lead is required to have good connectivity with the bonding wires which are conductive wires and good electrical conductivity. Specifically, the electric resistance is preferably within 300 $\mu\Omega$-cm and more preferably within 3 $\mu\Omega$-cm. Materials which satisfy these requirements include iron, copper, iron containing copper, tin containing copper, copper-, gold- or silver-plated aluminum, iron or copper.

[0042]

(Coating material 301)

The coating material 301 used in the present invention is provided in the cup of the mount lead 305 in addition to the molding material 304, and includes the phosphor which converts the light emitted by the LED chip 302. As the coating material, transparent resins of excellent weatherability such as epoxy resin, urea resin and silicone and acrylic resin, or inorganic material such as silicon dioxide as a silicide and aluminum oxide are preferably employed. A dispersant may be used together with the phosphor. As the dispersant, barium titanate, titanium oxide, aluminum oxide, silicon dioxide and the like are preferably used.

[0043]

(Molding material 101, 210, 304)

The molding may be provided in order to protect the LED, the conductive wire and the coating material which includes phosphor from external disturbance, depending on the application of the light emitting device. The molding material can be generally made of a resin or glass. The angle of view can be increased by containing the phosphor. And also, the angle of view can be further increased by adding a dispersant, thereby making the directivity of the emission from the LED chip dull.

[0044]

Further, the molding material may be formed in a desired shape having the function of lens to focus or diffuse the light emitted by the LED chip. Therefore, the molding material may be made in a structure of multiple layers laminated. Specifically, it may be a convex lens or a concave lens, and may have an elliptic shape when viewed in the direction of optical axis, or a combination of these.

[0045]

As the molding material, transparent resin of excellent weatherability such as epoxy resin, urea resin, silicone resin and acrylic resin, or glass having a low melting point are preferably employed. As the dispersant, barium titanate, titanium oxide, aluminum oxide, silicon dioxide and the like are preferably used. The phosphor may be contained either in the molding material or in the coating material and other part. Or otherwise, the coating may be of other materials such as a resin containing phosphor and the molding material may be glass. In this case, such a light emitting diode can be made that is suited to mass production and is less affected by moisture. The molding and the coating may also be made of the same material in consideration of the refractive index.

[0046]

(Planar light source)

A planar light source which is one of light emitting devices of the present invention can be made either by turning white light into planar light by means of an optical guide plate when emitting white light as shown in Fig. 2(A), or by converting blue light emitted by the LED chip which emits planar light into white light as shown in Fig. 2(B).

[0047]

When turning white light into planar light by means of an optical guide plate, it can be achieved either by such a construction that a light emitting diode 202 capable of emitting blue light and an optical guide plate 204 are arranged interposing a color conversion material 201 which includes phosphor, or by such a construction that the light emitting diode 202 having nitride semiconductor light emitting component which includes phosphor to be capable of emitting blue light and the optical guide plate 204 are optically coupled in a molding material 210 or the like.

[0048]

When converting blue light emitted by the LED chip 202 which emits planar light into white light, the light emitting diode 202, which includes a nitride semiconductor in the light emitting layer and is capable of emitting blue light, and the optical guide plate 204 are optically coupled and then contained in a diffusion sheet 206 on the optical guide plate 204, or otherwise applied on the diffusion sheet together with a binder resin to form a sheet. Further, such a construction may also be employed as a binder containing phosphor is formed into dot-shape on the optical guide plate.

[0049]

Specifically, the LED chip which is the light emitting component is fixed in a metal substrate 203 or the like having inverted C shape whereon an insulation layer and a conductive pattern are formed. After electrically connecting the LED chip and the conductive pattern, epoxy resin is applied onto the substrate whereon the LED chip 202 is mounted, thereby to optically couple with an end face of the acrylic optical guide plate 204. Placed on the principal light emitting plane of the optical guide plate 204 is a sheet 201 made by applying a mixture of phosphor and epoxy resin uniformly on a diffusion sheet. The diffusion sheet 206 comprises a layer made by applying epoxy resin containing particles of aluminum oxide, silicon dioxide, titanium oxide or barium titanate as diffusion agent in a base of acrylic resin and a layer containing phosphor.

[0050]

It is preferable that a reflector film 207 containing a white diffusion agent be arranged on one principal plane of the optical guide plate for the purpose of preventing fluorescence wherein intense light is emitted from near the light emitting diode. Similarly, a reflector 205 is provided on the entire surface on the back of the optical guide plate 204 and on one end face where the light emitting diode is not provided, in order to improve the light emission efficiency. With this construction, a planar light source can be obtained which generates enough luminance even when used as the back light of liquid crystal. Application to a liquid crystal display can be achieved by arranging a polarizer plate on the principal plane of the optical guide plate via liquid crystal injected between glass substrates whereon a translucent conductive pattern not shown in the drawing is formed. Examples of the present invention will be described below. It goes without saying that the present invention is not limited to the Examples.

[0051]

[Examples]

(Example 1)

$In_{0.05}Ga_{0.95}N$ semiconductor having emission peak at 450 nm is used as a light emitting component. A LED chip is made by flowing TMG (trimethyl gallium) gas, TMI (trimethyl indium) gas, nitrogen gas and dopant gas together with a carrier gas on a cleaned sapphire substrate and forming a gallium nitride compound semiconductor layer in MOCVD process. A gallium nitride semiconductor layer having N type conductivity and a gallium nitride semiconductor layer having P type conductivity are formed by switching SiH4 and Cp_2Mg as dopant gas, thereby forming a PN junction. For the semiconductor light emitting component, a contact layer which is gallium nitride semiconductor having N type conductivity, a clad layer which is gallium nitride aluminum semiconductor having N type conductivity, a clad layer which is gallium nitride aluminum semiconductor having P type conductivity and a contact layer which is gallium nitride semiconductor having P type conductivity are formed. An active layer of Zn-doped InGaN which makes a double-hetero junction is formed between the clad layer having N type conductivity and the clad layer having P type conductivity. (A buffer layer is provided on the sapphire substrate by forming gallium nitride semiconductor layer at a low temperature. The P type semiconductor is annealed at a temperature of 400 °C or above after forming the film.)

After exposing the surfaces of P type and N type semiconductor layers by etching, electrodes are formed by sputtering. After scribing the semiconductor wafer which has been made as described above, LED chips are made as light emitting components by dividing the wafer with external force.

[0052]

The LED chip is mounted on a mount lead which has a cup at the tip of a silver-plated copper lead frame, by die bonding with epoxy resin. Electrodes of the LED chip, the mount lead and inner lead are electrically connected by wire boding with gold wires.

[0053]

The lead frame with the LED chip attached thereon is placed in a bullet-shaped die and sealed with translucent epoxy resin for molding, which is then cured at 150 °C for 5 hours, thereby to form a blue light emitting diode. The blue light emitting diode is connected to one end face of an acrylic optical guide plate which is polished on all end faces. On one surface and side face of the acrylic plate, screen printing is applied by using barium titanate dispersed in an acrylic binder as white color reflector, which is then cured.

[0054]

On the other hand, phosphors of green and red colors are made by dissolving rare earth elements of Y, Gd, Ce and La in an acid in stoichiometrical proportions, and coprecipitating the solution with oxalic acid. Oxide of the coprecipitate obtained by sintering this material is mixed with aluminum oxide and gallium oxide, thereby to obtain respective mixture materials. The mixture is then mixed with ammonium fluoride used as a flux, and sintered in a crucible at a temperature of 1400 °C in air for 3 hours. Then the sintered material is ground by ball mill in water, washed, separated, dried and sieved thereby to obtain the desired material.

[0055]

120 Parts by weight of the first fluorescent material having a composition of $Y_3(Al_{0.6}Ga_{0.4})_5O_{12}$:Ce and capable of emitting green light, 100 parts by weight of the second fluorescent material having a composition of $(Y_{0.4}Gd_{0.6})_3Al_5O_{12}$:Ce and capable of emitting red light, prepared in a process similar

to that for the first fluorescent material, are sufficiently mixed with 100 parts by weight of an epoxy resin, to form a slurry. The slurry is applied uniformly onto an acrylic layer of thickness of 0.5 mm by means of a multi-coater and then dried to form a fluorescent material layer used as a color converting material having a thickness of about 30 μm. The fluorescent material layer is cut into the same size as that of the principal light emitting plane of the optical guide plate, and arranged on the optical guide plate thereby to form the light emitting device. Measurements of chromaticity point and color rendering index of the light emitting device gave values of (0.29, 0.34) for chromaticity point (x, y) and 92.0 for Ra (color rendering index) which are approximate to 3-waveform fluorescent lamp. Light emitting efficiency of 121 m/W comparable to that of an incandescent lamp was obtained. Further in weatherability tests under conditions of energization with a current of 60 mA at room temperature, 20 mA at room temperature and 20 mA at 60 °C with 90% RH, no change due to the fluorescent material was observed.

[0056]

(Comparative Example 1)

According to the same manner as that described in Example 1 except for mixing the same quantities of a green organic fluorescent pigment (FA-001, manufactured by Synleuch Chemical Co.) and a red organic fluorescent pigment (FA-005, manufactured by Synleuch Chemial Co.) which are perylene-derivatives for the first and the second phosphor, the formation of a light emitting diode and weatherability test were conducted. Chromaticity coordinates of the light emitting diode thus formed were (x, y) = (0.34, 0.35). The weatherability test was conducted by irradiating with ultraviolet ray generated by carbon arc for 200 hours, representing equivalent irradiation of sun light over a period of one year, while measuring the luminance retaining ratio and color tone at various times during the test period. In a reliability test, the LED chip was energized to emit light at a constant temperature of 70 °C while measuring the luminance and color tone at different times. The results are shown in Fig. 6 and Fig. 7, together with Example 1.

[0057]

(Example 2)

A LED chip having $In_{0.05}Ga_{0.95}N$ with emission peak at 450 nm was formed as a light emitting component according to the same manner as that described in Example 1. The LED chip was mounted on a mount lead which had a cup at the tip of a silver-plated copper lead frame, by die bonding with epoxy resin. Electrodes of the LED chip, the mount lead and inner lead were electrically connected by wire boding with gold wires.

[0058]

On the other hand, phosphors of green and red colors were made by dissolving rare earth elements of Y, Gd and Ce in an acid in stoichiometrical proportions, and coprecipitating the solution with oxalic acid. Oxide of the coprecipitation obtained by sintering it was mixed with aluminum oxide and gallium oxide, thereby to obtain respective mixture materials. The mixture was mixed with ammonium fluoride used as a flux, and sintered in a crucible at a temperature of 1400 °C in air for 3 hours. Then the sintered material was ground by ball mill in water, washed, separated, dried and sieved thereby to obtain the desired material.

[0059]

40 Parts by weight of the first fluorescent material having a composition of $Y_3(Al_{0.5}Ga_{0.5})_5O_{12}$:Ce and capable of emitting green light, 40 parts by weight of the second fluorescent material having a composition of $(Y_{0.2}Gd_{0.8})_3Al_5O_{12}$:Ce and capable of emitting red light and 100 parts by weight of an epoxy resin were sufficiently mixed to form a slurry. The slurry was poured into the cup which is provided on the mount lead wherein the LED chip was placed. Then the resin containing the fluorescent material was cured at 130 °C for 1 hour. Thus a coating layer containing the fluorescent material in thickness of 120 μm was formed on the LED chip. Concentration of the fluorescent material in the coating layer was increased gradually toward the LED chip. Further, the LED chip and the fluorescent material were molded with translucent epoxy resin for the purpose of

protection against extraneous stress, moisture and dust. A lead frame with the coating layer of phosphor formed thereon was placed in a bullet-shaped die and mixed with translucent epoxy resin and then cured at 150 °C for 5 hours. Under visual observation of the light emitting diode formed as described above in the direction normal to the light emitting plane, it was found that the central portion was rendered yellowish color due to the body color of the phosphor.

[0060]

Measurements of chromaticity point, color temperature and color rendering index of the light emitting diode which was obtained as described above and capable of emitting white light gave values of (0.32, 0.34) for chromaticity point (x, y), 89.0 for Ra (color rendering index) and light emitting efficiency of 101 m/W. Further in weatherability tests under conditions of energization with a current of 60 mA at room temperature, 20 mA at room temperature and 20 mA at 60 °C with 90% RH, no change due to the phosphor was observed, showing no difference from an ordinary blue light emitting diode in the service life characteristic.

[0061]

(Example 3)

In0.4Ga0.6N semiconductor having an emission peak at 470 nm was used as a light emitting component. A LED chip was made by flowing TMG (trimethyl gallium) gas, TMI (trimethyl indium) gas, nitrogen gas and dopant gas together with a carrier gas on a cleaned sapphire substrate and forming a gallium nitride compound semiconductor layer in MOCVD process. A gallium nitride semiconductor layer having N type conductivity and a gallium nitride semiconductor layer having P type conductivity were formed by switching SiH4 and Cp_2Mg used as the dopant gas, thereby forming a PN junction. For the semiconductor light emitting component, a contact layer which was gallium nitride semiconductor having P type conductivity, a clad layer which was gallium nitride aluminum semiconductor having P type conductivity and a contact layer which was gallium nitride semiconductor having P type conductivity were formed. An active layer of non-doped InGaN which had single quantum well structure with thickness of about 3 nm was formed between the contact layer having N type conductivity and the clad layer having P type conductivity. (A buffer layer was provided on the sapphire substrate by forming a gallium nitride semiconductor layer at a low temperature.)

After exposing the surfaces of P type and N type semiconductor layers by etching, electrodes were formed by sputtering. After scribing the semiconductor wafer which was made as described above, LED chips were made as light emitting components by dividing the wafer with an external force.

[0062]

The LED chip was mounted on a mount lead provided with a cup at the tip of a silver-plated copper lead frame, by die bonding with an epoxy resin. Electrodes of the LED chip, the mount lead and inner lead were electrically connected by wire boding with gold wires.

[0063]

The lead frame with the LED chip attached thereon was placed in a bullet-shaped die and sealed with translucent epoxy resin for molding, which was then cured at 150 °C for 5 hours, thereby to form a blue light emitting diode. The blue light emitting diode was connected to one end face of an acrylic optical guide plate which was polished on all end faces thereof. On one surface and side face of the acrylic plate, screen printing was applied by using barium titanate dispersed in acrylic binder as white color reflector, which was then cured.

[0064]

For the phosphor, a fluorescent material capable of emitting yellow light of a relatively short wavelength and a fluorescent material capable of emitting yellow light of a relatively long wavelength were used as two or more kinds of yttrium-aluminum oxide fluorescent material activated with cerium of different compositions. Rare earth elements of Y, Gd and Ce were dissolved in an acid in stoichiometrical proportions, and the solution was coprecipitated with oxalic acid. Oxide of the coprecipitate obtained by sintering the precipitate was mixed with aluminum oxide. The mixture was mixed with ammonium fluoride used as a flux, and sintered in a crucible at a temperature of 1400 °C in air for 3 hours. Then the sintered material was ground by ball mill in water, washed, separated, dried and sieved thereby to obtain the desired material.

[0065]

100 Parts by weight of the fluorescent material having a composition of $(Y_{0.8}Gd_{0.2})_3Al_5O_{12}$:Ce and capable of emitting yellow light of a relatively short wavelength and 100 parts by weight of the fluorescent material having a composition of $(Y_{0.4}Gd_{0.6})_3Al_5O_{12}$:Ce and capable of emitting yellow light of a relatively long wavelength, prepared in a process similar to that of the former, and 1000 parts by weight of an acrylic resin were well mixed and formed, by extrusion molding, into a fluorescent material layer as color conversion material in thickness of about 180 μm. The fluorescent material layer was cut into the same size as the principal light emitting plane of the optical guide plate, and arranged on the optical guide plate thereby to form the light emitting device. Measurements of chromaticity point and color rendering index of the light emitting device gave values of (0.33, 0.34) for chromaticity point (x, y) and 88.0 for Ra (color rendering index). Light emitting efficiency of 101 m/W was obtained. Further in weatherability tests under conditions of

energization with a current of 60 mA at room temperature, 20 mA at room temperature and 20 mA at 60 °C with 90% RH, no change due to the fluorescent material was observed. Similarly, desired chromaticity point can be maintained even when the wavelength of light emitted by the light emitting component is changed by changing the concentration of the fluorescent material.

[0066]

[Effect of the Invention]

According to the present invention, by using a high-output light emitting component of nitride compound semiconductor and two or more kinds of phosphors of different compositions which emit light upon excitation by the light from the light emitting component, a light emitting device which maintains a high light emitting efficiency over a long period of operation with a high luminance and is capable of emitting light of desired color can be made. The light emitting component which excites the fluorescent material emits light of a short wavelength and is capable of exciting the fluorescent material efficiently, and the light radiated isotropically by the fluorescent material is not absorbed by the light emitting layer of the light emitting component. Therefore, even higher efficiency of emitting light is made possible when the light emitting component is arranged on a reflective material. With high reliability, energy saving performance, compact construction and capability to change color temperature, the present invention can open up new applications containing display and illumination in automobile, aircraft and electric appliances in general, as well as outdoor use such as buoys for harbors and ports and sign and illumination for expressways. Also the light emitting diode of the present invention is better for the human eyes because white light imposes less stimulation to the eye when watched for a long period of time.

[0067]

The construction described in claim 1 of the present invention, in particular, makes it possible to obtain a light emitting device capable of emitting white light having desired components with high luminance, with minimum color shift and deterioration in light emission efficiency, even when used over an extended period of time. Also a light emitting device of high color rendering index can be made by using two or more kinds of fluorescent materials of different compositions. Moreover, a light emitting device which has favorable characteristics for mass production and is capable of emitting light of constant color can be made by adjusting the compositions and concentrations of the fluorescent materials, even when the wavelength of light emitted by the light emitting component deviates.

[0068]

By making the light emitting device in the specific construction as described in claim 2 of the present invention, it is made possible to emit desired light with minimum color shift and minimum deterioration in light emission efficiency, even when used over an extended period of time.

[0069]

By making the light emitting device in the construction as described in claim 3 of the present invention, it is made possible to emit white light with minimum color shift and minimum deterioration in light emission efficiency, even when used over an extended period of time.

[0070]

By making the light emitting device in the construction as described in claim 4 of the present invention, it is made possible to emit white light with minimum color shift and minimum deterioration in light emission efficiency, even when used over an extended period of time.

[0071]

By making the light emitting device in the construction as described in claim 5 of the present invention, it is made possible to emit desired light with minimum color shift and minimum deterioration in light emission efficiency, even when used over an extended period of time.

[0072]

By making the light emitting device in the construction as described in claim 6 of the present invention, it is made possible to emit light more efficiently with minimum color shift and minimum deterioration in light emission efficiency, even when used over an extended period of time.

[0073]

By making the light emitting device in the construction as described in claim 7 of the present invention, it is made possible to emit white light more uniformly in a planar construction with minimum color shift and minimum deterioration in light emission efficiency, even when used over an extended period of time.

[0074]

By making the light emitting diode in the construction as described in claim 8 of the present invention, it is made possible to emit white light containing RGB components with high luminance, with minimum color shift and minimum deterioration in light emission efficiency, even when used over an extended period of time under outdoor environment.

[Brief Description of the Drawings]

[Fig. 1] Fig. 1 is a schematic sectional view of the light emitting device of the present invention.

[Fig. 2] Fig. 2 is a schematic sectional view of the planar light source which is another light emitting device of the present invention, while (A) showing the planar light source having the phosphor between the optical guide plate and the light emitting diode, and (B) showing the planar light source having the phosphor on the principal plane of the optical guide plate.

[Fig. 3] Fig. 3 is a schematic sectional view of the light emitting diode which is another light emitting device of the present invention.

[Fig. 4] Fig. 4(A) shows an example of absorption spectrum of the first and the second phosphors used in the present invention, and Fig. 4(B) shows an example of emission spectrum of the first and the second phosphors used in the present invention.

[Fig. 5] Fig. 5 shows an example of emission spectrum of the light emitting component used in the present invention.

[Fig. 6] Fig. 6 shows the results of weatherability test for the comparison of the present invention with the reference light emitting device, while (A) shows a relation between the luminance retaining ratio and the time, and (B) is a graph showing a relation between the color tone and the time.

[Fig. 7] Fig. 7 shows the results of reliability test for the comparison of the present invention with the reference light emitting device, while (A) shows a relation between the luminance retaining ratio and the time, and (B) is a graph showing a relation between the color tone and the time.

[Fig. 8] Fig. 8 shows the chromaticity diagram of light which the light emitting device of the present invention can emit. Points A and B indicate the colors of light emitted by the light emitting device and points C and D indicate the colors of light emitted by two kinds of phosphors.

[Description of the Reference Numerals]

101, 210: Molding material wherein phosphor is contained

102, 202, 302: Light emitting component

103, 303: Conductive wire

104: Casing

105: External electrode

201: Color conversion material

203: Support

204: Optical guide plate

205, 207: Reflective material

206: Diffusion sheet

301: Coating material wherein phosphor is contained

304: Molding material

305: Mount lead

306: Inner lead

[Document Name] Abstract

[Abstract]

[Object] It is to provide a light emitting device used in back light source, illuminating switch, signal, display, LED display, indicator, etc and particularly to provide a light emitting device which emits light of desirable color with high luminance and high efficiency regardless of the operating environment.

[Means for solving] The light emitting device has a light emitting component using a gallium nitride semiconductor as a light emitting layer and a phosphor which absorbs at least a part of light emitted by the light emitting component to emit light of a wavelength longer than that of the light emitted by the light emitting component. The phosphor is composed of two or more kinds of yttrium-aluminum oxide fluorescent materials activated with cerium having different compositions.

Fig. 1

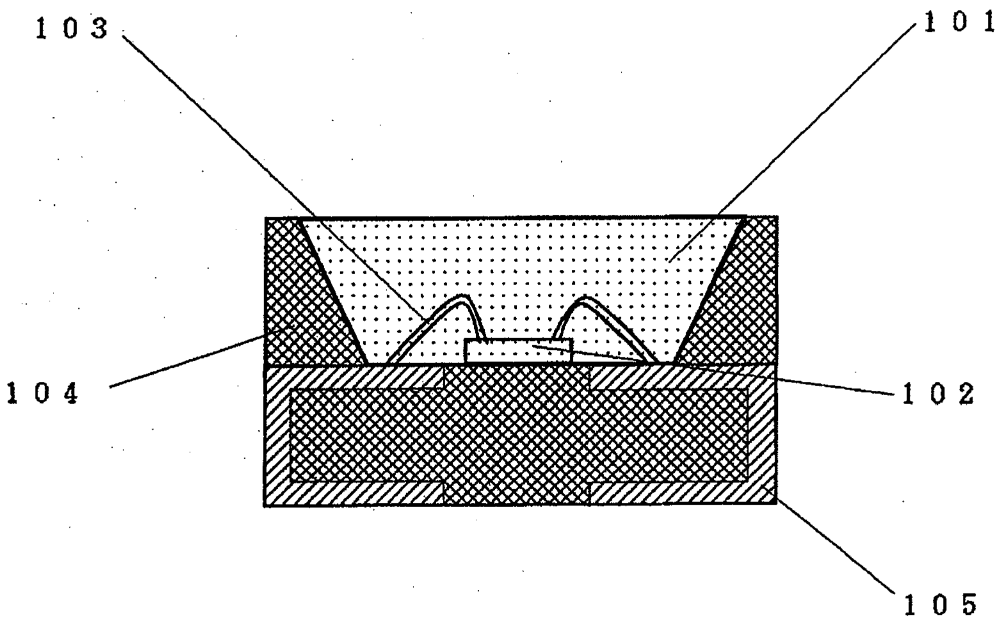
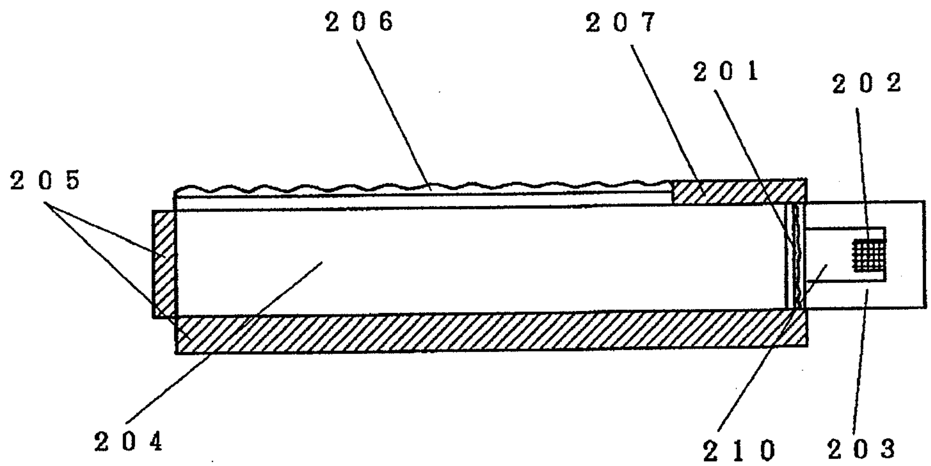
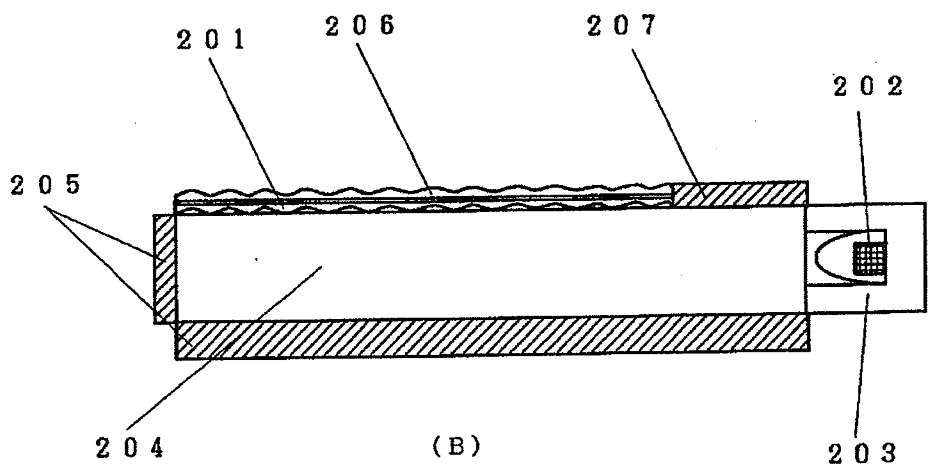


Fig. 2



(A)



(B)

Fig. 3

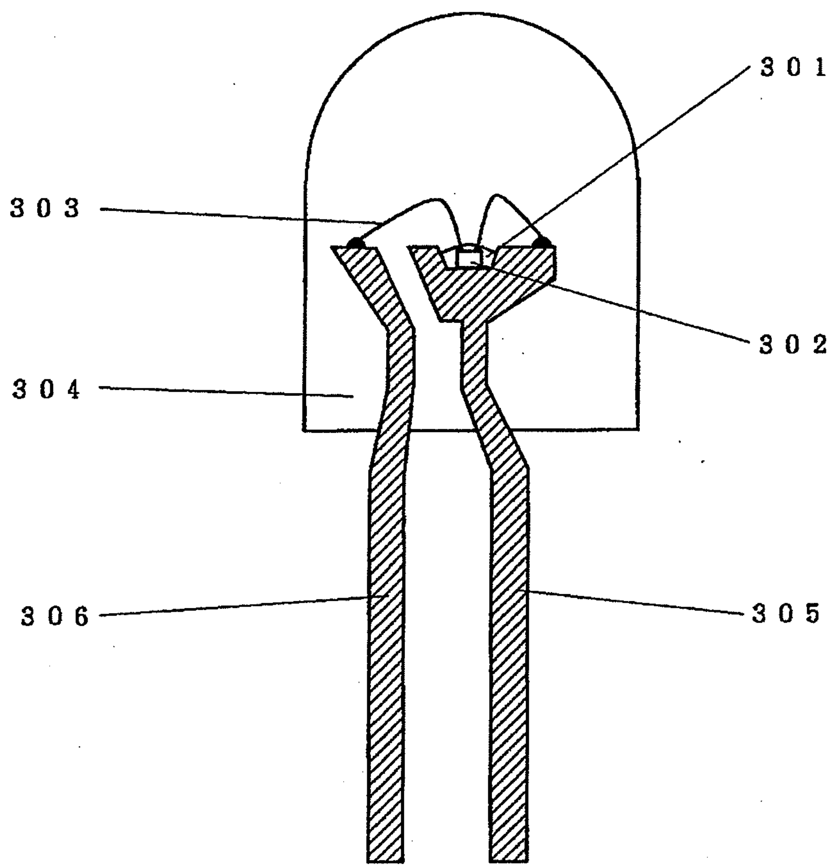
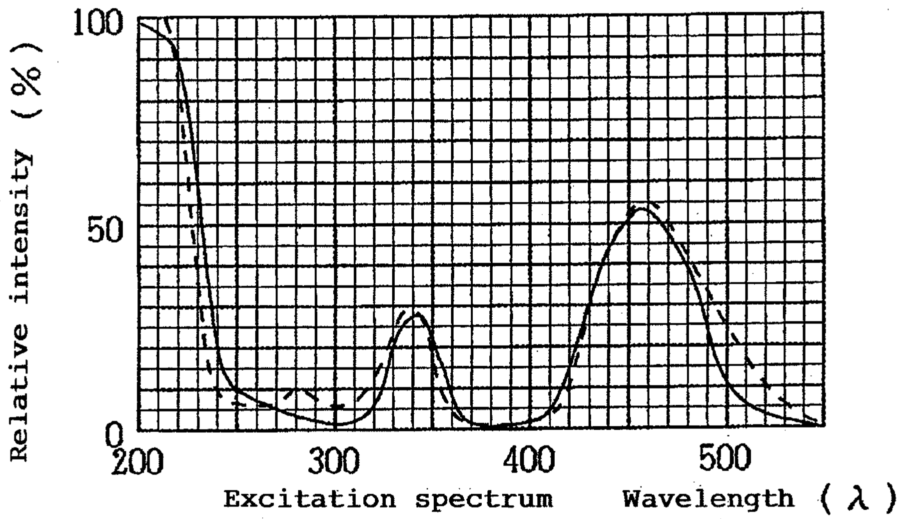
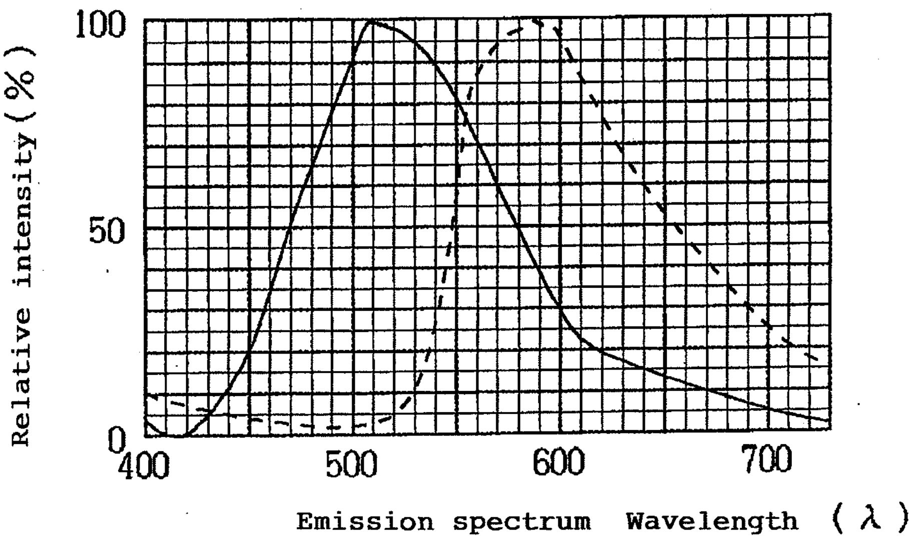


Fig. 4

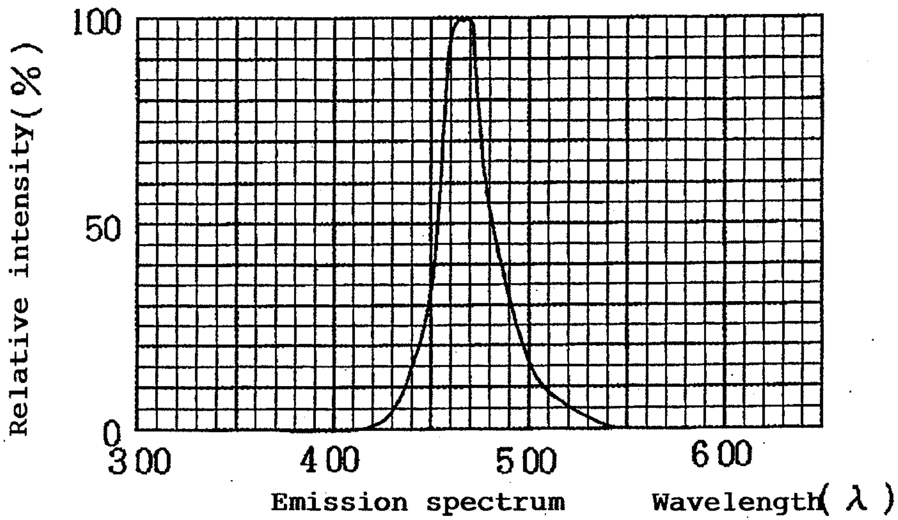

100
50
0
Relative intensity (%)
200
300
400
500
Excitation spectrum Wavelength (λ)

(A)


100
50
0
Relative intensity (%)
400
500
600
700
Emission spectrum Wavelength (λ)

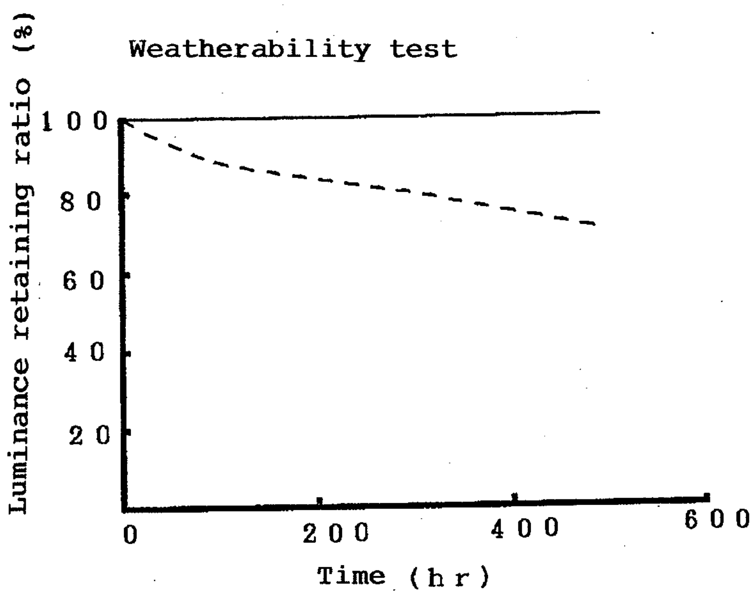
(B)

Fig. 5


Relative intensity(%)
100
50
0
300
400
500
600
Emission spectrum
Wavelength(λ)

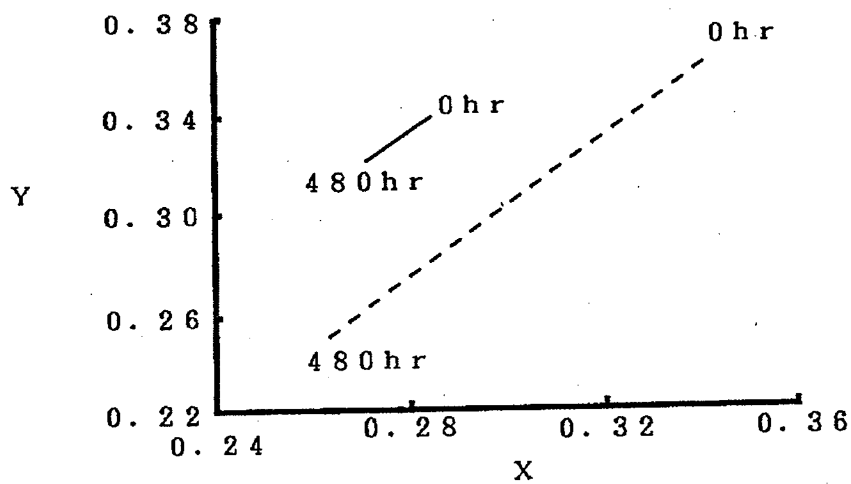
5

Fig. 6



Weatherability test
Luminance retaining ratio (%)
100
80
60
40
20
0
200
400
600
Time (hr)

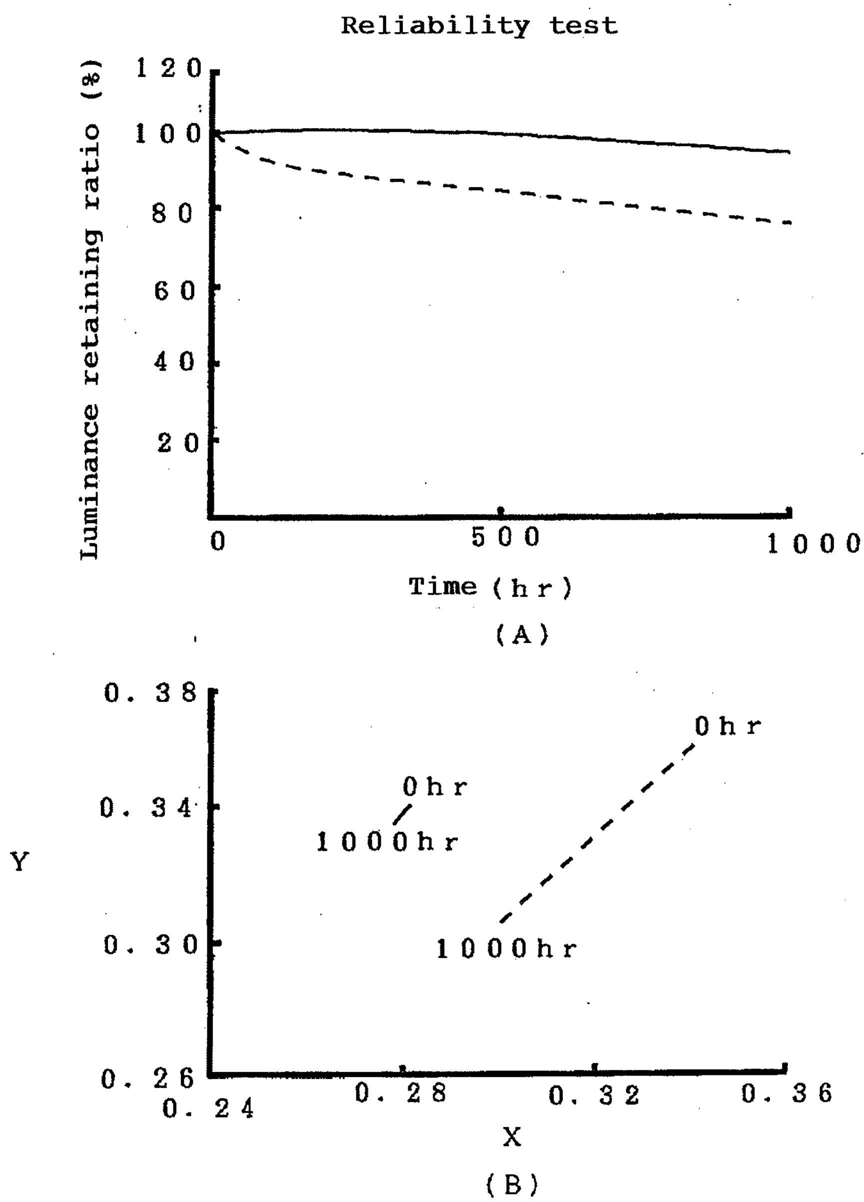
(A)



0.38
0.34
0.30
0.26
0.22
Y
0hr
480hr
0hr
480hr
0.24
0.28
0.32
0.36
X

(B)

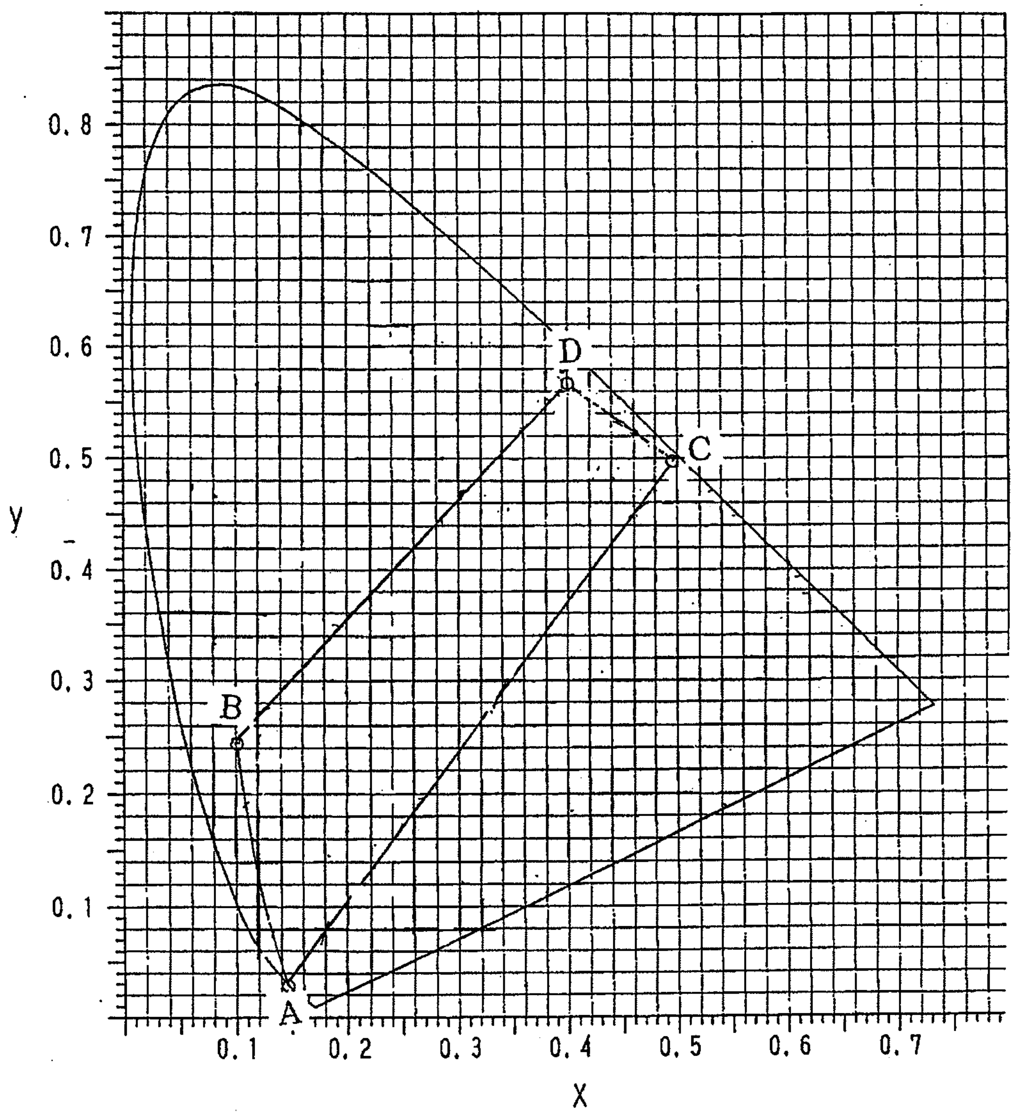
Fig. 7



Reliability test
Luminance retaining ratio (%)
120
100
80
60
40
20
0
500
1000
Time (hr)
(A)
0.38
0.34
0.30
0.26
Y
0hr
1000hr
0hr
1000hr
0.24
0.28
0.32
0.36
X
(B)

Fig. 8

Fig. 8



Electronic Patent Application Fee Transmittal

Application Number:	12942792
Filing Date:	09-Nov-2010
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimizu
Filer:	David Richard Anderson/Patti Young
Attorney Docket Number:	0020-5147PUS12

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Extension - 1 month with $0 paid	1251	1	150	150

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
	Total in USD ($)			**150**

Electronic Acknowledgement Receipt

EFS ID:	12895060
Application Number:	12942792
International Application Number:	
Confirmation Number:	2357
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimizu
Customer Number:	2292
Filer:	David Richard Anderson/Patti Young
Filer Authorized By:	David Richard Anderson
Attorney Docket Number:	0020-5147PUS12
Receipt Date:	30-MAY-2012
Filing Date:	09-NOV-2010
Time Stamp:	16:47:56
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$150
RAM confirmation Number	4036
Deposit Account	022448
Authorized User	ANDERSON,RICHARD D.

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		20120530Amendment.pdf	552057 ff64cf1130886a10386e6912b651d591c4ea97ab	yes	12

Multipart Description/PDF files in .zip description

Document Description	Start	End
Miscellaneous Incoming Letter	1	1
Extension of Time	2	2
Amendment/Req. Reconsideration-After Non-Final Reject	3	3
Claims	4	7
Applicant Arguments/Remarks Made in an Amendment	8	12

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
2	Miscellaneous Incoming Letter	20120530VerifiedEnglishTranslationofJP09081010.pdf	1877581 01aa2aafa02b5f3d543e9cf39d23cf15e97079ba	no	59

Warnings:

Information:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
3	Fee Worksheet (SB06)	fee-info.pdf	30135 e957083f64f421c1e3931ed7787a8f281180b22c	no	2

Warnings:

Information:

Total Files Size (in bytes):	2459773

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New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

FEE TRANSMITTAL

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 150.00

Complete if Known	
Application Number	12/942,792 Conf. No.: 2357
Filing Date	November 09, 2010
First Named Inventor	Yoshinori SHIMIZU
Examiner Name	A.B. MUSTAPHA
Art Unit	2812
Attorney Docket No.	0020-5147PUS12

METHOD OF PAYMENT (check all that apply)

☐ Check ☑ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): ____

☑ Deposit Account Deposit Account Number: 02-2448 Deposit Account Name: Birch, Stewart, Kolasch & Birch, LLP

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☐ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☑ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☑ Credit any overpayments

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FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
Application Type	**Fee ($)**	**Small Entity Fee ($)**	**Fee ($)**	**Small Entity Fee ($)**	**Fee ($)**	**Small Entity Fee ($)**	**Fees Paid ($)**
Utility	380	190	620	310	250	125	
Design	250	125	120	60	160	80	
Plant	250	125	380	190	200	100	
Reissue	380	190	620	310	750	375	
Provisional	250	125	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	**Fee ($)**	**Small Entity Fee ($)**
Each claim over 20 (including Reissues)	60	30
Each independent claim over 3 (including Reissues)	250	125
Multiple dependent claims	450	225

Total Claims 19 - 20 or HP = **Extra Claims** 0 x **Fee ($)** ____ = **Fee Paid ($)** 0.00

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims 1 - 3 or HP = **Extra Claims** 0 x **Fee ($)** ____ = **Fee Paid ($)** 0.00

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims

Fee ($) ____ **Fee Paid ($)** ____

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets ____ - 100 = **Extra Sheets** 0 / 50 = **Number of each additional 50 or fraction thereof** 0 (round **up** to a whole number) x **Fee ($)** ____ = **Fee Paid ($)** 0.00

4. OTHER FEE(S) **Fees Paid ($)**

Non-English Specification, $130 fee (no small entity discount) ____

Other (e.g., late filing surcharge): 1251 - 1 mo. EOT 150.00

SUBMITTED BY

Signature	[signature]	Registration No. (Attorney/Agent) 40,439	Telephone 703-205-8000
Name (Print/Type)	D. Richard Anderson		Date May 30, 2012

ot

PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a)	Docket Number (Optional) 0020-5147PUS12
Application Number 12/942,792	Filed November 09, 2010
For LIGHT EMITTING DEVICE AND DISPLAY	
Art Unit 2812	Examiner A.B. MUSTAPHA

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

	Fee	Small Entity Fee	
☑ One month (37 CFR 1.17(a)(1))	$150	$75	$ 150.00
☐ Two months (37 CFR 1.17(a)(2))	$560	$280	$
☐ Three months (37 CFR 1.17(a)(3))	$1270	$635	$
☐ Four months (37 CFR 1.17(a)(4))	$1980	$990	$
☐ Five months (37 CFR 1.17(a)(5))	$2690	$1345	$

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check in the amount of the fee is enclosed.

☑ Payment by credit card. Form PTO-2038 is attached.

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 02-2448.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the ☐ applicant/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) is enclosed (Form PTO/SB/96).

☑ attorney or agent of record. Registration Number 40,439

☐ attorney or agent under 37 CFR 1.34.
Registration number if acting under 37 CFR 1.34 ______

Signature	May 30, 2012 Date
D. Richard Anderson Typed or printed name	703-205-8000 Telephone Number

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below.

☐ Total of ______ forms are submitted.

Cot

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	1	of	2

Complete if Known	
Application Number	12/942,792
Filing Date	11-09-10
First Named Inventor	Yoshinori Shimizu
Art Unit	2812
Examiner Name	A.B. MUSTAPHA
Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

Examiner initial *	Cite No.	Document Number Number - Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	US-2006/0067668 - A1	03-30-2006	KITA	
	2	US-2008/0128735 - A1	06-05-2008	YOO et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial *	Cite No. 1	Foreign Patent Document Country[3] Code Number[4] Kind Code (if known)[5]	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear	T
	3	JP 9-116225 - A	05-02-1997			✓

Examiner Signature		Date Considered	

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not Considered. Include copy of this form with next communication to applicant. 1. Applicant's unique citation design number (optional). 2 See Kinds Codes of USPTO patent Documents. at www.uspto.gov or MPEP 901.04. 3. Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4. For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5. Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. 6. Applicant is to place a check mark here if English language Translation is attached.

ef

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 2 of 2

Complete if Known	
Application Number	12/942,792
Filing Date	11-09-10
First Named Inventor	Yoshinori Shimizu
Art Unit	2812
Examiner Name	A.B. MUSTAPHA
Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

Examiner initial *	Cite No. 1	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T 2
	4	U.S. Office Action, dated January 9, 2012, for U.S. Application No. 12/947,470.	
	5	U.S. Office Action, dated March 13, 2012, for U.S. Application No. 13/210,027.	

Examiner Signature		Date Considered	

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Docket No.: 0020-5147PUS12
(Patent)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application of:
Yoshinori SHIMIZU et al.

Application No.:	12/942,792	Confirmation No.:	2357
Filed:	November 09, 2010	Art Unit:	2812
For:	LIGHT EMITTING DEVICE AND DISPLAY	Examiner:	A.B. MUSTAPHA

LETTER REGARDING COPENDING APPLICATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Under the provisions of MPEP § 2001.06(b), the Examiner is hereby advised of the following copending U.S. Application:

Appl. No.	Filing Date	Group
13/210,027	August 15, 2011	2812

The subject matter contained in the above-listed copending U.S. application may be deemed to relate to the present application, and thus may be material to the prosecution of this instant application.

The above-listed co-pending application is not to be construed as prior art. By bringing the above-listed application to the attention of the Examiner, Applicants do NOT waive any confidentiality concerning the above-listed co-pending application or this application. See MPEP § 101.

If necessary, the Director is hereby authorized in this, concurrent, and future replies to charge any fees required during the pendency of the above-identified application or credit any overpayment to Deposit Account No. 02-2448.

Dated: APR 5 2012

Respectfully submitted, Reg. No.

By Corina Tanasa 64042

for D. Richard Anderson CORINA TANASA

Registration No.: 40439
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road, Suite 100 East
P.O. Box 747
Falls Church, VA 22040-0747
703-205-8000

Electronic Acknowledgement Receipt

EFS ID:	12466593
Application Number:	12942792
International Application Number:	
Confirmation Number:	2357
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimizu
Customer Number:	2292
Filer:	Corina E. Tanasa/Sarah Beatty (ts)
Filer Authorized By:	Corina E. Tanasa
Attorney Docket Number:	0020-5147PUS12
Receipt Date:	05-APR-2012
Filing Date:	09-NOV-2010
Time Stamp:	12:54:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Foreign Reference	JP-9-116225-AwithTranslation.pdf	2962797 612782c545a54da452bac5e2cf2f1a020d042a3c	no	13

Warnings:

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2	Non Patent Literature	USOAdated01-09-2012forApln 12-947470.pdf	1845677 9cd4184837bbc1df98a6e065617756563dc1b108	no	30
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3	Non Patent Literature	USOAdated03-13-2012forApln 13-210027.pdf	1774649 76f467abe4d4bcfd3c762368956e8ecd92393780	no	28
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4		2012-04-05_IDSTransmittals_0020-5147PUS12.pdf	347717 3ad2f182362da05a5cedd753ba6077f6f5372af9	yes	7

Multipart Description/PDF files in .zip description

Document Description	Start	End
Transmittal Letter	1	5
Information Disclosure Statement (IDS) Form (SB08)	6	7

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5	Miscellaneous Incoming Letter	2012-04-05_CopendingLetter_0020-5147PUS12.pdf	49228 0e5a62d2c88c46471e4a36129471dd208f19065b	no	2
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PATENT ABSTRACTS OF JAPAN

(11)Publication number : 09-116225
(43)Date of publication of application : 02.05.1997

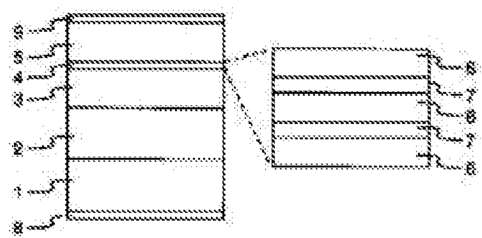
(51)Int.Cl. H01S 3/18

(21)Application number : 07-272321
(22)Date of filing : 20.10.1995

(71)Applicant : HITACHI LTD
(72)Inventor : NIWA ATSUKO
OTOSHI SO
KURODA TAKARO
TANAKA TOSHIAKI
WATANABE AKISADA

(54) SEMICONDUCTOR LIGHT EMITTING DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To reduce the threshold carrier density of a gallium nitride-based compound semiconductor laser by reducing the state density of a valence band and increasing the transition probability of the band.
SOLUTION: A quantum well active layer 4 having a biaxial tensile strain is grown on a substrate crystal 1 having plane orientation of (1-100)-plane, (11-20)-plane, or an equivalent plane, and a resonator is constituted in the direction perpendicular to the (0001)-direction. Therefore, the state density of the upper part of a valence band can be reduced and, at the same time, the transition probability of the band can be increased. In addition, a gallium nitride-based compound semiconductor laser can be obtained, because the threshold current density can be reduced.



CLAIMS

[Claim(s)]
[Claim 1]A semiconductor light emitting element comprising material whose grating constant in the state characterized by comprising the following where it is formed on a field or a field equivalent to this, and optically biaxial stress does not have a well layer of the above-mentioned quantum well active layer is smaller than a grating constant of the first crystal of the above.
It is a cladding layer of a bilayer of the first conductivity type and the second conductivity type on the first crystal that comprises a compound semiconductor at least and has wurtzite structure.
It is a semiconductor light emitting element which grows epitaxially a quantum well active layer inserted into the above-mentioned cladding layer, and the above-mentioned quantum well active layer is a gap of less than 10 degrees from a field (1-100).

[Claim 2]A semiconductor light emitting element comprising material whose grating constant in the state characterized by comprising the following where it is formed on a field or a field equivalent to this, and optically biaxial stress does not have a well layer of the above-mentioned quantum well active layer is smaller than a grating constant of the first crystal of the above.
It is a cladding layer of a bilayer of the first conductivity type and the second conductivity type on the first crystal that comprises a compound semiconductor at least and has wurtzite structure.
It is a semiconductor light emitting element which grows epitaxially a quantum well active layer inserted into the above-mentioned cladding layer, and the above-mentioned quantum well active layer is a gap of less than 10 degrees from a field (11-20).

[Claim 3]A semiconductor light emitting element, wherein a waveguide is formed in the direction vertical to the [0001] directions in a semiconductor light emitting element given in the 1-2nd clauses of a range of claim for patent.
[Claim 4]A semiconductor light emitting element, wherein the above-mentioned quantum well active layer is constituted from InxGayAl1-x-yNzAs1-z (0< x<=1, 0< y<=1, 0< z<=1) in a semiconductor light emitting element of a description by the 1-3rd clauses of a range of claim for patent.
[Claim 5]A semiconductor light emitting element, wherein the first crystal of the above is growing epitaxially on a ZnO board in a semiconductor light emitting element of claim for patent given in the 1-4th clauses of a range.
[Claim 6]A semiconductor light emitting element characterized by oscillation wavelengths being 350 nm - 550 nm in a semiconductor light emitting element of claim for patent given in the 1-5th clauses of a range.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the light emitting device which used the gallium nitride system compound semiconductor.
[0002]
[Description of the Prior Art]Gallium nitride system compound semiconductors, such as GaN, GaAlN, InGaN, and InGaAlN, are wide gap semiconductors which have a transited [directly] type, and are actively studied as a material which constitutes the light emitting device to an ultraviolet area from blue. The present, As a light emitting device using this material. The high-intensity blue LED of the double hetero structure which makes a luminous layer Zn dope InGaN layer constituted on silicon on sapphire is known (S. Nakamura et al., Appl. Phys. Lett., 64 (1994) 1687). The gallium nitride system light emitting device which constituted on the ZnO board and decreased the defect by a lattice strain is indicated by the JP,5-206513,A gazette. However, gallium nitride system compound semiconductor laser by current injection was not realized until now.
[0003]
[Problem to be solved by the invention]That the laser oscillation by current injection is difficult in a gallium nitride system compound semiconductor originates in the density of states of the valence band of this material system being large, and threshold carrier density being high. The band structure of the valence-band upper part near gamma point in case [of wurtzite type GaN / distorted] there is nothing is shown in drawing 5.
[0004]Incidentally, gamma point is a point that wave number vector k (equivalent to the wave number of the horizontal axis of drawing 5) of the electron inside a crystal is set to "0." Now, in a wurtzite type semiconductor, the split of the energy of gamma point is carried out to three by the crystal field and a spin orbit interaction. In the state of the wave function of gamma point, these three bands are made for convenience to be referred to as hh(heavy hole)1, hh2, and lh (light hole), respectively. The threshold carrier density which the density of states of the valence-band upper part of GaN gives laser oscillation since it is large as compared with common III-V fellows semiconductors, such as GaAs, increased, and the laser oscillation by current injection was difficult. In a wurtzite type semiconductor, since the character of the wave function of hh1 and hh2 is the same, even if it adds distortion, the energy split of hh1 and hh2 hardly changes. For this reason, with a wurtzite type semiconductor, reduction of the density of states by a compressive strain was not able to be expected, either.
[0005]According to the reduction of the density of states of the valence-band upper part and the increase of optical transition probability by the hauling distortion of a gallium nitride system compound semiconductor, this invention reduces threshold carrier density required for laser oscillation, and an object of this invention is to realize the gallium nitride semiconductor laser by current injection.
[0006]
[Means for solving problem]The gallium nitride system semiconductor light emitting device of this invention grows the quantum well active layer which has an optically biaxial hauling distortion on

the field (1-100) of the first crystal with wurtzite structure, and produces a waveguide in a direction vertical to the [0001] axes of the 1st crystal, i.e., the [11-20] direction. The same effect can be acquired also by growing up the active layer which has an optically biaxial hauling distortion on the field (11-20) of the first crystal, and producing a waveguide in a direction vertical to [0001] axes, i.e., the [1-100] direction. The same effect can be acquired also when the plane direction of the first above-mentioned crystal is a field which has a gap of (1-100) or (11-20) to 10 degrees. If it puts in another way, to the surface of a substrate in which an element is formed, the semiconductor light emitting element by this invention has the almost parallel c axis of the crystal which constitutes (1) active layer, and it pulls it to the well layer of (2) active layers, and it has the structural feature that distortion is added.
[0007]For example, the band structure of the valence-band upper part near gamma point at the time of adding 2% of optically biaxial hauling distortion to wurtzite type GaN becomes like drawing 6. By impressing hauling distortion as compared with drawing 5 shows that lh band which consists of a z orbit shifts to the upper part, and the density of states of the valence-band upper part of a direction parallel to c axis, i.e., [0001] axes, decreases substantially. That is, change of the energy (vertical axis) over the wave number (horizontal axis) of a direction parallel to c axis becomes sudden, and density of states is decreasing. Therefore, the density of states of a valence band can be reduced by constituting a quantum well active layer on a direction vertical to [0001] axes, i.e. (1-100), a field, a field, or a field equivalent to this, and considering it as the structure which impressed hauling distortion.
[0008]When a quantum well is formed on a field (1-100) or (11-20) a field, optical transition probability has a polarization direction dependency with quantum well side Uchi's anisotropy. For example, the polarization dependency of the transition-matrix element in gamma point of a quantum well that a plane direction is (1-100) becomes as it is shown in Table 1 as compared with the case of the distortionless quantum well constituted in the field (0001). Table 1 shows the calculation result of the optical matrix element in the band end in a GaN quantum well.
[0009]
[Table 1]
表 1

基板面 / 偏光	(0001) 無歪	(1-100) 2%引っ張り歪
TEモード	7.62 eV	13.2 eV (偏光 [0001])
		0.92 eV (偏光 [11-20])
TMモード	0 eV	1.05 eV

[0010]Table 1 shows that transition probability can be enlarged about 2 times in the hauling distortion quantum well on a field (1-100), if a waveguide is formed in a direction vertical to [0001], i.e., the [11-20] direction, (the energy value in front shows the ease of producing of optical transition, and transition probability is so high that it is large). By this, a gain increases, threshold carrier density required for an oscillation is reduced, and a gallium nitride semiconductor laser can be realized.
[0011]
[Mode for carrying out the invention]The first working example of this invention is described using drawing 1.
[0012]This multiplex quantum well laser like a graphic display on the field (1-100) n type ZnO board 1, InGaN buffer layer 2 which carries out lattice matching to the substrate 1, n-InGaAlN layer 3 which doped Si, the active layer 4 which consists of an undoping multiplex quantum well, and p-InGaAlN layer 5 which doped Mg are laminated successively, and is constituted. These

each layers grow epitaxially with a gas source molecular beam grown method. The thickness of the buffer layer 2, n-InGaAlN layer 3, and p-InGaAlN layer 5 is 2 micrometers, 0.15 micrometer, and 0.15 micrometer, respectively. The undoping multiplex quantum well active layer 4 has the double quantum well structure where the $In_{0.2}Ga_{0.6}$aluminum$_{0.2}$N barrier layer (8 nm of thickness) 6 and the $In_{0.1}Ga_{0.9}N$ well layer (4 nm of thickness) 7 were laminated by turns, as expanded and shown. The composition ratio of the well layer 7 is set up here so that gap deltaa/a of a future grating constant may be -1.8%, when the grating constant of ZnO is set to a, and an optically biaxial hauling distortion is impressed. After vapor-depositing the n side In electrode 8 at the rear face of the substrate 1 of the wafer produced by making it above and vapor-depositing Al electrode 9 to the p type InGaAlN layer 5, a cleavage is carried out a field (11-20), a resonator about 800 micrometers in length is formed in the [11-20] direction (side side of the active layer 4 of drawing 1), and a semiconductor laser is produced. In the room temperature, continuous oscillation of this semiconductor laser was carried out with about 50 mA of threshold current. The oscillation wavelength was about 420 nm.

[0013]In this example, the plane direction of the ZnO board was made into the field (11-20), and when the semiconductor laser which formed the resonator in the [1-100] direction was produced similarly, what has almost equivalent threshold current and oscillation wavelength was obtained. In this example, the plane direction of the ZnO board was made into Men who inclined 10 degrees in the [0001] directions from the field (1-100), and when the semiconductor laser which formed the resonator in the [11-20] direction was produced similarly, what has almost equivalent threshold current and oscillation wavelength was obtained.

[0014]Next, the second working example of this invention is described using drawing 2.

[0015]The presentation x of In1-xGaxN grown-up on the field (1-100) n type ZnO board 1 like a graphic display on the InGaN presentation inclined layer 11 which changes continuously from 0.8 to 0.5, The $In_{0.5}Ga_{0.5}N$ buffer layer 12 which carries out lattice matching to the presentation inclined layer 11, n-InGaAlN layer 13 which doped Si, the active layer 14 which consists of an undoping multiplex quantum well, and p-InGaAlN layer 15 which doped Mg are laminated successively, and is constituted. These each layers grow epitaxially with a gas source molecular beam grown method. The thickness of the buffer layer 12, n-InGaAlN layer 13, and p-InGaAlN layer 15 is 2 micrometers, 0.15 micrometer, and 0.15 micrometer, respectively. The undoping multiplex quantum well active layer 14 has the double quantum well structure where the $In_{0.35}Ga_{0.5}$aluminum$_{0.15}$N barrier layer (5 nm of thickness) 16 and the $In_{0.2}Ga_{0.8}N$ well layer (3 nm of thickness) 17 were laminated by turns, as expanded and shown. The composition ratio of the well layer 17 is set up here so that gap deltaa/a of a future grating constant may be -2.0%, when the grating constant of an $In_{0.5}Ga_{0.5}N$ buffer layer is set to a, and an optically biaxial hauling distortion is impressed. After vapor-depositing the n side In electrode 8 at the rear face of the substrate 1 of the wafer produced by making it above and vapor-depositing Al electrode 9 to the p type InGaAlN layer 5, a cleavage is carried out a field (11-20), a resonator about 800 micrometers in length is formed in the [11-20] direction, and a semiconductor laser is produced. In the room temperature, continuous oscillation of this semiconductor laser was carried out with about 60 mA of threshold current. The oscillation wavelength was about 450 nm.

[0016]Although InGaN was used as a quantum well layer and ZnO was used as a substrate in the above-mentioned working example, composition used for the light emitting device of this invention can be considered as the composition which is not limited to this, for example, is shown in drawing 3 - drawing 4.

[0017]The semiconductor laser shown in drawing 3 on the field (1-100) of the n type ZnO board 1, InGaN buffer layer 2 which carries out lattice matching to the substrate 1 grows, and on this buffer layer 2, n-InGaAlN layer 3, the undoping single quantum well active layer 21, and the p-InGaAlN cladding layer 5 are laminated successively, and are constituted. These each layers grow epitaxially with a gas source molecular beam grown method. The quantum well active layer 21 has here the single quantum well structure where the $GaN_{0.95}As_{0.05}$ well layer (5 nm of

thickness) 22 was inserted into the $In_{0.2}Ga_{0.6}aluminum_{0.2}N$ barrier layer (10 nm of thickness) 23, as expanded and shown. The composition ratio of the well layer 22 is set up here so that gap deltaa/a of a future grating constant may be −1.8%, when the grating constant of ZnO is set to a, and an optically biaxial hauling distortion is impressed. After vapor-depositing the n side In electrode 8 at the rear face of the substrate 1 of the wafer produced by making it above and vapor-depositing Al electrode 9 to the p type InGaAlN layer 5, a cleavage is carried out a field (11−20), a resonator about 800 micrometers in length is formed in the [11−20] direction, and a semiconductor laser is produced. In the room temperature, continuous oscillation of this semiconductor laser was carried out with about 50 mA of threshold current. The oscillation wavelength was about 450 nm.
[0018]On the field (1−100) of the silicon on sapphire 31, InGaN buffer layer 2 grows, n-InGaAlN layer 3, the undoping multiplex quantum well active layer 4, and the p-InGaAlN cladding layer 5 are laminated successively, and the semiconductor laser shown in drawing 4 is constituted at this buffer layer 2 top. These each layers grow epitaxially by metal-organic chemical vapor deposition. The quantum well active layer 4 has here the multiple quantum well structure by which the $In_{0.2}Ga_{0.6}aluminum_{0.2}N$ barrier layer (8 nm of thickness) 6 and two cycles of $In_{0.1}Ga_{0.9}N$ well layers (4 nm of thickness) 7 were laminated by turns, as expanded and shown. The composition ratio of the well layer 7 is set up here so that gap deltaa/a of a future grating constant may be −1.8%, when the grating constant of an InGaN buffer layer is set to a, and an optically biaxial hauling distortion is impressed. A part of p-InGaAlN cladding layer 5 of a wafer and quantum well active layer 4 produced by making it above are removed by etching, After exposing the n-InGaAlN cladding layer 3 and vapor-depositing Al electrode 9 to p-cladding layer and n-cladding layer, a cleavage is carried out a field (11−20), a resonator about 800 micrometers in length is formed in the [11−20] direction, and a semiconductor laser is produced. In the room temperature, continuous oscillation of this semiconductor laser was carried out with about 70 mA of threshold current. The oscillation wavelength was about 420 nm.
[0019]This invention is applicable not only to the laser structure shown in the working example but various semiconductor lasers, for example, a distributed feedback laser, a distributed Bragg reflector laser, tunable laser, and laser with an external resonator.
[0020]
[Effect of the Invention]As mentioned above, the gallium nitride system compound semiconductor light emitting device of this invention, Since a plane direction grows the quantum well active layer which has an optically biaxial hauling distortion on the base substance crystal which is a field (1−100) or (11−20) a field and is producing the waveguide in the direction vertical to the [0001] directions, transition probability can be small increased in the density of states of the valence-band upper part. Since a gain increases and threshold current density can be reduced by this, gallium nitride system compound semiconductor laser is realizable.
[0021]

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]The block diagram of the semiconductor laser of this invention working example.
[Drawing 2]The block diagram of the semiconductor laser of this invention working example.
[Drawing 3]The block diagram of the semiconductor laser of this invention working example.
[Drawing 4]The block diagram of the semiconductor laser of this invention working example.
[Drawing 5]The figure showing the energy dispersion of the valence-band upper part of wurtzite type GaN in case [distorted] there is nothing. .
[Drawing 6]The figure showing the energy dispersion of the valence-band upper part of wurtzite type GaN at the time of impressing optically biaxial hauling distortion 2%.
[Explanations of letters or numerals]
1 -- (1-100) field n type ZnO board, 2 -- InGaN buffer layer, 3 -- n-InGaAlN layer, 4 -- undoping multiplex quantum well active layer, 5 -- p-InGaAlN layer, 6 -- $In_{0.2}Ga_{0.6}aluminum_{0.2}N$ barrier layer, 7 -- $In_{0.1}Ga_{0.9}N$ well layer, 8 -- In electrode, 9 -- Al electrode, 11 -- InGaN presentation inclined layer, 12 -- $In_{0.5}Ga_{0.5}N$ buffer layer, 13 -- n-InGaAlN layer, 14 -- undoping multiplex quantum well active layer, 15 -- p-InGaAlN layer, 16 -- $In_{0.35}Ga_{0.5}aluminum_{0.15}N$ barrier layer, 17 -- $In_{0.2}Ga_{0.8}N$ well layer, 21 -- undoping single quantum well active layer, 22 -- $GaN_{0.95}As_{0.05}$ well layer, 23 -- $In_{0.2}Ga_{0.6}aluminum_{0.2}N$ barrier layer, 31 -- silicon on sapphire.

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12) **公開特許公報**（Ａ）　(11)特許出願公開番号

特開平9－116225

(43)公開日　平成９年(1997)５月２日

(51)Int.Cl.6	識別記号	庁内整理番号	ＦＩ	技術表示箇所
Ｈ０１Ｓ　3/18			Ｈ０１Ｓ　3/18	

審査請求　未請求　請求項の数６　ＯＬ　（全６頁）

(21)出願番号　特願平7－272321

(22)出願日　平成７年(1995)10月20日

(71)出願人　000005108
株式会社日立製作所
東京都千代田区神田駿河台四丁目６番地

(72)発明者　丹羽　敦子
東京都国分寺市東恋ケ窪１丁目280番地
株式会社日立製作所中央研究所内

(72)発明者　大▲歳▼　創
東京都国分寺市東恋ケ窪１丁目280番地
株式会社日立製作所中央研究所内

(72)発明者　黒田　崇郎
東京都国分寺市東恋ケ窪１丁目280番地
株式会社日立製作所中央研究所内

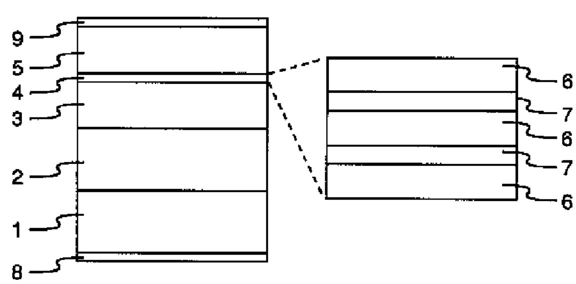
(74)代理人　弁理士　小川　勝男

最終頁に続く

(54)【発明の名称】　半導体発光素子

(57)【要約】
【課題】窒化ガリウム系化合物半導体レーザでは、価電子帯の状態密度低減と遷移確率増大によるしきい値キャリア密度の低減が必要であった。
【解決手段】面方位が（１－１００）面、あるいは（１１－２０）面、あるいはこれと等価な面である基体結晶上に二軸性の引っ張り歪をもつ量子井戸活性層を成長し、共振器を［０００１］方向に垂直な方向に作製する。
【効果】本発明によれば、価電子帯上部の状態密度を低減し、かつ、遷移確率を増大できる。これにより、しきい値電流密度を低減できるため、窒化ガリウム系化合物半導体レーザを実現できる。

図１



【特許請求の範囲】
【請求項１】少なくとも化合物半導体で構成され、ウルツ鉱構造をもつ第一の結晶上に、第一導電型及び第二導電型の二層のクラッド層と、上記クラッド層に挟まれた量子井戸活性層をエピタキシャル成長してなる半導体発光素子であって、上記量子井戸活性層が（１－１００）面から１０度以内のずれを有する面、あるいはこれと等価な面上に形成されており、上記量子井戸活性層の井戸層が、二軸性応力の無い状態での格子定数が上記第一の結晶の格子定数より小さい材料で構成されていることを特徴とする半導体発光素子。
【請求項２】少なくとも化合物半導体で構成され、ウルツ鉱構造をもつ第一の結晶上に、第一導電型及び第二導電型の二層のクラッド層と、上記クラッド層に挟まれた量子井戸活性層をエピタキシャル成長してなる半導体発光素子であって、上記量子井戸活性層が（１１－２０）面から１０度以内のずれを有する面、あるいはこれと等価な面上に形成されており、上記量子井戸活性層の井戸層が、二軸性応力の無い状態での格子定数が上記第一の結晶の格子定数より小さい材料で構成されていることを特徴とする半導体発光素子。
【請求項３】特許請求の範囲第１～２項に記載の半導体発光素子において、［０００１］方向と垂直な方向に導波路が形成されていることを特徴とする半導体発光素子。
【請求項４】特許請求の範囲第１～３項に記載の半導体発光素子において、上記量子井戸活性層が$\mathrm{In_xGa_yAl_{1-x-y}N_zAs_{1-z}}$（$0<x\leqq1$、$0<y\leqq1$、$0<z\leqq1$）で構成されていることを特徴とする半導体発光素子。
【請求項５】特許請求の範囲第１～４項記載の半導体発光素子において、上記第一の結晶がＺｎＯ基板上にエピタキシャル成長されていることを特徴とする半導体発光素子。
【請求項６】特許請求の範囲第１～５項記載の半導体発光素子において、発振波長が３５０ｎｍ～５５０ｎｍであることを特徴とする半導体発光素子。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は窒化ガリウム系化合物半導体を用いた発光素子に関する。
【０００２】
【従来の技術】ＧａＮ、ＧａＡｌＮ、ＩｎＧａＮ、ＩｎＧａＡｌＮ等の窒化ガリウム系化合物半導体は直接遷移型を有するワイドギャップ半導体であり、青色から紫外域までの発光素子を構成する材料として盛んに研究されている。現在、この材料を用いた発光素子としてサファイア基板上に構成したＺｎドープＩｎＧａＮ層を発光層とするダブルヘテロ構造の高輝度青色ＬＥＤが知られている(S. Nakamura et al., Appl. Phys. Lett., 64(1994) 1687)。また、ＺｎＯ基板上に構成し格子歪による欠陥を減少した窒化ガリウム系発光素子が特開平５－２０６５１３公報に開示されている。しかし、これまで電流注入による窒化ガリウム系化合物半導体レーザは実現されていなかった。
【０００３】
【発明が解決しようとする課題】窒化ガリウム系化合物半導体において電流注入によるレーザ発振が困難であるのは、この材料系の価電子帯の状態密度が大きく、しきい値キャリア密度が高いことに起因する。図５にウルツ鉱型ＧａＮの歪の無い場合のΓ点付近の価電子帯上部のバンド構造を示す。
【０００４】因みに、Γ点は結晶内部の電子の波数ベクトルｋ（図５の横軸の波数に相当）が「０」となる点である。さて、ウルツ鉱型半導体では、結晶場とスピン軌道相互作用によりΓ点のエネルギーは三つにスプリットする。この三つのバンドをΓ点の波動関数の状態で、便宜的に、それぞれｈｈ（ｈｅａｖｙ　ｈｏｌｅ）１、ｈｈ２、ｌｈ（ｌｉｇｈｔ　ｈｏｌｅ）と呼ぶことにする。ＧａＮの価電子帯上部の状態密度はＧａＡｓ等の一般的なＩＩＩ－Ｖ族半導体と比較して大きいため、レーザ発振を与えるしきい値キャリア密度が増大し、電流注入によるレーザ発振は困難であった。またウルツ鉱型半導体では、ｈｈ１とｈｈ２の波動関数の性質が同じであるため、歪を加えてもｈｈ１、ｈｈ２のエネルギースプリットはほとんど変化しない。このため、ウルツ鉱型半導体では圧縮歪による状態密度の低減も期待できなかった。
【０００５】本発明は窒化ガリウム系化合物半導体の引っ張り歪による価電子帯上部の状態密度の低減と光学遷移確率の増大により、レーザ発振に必要なしきい値キャリア密度を低減し、電流注入による窒化ガリウム系半導体レーザを実現することを目的とする。
【０００６】
【課題を解決するための手段】本発明の窒化ガリウム系半導体発光素子は、ウルツ鉱構造をもつ第一の結晶の（１－１００）面上に二軸性の引っ張り歪をもつ量子井戸活性層を成長し、導波路を第１の結晶の［０００１］軸に垂直な方向、すなわち［１１－２０］方向に作製することを特徴とする。また、第一の結晶の（１１－２０）面上に二軸性の引っ張り歪をもつ活性層を成長し、導波路を［０００１］軸に垂直な方向、すなわち［１－１００］方向に作製することによっても同様の効果を得ることができる。また、上記の第一の結晶の面方位が（１－１００）あるいは（１１－２０）から１０度以内のずれを有する面である場合にも同様の効果を得ることができる。換言すれば、本発明による半導体発光素子は、（１）活性層を構成する結晶のｃ軸が素子が形成される基板の表面に対して略平行であり、且つ（２）活性層の井戸層には引っ張り歪が加えられているという構造

的な特徴を有する。

【０００７】例えばウルツ鉱型ＧａＮに２％の二軸性引っ張り歪を加えた場合のΓ点付近の価電子帯上部のバンド構造は図６のようになる。図５と比較すると、引っ張り歪を印加することによりｚ軌道からなるｌｈバンドが上側にシフトしｃ軸すなわち［０００１］軸に平行な方向の価電子帯上部の状態密度が大幅に低減することがわかる。即ち、ｃ軸に平行な方向の波数（横軸）に対するエネルギ（縦軸）の変化が急となり、状態密度が低減している。したがって、量子井戸活性層を［０００１］軸に垂直な方向、すなわち（１－１００）面あるいは（１１－２０）面、またはこれと等価な面上に構成し、引っ＊張り歪を印加した構造とすることにより価電子帯の状態密度を低減することができる。

【０００８】また、（１－１００）面あるいは（１１－２０）面上に量子井戸を形成すると量子井戸面内の異方性により光学遷移確率は偏光方向依存性をもつ。例えば、面方位が（１－１００）である量子井戸のΓ点における遷移行列要素の偏光依存性は、（０００１）面に構成した無歪の量子井戸の場合と比較すると表１のようになる。表１は、ＧａＮ量子井戸におけるバンド端での光学行列要素の計算結果を示す。

【０００９】

【表１】

表１

偏光＼基板面	(0001) 無歪	(1-100) 2%引っ張り歪
TEモード	7.62 eV	13.2 eV (偏光 [0001])
		0.92 eV (偏光 [11-20])
TMモード	0 eV	1.05 eV

【００１０】表１より、（１－１００）面上の引っ張り歪量子井戸では導波路を［０００１］と垂直な方向、すなわち［１１－２０］方向に形成すれば、遷移確率を２倍程度大きくできることがわかる（表中のエネルギ値は光学遷移の生じ易さを示し、大きいほど遷移確率は高い）。これにより、利得が増大し、発振に必要なしきい値キャリア密度が低減され、窒化ガリウム系半導体レーザを実現できる。

【００１１】

【発明の実施の形態】本発明の第一の実施例を図１を用いて説明する。

【００１２】図示のように、この多重量子井戸レーザは、（１－１００）面ｎ型ＺｎＯ基板１上に、基板１と格子整合するＩｎＧａＮバッファ層２、Ｓｉをドープしたｎ－ＩｎＧａＡｌＮ層３、アンドープ多重量子井戸からなる活性層４、Ｍｇをドープしたｐ－ＩｎＧａＡｌＮ層５が順次積層されて構成される。これらの各層はガスソース分子線成長法によりエピタキシャル成長される。バッファ層２、ｎ－ＩｎＧａＡｌＮ層３、ｐ－ＩｎＧａＡｌＮ層５の膜厚はそれぞれ、２μｍ、０．１５μｍ、０．１５μｍである。アンドープ多重量子井戸活性層４は、拡大して示したように、$In_{0.2}Ga_{0.6}Al_{0.2}N$障壁層（膜厚８ｎｍ）６と$In_{0.1}Ga_{0.9}N$井戸層（膜厚４ｎｍ）７が交互に積層形成された二重量子井戸構造を有する。ここで井戸層７の組成比は、ＺｎＯの格子定数をａとしたとき、これからの格子定数のずれΔａ／ａが－１．８％となるように設定されており、二軸性の引っ張り歪が印加されている。以上のようにして得られたウエハーの基板１の裏面にｎ側Ｉｎ電極８、ｐ型ＩｎＧａＡｌＮ層５にＡｌ電極９を蒸着したのち、（１１－２０）面でへき開し［１１－２０］方向（図１の活性層４の側面側）に長さ約８００μｍの共振器を形成し半導体レーザを作製する。本半導体レーザは室温においてしきい値電流約５０ｍＡで連続発振した。発振波長は約４２０ｎｍであった。

【００１３】本実施例において、ＺｎＯ基板の面方位を（１１－２０）面とし、共振器を［１－１００］方向に形成した半導体レーザを同様に作製したところ、しきい値電流、発振波長はほぼ同等のものが得られた。また、本実施例において、ＺｎＯ基板の面方位を（１－１００）面から［０００１］方向に１０度傾斜した面とし、共振器を［１１－２０］方向に形成した半導体レーザを同様に作製したところ、しきい値電流、発振波長はほぼ同等のものが得られた。

【００１４】次に本発明第二の実施例を図２を用いて説明する。

【００１５】図示のように、（１－１００）面ｎ型ＺｎＯ基板１上に成長した$In_{1-x}Ga_xN$の組成ｘが０．８から０．５まで連続的に変化するＩｎＧａＮ組成傾斜層１１上に、組成傾斜層１１に格子整合する$In_{0.5}Ga_{0.5}N$バッファ層１２、Ｓｉをドープしたｎ－ＩｎＧａＡｌＮ層１３、アンドープ多重量子井戸からなる活性層１４、Ｍｇをドープしたｐ－ＩｎＧａＡｌＮ層１５が順次積層されて構成される。これらの各層はガスソース分

子線成長法によりエピタキシャル成長される。バッファ層１２、ｎ－ＩｎＧａＡｌＮ層１３、ｐ－ＩｎＧａＡｌＮ層１５の膜厚はそれぞれ、２μｍ、０．１５μｍ、０．１５μｍである。アンドープ多重量子井戸活性層１４は、拡大して示したように、$In_{0.35}$ $Ga_{0.5}$ $Al_{0.15}$ Ｎ障壁層（膜厚５ｎｍ）１６と$In_{0.2}$ $Ga_{0.8}$ Ｎ井戸層（膜厚３ｎｍ）１７が交互に積層形成された二重量子井戸構造を有する。ここで井戸層１７の組成比は、$In_{0.5}$ $Ga_{0.5}$ Ｎバッファ層の格子定数をａとしたとき、これからの格子定数のずれΔａ／ａが－２．０％となるように設定されており、二軸性の引っ張り歪が印加されている。以上のようにして得られたウエハーの基板１の裏面にｎ側Ｉｎ電極８、ｐ型ＩｎＧａＡｌＮ層５にＡｌ電極９を蒸着したのち、（１１－２０）面でへき開し［１１－２０］方向に長さ約８００μｍの共振器を形成し半導体レーザを作製する。本半導体レーザは室温においてしきい値電流約６０ｍＡで連続発振した。発振波長は約４５０ｎｍであった。

【００１６】上記の実施例では量子井戸層としてＩｎＧａＮ、基板としてＺｎＯを用いたが、本発明の発光素子に使用される構成はこれに限定されず、例えば図３～図４に示す構成とすることができる。

【００１７】図３に示した半導体レーザは、ｎ型ＺｎＯ基板１の（１－１００）面上に、基板１と格子整合するＩｎＧａＮバッファ層２が成長され、このバッファ層２上にｎ－ＩｎＧａＡｌＮ層３、アンドープ単一量子井戸活性層２１、ｐ－ＩｎＧａＡｌＮクラッド層５が順次積層されて構成されている。これらの各層はガスソース分子線成長法によりエピタキシャル成長される。ここで量子井戸活性層２１は、拡大して示したように、$GaN_{0.95}$ $As_{0.05}$ 井戸層（膜厚５ｎｍ）２２が$In_{0.2}$ $Ga_{0.6}$ $Al_{0.2}$ Ｎ障壁層（膜厚１０ｎｍ）２３にはさまれた単一量子井戸構造を有する。ここで井戸層２２の組成比は、ＺｎＯの格子定数をａとしたとき、これからの格子定数のずれΔａ／ａが－１．８％となるように設定されており、二軸性の引っ張り歪が印加されている。以上のようにして得られたウエハーの基板１の裏面にｎ側Ｉｎ電極８、ｐ型ＩｎＧａＡｌＮ層５にＡｌ電極９を蒸着したのち、（１１－２０）面でへき開し［１１－２０］方向に長さ約８００μｍの共振器を形成し半導体レーザを作製する。本半導体レーザは室温においてしきい値電流約５０ｍＡで連続発振した。発振波長は約４５０ｎｍであった。

【００１８】図４に示した半導体レーザは、サファイア基板３１の（１－１００）面上に、ＩｎＧａＮバッファ層２が成長され、このバッファ層２上にｎ－ＩｎＧａＡｌＮ層３、アンドープ多重量子井戸活性層４、ｐ－ＩｎＧａＡｌＮクラッド層５が順次積層されて構成されている。これらの各層は有機金属気相成長法によりエピタキシャル成長される。ここで量子井戸活性層４は、拡大して示したように、$In_{0.2}$ $Ga_{0.6}$ $Al_{0.2}$ Ｎ障壁層（膜厚８ｎｍ）６と$In_{0.1}$ $Ga_{0.9}$ Ｎ井戸層（膜厚４ｎｍ）７が交互に２周期積層形成された多重量子井戸構造を有する。ここで井戸層７の組成比は、ＩｎＧａＮバッファ層の格子定数をａとしたとき、これからの格子定数のずれΔａ／ａが－１．８％となるように設定されており、二軸性の引っ張り歪が印加されている。以上のようにして得られたウエハーのｐ－ＩｎＧａＡｌＮクラッド層５と量子井戸活性層４の一部をエッチングにより取り除き、ｎ－ＩｎＧａＡｌＮクラッド層３を露出させ、ｐ－クラッド層とｎ－クラッド層にＡｌ電極９を蒸着したのち、（１１－２０）面でへき開し［１１－２０］方向に長さ約８００μｍの共振器を形成し半導体レーザを作製する。本半導体レーザは室温においてしきい値電流約７０ｍＡで連続発振した。発振波長は約４２０ｎｍであった。

【００１９】なお、本発明は、実施例に示したレーザ構造に限らず、さまざまな半導体レーザ、例えば分布帰還型レーザ、ブラッグ反射型レーザ、波長可変レーザ、外部共振器付きレーザにも適用できる。

【００２０】

【発明の効果】以上のように、本発明の窒化ガリウム系化合物半導体発光素子は、面方位が（１－１００）面、あるいは（１１－２０）面である基体結晶上に二軸性の引っ張り歪をもつ量子井戸活性層を成長し、導波路を［０００１］方向に垂直な方向に作製しているので、価電子帯上部の状態密度を小さく、かつ、遷移確率を増大できる。これにより、利得が増大し、しきい値電流密度を低減できるため、窒化ガリウム系化合物半導体レーザを実現できる。

【００２１】

【図面の簡単な説明】

【図１】本発明実施例の半導体レーザの構成図。

【図２】本発明実施例の半導体レーザの構成図。

【図３】本発明実施例の半導体レーザの構成図。

【図４】本発明実施例の半導体レーザの構成図。

【図５】歪の無い場合のウルツ鉱型ＧａＮの価電子帯上部のエネルギー分散を示す図。。

【図６】２％二軸性引っ張り歪を印加した場合のウルツ鉱型ＧａＮの価電子帯上部のエネルギー分散を示す図。

【符号の説明】

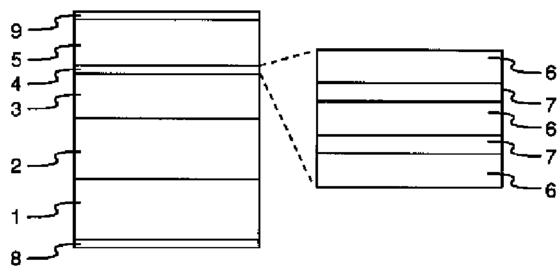
１…（１－１００）面ｎ型ＺｎＯ基板、２…ＩｎＧａＮバッファ層、３…ｎ－ＩｎＧａＡｌＮ層、４…アンドープ多重量子井戸活性層、５…ｐ－ＩｎＧａＡｌＮ層、６…$In_{0.2}$ $Ga_{0.6}$ $Al_{0.2}$ Ｎ障壁層、７…$In_{0.1}$ $Ga_{0.9}$ Ｎ井戸層、８…Ｉｎ電極、９…Ａｌ電極、１１…ＩｎＧａＮ組成傾斜層、１２…$In_{0.5}$ $Ga_{0.5}$ Ｎバッファ層、１３…ｎ－ＩｎＧａＡｌＮ層、１４…アンドープ多重量子井戸活性層、１５…ｐ－ＩｎＧａＡｌＮ層、１６…$In_{0.35}$ $Ga_{0.5}$ $Al_{0.15}$ Ｎ障壁層、１７…$In_{0.2}$ Ｇ

$a_{0.8}N$井戸層、21…アンドープ単一量子井戸活性層、22…$GaN_{0.95}As_{0.05}$井戸層、23…$In_{0.2}$＊

＊$Ga_{0.6}Al_{0.2}N$障壁層、31…サファイア基板。

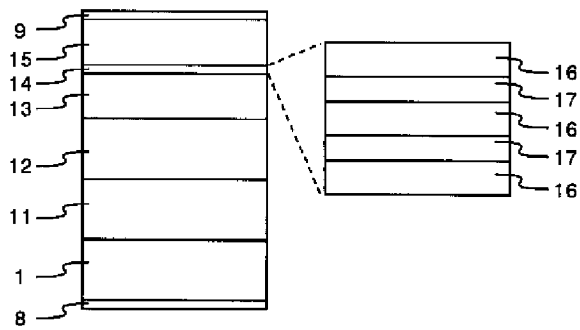
【図1】

図1



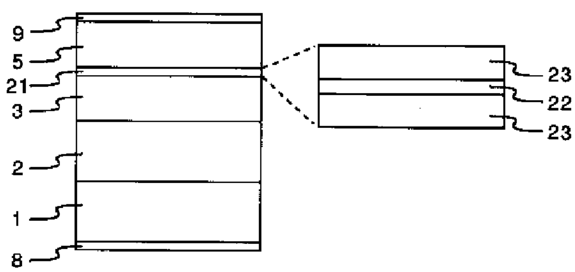
【図2】

図2



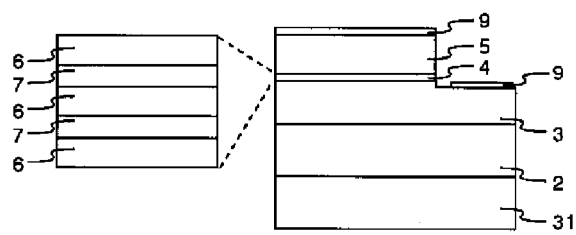
【図3】

図3



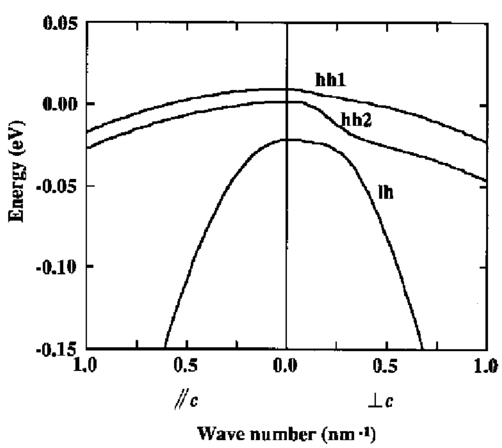
【図4】

図4



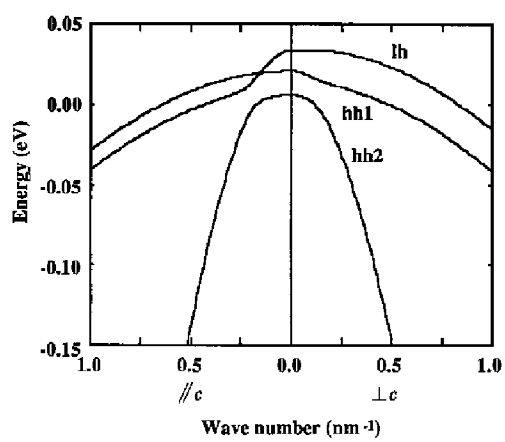
【図5】

図5



【図6】

図6



フロントページの続き

(72)発明者　田中　俊明
東京都国分寺市東恋ケ窪１丁目280番地
株式会社日立製作所中央研究所内

(72)発明者　渡辺　明禎
東京都国分寺市東恋ケ窪１丁目280番地
株式会社日立製作所中央研究所内

Docket No.: 0020-5147PUS12
(Patent)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application of:
Yoshinori SHIMIZU et al.

Application No.:	12/942,792	Confirmation No.:	2357
Filed:	November 09, 2010	Art Unit:	2812
For:	LIGHT EMITTING DEVICE AND DISPLAY	Examiner:	A.B. MUSTAPHA

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Applicant(s) hereby submit(s) an Information Disclosure Statement for consideration by the Examiner.

I. LIST OF PATENTS, PUBLICATIONS OR OTHER INFORMATION

The patents, publications, or other information submitted for consideration by the Office are listed on the attached PTO/SB/08.

II. COPIES

☑ a. Copies of foreign patent documents, non-patent literature and other information.

☐ b. REFERENCES PREVIOUSLY CITED OR SUBMITTED: Copies of any information not provided can be found in one or more of the following applications which has been relied upon for an earlier filing date under 35 U.S.C. § 120:

ak

III. CONCISE EXPLANATION OF THE RELEVANCE/OTHER INFORMATION

☑ a. NON-ENGLISH LANGUAGE DOCUMENTS: A concise explanation of the relevance of all non-English language patents, publications, or other information listed is as follows:

An English language abstract is provided (as a partial translation) for the following reference(s): JP-9-116225-A.

A machine generated translation is provided for the following reference(s): JP-9-116225-A.

☐ b. ENGLISH LANGUAGE SEARCH REPORT OR FOREIGN PATENT OFFICE COMMUNICATION: An English language version of the search report or Foreign Patent Office communication that indicates the degree of relevance is attached.

☑ c. OTHER: The following additional information is provided.

A copy of the Office Action, dated January 9, 2012, for copending U.S. Application No. 12/947,470 is provided. US-3,875,456-A, US-5,847,507-A and US-6,600,175-B1, cited in said Office Action, were previously cited in the Information Disclosure Statement filed November 9, 2010. Additionally, US-5,847,507-A was cited by the Examiner in the Office Action dated January 30, 2012, in the present application.

A copy of the Office Action, dated March 13, 2012, for copending U.S. Application No. 13/210,027 is provided. US-5,847,507-A, cited in said Office Action, was previously cited in the Information Disclosure Statement filed November 9, 2012, and was also cited by the Examiner in the Office Action dated January 30, 2012, in the present application.

IV. STATEMENT UNDER 37 C.F.R. § 1.97(e)

The undersigned hereby states that:

☐ a. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **30**

days prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☐ b. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☑ c. No item of information contained in the IDS was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of IDS was known to any individual designated in 37 C.F.R. § 1.56(c) more than **three months** prior to the filing of the IDS; or

☐ d. Some of the items of information in the IDS were cited in a communication from a foreign patent office. Such items were first cited in a communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office. As to the remaining items of information, to the knowledge of the person signing the certification after making reasonable inquiry, such remaining items were not known to any individual designated in 37 C.F.R. § 1.56(c) more than **three months** prior to the filing of this statement.

V. FEES

☐ a. This Information Disclosure Statement is being filed concurrently with the filing of a new patent application or Request for Continued Examination. No fee is required.

☐ b. This Information Disclosure Statement is being filed within three months of the filing date of an application. No fee is required.

☐ c. This Information Disclosure Statement is being filed before the mailing date of a first Action on the merits. No fee is required. If a first Office Action on the merits has issued, please consider this IDS under 37 C.F.R. § 1.97(c) and see the statement under 37 C.F.R. § 1.97(e) above. If no statement has been made, charge our deposit account for the required fee.

☑ d. This Information Disclosure Statement is being filed before the mailing date of a Final Office Action or before the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(c)(1)).

☐ No statement. The fee as required by 37 C.F.R. § 1.17(p) is provided.

or

☑ See the above statement. No fee is required.

☐ e. This Information Disclosure Statement is being filed after the mailing date of a Final Office Action or after the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(d)), see the statement above. The fee as required by 37 C.F.R. § 1.17(p) is provided.

VI. PAYMENT OF FEES

☐ The required fee is listed on the attached Fee Transmittal.

☑ No fee is required.

If the Examiner has any questions concerning this IDS, please contact the undersigned. If it is determined that this IDS has been filed under the wrong rule, the USPTO is requested to consider this IDS under the proper rule and charge the appropriate fee to Deposit Account No. 02-2448.

Dated: APR 5 2012

Respectfully submitted, Reg. NO. 64042

By Corina Tanasa

for D. Richard Anderson
Registration No.: 40439 CORINA TANASA
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road, Suite 100 East
P.O. Box 747
Falls Church, VA 22040-0747
703-205-8000

Attachment(s):

- ☑ PTO/SB/08
- ☑ Document(s)
- ☐ Foreign Patent Office Communication
- ☐ Foreign Search Report
- ☐ Fee
- ☑ Other: **Two (2) U.S. Office Actions**

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/942,792	11/09/2010	Yoshinori Shimizu	0020-5147PUS12	2357

2292 7590 01/30/2012
BIRCH STEWART KOLASCH & BIRCH
PO BOX 747
FALLS CHURCH, VA 22040-0747

EXAMINER	
MUSTAPHA, ABDULFATTAH B	

ART UNIT	PAPER NUMBER
2812	

NOTIFICATION DATE	DELIVERY MODE
01/30/2012	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

mailroom@bskb.com

PTOL-90A (Rev. 04/07)

Office Action Summary	Application No. 12/942,792	Applicant(s) SHIMIZU ET AL.	
	Examiner ABDULFATTAH MUSTAPHA	Art Unit 2812	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *09 November 2010*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5)☒ Claim(s) *1-19* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1-17 and 19* is/are rejected.

8)☒ Claim(s) *18* is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *09 November 2010* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

12)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *See Continuation Sheet*.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

Continuation of Attachment(s) 3). Information Disclosure Statement(s) (PTO/SB/08), Paper No(s)/Mail Date :11/10/2011, 08/30/2011, 06/23/2011, 04/12/2011, 12/23/2010 and 11/09/2010.

DETAILED ACTION

Priority

The applicant filed for the priority date of a foreign application and divisional application, but there is no basis in the priority for the following;

- Light emitting component having an active layer of a semiconductor.
- phosphor is a fluorescent material represented by formula $(Re_{l-r}Sm_r)_3(Al_{l-s}Ga_s)_5O_{12}$: Ce where $0 \leq r < 1$, $0 \leq s \leq 1$ and Re is at least one element selected from Y, Gd and La.

The applicant will be given priority consideration for the effective filling date of the application.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1 – 17 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Butterworth et al. [US 5,847,507], and further in view of Hide et al. [US 5,966,393].

Butterworth et al. disclose preparing a light emitting component having an active layer of a semiconductor (Col. 1; Line 31 – 44, Col. 2; Line 55 - 65, Figures 1 and 2), preparing a phosphor (e.g. phosphor dye in lens 240, Col. 3; Lines 3 – 5) capable of absorbing a part of the blue color light emitted from said light emitting component and emitting a yellow color light having a broad emission spectrum comprising a peak wavelength existing around the range from 510 to 600 nm (e.g. shifting to 488nm – 688nm) and a tail continuing beyond 700 nm, wherein selection of said phosphor is controlled based on an emission wavelength of said light emitting component (In re Aller – result effective variable w/ dyes, Col. 3; Lines 58 – 64); and combining said light emitting component and said phosphor so that the blue color light from said light emitting component and the yellow color light from said phosphor are mixed to make a white color light, wherein a chromaticity point of the white color light is on a straight line connecting a point of chromaticity of the blue color light and a point of chromaticity of the yellow color light, and wherein a content of said phosphor in said light emitting device is selected to obtain a desired chromaticity of the white color light (dyes partially absorbing blue and emitting yellow in encapsulating lens (e.g. lens in direct line of LED emissions) combined w/ blue LED emission for “white light” Col. 3; Lines 3 – 5)) (Claim 1).

Butterworth et al. fail to disclose active layer comprising a gallium nitride based semiconductor containing indium and being capable of emitting a blue color light having a spectrum with a peak wavelength within the range from 420 to 490 nm.

Hide et al. disclose active layer comprising a gallium nitride based semiconductor containing indium and being capable of emitting a blue color light having a spectrum with a peak wavelength within the range from 420 to 490 nm (Zn-doped InGaN LED, Col. 12; Lines 15 – 20) (Claim 1).

Hide et al. disclose the active layer of said light emitting component has a single quantum well or multi quantum well structure (Col. 14; Lines 7 – 9) (Claim 7).

Hide et al. disclose the active layer of said light emitting component comprises InGaN (Col. 12; Lines 15 – 20) (Claim 8).

It would have been obvious for one of ordinary skill in the art at the time of invention to modify the invention of Butterworth et al. by adding active layer comprising a gallium nitride based semiconductor containing indium and being capable of emitting a blue color light having a spectrum with a peak wavelength within the range from 420 to 490 nm; the active layer of said light emitting component has a single quantum well or multi quantum well structure and comprise of InGaN as taught by Hide et al. in order to obtain efficient white light emission or emission over a wide range of colors (Col. 1; Line 30 - 31).

Butterworth et al. disclose phosphor comprises a garnet fluorescent material activated with cerium (Col. 1; Lines 36 - 38) (Claim 2).

Butterworth et al. disclose phosphor comprises two or more kinds of fluorescent materials (Abstract) (Claim 3).

Butterworth et al. disclose the emission spectrum of said phosphor comprises a peak wavelength existing around the range from 530 to 570 nm (e.g. shifting to 488nm

– 688nm) and a tail continuing beyond 700 nm (In re Aller – result effective variable w/ dyes, Col. 3; Lines 58 – 64) (Claim 4).

Butterworth et al. disclose phosphor comprises an yttrium-aluminum-garnet fluorescent material containing Y and Al (Col. 1; Lines 36 - 38) (Claim 5).

Butterworth et al. disclose controlling emission color of said light emitting device by changing a content of said phosphor with respect to a content of a resin in a coating material (In re Aller – result effective variable w/ dyes, Col. 3; Lines 35 – 64) (Claim 10).

Butterworth et al. disclose step of controlling selection of said phosphor is used to reduce variation in the emission wavelength of said light emitting device, by compensating for a variation of the emission wavelength of said light emitting component (In re Aller – result effective variable w/ dyes, Col. 3; Lines 35 – 64) (Claim 11).

Butterworth et al. disclose controlling compositions or quantities of light emitting components and fluorescent materials included in said light emitting device, to control color emitted by said light emitting device (In re Aller – result effective variable w/ dyes, Col. 3; Lines 35 – 64) (Claim 12).

Butterworth et al. disclose the emission wavelength of the fluorescent materials are selected so that said light emitting device produces RGB components with high luminance (In re Aller – result effective variable w/ dyes, RGB colors are produce by different materials, Col. 3; Lines 35 – 64) (Claim 13).

Butterworth et al. disclose the emission spectrum of one fluorescent material comprises a peak wavelength around 510 nm (e.g. shifting to 488nm – 688nm), and the emission spectrum tails out to around 700 nm (In re Aller – result effective variable w/ dyes), and the emission spectrum of a second fluorescent material comprises a peak wavelength around 600 nm, and the emission spectrum tails out to around 750 nm (In re Aller – result effective variable w/ dyes), so that said light emitting device produces RGB components with high luminance (In re Aller – result effective variable w/ dyes, RGB colors are produce by different materials, Col. 3; Lines 35 – 64) (Claim 14).

Butterworth et al. disclose mixing said two or more kinds of fluorescent materials (Col. 3; Lines 35 – 55) (Claim 15).

Butterworth et al. disclose two or more kinds of fluorescent materials are arranged independently to adjust color by laminating the layers of fluorescent materials (Col. 3; Lines 35 – 55) (Claim 16).

Butterworth et al. disclose one of said fluorescent materials absorbs light of a shorter wavelength and another of said fluorescent materials absorbs light of a longer wavelength, and said fluorescent material that absorbs light of a longer wavelength is arranged away from said light emitting component, while said fluorescent material that absorbs light of a shorter wavelength is arranged near said light emitting component (In re Aller – result effective variable w/ dyes, Col. 3; Lines 35 – 64) (Claim 17).

Butterworth et al. disclose controlling compositions or quantities of light emitting components included in said light emitting device and controlling composition of said phosphor, to control color emitted by said light emitting device (Col. 3; Lines 35 – 64) (Claim 19).

Allowable Subject Matter

Claim 18 objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

"phosphor is a fluorescent material represented by formula $(R_{l-r}Sm_r)_3(Al_{l-s}Ga_s)_5O_{12}$: Ce where $0 \leq r < 1$, $0 \leq s \leq 1$ and Re is at least one element selected from Y, Gd and La" as recite in claim 18.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ABDULFATTAH MUSTAPHA whose telephone number is (571)272-9736. The examiner can normally be reached on Monday, Tuesday, Wednesday, and Friday. (06:00am - 4:00pm).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Charles Garber can be reached on 571-272-2194. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Abdulfattah Mustapha/
Examiner, Art Unit 2812

/Charles D. Garber/
Supervisory Patent Examiner, Art Unit 2812

Notice of References Cited	Application/Control No. 12/942,792	Applicant(s)/Patent Under Reexamination SHIMIZU ET AL.	
	Examiner ABDULFATTAH MUSTAPHA	Art Unit 2812	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-5,847,507	12-1998	Butterworth et al.	313/512
*	B	US-5,966,393	10-1999	Hide et al.	372/23
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Receipt date: 06/23/2011

PTO/SB/08b (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
Under the Paperwork reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number

Substitute for form 1449B/PTO	Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	Application Number	12/942,792
	Filing Date	11-09-10
	First Named Inventor	Yoshinori Shimizu
(Use as many sheets as necessary)	Art Unit	2812
	Examiner Name	~~Not Yet Assigned~~ Mustapha
Sheet 1 of 1	Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

Examiner Initial *	Cite No. 1	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T 2
/A.M./	1	U.S. Office Action issued in co-pending Application No. 12/575,155, dated April 19, 2011.	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	12/11/2011

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.
1 Applicant's unique citation designation number. (optional) 2. Applicant is to place a check mark here if English language Translation is attached.
This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450 Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS.
SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	12/942,792
Filing Date	11-09-10
First Named Inventor	Yoshinori Shimizu
Art Unit	2812
Examiner Name	~~Not Yet Assigned~~ Mustapha
Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

Examiner Initial *	Cite No.	Document Number: Number - Kind Code² (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear
/A.M./	1	US-3,623,867	11-30-1971	Saulnier	
/A.M./	2	US-3,842,306	10-15-1974	Henderson et al	
/A.M./	3	US-5,640,216	06-17-1997	Hasegawa et al.	
/A.M./	4	US-5,670,797	09-23-1997	Okazaki	
/A.M./	5	US-5,816,577 -	10-06-1998	Kurematsu et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial *	Cite No. ¹	Foreign Patent Document: Country Code³	Number⁴ Kind Code (if known)⁵	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear	T⁶

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	12/11/2011

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not Considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation design number (optional). 2 See Kinds Codes of USPTO patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4. For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5. Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. 6. Applicant is to place a check mark here if English language Translation is attached

Substitute for form 1449B/PTO				Complete If Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	12/942,782
				Filing Date	11-09-10
				First Named Inventor	Yoshinori Shimizu
(Use as many sheets as necessary)				Art Unit	2812
				Examiner Name	~~Not Yet Assigned~~ Mustapha
Sheet	2	of	2	Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

Examiner Initial *	Cite No. 1	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T 2
/A.M./	6	U.S. Office Action issued in co-pending application 12/548,614 on June 27, 2011.	
/A.M./	7	U.S. Office Action issued in co-pending application 12/689,681 on June 23, 2011.	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	12/11/2011

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12942792	SHIMIZU ET AL.
	Examiner	**Art Unit**
	ABDULFATTAH MUSTAPHA	2812

SEARCHED

Class	Subclass	Date	Examiner
438	21-27	12/16/2011	MBA
257	98,E33.044, E33.059	12/16/2011	MBA
349	69-105	12/16/2011	MBA

SEARCH NOTES

Search Notes	Date	Examiner
East search	12/16/2011	MBA
References and suggestions provided by SPE C. Garber.	12/30/2011	MBA

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner
	See report.	12/16/2011	MBA

Receipt date: 11/10/2011

PTO/SB/08b (07-09)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Sheet 1 of 1

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Examiner initial *	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
/A.M./	1	Office Action issued in co-pending US Appl. No. 12/575,155 on September 30, 2011.	☐
/A.M./	2	Request for Invalidation with Notification of Acceptance of Request for Invalidation of Chinese Patent No. 03159595.2 dispatched on August 10, 2011.	☐
/A.M./	3	Yao Go et al., Synthesis and Luminescence Gallium Nitride LED Blue Light Conversion Materials, ACTA PHYSICO-CHIMICA SINICA, Vol.19, No.3, March 2003, p226 – 229.	☑
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Examiner Signature	/Abdulfattah Mustapha/	Date Considered	12/11/2011

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Receipt date: 12/23/2010

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First Named Inventor	Yoshinori Shimizu
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U.S. PATENT DOCUMENTS

Examiner initial *	Cite No.	Document Number: Number - Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear
/A.M./	1	US-2009/0315014-A1	12-24-2009	SHIMIZU et al.	
/A.M./	2	US-5,045,867-A	09-03-1991	FUSE	

FOREIGN PATENT DOCUMENTS

Examiner Initial *	Cite No. 1	Foreign Patent Document: Country[3] Code Number[4] Kind Code (if known)[5]	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear	T

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	12/11/2011

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Receipt date: 12/23/2010

Substitute for form 1449B/PTO	Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT	**Application Number**	12/942,792
	Filing Date	11-09-10
	First Named Inventor	Yoshinori Shimizu
(Use as many sheets as necessary)	Art Unit	2812
	Examiner Name	~~Not Yet Assigned~~ Mustapha
Sheet 2 of 2	Attorney Docket Number	0020-5147PUS12

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Examiner initial *	Cite No. [1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T [2]
/A.M./	3	Office Action dated July 7, 2010 for US Application No. 12/548,614.	
/A.M./	4	Office Action dated June 16, 2010 for US Application No. 12/548,621.	
/A.M./	5	Office Action dated November 10, 2010 for US Application No. 12/575,162.	
/A.M./	6	Office Action dated November 15, 2010 for US Application No. 12/548,614.	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	12/11/2011

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1. Applicants unique citation designation number. (optional) 2. Applicant is to place a check mark here if English language Translation is attached.

Index of Claims	Application/Control No. 12942792	Applicant(s)/Patent Under Reexamination SHIMIZU ET AL.
	Examiner ABDULFATTAH MUSTAPHA	Art Unit 2812

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	12/29/2011								
	1	✓								
	2	✓								
	3	✓								
	4	✓								
	5	✓								
	6	✓								
	7	✓								
	8	✓								
	9	✓								
	10	✓								
	11	✓								
	12	✓								
	13	✓								
	14	✓								
	15	✓								
	16	✓								
	17	✓								
	18	O								
	19	✓								

Receipt date: 04/12/2011

Substitute for form 1449A/PTO

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Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

Examiner Initial *	Cite No	Document Number: Number - Kind Code 2 (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear
/A.M./	1	US-4,992,704	02-12-1991	Stinson	

FOREIGN PATENT DOCUMENTS

Examiner Initial *	Cite No. 1	Foreign Patent Document: Country Code 3 Number 4 Kind Code (if known) 5	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear	T

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	12/11/2011

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Receipt date: 04/12/2011

PTO/SB/08b (07-09)
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Examiner Initial *	Cite No. 1	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T 2
/A.M./	2	U.S. Office Action issued in Application No. 12/559,042 on March 15, 2011.	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	12/11/2011

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1 Applicant's unique citation designation number. (optional) 2. Applicant is to place a check mark here if English language Translation is attached.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L4	4	("6600175" "3842306" "3875456" "5126214").pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2011/12/16 18:21
L5	12	("6600175" "3842306" "3875456" "5126214").pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/12/16 18:30
L6	5002	phosphor with (blue and yellow) with (LED or light or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/16 18:52
L7	16936281	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/16 18:53
L8	110	L6 and L7	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/16 18:53
L9	1681	(light emit$3 or LED) with (gallium nitride or GaN) with wavelength	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/16 18:54
L10	7	L8 and L9	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/16 18:54
L11	12	("5798537" "5998925" "6069440" "6608332" "6614179" "7026756" "7071616" "7126274" "7215074" "7329988" "7362048" "7531960").pn.	US-PGPUB; USPAT; USOCR	OR	ON	2011/12/16 18:58

L12	48488	((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/16 18:58
L13	12	L12 and L11	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/16 18:58
L14	0	L8 and L13	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/16 18:59
S1	488	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:32
S2	17750983	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:33
S3	47	S1 and S2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:34
S4	53731	stoichiometri$3 and (coprecipitat$3 or precipitat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:35
S5	0	S3 and S4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:35
S6	464	stoichiometri$3 and (coprecipitat$3 or precipitat$3) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	ON	2009/03/09 09:36

			DERWENT; IBM_TDB			
S7	13	S1 and S6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:37
S8	36	("20010030326" | "3510732" | "3652956" | "3691482" | "3699478" | "3819974" | "3875456" | "4298820" | "4314910" | "4550256" | "4644223" | "4716337" | "4727283" | "4905060" | "5006908" | "5118985" | "5202777" | "5257049" | "5369289" | "5471113" | "5550657" | "5578839" | "5602418" | "5700713" | "5825125" | "5847507" | "5959316" | "6004001" | "6066861" | "6340824" | "6538371" | "6576930" | "6784511" | "6798537" | "6812500").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/03/09 09:40
S9	0	S1 and S8	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:41
S10	2	S6 and S8	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:41
S11	1	"20080138918".pn.	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/03/09 09:43
S12	33641	((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:44
S13	159	S12 and S6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:44
S14	11	S13 and S2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2009/03/09 09:44

			IBM_TDB			
S15	3726370	(oxide or ammonium or fluoride or aluminum)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:47
S16	2125	(ammonium adj3 fluoride) and (aluminum adj3 oxide)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:48
S17	2125	S15 and S16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:48
S18	47	S6 and S17	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:49
S19	2	S1 and S18	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:49
S20	35	("20010030326" | "3510732" | "3652956" | "3691482" | "3699478" | "3819974" | "3875456" | "4298820" | "4314910" | "4550256" | "4644223" | "4716337" | "4727283" | "4905060" | "5006908" | "5118985" | "5202777" | "5257049" | "5369289" | "5471113" | "5550657" | "5578839" | "5602418" | "5798537" | "5825125" | "5847507" | "5959316" | "6004001" | "6066861" | "6340824" | "6538371" | "6576930" | "6784511" | "6812500").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/03/09 09:55
S21	1	"4644223".pn.	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/03/09 09:56
S22	24	("2143077" | "3294699" | "3595802" | "3925239" | "4174294" | "4319161").PN. OR ("4644223").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/03/09 09:56
S23	334	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same phosphor	US-PGPUB; USPAT; USOCR; FPRS;	ADJ	ON	2009/03/09 10:00

			EPO; JPO; DERWENT; IBM_TDB			
S24	13	S6 and S23	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 10:00
S25	0	S24 and S2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 10:00
S26	17750983	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:40
S27	464	stoichiometri$3 and (coprecipitat$3 or precipitat$3) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:40
S28	334	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:40
S29	13	S27 and S28	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:40
S30	0	S26 and S29	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:40
S31	13476	((light adj3 emit$3) or LED) same nitride	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:42
S32	1482	S26 and S31	US-PGPUB; USPAT;	ADJ	ON	2009/03/09 19:42

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S33	0	S32 and S27	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:43
S34	53731	stoichiometri$3 and (coprecipitat$3 or precipitat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:43
S35	7	S32 and S34	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:43
S36	7	S35 and S35	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:45
S37	7	S35 and S31	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:45
S38	0	S37 and S33	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:45
S39	15	("56016584" "60011069" "3748548" "105061" "4857228" "4991941" "19910307").pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/03/09 19:49
S40	1833	((light adj3 emit$3) or LED) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:51

S41	32	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:04
S42	32	S40 and S41	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:05
S43	0	S26 and S42	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:05
S44	696	(light adj3 emit$3) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:08
S45	9	S26 and S44	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:08
S46	3726370	(oxide or ammonium or fluoride or aluminum)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:58
S47	2125	(ammonium adj3 fluoride) and (aluminum adj3 oxide)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:58
S48	2125	S46 and S47	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:58
S49	47	S27 and S48	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	ON	2009/03/09 20:58

			DERWENT; IBM_TDB			
S50	86160	fir$3 near3 (oxide or (ammonium adj3 fluoride) or (aluminum adj3 oxide))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:00
S51	45	S49 and S50	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:01
S52	0	S26 and S51	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:01
S53	27176	S26 and S50	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:02
S54	89	S53 and S48	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:03
S55	25	fir$3 near3 (oxide and (ammonium fluoride) and (aluminum oxide))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:05
S56	1	S26 and S55	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:06
S57	1945	dissolv$3 near5 stoichiometric$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:08
S58	1279	S34 and S57	US-PGPUB; USPAT; USOCR;	ADJ	ON	2009/03/09 21:08

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S59	674	S26 and S58	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:08
S60	11	S53 and S59	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:09
S61	49	("4924612" "6139162" "5907373" "6014489" "4772780" "5729024" "5786665" "5818062" "5929436" "6036328" "6094404" "5462164" "5519519" "5671028" "5828302" "6102545" "6215535" "6215535" "4405858" "4807026" "4840137" "4864144" "4865196" RE34411 "5266811" "5398170" "5410212" "5467216" "5573107" "5757447" "5841154" "6048071" "6231200" "6249370" "4250575" "4251142" "4259963" "4340292" "4494874" "4616293" "4814948" "4875074" "4916478" "5219418" "5319414" "5408296" "5459000" "5459505" "5471050" "5510869").pn.	US-PGPUB; USPAT; USOCR	OR	ON	2009/03/09 21:44
S62	0	blue color near5 (420-490) adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 18:58
S63	210	blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 18:59
S64	184	blue color near5 ("510" or "515" or "520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:01
S65	5	S63 and S64	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2009/10/12 19:02

			IBM_TDB			
S66	2	phosphor near5 blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:28
S67	788	(light adj3 emit$3) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:30
S68	14	S63 and S67	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:30
S69	16927698	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:33
S70	0	S68 and S69	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:33
S71	14	S68 and S67	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:34
S72	41	S63 and S69	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:35
S73	0	S64 and S72	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:35
S74	733	NICHIA CORPORATION.as.	US-PGPUB; USPAT; USOCR; FPRS;	ADJ	ON	2009/10/12 19:43

			EPO; JPO; DERWENT; IBM_TDB			
S75	12	NICHIA KAGAKU KOGYO KABUSHIKI KAISHA.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:43
S76	745	S74 or S75	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:44
S77	0	S72 and S76	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:44
S78	0	Yoshinori Shimizu.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:46
S79	0	Kensho Sakano.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:46
S80	0	Yasunobu Noguchi.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:47
S81	0	Toshio Moriguchi.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:47
S89	12	("5798537" "5998925" "6069440" "6608332" "6614179" "7026756" "7071616" "7126274" "7215074" "7329988" "7362048" "7531960").pn.	US-PGPUB; USPAT; USOCR	OR	ON	2009/11/23 09:03
S90	36867	((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS;	ADJ	ON	2009/11/23 09:09

			EPO; JPO; DERWENT; IBM_TDB			
S91	12	S90 and S89	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:09
S92	2163	((light adj3 emit$3) or LED) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:10
S93	40	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:10
S94	40	S92 and S93	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:10
S95	0	S94 and S91	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:10
S96	188	blue color near5 ("510" or "515" or "520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:11
S97	0	S96 and S91	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:11
S98	212	blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:13
S99	0	S98 and S91	US-PGPUB; USPAT;	ADJ	ON	2009/11/23 09:13

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S100	321	blue color near5 (wavelength or wave length) same ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:14
S101	358	blue color near5 (wavelength or wave length) same ("510" or "515" or "520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:15
S102	1	S100 and S91	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:15
S103	1	S101 and S91	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:15
S104	16928194	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:33
S105	0	S94 and S104	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:33
S106	745	NICHIA CORPORATION.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:39
S107	12	NICHIA KAGAKU KOGYO KABUSHIKI KAISHA.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2009/11/23 09:39

			IBM_TDB			
S108	757	S106 or S107	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:39
S109	757	S106 or S107	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:40
S110	9	S100 and S109	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:40
S111	5	S101 and S109	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:40
S112	10	S110 or S111	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:40
S113	0	S112 and S104	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:41
S114	17759950	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:20
S115	520	stoichiometri$3 and (coprecipitat$3 or precipitat$3) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:21
S116	460	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same phosphor	US-PGPUB; USPAT; USOCR; FPRS;	ADJ	ON	2010/05/31 14:21

			EPO; JPO; DERWENT; IBM_TDB			
S117	13	S115 and S116	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:21
S118	0	S117 and S114	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:21
S119	104	(LED or light emit$3) near5 spectrum near3 ("420" or "430" or "440" or "450" or "460" or "470" or "480" or "490" or "500" or "510" or "520" or "530" or "540" or "550" or "560" or "570" or "580" or "590" or "600" or "610" or "620" or "630" or "640" or "650" or "660" or "670" or "680" or "690" or "700") adj (nm or nano meter or nano metre)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:28
S120	15	S114 and S119	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:29
S121	2506	spectrum near3 phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:29
S122	2	S120 and S121	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:29
S123	108	("20010030326" | "3510732" | "3652956" | "3691482" | "3699478" | "3748548" | "3819974" | "3875456" | "4298820" | "4314910" | "4550256" | "4644223" | "4716337" | "4727283" | "4857228" | "4905060" | "5006908" | "5118985" | "5202777" | "5257049" | "5369289" | "5471113" | "5512210" | "5550657" | "5578839" | "5602418" | "5630741" | "5700713" | "5798537" | "5825113" | "5847507" | "5949182" | "5959316" | "5998925" | "6004001"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:32

		| "6066511" | "6069440" | "6340824" | "6538371" | "6576930" | "6608332" | "6614179" | "6784511" | "6798537" | "6812500" | "7026756" | "7071616" | "7126274" | "7215074" | "7329988" | "7362048" | "7531960").PN.				
S124	504	((light adj3 emit$3) or LED) near5 transparent material	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:34
S125	0	S123 and S124	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:34
S126	5	S124 and S121	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:35
S127	0	S120 and S126	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:35
S128	2458	((light adj3 emit$3) or LED) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:36
S129	46	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:36
S130	46	S128 and S129	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:36
S131	49415	(LCD or liquid crystal display) same color filter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	ON	2010/05/31 14:37

			DERWENT; IBM_TDB			
S132	4	S119 and S131	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:37
S133	236146	"257"/$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:38
S134	195807	"438"/$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:38
S135	115041	S133 and S134	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:39
S136	46352	"349"/$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:39
S137	3373	S135 and S136	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:39
S138	125801	"359"/$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:39
S139	64206	"313"/$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:39
S140	3125	S138 and S139	US-PGPUB; USPAT; USOCR;	ADJ	ON	2010/05/31 14:40

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S141	186	S131 and S140	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:40
S142	18	S137 and S141	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:40
S143	111	S128 and S131	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:40
S144	1	S142 and S143	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:41
S145	8649	349/69-105.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:07
S146	1822	S131 and S145	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:07
S147	17	S119 and S121	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:08
S148	0	S146 and S147	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:08
S149	5106	(LCD or liquid crystal display) near3	US-PGPUB;	ADJ	ON	2010/05/31

		(glass or transparent) adj (wafer or substrate)	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			15:11
S150	872	liquid crystal near3 (inject$3 or introduc$3 or dispens$3) near5 (glass or transparent) adj (wafer or substrate)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:14
S151	129	S149 and S150	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:14
S152	0	S119 and S151	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:15
S153	0	("10677382" "12548614" "12548620" "12559042").ap.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 17:39
S154	0	("10/677382" "12/548614" "12/548620" "12/559042").ap.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 17:40
S155	24	("677382" "548614" "548620" "559042").ap.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 17:40
S156	4	("20090315015" "20100001258" "20090315014" "7026756" "7026756").pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 17:45
S157	0	"7362048.pn"	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 19:46
S158	0	"7362048.pn."	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 19:46
S159	1	"7362048".pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 19:47
S160	894622	phosphor near5 transparent material same (LED or light emit$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 19:56
S161	227	blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 19:56
S162	198	blue color near5 ("510" or "515" or	US-PGPUB;	ADJ	ON	2010/06/07

		"520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or nano meter or ANG)	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			19:56
S163	7	S161 and S162	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 19:56
S164	67510	("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:02
S165	137544	("510" or "515" or "520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:02
S166	31514	S164 and S165	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:02
S167	13207	S160 and S166	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:02
S168	17760117	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:03
S169	16666	((light adj3 emit$3) or LED) same nitride	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:03
S170	1488	S168 and S169	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2010/06/07 20:03

			IBM_TDB			
S171	5111	(LCD or liquid crystal display) near3 (glass or transparent) adj (wafer or substrate)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:03
S172	873	liquid crystal near3 (inject$3 or introduc$3 or dispens$3) near5 (glass or transparent) adj (wafer or substrate)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:03
S173	129	S171 and S172	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:03
S174	0	S170 and S173	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:04
S175	61	S170 and S167	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:04
S176	0	transparent adj mateial near5 (LED or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:05
S177	1555	transparent adj material near5 (LED or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:05
S178	0	S175 and S177	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:05
S179	2	"5700713".pn.	US-PGPUB; USPAT; USOCR; FPRS;	ADJ	OFF	2010/06/08 13:30

			EPO; JPO; DERWENT; IBM_TDB			
S180	0	bck light near5 (LED or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/08 19:27
S181	2980	back light near5 (LED or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/08 19:27
S182	5397	liquid crystal near5 glass substrate	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/08 19:28
S183	40	S181 and S182	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/08 19:28
S184	17760148	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/08 19:29
S185	16932587	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/08 19:29
S186	3	S183 and S185	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/08 19:30
S187	56	("20010030326" | "20090315014" | "20090315015" | "20100001258" | "3510732" | "3652956" | "3691482" | "3699478" | "3748548" | "3819974" | "3875456" | "4298820" | "4314910" | "4550256" | "4644223" | "4716337" | "4727283" | "4857228" | "4905060" | "5006908" | "5118985" | "5202777"	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/06/19 13:54

		| "5257049" | "5369289" | "5471113" | "5512210" | "5550657" | "5578839" | "5602418" | "5630741" | "5700713" | "5798537" | "5825125" | "5847507" | "5949182" | "5959316" | "5998925" | "6004001" | "6066861" | "6069440" | "6340824" | "6538371" | "6575930" | "6608332" | "6614179" | "6784511" | "6798537" | "6812500" | "7026756" | "7071616" | "7126274" | "7215074" | "7329988" | "7362048" | "7531960").PN.				
S188	24	(diameter or radi$3) near3 (conduct$3 or wire) near3 ("10" or "15" or "20" or "25" or "30" or "35" or "40" or "45") adj (mu or micro or meter)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 13:59
S189	0	S187 and S188	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 14:02
S190	1	"20090315014".pn.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/06/19 14:04
S191	55	S187 and (diameter or radi$3 or conduct$3 or wire or ".mu.m" or "10" or "15" or "20" or "25" or "30" or "35" or "40" or "45")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 14:08
S192	75	(LED or Light emit$3) adj3 chip near5 conduct$3 adj wire	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 14:44
S193	1	S187 and S192	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 14:44
S194	11	("1305111" or "6340824").pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:13
S195	951	diameter near5 conduct$3 adj wire	US-PGPUB; USPAT;	ADJ	OFF	2010/06/19 15:16

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S196	14	S191 and S195	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:17
S197	168	phosphor near3 transparent material	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:18
S198	3	S196 and S197	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:18
S199	178048	shimizu.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:19
S200	161	S197 NOT S199	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:20
S201	2	("5949182" "3748548").pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/19 15:28
S202	34	("2913632" | "3173101" | "3179542" | "3209214" | "3229104" | "3234057" | "3260902" | "3270235" | "3283160" | "3372069").PN. OR ("3748548").URPN.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/06/19 15:28
S203	21	("3665241" | "3755704" | "3812559" | "4513308" | "5064396" | "5186670" | "5199917" | "5229331" | "5232549" | "5316979" | "5329207" | "5363021" | "5438240" | "5448132" | "5615143").PN. OR ("5949182").URPN.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/06/19 15:30
S204	2	("5630741" "4857228").pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/19 15:34
S205	2	S192 and S197	US-PGPUB; USPAT;	ADJ	OFF	2010/06/19 15:38

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S206	16932745	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/19 15:41
S207	2	S192 and S206	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:42
S208	318	S195 and S206	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:42
S209	0	S208 and S197	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:43
S210	6	("3699478" | "5221984" | "5594751" | "5801435" | "6015200" | "6600175").PN.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/21 16:00
S211	5	("4001628" | "5208462" | "5706022" | "5743629" | "6600175").PN.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/21 16:09
S212	2	"6600175".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/10/24 13:21
S213	6	("3699478" | "5221984" | "5594751" | "5801435" | "6015200" | "6600175").PN.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/24 13:25
S214	3	"3699478".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/04/21 16:56
S215	3	("4992704" "20090315014" "5045867").pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2011/04/22 14:59
S216	2	("2009/0315014").URPN.	USPAT	ADJ	OFF	2011/04/22

						14:59
S217	581	(conduct$3 or electric$3) adj5 (wire or cable) with (diameter or radius or size) with (("10" "15" "20" "25" "30" "35" "40" "45") adj(".mu.m" or micro or micron or meter or metre))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/04/22 15:19
S218	16934970	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:20
S219	82	S217 and S218	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:20
S220	19216	((light adj3 emit$3) or LED) same nitride	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:21
S221	1245	S218 and S220	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:22
S222	0	S219 and S221	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:22
S223	7	((light adj3 emit$3) or LED) and S219	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:22
S224	0	(transparent$3 or visibl$3) adj5 material with (LED or light emit$3 diode or light emit$3) and S219	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:24
S225	0	(transparent$3 or visibl$3) adj5 material with phosphor and S219	US-PGPUB; USPAT; USOCR; FPRS;	ADJ	ON	2011/04/22 15:25

			EPO; JPO; DERWENT; IBM_TDB			
S226	2	"4992704".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/13 16:16
S227	2	"20090315015".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 11:44
S228	3	("2009/0315015").URPN.	USPAT	ADJ	OFF	2011/05/17 11:51
S229	550	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius) with (("10" or "15" or "20" or "25" or "30" or "35" or "40" or "45") adj (".mu.m" or micron or nm or mm))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 15:40
S230	2267282	((LCD or liquid crystal display or liquid crystal) or (LED or light emitting diode or light emit$3) or (bak light))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 15:48
S231	227	S229 and S230	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 15:48
S232	16935137	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/05/17 15:49
S233	18	S232 and S231	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/05/17 15:50
S234	47	phosphor near3 transparent material with (light emit$3 or LED)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 15:54

S235	0	S233 and S234	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 15:54
S236	12	S234 and S231	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/05/17 15:54
S237	950368	phosphor near5 transparent material same (LED or light emit$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2011/05/17 16:55
S238	40	S234 and S237	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/05/17 16:56
S239	0	S233 and S238	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 16:57
S240	195589	S232 and S237	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/05/17 16:57
S241	6	S231 and S240	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/05/17 16:58
S242	283	(wir$3 or (conduct$3 adj wire)) near3 (diameter or radius) with (LED or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 13:15
S243	74	(wir$3 or (conduct$3 adj wire)) near3 (diameter or radius) with (LED or light emit$3) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 13:15
S244	74	(wir$3 or (conduct$3 adj wire)) near3 (diameter or radius) with (LED	US-PGPUB; USPAT;	ADJ	OFF	2011/06/03 14:44

		or light emit$3) and @ad<"19970331"	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S245	13	S244 and (light emit$3 or light emit$3 diode or light emit$3 display)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 14:44
S246	74	S244 and (LED or light emit$3 or light emit$3 diode or light emit$3 display)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 14:47
S247	16	(wir$3 or (conduct$3 adj wire)) with (diameter or radius) with (light emit$3 or light emit$3 diode or light emit$3 display) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 15:22
S248	93	(wir$3 or (conduct$3 adj wire) or conduct$3) near3 (diameter or radius) with (LED or light emit$3) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 16:05
S249	122	(wir$3 or (conduct$3 adj wire) or conduct$3) near3 (diameter or radi$3) with (LED or light emit$3) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 16:05
S250	20	(wir$3 or (conduct$3 adj wire) or conduct$3) near3 (diameter or radi$3) with (light emit$3 or light emit$3 diode or light emit$3 display) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 16:06
S251	20	(wir$3 or (conduct$3 adj wire) or conduct$3) near3 (diameter or radi$3) with (light emit$3 or light emit$3 diode or light emit$3 display) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 16:06
S252	20	S250 and S251	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 16:06

S253	6501	257/98.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 10:27
S254	6501	(257/98).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/06/08 10:27
S255	4900	(257/99).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/06/08 10:27
S256	1730	(257/100).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/06/08 10:29
S257	78	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius or thick$3) and S253	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 10:30
S258	6	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius or thick$3) and S253 and @ad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 10:30
S259	6	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius or thick$3) and S254 and @ad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 10:33
S260	7	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius or thick$3) and S255 and @ad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 10:34
S261	1	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius or thick$3) and S256 and @ad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	OFF	2011/06/08 10:35

			DERWENT; IBM_TDB			
S262	0	438/106-127.ccls. and light near2 emitting near2 diode and (lead wire wiring conductor) near4 (thickness thick diameter)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 13:33
S263	56	438/106-127.ccls. and light near2 emitting near2 diode and (lead wire wiring conductor) near4 (thickness thick diameter)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/06/08 13:33
S264	3	("4347655" "5125153" "5885893").pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2011/06/08 13:34
S265	1730	(257/100).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/06/08 13:35
S266	0	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius or thick$3) and S265 and S264	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 13:35
S267	3	S264 and (wir$3 or LED or light or emit$3 or diameter or thick$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2011/06/08 13:38
S268	6501	257/98.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 13:46
S269	6501	257/98.ccls. and S268	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 13:46
S270	119519	quantum well and S268	US-PGPUB; USPAT; USOCR	OR	OFF	2011/06/08 13:47
S271	1489	quantum well and S268	US-PGPUB; USPAT; USOCR	ADJ	OFF	2011/06/08 13:47
S272	50	quantum well and S268 and @ad<"19970331"	US-PGPUB; USPAT; USOCR	ADJ	OFF	2011/06/08 13:48
S273	25	((single or multi$3) adj quantum	US-PGPUB;	ADJ	OFF	2011/06/08

		well) and S268 and @ad<"19970331"	USPAT; USOCR			13:55
S274	27356	liquid crystal with (glass adj substrate)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:10
S275	17763698	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:10
S276	4812	S274 and S275	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:11
S277	6515	257/98.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:11
S278	1493	quantum well and S277	US-PGPUB; USPAT; USOCR	ADJ	OFF	2011/06/09 12:11
S279	0	S278 and S276	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:11
S280	3	S277 and S276	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:11
S281	1071	(inject$3 or introduc$3 or insert$3) with liquid crystal with (glass adj substrate)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:16
S282	0	S281 and S275 and S277	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:16

S283	505	(inject$3 or introduc$3 or insert$3) with liquid crystal with (glass adj substrate) and color filter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:19
S284	123	S275 and S283	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:20
S285	0	S277 and S284	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:20
S286	3	(inject$3 or introduc$3 or insert$3) with liquid crystal with (glass adj substrate) and color filter with (LED or light emitting diode or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:22
S287	144	(inject$3 or introduc$3 or insert$3) with liquid crystal with (glass adj substrate) and color filter and (LED or light emitting diode or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:22
S288	55	S275 and S287	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:25
S289	7280	liquid crystal with (glass adj substrate) and color filter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:25
S290	55	S288 and S289	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:25
S291	0	S277 and S290	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	ON	2011/06/09 12:26

			DERWENT; IBM_TDB			
S292	2596	liquid crystal with (glass adj substrate) with color filter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:33
S293	19	S290 and S292	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:33
S294	17764738	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/04 17:14
S295	4	("3623867" | "3842306" | "5816677").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/11/04 17:17
S296	17764740	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 13:05
S297	4	("3623867" | "3842306" | "5816677").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/11/05 13:06
S298	1	("3875456").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/11/05 13:13
S299	17764740	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 13:51
S300	568	stoichiometri$3 and (coprecipitat$3 or precipitat$3) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 13:51
S301	47842	((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 13:51

S302	239	S301 and S300	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 13:51
S303	11	S302 and S299	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 13:51
S304	11176	phosphor with (concentrat$3 or quatity or quality or different or mix$3) with (LED or light or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:04
S305	1869	S296 and S304	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:04
S306	773	S301 and S305	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:04
S307	21084	((light adj3 emit$3) or LED) same nitride	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:04
S308	984	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S309	4468235	(oxide or ammonium or fluoride or aluminum)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S310	2933	(ammonium adj3 fluoride) and (aluminum adj3 oxide)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	ON	2011/11/05 14:05

			DERWENT; IBM_TDB			
S311	2933	S309 and S310	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S312	80	S300 and S311	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S313	3	S308 and S312	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S314	12	("5798537" "5998925" "6069440" "6608332" "6614179" "7026756" "7071616" "7126274" "7215074" "7329988" "7362048" "7531960").pn.	US-PGPUB; USPAT; USOCR	OR	ON	2011/11/05 14:05
S315	47842	((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S316	12	S315 and S314	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S317	260	blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S318	961	NICHIA CORPORATION.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S319	12	NICHIA KAGAKU KOGYO KABUSHIKI KAISHA.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	ON	2011/11/05 14:05

			DERWENT; IBM_TDB			
S320	973	S318 or S319	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S82	469	NICHIA CORPORATION.as.	USPAT; UPAD	ADJ	ON	2009/10/12 19:51
S83	7	NICHIA KAGAKU KOGYO KABUSHIKI KAISHA.as.	USPAT; UPAD	ADJ	ON	2009/10/12 19:51
S84	99	blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	USPAT; UPAD	ADJ	ON	2009/10/12 19:51
S85	94	blue color near5 ("510" or "515" or "520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or nano meter or ANG)	USPAT; UPAD	ADJ	ON	2009/10/12 19:51
S86	0	S82 and S83	USPAT; UPAD	ADJ	ON	2009/10/12 19:52
S87	1	S84 and S85	USPAT; UPAD	ADJ	ON	2009/10/12 19:52
S88	0	phosphor near5 blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	USPAT; UPAD	ADJ	ON	2009/10/12 19:57

12/16/2011 6:59:32 PM
C:\Users\amustapha\Documents\EAST\Workspaces\12_942792.wsp

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L31	7317	(light emit$3 or LED) with (gallium nitride or GaN) with ((blue or yellow) near3 light)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/12/11 19:13
L32	7474	(light emit$3 or LED) with (gallium nitride or GaN) with ((blue or yellow) near3 light)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/12/11 19:16
L33	7317	L31 and L32	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/12/11 19:17
L34	2117	(light emit$3 or LED) with (gallium nitride or GaN) with ((blue or yellow) near3 light)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/11 19:17
L35	11512	phosphor with ((blue or yellow) near3 light)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/12/11 19:20
L36	11512	phosphor with ((blue or yellow) near3 light)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/11 19:21
L37	11512	L35 and L36	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/12/11 19:21
L38	1438	L33 and L37	US-PGPUB;	OR	ON	2011/12/11

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			19:22
L39	15	L38 and @ad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/11 19:22
L40	13	L38 and @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/11 19:23
L41	21	L39 or L40	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/11 19:24
L42	9274	(light emit$3 or LED) with (gallium nitride or GaN) with wavelength	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/12/11 20:05
L43	0	L41 and L42	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/12/11 20:05
L44	489836	(light emit$3 or LED) with wavelength	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/12/11 20:05
L45	14	L41 and L44	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/12/11 20:12
L46	123715	(light emit$3 or LED) with (wavelength near3 nm)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	OFF	2011/12/11 20:46

			IBM_TDB			
L47	0	L41 and L46	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/12/11 20:47
L48	575	stoichiometri$3 and (coprecipitat$3 or precipitat$3) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/11 20:48
L49	755	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/11 20:48
L50	15	L48 and L49	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/11 20:48
L51	13794	L46 and @ad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/11 21:12
L52	3379	L51 and @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/12/11 21:13
L53	0	L41 and L52	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/12/11 21:21
L54	3379	L51 and L52	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/12/11 21:21
L55	65	L42 and L54	US-PGPUB; USPAT; USOCR; FPRS;	OR	OFF	2011/12/11 21:21

			EPO; JPO; DERWENT; IBM_TDB			
L56	73	("20100001258" | "3510732" | "5512210" | "5847507" | "6608332" | "6812500" | "5670797" | "4001628" | "4314910" | "5208462" | "5550657" | "5578839" | "5594751" | "5602418" | "5825125" | "5959316" | "6066861" | "6538371" | "7329988" | "7362048" | "7531960" | "4716337" | "5202777" | "5257049" | "5369289" | "6015200" | "6600175" | "7126274" | "20090315015" | "3691482" | "4298820" | "4644223" | "4727283" | "5471113" | "7215074" | "7682848" | "5045867" | "3623867" | "4550256" | "4905060" | "5706022" | "5801435" | "7026756" | "20090315014" | "3842306" | "5640216" | "5816677" | "3652956" | "3875456" | "4857228" | "5998925" | "6784511" | "20010030326" | "3699478" | "3819974" | "5630741" | "5700713" | "5743629" | "5798537" | "5949182" | "6004001" | "6069440" | "6340824" | "6576930" | "6614179" | "4992704" | "3748548" | "5006908" | "5118985" | "5221984" | "7071616").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2011/12/11 21:24
L57	28	L46 and L56	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/12/11 21:25
S1	488	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:32
S2	17750983	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:33
S3	47	S1 and S2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:34
S4	53731	stoichiometri$3 and (coprecipitat$3 or precipitat$3)	US-PGPUB; USPAT;	ADJ	ON	2009/03/09 09:35

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S5	0	S3 and S4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:35
S6	464	stoichiometri$3 and (coprecipitat$3 or precipitat$3) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:36
S7	13	S1 and S6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:37
S8	36	("20010030326" | "3510732" | "3652956" | "3691482" | "3699478" | "3819974" | "3875456" | "4298820" | "4314910" | "4550256" | "4644223" | "4716337" | "4727283" | "4905060" | "5006908" | "5118985" | "5202777" | "5257049" | "5369289" | "5471113" | "5550657" | "5578839" | "5602418" | "5700713" | "5825125" | "5847507" | "5959316" | "6004001" | "6066861" | "6340824" | "6538371" | "6576930" | "6784511" | "6798537" | "6812500").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/03/09 09:40
S9	0	S1 and S8	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:41
S10	2	S6 and S8	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:41
S11	1	"20080138918".pn.	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/03/09 09:43
S12	33641	((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR;	ADJ	ON	2009/03/09 09:44

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S13	159	S12 and S6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:44
S14	11	S13 and S2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:44
S15	3726370	(oxide or ammonium or fluoride or aluminum)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:47
S16	2125	(ammonium adj3 fluoride) and (aluminum adj3 oxide)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:48
S17	2125	S15 and S16	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:48
S18	47	S6 and S17	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:49
S19	2	S1 and S18	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 09:49
S20	35	("20010030326" | "3510732" | "3652956" | "3691482" | "3699478" | "3819974" | "3875456" | "4298820" | "4314910" | "4550256" | "4644223" | "4716337" | "4727283" | "4905060" | "5006908" | "5118985" | "5202777" | "5257049" | "5369289" | "5471113"	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/03/09 09:55

		| "5550657" | "5578839" | "5602418" | "5798537" | "5825125" | "5847507" | "5959316" | "6004001" | "6066861" | "6340824" | "6538371" | "6576930" | "6784511" | "6812500").PN.				
S21	1	"4644223".pn.	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/03/09 09:56
S22	24	("2143077" | "3294699" | "3595802" | "3925239" | "4174294" | "4319161").PN. OR ("4644223").URPN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2009/03/09 09:56
S23	334	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 10:00
S24	13	S6 and S23	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 10:00
S25	0	S24 and S2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 10:00
S26	17750983	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:40
S27	464	stoichiometri$3 and (coprecipitat$3 or precipitat$3) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:40
S28	334	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:40
S29	13	S27 and S28	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2009/03/09 19:40

			IBM_TDB			
S30	0	S26 and S29	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:40
S31	13476	((light adj3 emit$3) or LED) same nitride	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:42
S32	1482	S26 and S31	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:42
S33	0	S32 and S27	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:43
S34	53731	stoichiometri$3 and (coprecipitat$3 or precipitat$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:43
S35	7	S32 and S34	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:43
S36	7	S35 and S35	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:45
S37	7	S35 and S31	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:45
S38	0	S37 and S33	US-PGPUB; USPAT; USOCR; FPRS;	ADJ	ON	2009/03/09 19:45

			EPO; JPO; DERWENT; IBM_TDB			
S39	15	("56016584" "60011069" "3748548" "105061" "4857228" "4991941" "19910307").pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/03/09 19:49
S40	1833	((light adj3 emit$3) or LED) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 19:51
S41	32	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:04
S42	32	S40 and S41	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:05
S43	0	S26 and S42	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:05
S44	696	(light adj3 emit$3) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:08
S45	9	S26 and S44	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:08
S46	3726370	(oxide or ammonium or fluoride or aluminum)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:58
S47	2125	(ammonium adj3 fluoride) and (aluminum adj3 oxide)	US-PGPUB; USPAT;	ADJ	ON	2009/03/09 20:58

			USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S48	2125	S46 and S47	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:58
S49	47	S27 and S48	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 20:58
S50	86160	fir$3 near3 (oxide or (ammonium adj3 fluoride) or (aluminum adj3 oxide))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:00
S51	45	S49 and S50	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:01
S52	0	S26 and S51	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:01
S53	27176	S26 and S50	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:02
S54	89	S53 and S48	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:03
S55	25	fir$3 near3 (oxide and (ammonium fluoride) and (aluminum oxide))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:05

S56	1	S26 and S55	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:06
S57	1945	dissolv$3 near5 stoichiometric$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:08
S58	1279	S34 and S57	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:08
S59	674	S26 and S58	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:08
S60	11	S53 and S59	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/03/09 21:09
S61	49	("4924612" "6139162" "5907373" "6014489" "4772780" "5729024" "5786665" "5818062" "5929436" "6036328" "6094404" "5462164" "5519519" "5671028" "5828302" "6102545" "6215535" "6215535" "4405858" "4807026" "4840137" "4864144" "4865196" RE34411 "5266811" "5398170" "5410212" "5467216" "5573107" "5757447" "5841154" "6048071" "6231200" "6249370" "4250575" "4251142" "4259963" "4340292" "4494874" "4616293" "4814948" "4875074" "4916478" "5219418" "5319414" "5408296" "5459000" "5459505" "5471050" "5510869").pn.	US-PGPUB; USPAT; USOCR	OR	ON	2009/03/09 21:44
S62	0	blue color near5 (420-490) adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 18:58
S63	210	blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or	US-PGPUB; USPAT; USOCR;	ADJ	ON	2009/10/12 18:59

		"485" or "490") adj (nm or nanometre or nano meter or ANG)	FPRS; EPO; JPO; DERWENT; IBM_TDB			
S64	184	blue color near5 ("510" or "515" or "520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:01
S65	5	S63 and S64	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:02
S66	2	phosphor near5 blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:28
S67	788	(light adj3 emit$3) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:30
S68	14	S63 and S67	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:30
S69	16927698	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:33
S70	0	S68 and S69	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:33
S71	14	S68 and S67	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:34
S72	41	S63 and S69	US-PGPUB;	ADJ	ON	2009/10/12

			USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			19:35
S73	0	S64 and S72	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:35
S74	733	NICHIA CORPORATION.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:43
S75	12	NICHIA KAGAKU KOGYO KABUSHIKI KAISHA.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:43
S76	745	S74 or S75	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:44
S77	0	S72 and S76	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:44
S78	0	Yoshinori Shimizu.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:46
S79	0	Kensho Sakano.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:46
S80	0	Yasunobu Noguchi.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2009/10/12 19:47

			IBM_TDB			
S81	0	Toshio Moriguchi.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/10/12 19:47
S89	12	("5798537" "5998925" "6069440" "6608332" "6614179" "7026756" "7071616" "7126274" "7215074" "7329988" "7362048" "7531960").pn.	US-PGPUB; USPAT; USOCR	OR	ON	2009/11/23 09:03
S90	36867	((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:09
S91	12	S90 and S89	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:09
S92	2163	((light adj3 emit$3) or LED) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:10
S93	40	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:10
S94	40	S92 and S93	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:10
S95	0	S94 and S91	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:10
S96	188	blue color near5 ("510" or "515" or "520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2009/11/23 09:11

		nano meter or ANG)	IBM_TDB			
S97	0	S96 and S91	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:11
S98	212	blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:13
S99	0	S98 and S91	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:13
S100	321	blue color near5 (wavelength or wave length) same ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:14
S101	358	blue color near5 (wavelength or wave length) same ("510" or "515" or "520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:15
S102	1	S100 and S91	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:15
S103	1	S101 and S91	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:15
S104	16928194	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:33
S105	0	S94 and S104	US-PGPUB; USPAT; USOCR;	ADJ	ON	2009/11/23 09:33

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S106	745	NICHIA CORPORATION.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:39
S107	12	NICHIA KAGAKU KOGYO KABUSHIKI KAISHA.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:39
S108	757	S106 or S107	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:39
S109	757	S106 or S107	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:40
S110	9	S100 and S109	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:40
S111	5	S101 and S109	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:40
S112	10	S110 or S111	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:40
S113	0	S112 and S104	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2009/11/23 09:41
S114	17759950	@ad<"19970331" or	US-PGPUB;	ADJ	ON	2010/05/31

		@rlad<"19970331"	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			14:20
S115	520	stoichiometri$3 and (coprecipitat$3 or precipitat$3) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:21
S116	460	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:21
S117	13	S115 and S116	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:21
S118	0	S117 and S114	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:21
S119	104	(LED or light emit$3) near5 spectrum near3 ("420" or "430" or "440" or "450" or "460" or "470" or "480" or "490" or "500" or "510" or "520" or "530" or "540" or "550" or "560" or "570" or "580" or "590" or "600" or "610" or "620" or "630" or "640" or "650" or "660" or "670" or "680" or "690" or "700") adj (nm or nano meter or nano metre)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:28
S120	15	S114 and S119	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:29
S121	2506	spectrum near3 phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:29
S122	2	S120 and S121	US-PGPUB; USPAT; USOCR;	ADJ	ON	2010/05/31 14:29

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S123	108	("20010030326" | "3510732" | "3652956" | "3691482" | "3699478" | "3748548" | "3819974" | "3875456" | "4298820" | "4314910" | "4550256" | "4644223" | "4716337" | "4727283" | "4857228" | "4905060" | "5006908" | "5118985" | "5202777" | "5257049" | "5369289" | "5471113" | "5512210" | "5550657" | "5578839" | "5602418" | "5630741" | "5700713" | "5798537" | "5825113" | "5847507" | "5949182" | "5959316" | "5998925" | "6004001" | "6066511" | "6069440" | "6340824" | "6538371" | "6576930" | "6608332" | "6614179" | "6784511" | "6798537" | "6812500" | "7026756" | "7071616" | "7126274" | "7215074" | "7329988" | "7362048" | "7531960").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:32
S124	504	((light adj3 emit$3) or LED) near5 transparent material	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:34
S125	0	S123 and S124	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:34
S126	5	S124 and S121	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:35
S127	0	S120 and S126	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:35
S128	2458	((light adj3 emit$3) or LED) same (phosphor and nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:36
S129	46	(adjust$3 or align$3 or alin$3) near5 ((light adj3 emit$3) or LED) same	US-PGPUB; USPAT;	ADJ	ON	2010/05/31 14:36

		(phosphor and nitri$3)	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S130	46	S128 and S129	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:36
S131	49415	(LCD or liquid crystal display) same color filter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:37
S132	4	S119 and S131	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:37
S133	236146	"257"/$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:38
S134	195807	"438"/$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:38
S135	115041	S133 and S134	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:39
S136	46352	"349"/$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:39
S137	3373	S135 and S136	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:39

S138	125801	"359"/$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:39
S139	64206	"313"/$	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:39
S140	3125	S138 and S139	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:40
S141	186	S131 and S140	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:40
S142	18	S137 and S141	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:40
S143	111	S128 and S131	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:40
S144	1	S142 and S143	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 14:41
S145	8649	349/69-105.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:07
S146	1822	S131 and S145	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	ON	2010/05/31 15:07

			DERWENT; IBM_TDB			
S147	17	S119 and S121	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:08
S148	0	S146 and S147	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:08
S149	5106	(LCD or liquid crystal display) near3 (glass or transparent) adj (wafer or substrate)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:11
S150	872	liquid crystal near3 (inject$3 or introduc$3 or dispens$3) near5 (glass or transparent) adj (wafer or substrate)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:14
S151	129	S149 and S150	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:14
S152	0	S119 and S151	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/05/31 15:15
S153	0	("10677382" "12548614" "12548620" "12559042").ap.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 17:39
S154	0	("10/677382" "12/548614" "12/548620" "12/559042").ap.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 17:40
S155	24	("677382" "548614" "548620" "559042").ap.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 17:40
S156	4	("20090315015" "20100001258" "20090315014" "7026756" "7026756").pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 17:45
S157	0	"7362048.pn"	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 19:46
S158	0	"7362048.pn."	US-PGPUB;	OR	OFF	2010/06/07

			USPAT; USOCR			19:46
S159	1	"7362048".pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 19:47
S160	894622	phosphor near5 transparent material same (LED or light emit$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/07 19:56
S161	227	blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 19:56
S162	198	blue color near5 ("510" or "515" or "520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 19:56
S163	7	S161 and S162	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 19:56
S164	67510	("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:02
S165	137544	("510" or "515" or "520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or nano meter or ANG)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:02
S166	31514	S164 and S165	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:02
S167	13207	S160 and S166	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:02
S168	17760117	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR;	ADJ	ON	2010/06/07 20:03

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S169	16666	((light adj3 emit$3) or LED) same nitride	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:03
S170	1488	S168 and S169	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:03
S171	5111	(LCD or liquid crystal display) near3 (glass or transparent) adj (wafer or substrate)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:03
S172	873	liquid crystal near3 (inject$3 or introduc$3 or dispens$3) near5 (glass or transparent) adj (wafer or substrate)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:03
S173	129	S171 and S172	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:03
S174	0	S170 and S173	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:04
S175	61	S170 and S167	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:04
S176	0	transparent adj mateial near5 (LED or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:05
S177	1555	transparent adj material near5 (LED	US-PGPUB;	ADJ	ON	2010/06/07

		or light emit$3)	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			20:05
S178	0	S175 and S177	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/07 20:05
S179	2	"5700713".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/08 13:30
S180	0	bck light near5 (LED or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/08 19:27
S181	2980	back light near5 (LED or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/08 19:27
S182	5397	liquid crystal near5 glass substrate	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/08 19:28
S183	40	S181 and S182	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/08 19:28
S184	17760148	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/08 19:29
S185	16932587	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2010/06/08 19:29

			IBM_TDB			
S186	3	S183 and S185	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/08 19:30
S187	56	("20010030326" | "20090315014" | "20090315015" | "20100001258" | "3510732" | "3652956" | "3691482" | "3699478" | "3748548" | "3819974" | "3875456" | "4298820" | "4314910" | "4550256" | "4644223" | "4716337" | "4727283" | "4857228" | "4905060" | "5006908" | "5118985" | "5202777" | "5257049" | "5369289" | "5471113" | "5512210" | "5550657" | "5578839" | "5602418" | "5630741" | "5700713" | "5798537" | "5825125" | "5847507" | "5949182" | "5959316" | "5998925" | "6004001" | "6066861" | "6069440" | "6340824" | "6538371" | "6575930" | "6608332" | "6614179" | "6784511" | "6798537" | "6812500" | "7026756" | "7071616" | "7126274" | "7215074" | "7329988" | "7362048" | "7531960").PN.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/06/19 13:54
S188	24	(diameter or radi$3) near3 (conduct$3 or wire) near3 ("10" or "15" or "20" or "25" or "30" or "35" or "40" or "45") adj (mu or micro or meter)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 13:59
S189	0	S187 and S188	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 14:02
S190	1	"20090315014".pn.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/06/19 14:04
S191	55	S187 and (diameter or radi$3 or conduct$3 or wire or ".mu.m" or "10" or "15" or "20" or "25" or "30" or "35" or "40" or "45")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 14:08
S192	75	(LED or Light emit$3) adj3 chip near5 conduct$3 adj wire	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 14:44

S193	1	S187 and S192	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 14:44
S194	11	("1305111" or "6340824").pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:13
S195	951	diameter near5 conduct$3 adj wire	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:16
S196	14	S191 and S195	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:17
S197	168	phosphor near3 transparent material	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:18
S198	3	S196 and S197	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:18
S199	178048	shimizu.in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:19
S200	161	S197 NOT S199	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:20
S201	2	("5949182" "3748548").pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/19 15:28
S202	34	("2913632" | "3173101" | "3179542"	US-PGPUB;	ADJ	OFF	2010/06/19

		| "3209214" | "3229104" | "3234057" | "3260902" | "3270235" | "3283160" | "3372069").PN. OR ("3748548").URPN.	USPAT; USOCR			15:28
S203	21	("3665241" | "3755704" | "3812559" | "4513308" | "5064396" | "5186670" | "5199917" | "5229331" | "5232549" | "5316979" | "5329207" | "5363021" | "5438240" | "5448132" | "5615143").PN. OR ("5949182").URPN.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/06/19 15:30
S204	2	("5630741" "4857228").pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2010/06/19 15:34
S205	2	S192 and S197	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:38
S206	16932745	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2010/06/19 15:41
S207	2	S192 and S206	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:42
S208	318	S195 and S206	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:42
S209	0	S208 and S197	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2010/06/19 15:43
S210	6	("3699478" | "5221984" | "5594751" | "5801435" | "6015200" | "6600175").PN.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/21 16:00
S211	5	("4001628" | "5208462" | "5706022" | "5743629" | "6600175").PN.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/21 16:09
S212	2	"6600175".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	ADJ	OFF	2010/10/24 13:21

			DERWENT; IBM_TDB			
S213	6	("3699478" | "5221984" | "5594751" | "5801435" | "6015200" | "6600175").PN.	US-PGPUB; USPAT; USOCR	ADJ	OFF	2010/10/24 13:25
S214	3	"3699478".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/04/21 16:56
S215	3	("4992704" "20090315014" "5045867").pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2011/04/22 14:59
S216	2	("2009/0315014").URPN.	USPAT	ADJ	OFF	2011/04/22 14:59
S217	581	(conduct$3 or electric$3) adj5 (wire or cable) with (diameter or radius or size) with (("10" "15" "20" "25" "30" "35" "40" "45") adj(".mu.m" or micro or micron or meter or metre))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/04/22 15:19
S218	16934970	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:20
S219	82	S217 and S218	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:20
S220	19216	((light adj3 emit$3) or LED) same nitride	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:21
S221	1245	S218 and S220	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:22
S222	0	S219 and S221	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:22
S223	7	((light adj3 emit$3) or LED) and	US-PGPUB;	ADJ	ON	2011/04/22

		S219	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			15:22
S224	0	(transparent$3 or visibl$3) adj5 material with (LED or light emit$3 diode or light emit$3) and S219	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:24
S225	0	(transparent$3 or visibl$3) adj5 material with phosphor and S219	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/04/22 15:25
S226	2	"4992704".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/13 16:16
S227	2	"20090315015".pn.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 11:44
S228	3	("2009/0315015").URPN.	USPAT	ADJ	OFF	2011/05/17 11:51
S229	550	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius) with (("10" or "15" or "20" or "25" or "30" or "35" or "40" or "45") adj (".mu.m" or micron or nm or mm))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 15:40
S230	2267282	((LCD or liquid crystal display or liquid crystal) or (LED or light emitting diode or light emit$3) or (bak light))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 15:48
S231	227	S229 and S230	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 15:48
S232	16935137	@ad<"19960729" or @rlad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS;	ADJ	ON	2011/05/17 15:49

			EPO; JPO; DERWENT; IBM_TDB			
S233	18	S232 and S231	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/05/17 15:50
S234	47	phosphor near3 transparent material with (light emit$3 or LED)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 15:54
S235	0	S233 and S234	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 15:54
S236	12	S234 and S231	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/05/17 15:54
S237	950368	phosphor near5 transparent material same (LED or light emit$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2011/05/17 16:55
S238	40	S234 and S237	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/05/17 16:56
S239	0	S233 and S238	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/05/17 16:57
S240	195589	S232 and S237	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/05/17 16:57
S241	6	S231 and S240	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	ADJ	ON	2011/05/17 16:58

			IBM_TDB			
S242	283	(wir$3 or (conduct$3 adj wire)) near3 (diameter or radius) with (LED or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 13:15
S243	74	(wir$3 or (conduct$3 adj wire)) near3 (diameter or radius) with (LED or light emit$3) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 13:15
S244	74	(wir$3 or (conduct$3 adj wire)) near3 (diameter or radius) with (LED or light emit$3) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 14:44
S245	13	S244 and (light emit$3 or light emit$3 diode or light emit$3 display)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 14:44
S246	74	S244 and (LED or light emit$3 or light emit$3 diode or light emit$3 display)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 14:47
S247	16	(wir$3 or (conduct$3 adj wire)) with (diameter or radius) with (light emit$3 or light emit$3 diode or light emit$3 display) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 15:22
S248	93	(wir$3 or (conduct$3 adj wire) or conduct$3) near3 (diameter or radius) with (LED or light emit$3) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 16:05
S249	122	(wir$3 or (conduct$3 adj wire) or conduct$3) near3 (diameter or radi$3) with (LED or light emit$3) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 16:05
S250	20	(wir$3 or (conduct$3 adj wire) or conduct$3) near3 (diameter or radi$3) with (light emit$3 or light emit$3 diode or light emit$3 display)	US-PGPUB; USPAT; USOCR; FPRS;	ADJ	OFF	2011/06/03 16:06

		and @ad<"19970331"	EPO; JPO; DERWENT; IBM_TDB			
S251	20	(wir$3 or (conduct$3 adj wire) or conduct$3) near3 (diameter or radi$3) with (light emit$3 or light emit$3 diode or light emit$3 display) and @ad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 16:06
S252	20	S250 and S251	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/03 16:06
S253	6501	257/98.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 10:27
S254	6501	(257/98).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/06/08 10:27
S255	4900	(257/99).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/06/08 10:27
S256	1730	(257/100).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/06/08 10:29
S257	78	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius or thick$3) and S253	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 10:30
S258	6	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius or thick$3) and S253 and @ad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 10:30
S259	6	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter	US-PGPUB; USPAT;	ADJ	OFF	2011/06/08 10:33

		or radius or thick$3) and S254 and @ad<"19960729"	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S260	7	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius or thick$3) and S255 and @ad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 10:34
S261	1	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius or thick$3) and S256 and @ad<"19960729"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 10:35
S262	0	438/106-127.ccls. and light near2 emitting near2 diode and (lead wire wiring conductor) near4 (thickness thick diameter)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 13:33
S263	56	438/106-127.ccls. and light near2 emitting near2 diode and (lead wire wiring conductor) near4 (thickness thick diameter)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/06/08 13:33
S264	3	("4347655" "5125153" "5885893").pn.	US-PGPUB; USPAT; USOCR	OR	OFF	2011/06/08 13:34
S265	1730	(257/100).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2011/06/08 13:35
S266	0	(conduct$3 or connect$3) adj3 (wire or lead or electrode) with (diameter or radius or thick$3) and S265 and S264	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 13:35
S267	3	S264 and (wir$3 or LED or light or emit$3 or diameter or thick$3)	US-PGPUB; USPAT; USOCR	OR	OFF	2011/06/08 13:38
S268	6501	257/98.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 13:46

S269	6501	257/98.ccls. and S268	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/08 13:46
S270	119519	quantum well and S268	US-PGPUB; USPAT; USOCR	OR	OFF	2011/06/08 13:47
S271	1489	quantum well and S268	US-PGPUB; USPAT; USOCR	ADJ	OFF	2011/06/08 13:47
S272	50	quantum well and S268 and @ad<"19970331"	US-PGPUB; USPAT; USOCR	ADJ	OFF	2011/06/08 13:48
S273	25	((single or multi$3) adj quantum well) and S268 and @ad<"19970331"	US-PGPUB; USPAT; USOCR	ADJ	OFF	2011/06/08 13:55
S274	27356	liquid crystal with (glass adj substrate)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:10
S275	17763698	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:10
S276	4812	S274 and S275	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:11
S277	6515	257/98.ccls.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:11
S278	1493	quantum well and S277	US-PGPUB; USPAT; USOCR	ADJ	OFF	2011/06/09 12:11
S279	0	S278 and S276	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:11
S280	3	S277 and S276	US-PGPUB; USPAT; USOCR;	ADJ	ON	2011/06/09 12:11

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S281	1071	(inject$3 or introduc$3 or insert$3) with liquid crystal with (glass adj substrate)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:16
S282	0	S281 and S275 and S277	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:16
S283	505	(inject$3 or introduc$3 or insert$3) with liquid crystal with (glass adj substrate) and color filter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:19
S284	123	S275 and S283	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:20
S285	0	S277 and S284	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:20
S286	3	(inject$3 or introduc$3 or insert$3) with liquid crystal with (glass adj substrate) and color filter with (LED or light emitting diode or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:22
S287	144	(inject$3 or introduc$3 or insert$3) with liquid crystal with (glass adj substrate) and color filter and (LED or light emitting diode or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:22
S288	55	S275 and S287	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:25
S289	7280	liquid crystal with (glass adj	US-PGPUB;	ADJ	OFF	2011/06/09

		substrate) and color filter	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			12:25
S290	55	S288 and S289	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:25
S291	0	S277 and S290	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/06/09 12:26
S292	2596	liquid crystal with (glass adj substrate) with color filter	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:33
S293	19	S290 and S292	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	OFF	2011/06/09 12:33
S294	17764738	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/04 17:14
S295	4	("3623867" | "3842306" | "5816677").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/11/04 17:17
S296	17764740	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 13:05
S297	4	("3623867" | "3842306" | "5816677").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/11/05 13:06
S298	1	("3875456").PN.	US-PGPUB; USPAT; USOCR	ADJ	ON	2011/11/05 13:13
S299	17764740	@ad<"19970331" or @rlad<"19970331"	US-PGPUB; USPAT; USOCR;	ADJ	ON	2011/11/05 13:51

			FPRS; EPO; JPO; DERWENT; IBM_TDB			
S300	568	stoichiometri$3 and (coprecipitat$3 or precipitat$3) same phosphor	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 13:51
S301	47842	((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 13:51
S302	239	S301 and S300	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 13:51
S303	11	S302 and S299	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 13:51
S304	11176	phosphor with (concentrat$3 or quatity or quality or different or mix$3) with (LED or light or light emit$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:04
S305	1869	S296 and S304	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:04
S306	773	S301 and S305	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:04
S307	21084	((light adj3 emit$3) or LED) same nitride	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:04
S308	984	(adjust$3 or align$3 or alin$3) near5	US-PGPUB;	ADJ	ON	2011/11/05

		((light adj3 emit$3) or LED) same (phosphor or nitri$3)	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			14:05
S309	4468235	(oxide or ammonium or fluoride or aluminum)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S310	2933	(ammonium adj3 fluoride) and (aluminum adj3 oxide)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S311	2933	S309 and S310	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S312	80	S300 and S311	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S313	3	S308 and S312	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S314	12	("5798537" "5998925" "6069440" "6608332" "6614179" "7026756" "7071616" "7126274" "7215074" "7329988" "7362048" "7531960").pn.	US-PGPUB; USPAT; USOCR	OR	ON	2011/11/05 14:05
S315	47842	((light adj3 emit$3) or LED) same (phosphor or nitri$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S316	12	S315 and S314	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S317	260	blue color near5 ("420" or "425" or	US-PGPUB;	ADJ	ON	2011/11/05

		"430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			14:05
S318	961	NICHIA CORPORATION.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S319	12	NICHIA KAGAKU KOGYO KABUSHIKI KAISHA.as.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05
S320	973	S318 or S319	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	ADJ	ON	2011/11/05 14:05

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S82	469	NICHIA CORPORATION.as.	USPAT; UPAD	ADJ	ON	2009/10/12 19:51
S83	7	NICHIA KAGAKU KOGYO KABUSHIKI KAISHA.as.	USPAT; UPAD	ADJ	ON	2009/10/12 19:51
S84	99	blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	USPAT; UPAD	ADJ	ON	2009/10/12 19:51
S85	94	blue color near5 ("510" or "515" or "520" or "525" or "530" or "535" or "540" or "545" or "550" or "555" or "560" or "565" or "570" or "575" or "580" or "585" or "590" or "595" or "600") adj (nm or nanometre or nano meter or ANG)	USPAT; UPAD	ADJ	ON	2009/10/12 19:51
S86	0	S82 and S83	USPAT; UPAD	ADJ	ON	2009/10/12 19:52
S87	1	S84 and S85	USPAT; UPAD	ADJ	ON	2009/10/12 19:52
S88	0	phosphor near5 blue color near5 ("420" or "425" or "430" or "435" or "440" or "445" or "460" or "470" or "475" or "480" or "485" or "490") adj (nm or nanometre or nano meter or ANG)	USPAT; UPAD	ADJ	ON	2009/10/12 19:57

12/11/2011 9:27:34 PM
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Receipt date: 11/09/2010

PTO/SB/08a (07-09)
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(Use as many sheets as necessary)

Sheet 1 of 12

Complete if Known	
Application Number	~~NEW~~ 12/942792
Filing Date	~~Concurrently Herewith~~ ~~11/09~~/2010
First Named Inventor	Yoshinori SHIMIZU
Art Unit	~~N/A~~ 2812
Examiner Name	~~Not Yet Assigned~~ Mustapha
Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
/A.M./	AA*	US-5,700,713-A	12-23-1997	Yamazaki et al.	
	AB*	US-5,257,049	10-26-1993	Van Peteghem	
	AC*	US-6,812,500	11-02-2004	Reeh et al.	
	AD*	US-2001-0030326-A1	10-18-2001	Reeh et al.	
	AE*	US-6,576,930	06-10-2003	Reeh et al.	
	AF*	US-6,784,511	08-31-2004	Kunihara et al.	
	AG*	US-6,066,861	05-23-2000	Hohn et al.	
	AH*	US-5,959,316	09-28-1999	Lowery	
	AI*	US-5,118,985-A	06-02-1992	Patton et al.	
	AJ*	US-4,644,223	02-17-1987	de Hair et al.	
	AK*	US-6,538,371	03-25-2003	Duggal et al.	
	AL*	US-3,875,456	04-01-1975	Kano et al.	
	AM*	US-3,510,732	05-05-1970	R.L. Amans	
	AN*	US-5,550,657	08-27-1996	Tanaka et al.	
	AO*	US-5,578,839	11-26-1996	Nakamura et al.	
	AP*	US-6,004,001-A	12-21-1999	Noll	
	AQ*	US-4,905,060	02-27-1990	Chinone et al.	
	AR*	US-3,652,956	03-28-1972	Pinnow et al.	
/A.M./	AS*	US-4,314,910	02-09-1982	Barnes	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
/A.M./	BA	JP-2002-270020-A	09-20-2002	CASIO COMPUTER CO LTD		
	BB	JP-7-321407	12-08-1995	FUJI ELECTRIC CO LTD.		
	BC	JP-6-115158	04-26-1994	AGFA GEVAERT NV		
	BD	JP-61-158606	07-18-1986			
	BE	JP-2000-512806-A	09-26-2000			
/A.M./	BF	JP-07-288341	10-31-1995	NICHIA CHEM IND LTD		

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	12/11/2011

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. * CITE NO.: Those application(s) which are marked with an single asterisk (*) next to the Cite No. are not supplied (under 37 CFR 1.98(a)(2)(iii)) because that application was filed after June 30, 2003 or is available in the IFW. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

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PTO/SB/08a (07-09)
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Sheet 2 of 12

Complete if Known	
Application Number	~~NEW~~ 12/942792
Filing Date	~~Concurrently Herewith~~ 11/09/2010
First Named Inventor	Yoshinori SHIMIZU
Art Unit	~~N/A~~ 2812
Examiner Name	~~Not Yet Assigned~~ Mustapha
Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
/A.M./	AT*	US-5,006,908	04-09-1991	Matsuoka et al.	
	AU*	US-5,369,289	11-29-1994	Tamaki et al.	
	AV*	US-4,727,283	02-23-1988	van Kemenade et al.	
	AW*	US-4,298,820	11-03-1981	Bongers et al.	
	AX*	US-3,699,478	10-17-1972	Pinnow et al.	
	AY*	US-5,798,537	08-25-1998	Nitta	
	AZ*	US-5,202,777	04-13-1993	Sluzky et al.	
	AA1*	US-3,819,974	06-25-1974	Stevenson et al.	
	AB1*	US-5,847,507	12-08-1998	Butterworth et al.	
	AC1*	US-3,691,482	09-12-1972	Pinnow et al.	
	AD1*	US-4,550,256	10-29-1985	Berkstesser et al.	
	AE1*	US-4,716,337	12-29-1987	Huiskes et al.	
	AF1*	US-5,471,113	11-28-1995	De Backer et al.	
	AG1*	US-5,825,125-A	10-20-1998	Ligthart et al.	
	AH1*	US-5,602,418-A	02-11-1997	Imai et al.	
	AI1*	US-5,998,925-A	12-07-1999	Shimizu et al.	
	AJ1*	US-6,069,440-A	05-30-2000	Shimizu et al.	
	AK1*	US-6,608,332-B2	08-19-2003	Shimizu et al.	
/A.M./	AL1*	US-6,614,179-B1	09-02-2003	Shimizu et al.	

FOREIGN PATENT DOCUMENTS

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/A.M./	BG	JP-5-226676	03-09-1993	SHARP CORP.		
	BH	JP-49-122292	11-22-1974			
	BI	JP-11-500584	01-12-1999			
	BJ	JP-8-78727-A	03-22-1996			
	BK	JP-03-152898-A	06-28-1991			
/A.M./	BL	JP-06-139973-A	05-20-1994			

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	12/11/2011

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/A.M./	AM1*	US-7,329,988-B2	02-12-2008	Shimizu et al.	
	AN1*	US-7,126,274-B2	10-24-2006	Shimizu et al.	
	AO1*	US-7,026,756-B2	04-11-2006	Shimizu et al.	
	AP1*	US-7,215,074-B2	05-08-2007	Shimizu et al.	
	AQ1*	US-7,071,616-B2	07-04-2006	Shimizu et al.	
	AR1*	US-7,531,960-B2	05-12-2009	Shimizu et al.	
	AS1*	US-7,362,048-B2	04-22-2008	Shimizu et al.	
	AT1*	US-5,949,182	09-07-1999	Shealy et al.	
	AU1*	US-3,748,548	07-24-1973	Haisty et al.	
	AV1*	US-5,512,210	04-30-1996	Sluzky et al.	
	AW1*	US-5,630,741	05-20-1997	Potter	
	AX1*	US-4,857,228	08-15-1989	Kabay et al.	
	AY1*	US-6,340,824	01-22-2002	Komoto et al.	
	AZ1*	US-4,001,628	01-04-1977	Ryan	
	AA2*	US-5,208,462	05-04-1993	O'Connor et al.	
	AB2*	US-5,706,022	01-06-1998	Hato	
	AC2*	US-5,743,629	04-28-1998	Helstern et al.	
	AD2*	US-6,600,175	07-29-2003	Baretz et al.	
/A.M./	AE2*	US-20100001258	01-07-2010	Shimizu et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
/A.M./	BM	EP-0 500 937-A1	09-02-1992			
	BN	JP-2001-320094-A	11-16-2001			
	BO	DE-3804293-A1	08-24-1989			
	BP	JP-06-231605-A	08-19-1994			
	BQ	GB-2 000 173	01-04-1979			
/A.M./	BR	EP-0 383 215-A	08-22-1990			

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First Named Inventor	Yoshinori SHIMIZU
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Examiner Name	~~Not Yet Assigned~~ Mustapha
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/A.M./	AF2*	US-20090315015	12-24-2009	SHIMIZU et al.	
	AG2*	US-5,221,984	06-22-1993	Furuyama et al.	
	AH2*	US-5,594,751	01-14-1997	Scott	
	AI2*	US-5,801,435	09-01-1998	Otsuki	
	AJ2*	US-6,015,200	01-18-2000	Ogura	
/A.M./	AK2*	US-7,682,848-A1	03-23-2010	Shimizu et al.	

FOREIGN PATENT DOCUMENTS

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/A.M./	BS	DE-9013615-U	01-24-1991			
	BT	JP-59-30107-U	02-24-1984			
	BU	JP-7-32638-U	06-16-1995			
	BV	JP-01-257993-A	10-16-1989			
	BW	JP-01-260707-A	10-18-1989			
/A.M./	BX	JP-02-111922-A	04-24-1990			

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	12/11/2011

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	~~NEW~~ 12/942792
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				First Named Inventor	Yoshinori SHIMIZU
(Use as many sheets as necessary)				Art Unit	~~N/A~~ 2812
				Examiner Name	~~Not Yet Assigned~~ Mustapha
Sheet	5	of	12	Attorney Docket Number	0020-5147PUS12

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/A.M./	BY	JP-05-142424-A	06-11-1993			
	BZ	JP-06-160635-A	06-07-1994			
	BA1	JP-06-027327-A	02-04-1994			
	BB1	JP-06-82633-A	03-25-1994			
	BC1	JP-07-114904-A	05-02-1995			
	BD1	JP-07-235207-A	09-05-1995			
	BE1	JP-53-7153	01-21-1978			
	BF1	JP-7-42152-A	07-21-1995			
	BG1	JP-55-4898-A	01-14-1980			
	BH1	JP-55-005533-A	01-16-1990			
	BI1	JP-60-185457	09-20-1985			
	BJ1	JP-62-20237-A	01-28-1987			
	BK1	JP-62-232827-A	10-13-1987			
	BL1	JP-01-189695-A	07-28-1989			
	BM1	JP-07-120754-A	05-12-1995			
	BN1	JP-06-177423-A	06-24-1994			
	BO1	JP-7-99345-A	04-11-1995			
	BP1	JP-09-027642-A	01-28-1997			
	BQ1	JP-05-63068-U	08-20-1993			
	BR1	EP-0 209 942-A1	01-28-1987			
	BS1	EP-0 541 373-A2	11-05-1992			
	BT1	JP-0 599 224-A1	06-01-1994			
	BU1	JP-01179471-A	07-17-1989			
	BV1	JP-5043913-C1	04-21-1975			
	BW1	JP-554898-A	01-14-1980			
	BX1	JP-09027642-A	01-28-1997			
	BY1	JP-08007614-A	01-12-1996			
	BZ1	JP-07176794-A	07-14-1995			
	BA2	JP-07099345-A	04-11-1995			
	BB2	JP-05152609	06-18-1993			
	BC2	JP-6220237-A	01-28-1987			
	BD2	WO-97/50132-A1	12-31-1997			
	BE2	WO-98/12757-A1	03-26-1998			
	BF2	JP-5079379	11-24-1973			
	BG2	JP-742152	07-21-1995			
	BH2	JP-4717684	09-09-1972			
	BI2	JP-491221	01-12-1974			
	BJ2	JP-49112577	10-26-1974			
	BK2	JP-62189770	02-15-1986			
	BL2	JP-291980	09-29-1988			
/A.M./	BM2	JP-5152609-A	06-18-1993			
/A.M./	BN2	JP-5-183189-A	07-23-1993	Nichia Kagaku Kogyo Kk		

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First Named Inventor	Yoshinori SHIMIZU
Art Unit	~~N/A~~ 2812
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/A.M./	BO2	JP-863119	03-08-1996			
	BP2	JP-10036835-A	02-10-1998			
	BQ2	JP-49106283	12-27-1972			
	BR2	JP-5245181	10-14-1977			
	BS2	GB-1589964	05-20-1981			
	BT2	JP-5441660	12-05-1979			
	BU2	JP-5472484	11-07-1978			
	BV2	JP-5950445	04-01-1984			
	BW2	JP-324692	03-14-1991			
	BX2	JP-463162	05-29-1992			
	BY2	JP-463163	05-29-1992			
	BZ2	JP-563068	08-20-1993			
	BA3	JP-8170077	07-02-1996			
	BB3	JP-5331584	03-24-1978			
	BC3	JP-60144381	07-30-1985			
	BD3	JP-62167387	07-23-1987			
	BE3	JP-6208845	07-26-1994			
	BF3	JP-06177423	06-24-1994			
	BG3	JP-06260680	09-16-1994			
	BH3	JP-06268257	09-22-1994			
	BI3	JP-4-234481-A	08-24-1992			
	BJ3	JP-4-80286-A	03-13-1992			
	BK3	GB-1 305 111	01-31-1973			
	BL3	EP-0 667 383-A2	08-16-1995			
	BM3	JP-6-296043-A	10-21-1994			
/A.M./	BM4	EP-0-550-937-A1	09-02-1992			

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	First Named Inventor	Yoshinori SHIMIZU
	Art Unit	~~N/A~~ 2812
	Examiner Name	~~Not Yet Assigned~~ Mustapha
Sheet 7 of 12	Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

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/A.M./	CA	"White LED lamp: Efficient light-emitting; Manufacture cost half", Nikkei Sangyo Shimbun, September 13, 1996, Published by Nihon Keizai Shimbunsha.	
	CB	"SIMENS SMT-TOPLED fur die Oberflachenmontage" Frank Mollmer et al. Simens Components, 29 (1991) Hfet 4.	
	CC	"Proceedings of the Institute of Phosphor Society", Translation of pages 1, 5 to 14 of the 264th Proceedings of the Institute of Phosphor Society, Nov. 29, 1996.	
	CD	"Nichia Chemical starts the sample shipment of white light emitting diode", News Report, translation of page 15 of Nikkei Electronics 1996.9.23 (No. 671).	
	CE	"GaNpn Contact Blue/Ultraviolet light Emitting Diode", H. Amano et al., Applied Physics, Vol. 20, No. 2, pp. 163-166 (1991)	
	CF	"Phosphors Based on Rare-Earths, A New Era in Fluorescent Lighting", B.M.J. Smets, Materials Chemistry and Physics, 16 pp. 283-299 (1987)	
	CG	"Proceedings of the Institute of Phosphor Society", Translation of pages 1, 5 to 14 of the 264th Proceedings of the Institute of Phosphor Society.	
	CH	"A New Phosphor for Flying-Spot Cathode-Ray Tubes for Color Television: Yellow Emitting..", G. Blasse et al., App. Phys. Lett. Vol. 11, No. 2, pp. 53-55 (1967)	
/A.M./	CI	Y. Nayatani, Color Research & Application, Vol. 20, No. 3, June 1995, pp. 143-155.	
/A.M./	CJ	WUSTLICH MIKRO-/OPTO-ELEKTRONIK GMBH (1994/1995)	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	12/11/2011

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/A.M./	CK	W.W. Holloway, Jr. et at., "Optical Properties of Cerium-Activated Garnet Crystals", 1969 Journal of the Optical Society of America, Vol. 59, No. 1, pp. 60-63	
	CL	W.W. HOLLOWAY, Jr. et al., "On The Fluorescence of Cerium - Activated Garnet Crystals", Physics Letters, Vol. 25A, No. 8, 23 October 1967, pp. 614-615.	
	CM	W.J. MINISCALCO et al., "Measurements of Excited-State Absorption in Ce3+:YAGa)", J. Appl. Phys. Vol. 49, No. 12, December 1978, pp. 6109-6111.	
	CN	Takashi MATSUOKA et al., "Growth and Properties of a Wide-Gap Semiconductor InGaN", Optoelectronics-Devices and Technologies, Vol. 5, No. 1, pp.53-64, June 1990.	
	CO	Tadao MIURA, ELECTRONICS ENGINEERING, "High-intensity White Backlighting for LCD of Car Audios", July 1996, Vol. 38, No. 7, pp. 55-58	
	CP	T. NAGATOMO et al., "Ga1-xInxN Blue Light-Emitting Diodes", Proc. Electrochem. Soc., 1993, Vol. 93-10, pp. 136-141.	
	CQ	Shuji NAKAMURA, "Zn-doped InGaN growth and InGaN/AlGaN double-heterostructure blue-light-emitting diodes", Journal of Crystal Growth, 145 (1994), pp. 911-917.	
	CR	Shuji NAKAMURA, "InGaN/AlGaN blue-light-emitting diodes", J. Vac. Sci. Technol. A 13(3), May/Jun 1995, pp.705-710.	
	CS	Shuji NAKAMURA, "High-Power InGaN/AlGaN Double-Heterostructure Blue-Light-Emitting Diodes", IEDM 94 (1994), IEEE, pp. 567-570.	
/A.M./	CT	Shuji NAKAMURA et al., "Si-Doped InGaN Films Grown on GaN Films", Jpn. J. Appl. Phys. Vol. 32 (1993), pp. L16-L19, Part 2, No. 1A/B, 15 January 1993.	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	12/11/2011

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/A.M./	CU	Shuji NAKAMURA et al., "P-GaN/N-InGaN/N-GaN Double-Heterostructure Blue-Light-Emitting Diodes", Jpn. J. Appl. Phys. Vol. 32 (1993), pp. L8-L11, Part 2, No. 1A/B, 15, January 1993.	
	CV	Shigeo SHIONOYA et al. (editors), "Phosphor Handbook", pp. 505-508, CRC Press, 1999.	
	CW	Shigeo SHIONOYA et al. (editors), "Phosphor Handbook", pp. 505-508, CRC Press.	
	CX	Sato et al., Japanese Journal of Applied Physics, Vol. 35, July 1, 1996, pp. L838-L839.	
	CY	S. Nakaura et al., Japanese Journal of Applied Physics Part 2, Vol. 31, No. 10B, 1992, pp. L1457-1459.	
	CZ	R. W. G. Hunt, Color Research & Application, Vol. 16, No. 3, 1991, pp. 146-165.	
	CA1	Proceedings of Illumination National Convention in 1983, page 12.	
	CB1	Phosphor Handbook, 1st Edition, 1987, pp. 233-240 and 275-277.	
	CC1	P. Schlouer et al. "Luminescence Conversion of Blue Light Emitting Diodes", Applied Physics Letter, vol. 46, p. 417-418, February 1997	
	CD1	Nikkei Sangyo Shin-bun of September 13, 1996.	
	CE1	Nakamura, SPIE, Vol. 3002, pp. 26-35 (1997)	
	CF1	Mitsubishi Electric Company Technical Report, Vol. 48, No. 9, 1974, pp. 1121-1124.	
	CG1	M.F. YAN et al., "Preparation of Y3Al5O12-Based Phosphor Powders, J. Electrochem. Soc., Vol. 134, No. 2.	
	CH1	M.F. YAN et al., "Preparation of Y3Al5O12-Based Phosphor Powders, J. Electrochem. Soc., Vol. 134, No. 2, Feb. 1987.	
	CI1	M. Ikeda, Journal of the Illumination Society, Vol. 71, No. 10, 1987, pp. 612-617 and English Abstract.	
	CJ1	M. Ikeda et al., Color Research & Application, Vol. 16, No. 2, April 1991, pp. 72-80.	
	CK1	M. Ikeda et al., Color Research & Application, Vol. 14, No. 4, August 1989, pp. 198-206.	
	CL1	Kozo OSAMURA et al., "Preparation and optical properties of Ga1-xInxN thin films", Journal of Applied Physics, Vol. 46, No. 8, August 1975, pp. 3432-3437.	
	CM1	Journal of the Television Society, Vol. 47, No. 5, 1993, pp. 753-764.	
/A.M./	CN1	J.M. Robertson, et al., "Colourshift of the Ce3+ Emission in Monocrystalline Epitaxially Grown Garnet Layers", 1981 Philips J. Res. 36, pp. 15-30	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	12/11/2011

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Substitute for form 1449/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	~~NEW~~ 12/942792
(Use as many sheets as necessary)				Filing Date	~~Concurrently Herewith~~ 11/09/2010
				First Named Inventor	Yoshinori SHIMIZU
				Art Unit	~~N/A~~ 2812
				Examiner Name	~~Not Yet Assigned~~ Mustapha
Sheet	10	of	12	Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
/A.M./	CI2	Office Action issued February 28, 2006, in U.S. Application No. 10/677,382 (U.S. Patent 7,026,756).	
	CJ2	Notice of Allowance and Examiner's Comments on Allowance issued February 13, 2008, in connection with U.S. Application No. 10/609,402 (U.S. Patent 7,362,048).	
	CK2	Notice of Allowance and Examiner's Comments on Allowance issued February 11, 2009, in U.S. Application No. 11/682,014 (U.S. Patent 7,531,960).	
	CL2	Notice of Allowance and Examiner's Comments on Allowance issued March 10, 2006, in U.S. Application No. 10/864,544 (U.S. Patent 7,126,274).	
	CM2	Notice of Allowance and Examiner's Comments on Allowance issued September 7, 2006, in U.S. Application No. 11/208,729 (U.S. Patent 7,215,074).	
	CN2	Notice of Allowance and Examiner's Comments on Allowance issued May 4, 2005, in U.S. Application No. 10/609,503 (U.S. Patent 7,071,616).	
	CO2	Notice of Allowance and Examiner's Comments on Allowance issued March 25, 2003, in U.S. Application No. 09/736,425 (U.S. Patent 6,608,332).	
	CP2	Notice of Allowance and Examiner's Comments on Allowance issued March 26, 2003, in U.S. Application No. 09/458,024 (U.S. Patent 6,614,179).	
	CQ2	Notice of Allowance and Examiner's Comments on Allowance issued September 25, 2007, in U.S. Application No. 11/653,275 (U.S. Patent 5,998,925).	
/A.M./	CR2	Notice of Allowance and Examiner's Comments on Allowance issued March 8, 1999, in U.S. Application No. 09/300,315 (U.S. Patent 6,069,440).	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	12/11/2011

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Substitute for form 1449/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	~~NEW~~ 12/942792
(Use as many sheets as necessary)				Filing Date	~~Concurrently Herewith~~ 11/09/2010
				First Named Inventor	Yoshinori SHIMIZU
				Art Unit	~~N/A~~ 2812
				Examiner Name	~~Not Yet Assigned~~ Mustapha
Sheet	11	of	12	Attorney Docket Number	0020-5147PUS12

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/A.M./	CS2	Notice of Allowance and Examiner's Comments on Allowance issued January 28, 1999, in U.S. Application No. 08/902,725 (U.S. Patent 5,998,925).	
	CT2	Office Action issued November 17, 2000, in U.S. Application No. 08/902,725 (U.S. Patent 5,998,925).	
	CU2	Notice of Allowance and Examiner's Comments on Allowance issued September 22, 2005, in U.S. Application No. 10/677,382 (U.S. Patent 7,026,756).	
	CV2	Office Action issed October 20, 2009, in Japanese Patent Application No. 2009-065948 with partial English translation.	
	CW2	Office Action issued April 4, 2007, in U.S. Application 11/653,275 (U.S. Patent 7,329,988 B2).	
	CX2	Notice of Allowance and Examiner's Comments on Allowance issued February 13, 2008, in U.S. Application No. 10/609,402 (U.S. Patent 7,362,048).	
	CY2	Notice of Allowance and Examiner's Comments on Allowance issued September 25, 2007, in U.S. Application No. 11/653,275 (U.S. Patent 7,329,988).	
	CZ2	Notice of Allowance and Examiner's Comments on Allowance issued October 8, 1999, in U.S. Application No. 09/300,315 (U.S. Patent 6,069,440).	
	CA3	Office Action issUed October 20, 2009, in Japanese Patent Application No. 2009-065948 with partial English translation.	
/A.M./	CB3	Hide et al., "White light from InGaN/conjugated polymer hybrid light-emitting diodes," Appl. Phys. Lett., Vol. 70 (20), May 19, 1997, http://apl.aip.org/apl/copyright.jsp, pp. 2664-2666.	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	~~NEW~~ 12/942792
				Filing Date	~~Concurrently Herewith~~ 11/09/2010
(Use as many sheets as necessary)				First Named Inventor	Yoshinori SHIMIZU
				Art Unit	~~N/A~~ 2812
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/A.M./	CC3	NAKAMURA et al., "High-Brightness InGaN Blue, Green and Yellow Light-Emitting Diodes with Quantum Well Structures", Japanese Journal of Applied Physics, Vol. 34, No. 7A, Part 2, July 1, 1995, pp. L797-L799 XP000702022	
	CD3	Non-Final Office Action issued August 2, 2010, in co-pending U.S. Application Serial No. 12/559,042.	
	CD4	Hoffman, Journal of les, pp. 89-91 (1977).	
	CD5	H. Shinoda et al., Color Research & Application, Vol. 18, No. 5, October 1993, pp. 326-333.	
	CD6	G. BLASSE et al., "Investigation of Some Ce3+-Activated Phosphors", Journal of Chemical Physics, Vol. 47, No. 12, 15 December 1967.	
	CD7	E.F. GIBBONS et al., "Some Factors Influencing the Luminous Decay characteristics of Y3Al5O12:Ce3+", J. Electrochem. Soc., Vol. 120, No. 6, June 1973.	
	CD8	D.J. ROBBINS et al., "Lattice Defects and Energy Transfer Phenomena in Y3Al5O12:Ce3+", pp. 1004-1013, printed June 19, 2001.	
	CD9	Bando et al., Development and applications of highbright white LED lamps, November 29, 1996, The 264th Proceedings of the Institute of Phosphor Society, pages 4-16 of the English translation.	
	CD10	Office Action issued December 13, 2005, in U.S. Application No. 11/208,729 (U.S. Patent No. 7,215,074).	
	CD11	Office Action issued March 13, 2001, in U.S. Application No. 09/458,024 (U.S. Patent No. 6,614,179).	
	CD12	Office Action issued August 14, 2002, in U.S. Application No. 09/736,425 (U.S. Patent No. 6,608,332).	
	CD13	Office Action issued August 19, 2005, in U.S. Application No. 10/609,402 (U.S. Patent No. 7,362,048).	
	CD14	Office Action issued July 27, 2007, in U.S. Application No. 10/609,402 (U.S. Patent No. 7,362,048).	
	CD15	Office Action issued January 2, 2008, in U.S. Application No. 10/609,402 (U.S. Patent No. 7,362,048).	
	CD16	Office Action issued April 8, 2005, in U.S. Application No. 10/677,382 (U.S. Patent No. 7,026,756).	
/A.M./	CD17	Office Action issued September 7, 2005, in U.S. Application No. 10/864,544 (U.S. Patent No. 7,126,274).	

Examiner Signature	/Abdulfattah Mustapha/	Date Considered	12/11/2011

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Sheet	1	of	1

Complete if Known	
Application Number	12/942,792
Filing Date	11-09-10
First Named Inventor	Yoshinori Shimizu
Art Unit	2812
Examiner Name	A. Mustapha
Attorney Docket Number	0020-5147PUS12

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Examiner Initial *	Cite No. [1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T [2]
	1	U.S. Office Action issued in co-pending application 12/689,681 on December 5, 2011.	

Examiner Signature		Date Considered	

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This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450 Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS.

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EFS ID:	11886558
Application Number:	12942792
International Application Number:	
Confirmation Number:	2357
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimizu
Customer Number:	2292
Filer:	David Richard Anderson/Patti Young
Filer Authorized By:	David Richard Anderson
Attorney Docket Number:	0020-5147PUS12
Receipt Date:	20-JAN-2012
Filing Date:	09-NOV-2010
Time Stamp:	15:57:20
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

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1		20120120IDS.pdf	2465793 1485e6c1728440ba7166156ec402f9d0a46fb0ea	yes	6

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	Document Description	**Start**	**End**
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<u>National Stage of an International Application under 35 U.S.C. 371</u>
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<u>New International Application Filed with the USPTO as a Receiving Office</u>
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Docket No.: 0020-5147PUS12
(Patent)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application of:
Yoshinori SHIMIZU et al.

Application No.: 12/942,792 Confirmation No.: 2357

Filed: November 09, 2010 Art Unit: 2812

For: LIGHT EMITTING DEVICE AND DISPLAY Examiner: A. Mustapha

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

Applicant(s) hereby submit(s) an Information Disclosure Statement for consideration by the Examiner.

I. LIST OF PATENTS, PUBLICATIONS OR OTHER INFORMATION

The patents, publications, or other information submitted for consideration by the Office are listed on the attached PTO/SB/08.

II. COPIES

☑ a. Copies of foreign patent documents, non-patent literature and other information.

☐ b. REFERENCES PREVIOUSLY CITED OR SUBMITTED: Copies of any information not provided can be found in one or more of the following applications which has been relied upon for an earlier filing date under 35 U.S.C. § 120:

U.S. Application No. and U.S. Filing Date

12/548,614 filed August 27, 2009

III. CONCISE EXPLANATION OF THE RELEVANCE/OTHER INFORMATION

☐ a. NON-ENGLISH LANGUAGE DOCUMENTS: A concise explanation of the relevance of all non-English language patents, publications, or other information listed is as follows:

☐ b. ENGLISH LANGUAGE SEARCH REPORT OR FOREIGN PATENT OFFICE COMMUNICATION: An English language version of the search report or Foreign Patent Office communication that indicates the degree of relevance is attached.

☑ c. OTHER: The following additional information is provided.

A U.S. Office Action issued in co-pending application 12/689,681 on December 5, 2011 is attached. The references discussed in the Office Action were previously submitted to the USPTO in an IDS.

IV. STATEMENT UNDER 37 C.F.R. § 1.97(e)

The undersigned hereby states that:

☐ a. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **30 days** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☐ b. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☑ c. No item of information contained in the IDS was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of IDS was known to any individual designated in 37 C.F.R. § 1.56(c) more than **three months** prior to the filing of the IDS; or

☐ d. Some of the items of information in the IDS were cited in a communication from a foreign patent office. Such items were first cited in a communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office. As to the remaining items of information, to the knowledge of the person signing the certification after making reasonable inquiry, such remaining items were not known to any individual designated in 37 C.F.R. § 1.56(c) more than **three months** prior to the filing of this statement.

V. FEES

☐ a. This Information Disclosure Statement is being filed concurrently with the filing of a new patent application or Request for Continued Examination. No fee is required.

☐ b. This Information Disclosure Statement is being filed within three months of the filing date of an application. No fee is required.

☑ c. This Information Disclosure Statement is being filed before the mailing date of a first Action on the merits. No fee is required. If a first Office Action on the merits has issued, please consider this IDS under 37 C.F.R. § 1.97(c) and see the statement under 37 C.F.R. § 1.97(e) above. If no statement has been made, charge our deposit account for the required fee.

☐ d. This Information Disclosure Statement is being filed before the mailing date of a Final Office Action or before the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(c)(1)).

- ☐ No statement. The fee as required by 37 C.F.R. § 1.17(p) is provided.

  or

- ☐ See the above statement. No fee is required.

☐ e. This Information Disclosure Statement is being filed after the mailing date of a Final Office Action or after the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(d)), see the statement above. The fee as required by 37 C.F.R. § 1.17(p) is provided.

VI. PAYMENT OF FEES

- ☐ The required fee is listed on the attached Fee Transmittal.
- ☑ No fee is required.

If the Examiner has any questions concerning this IDS, please contact the undersigned. If it is determined that this IDS has been filed under the wrong rule, the USPTO is requested to consider this IDS under the proper rule and charge the appropriate fee to Deposit Account No. 02-2448.

Dated: January 20, 2012

Respectfully submitted,

By ______________________

D. Richard Anderson
Registration No.: 40,439
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road, Suite 100 East
P.O. Box 747
Falls Church, VA 22040-0747
703-205-8000

Attachment(s):

- ☑ PTO/SB/08
- ☑ Document(s)
- ☐ Foreign Patent Office Communication
- ☐ Foreign Search Report
- ☐ Fee
- ☐ Other:

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Complete if Known	
Application Number	12/942,792
Filing Date	11-09-10
First Named Inventor	Yoshinori Shimizu
Art Unit	2812
Examiner Name	Not Yet Assigned
Attorney Docket Number	0020-5147PUS12

Sheet 1 of 1

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	1	Office Action issued in co-pending US Appl. No. 12/575,155 on September 30, 2011.	☐
	2	Request for Invalidation with Notification of Acceptance of Request for Invalidation of Chinese Patent No. 03159595.2 dispatched on August 10, 2011.	☐
	3	Yao Go et al., Synthesis and Luminescence Gallium Nitride LED Blue Light Conversion Materials, ACTA PHYSICO-CHIMICA SINICA, Vol.19, No.3, March 2003, p226 – 229.	✓
			☐
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EFS ID:	11383732
Application Number:	12942792
International Application Number:	
Confirmation Number:	2357
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimizu
Customer Number:	2292
Filer:	David Richard Anderson
Filer Authorized By:	
Attorney Docket Number:	0020-5147PUS12
Receipt Date:	10-NOV-2011
Filing Date:	09-NOV-2010
Time Stamp:	18:37:10
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

<u>New Applications Under 35 U.S.C. 111</u>
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

<u>National Stage of an International Application under 35 U.S.C. 371</u>
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

<u>New International Application Filed with the USPTO as a Receiving Office</u>
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Docket No.: 0020-5147PUS12
(Patent)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application of:	Yoshinori SHIMIZU et al.		
Application No.:	12/942,792	Confirmation No.:	2357
Filed:	November 09, 2010	Art Unit:	2812
For: LIGHT EMITTING DEVICE AND DISPLAY		Examiner:	Not Yet Assigned

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Applicants hereby submit an Information Disclosure Statement for consideration by the Examiner.

I. LIST OF PATENTS, PUBLICATIONS OR OTHER INFORMATION

The patents, publications, or other information submitted for consideration by the Office are listed on the attached PTO/SB/08.

II. COPIES

☐ a. Copies of foreign patent documents, non-patent literature and other information.

☑ b. REFERENCES PREVIOUSLY CITED OR SUBMITTED: Copies of any information not provided can be found in one or more of the following applications which has been relied upon for an earlier filing date under 35 U.S.C. § 120:

U.S. Application No. and U.S. Filing Date

12/028,062 filed February 8, 2008

ct

III. CONCISE EXPLANATION OF THE RELEVANCE/OTHER INFORMATION

☐ a. NON-ENGLISH LANGUAGE DOCUMENTS: A concise explanation of the relevance of all non-English language patents, publications, or other information listed is as follows:

☐ b. ENGLISH LANGUAGE SEARCH REPORT OR FOREIGN PATENT OFFICE COMMUNICATION: An English language version of the search report or Foreign Patent Office communication that indicates the degree of relevance is attached.

☑ c. OTHER: The following additional information is provided.

The publication by Yao Go submitted herein was cited in the Request for Invalidation of Chinese Patent No. 03159595.2 submitted herein. Chinese Patent No. 03159595.2 is a counterpart foreign application of the present US application. The Request for Invalidation submitted herein was submitted to the Chinese Patent Office by a third party and then the Chinese Patent Office dispatched a Notification of Acceptance of Request for Invalidation, submitted herein, for informing the fact that a third party submitted a Request for Invalidation.

A concise explanation regarding publication by Yao Go and the Request for Invalidation is submitted herein, as follows. The publication by Yao Go cited in the Request for Invalidation is alleged to describe that a crystal structure of the garnet will have a defect and a light emitting characteristics will be suddenly changed if all Y is replaced with Gd. This concise explanation corresponds to a portion of the publication by Yao Go cited in the Request for Invalidation.

All references discussed and cited in the US Office Action of co-pending Appl. No. 12/575,155 submitted herein were previously submitted to USPTO.

cto

IV. STATEMENT UNDER 37 C.F.R. § 1.97(e)

The undersigned hereby states that:

☐ a. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **30 days** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☐ b. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☑ c. No item of information contained in the IDS was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of IDS was known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of the IDS. cet

☐ d. Some of the items of information in the IDS were cited in a communication from a foreign patent office. Such items were first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office. As to the remaining items of information, to the knowledge of the person signing the certification after making reasonable inquiry, such remaining items were not known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of this statement.

V. FEES

☐ a. This Information Disclosure Statement is being filed concurrently with the filing of a new patent application or Request for Continued Examination. No fee is required.

☐ b. This Information Disclosure Statement is being filed within three months of the filing date of an application. No fee is required.

☑ c. This Information Disclosure Statement is being filed before the mailing date of a first Action on the merits. No fee is required. If a first Office Action on the merits has issued, please consider this IDS under 37 C.F.R. § 1.97(c) and see the statement under 37 C.F.R. § 1.97(e) above. If no statement has been made, charge our deposit account for the required fee.

☐ d. This Information Disclosure Statement is being filed before the mailing date of a Final Office Action or before the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(c)(1)). Cet

☐ No statement. The fee as required by 37 C.F.R. § 1.17(p) is provided.

or

See the above statement. No fee is required.

☐ e. This Information Disclosure Statement is being filed after the mailing date of a Final Office Action or after the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(d)), see the statement above. The fee as required by 37 C.F.R. § 1.17(p) is provided.

VI. PAYMENT OF FEES

☐ The required fee is listed on the attached Fee Transmittal.

☑ No fee is required.

If the Examiner has any questions concerning this IDS, please contact the undersigned. If it is determined that this IDS has been filed under the wrong rule, the USPTO is requested to consider this IDS under the proper rule and charge the appropriate fee to Deposit Account No. 02-2448.

Dated: November 10, 2011

Respectfully submitted,

By ____________________

D. Richard Anderson
Registration No.: 40439
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road, Suite 100 East
P.O. Box 747
Falls Church, VA 22040-0747
703-205-8000

Attachment(s):

- ☑ PTO/SB/08
- ☑ Document(s)
- ☐ Foreign Patent Office Communication
- ☐ Foreign Search Report
- ☐ Fee
- ☑ Other: (1) Request for Invalidation with Notification of Acceptance of Request for Invalidation of Chinese Patent No. 03159595.2 dispatched on August 10, 2011.
  (2) Office Action issued in co-pending US Appl. No. 12/575,155 on September 30, 2011.

cet

PTO/SB/08a (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449A/PTO				*Complete if Known*	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	12/942,792
				Filing Date	11-09-10
				First Named Inventor	Yoshinori Shimizu
				Art Unit	2812
(Use as many sheets as necessary)				Examiner Name	Not Yet Assigned
Sheet	1	of	2	Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

Examiner Initial *	Cite No.	Document Number Number - Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	US-3,623,867	11-30-1971	Saulnier	
	2	US-3,842,306	10-15-1974	Henderson et al	
	3	US-5,640,216	06-17-1997	Hasegawa et al.	
	4	US-5,670,797	09-23-1997	Okazaki	
	5	US-5,816,677 -	10-06-1998	Kurematsu et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initial *	Cite No. 1	Foreign Patent Document Country[3] Code Number[4] Kind Code (if known)[5]	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear	T

Examiner Signature		Date Considered	

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not Considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation design number (optional). 2 See Kinds Codes of USPTO patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4. For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5. Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. 6. Applicant is to place a check mark here if English language Translation is attached

Substitute for form 1449B/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	2	of	2

Complete If Known	
Application Number	12/942,782
Filing Date	11-09-10
First Named Inventor	Yoshinori Shimizu
Art Unit	2812
Examiner Name	Not Yet Assigned
Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

Examiner Initial *	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	6	U.S. Office Action issued in co-pending application 12/548,614 on June 27, 2011.	
	7	U.S. Office Action issued in co-pending application 12/689,681 on June 23, 2011.	

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

1. Applicants unique citation designation number (optional) 2. Applicant is to place a check mark here if English language Translation is attached.

Docket No.: 0020-5147PUS12
(Patent)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application of:	Yoshinori SHIMIZU et al.		
Application No.:	12/942,792	Confirmation No.:	2357
Filed:	November 09, 2010	Art Unit:	2812
For: LIGHT EMITTING DEVICE AND DISPLAY		Examiner:	Not Yet Assigned

RESPONSE TO NOTICE REGARDING POWER OF ATTORNEY

MS Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

A USPTO Notice dated November 23, 2010 indicated that the Power of Attorney filed on November 9, 2010 is improper under 37 C.F.R. 1.32. Applicants respectfully submit the following to cure the above-mentioned issues with the Power of Attorney:

☑ Attached is a copy of the Notice Regarding Power of Attorney.

☑ Under the provisions of 37 C.F.R. §§ 1.41(c) and 1.53(f), attached hereto is the executed Declaration of the inventor(s) (☐ original ☑ photocopy), which was submitted to USPTO on November 9, 2010 and included the Power of Attorney.

☑ The undersigned hereby declares that "Attorney Docket No. 20-4260P" on page 1 of the attached inventors' Declaration, corresponds to Appl. No. 08/902,725, filed July 29, 1997, now US Patent 5,998,925, entitled "LIGHT EMITTING DEVICE HAVING A NITRIDE COMPOUND SEMICONDUCTOR AND A PHOSPHOR CONTAINING A GARNET FLUORESCENT MATERIAL", and which is a priority document in the domestic priority chain of the present application.

37 C.F.R. 1.32(c)(3)

A power of attorney may only name as representative ten (10) or fewer practitioners, stating the name and registration number of each patent practitioner. **Under this rule the following ten (10) or fewer practitioners to be recognized by the Office are listed herein below:**

Name	Reg. No.		Name	Reg. No.
Andrew D. Meikle	32,868		Terrell C. Birch	19,382
Joseph A. Kolasch	22,463		James M. Slattery	28,380
Michael K. Mutter	29,680		Charles Gorenstein	29,271
Leonard R. Svensson	30,330		Gerald M. Murphy, Jr.	28,977

Applicants submit that the correction above addresses the issue concerning the Power of Attorney. Applicants respectfully request that the Power of Attorney in the present application be accepted.

Conclusion

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to our Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. § 1.16 or under § 1.17; particularly, extension of time fees.

Dated: AUG 30 2011

Respectfully submitted,

By ________________________

Andrew D. Meikle
Registration No.: 32,868
8110 Gatehouse Road, Suite 100 East
Falls Church, VA 22040-0747
703-205-8000

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/942,792	11/09/2010	Yoshinori Shimizu	0020-5147PUS12

CONFIRMATION NO. 2357

2292
BIRCH STEWART KOLASCH & BIRCH
PO BOX 747
FALLS CHURCH, VA 22040-0747

IMPROPER CPOA LETTER

OC00000044598554

Date Mailed: 11/23/2010

NOTICE REGARDING POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/09/2010. The Power of Attorney in this application is not accepted for the reason(s) listed below:

- The Power of Attorney you provided did not comply with the new Power of Attorney rules that became effective on June 25, 2004. See 37 CFR 1.32.

/cma/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

BIR( )STEWART, KOLASCH & B. .H, LLP **COPY**

COMBINED . CLARATION AND POWER OF ATTORN)

FOR PATENT AND DESIGN APPLICATIONS

ATTORNEY DOCKET NO. 20-4260P

PLEASE NOTE: YOU MUST COMPLETE THE FOLLOWING:

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated next to my name; that I verily believe that I am the original, first and sole inventor (if only one inventor is named below) or an original, first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:*

Insert Title: LIGHT EMITTING DEVICE AND DISPLAY

Check Box If Appropriate - For Use Without Specification Attached

the specification of which is attached hereto unless the following box is checked:

☐ was filed on ______ as United States Application Number ______ or PCT International Application Number ______ and was amended on ______ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I do not know and do not believe the same was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof, or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (six months for designs) prior to this application, and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States of America prior to this application by me or my legal representatives or assigns, except as follows.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 (a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Insert Priority Information (if appropriate)

Prior Foreign Application(s)

(Number)	(Country)	(Month/Day/Year Filed)	Priority Claimed Yes	No
P 08-198585	Japan	07/29/1996	☒	☐
P 08-244339	Japan	09/17/1996	☒	☐
P 08-245381	Japan	09/18/1996	☒	☐
P 08-359004	Japan	12/27/1996	☒	☐
P 09-081010	Japan	03/31/1997	☒	☐

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

______ (Application Number) ______ (Filing Date)

______ (Application Number) ______ (Filing Date)

All Foreign Applications, if any, for any Patent or Inventor's Certificate Filed More Than 12 Months (6 Months for Designs) Prior To The Filing Date of This Application:

Country ______ Application No. ______ Date of Filing (Month/Day/Year) ______

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

______ (Application Number) ______ (Filing Date) ______ (Status — patented, pending, abandoned)

*NOTE: Must be completed.

20-4260P

I hereby a[ppoin]t the following attorneys to prosecute [this] application and/or an international application based [on] this application and to transact all busi[ness] in the Patent and Trademark Office connected therewith [a]nd in connection with the resulting paten[t b]ased on instructions received from the entity who first sent the application papers to the attorneys identified below, unless the inventor(s) or assignee provides said attorneys with a written notice to the contrary:

RAYMOND C. STEWART (Reg. No. 21,066)
JOSEPH A. KOLASCH (Reg. No. 22,463)
JAMES M. SLATTERY (Reg. No. 28,380)
[redacted]
CHARLES GORENSTEIN (Reg. No. 29,271)
LEONARD R. SVENSSON (Reg. No. 30,330)
MARC S. WEINER (Reg. No. 32,181)
JOE McKINNEY MUNCY (Reg. No. 32,334)
C. JOSEPH FARACI (Reg. No. 32,350)
TERRELL C. BIRCH (Reg. No. 19,382)
ANTHONY L. BIRCH (Reg. No. 26,122)
BERNARD L. SWEENEY (Reg. No. 24,448)
MICHAEL K. MUTTER (Reg. No. 29,680)
GERALD M. MURPHY, JR. (Reg. No. 28,977)
TERRY L. CLARK (Reg. No. 32,644)
ANDREW D. MEIKLE (Reg. No. 32,868)
ANDREW F. REISH (Reg. No. 33,443)

PLEASE NOTE: YOU MUST COMPLETE THE FOLLOWING:

Send Correspondence to: **BIRCH, STEWART, KOLASCH AND BIRCH, LLP**

P.O. Box 747
Falls Church, Virginia 22040-0747
Telephone: (703) 205-8000
Facsimile: (703) 205-8050

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of First or Sole Inventor: Insert Name of Inventor Insert Date This Document Is Signed

GIVEN NAME / FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
Yoshinori SHIMIZU	Yoshinori Shimizu	07/22/1997

Insert Residence Insert Citizenship

Residence (City, State & Country)	CITIZENSHIP
Naka-gun, Tokushima, Japan	Japan

Insert Post Office Address

POST OFFICE ADDRESS (Complete Street Address including City, State & Country)
c/o Nichia Kagaku Kogyo Kabushiki Kaisha, 491-100, Oka, Kaminakacho, Anan-shi, TOKUSHIMA 774 JAPAN

Full Name of Second Inventor, if any: see above

GIVEN NAME / FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
Kensho SAKANO	Kensho Sakano	07/22/1997

Residence (City, State & Country)	CITIZENSHIP
Anan-shi, Tokushima, Japan	Japan

POST OFFICE ADDRESS (Complete Street Address including City, State & Country)
c/o Nichia Kagaku Kogyo Kabushiki Kaisha, 491-100, Oka, Kaminakacho, Anan-shi, TOKUSHIMA 774 JAPAN

Full Name of Third Inventor, if any: see above

GIVEN NAME / FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
Yasunobu NOGUCHI	Yasunobu Noguchi	07/22/1997

Residence (City, State & Country)	CITIZENSHIP
Naka-gun, Tokushima, Japan	Japan

POST OFFICE ADDRESS (Complete Street Address including City, State & Country)
c/o Nichia Kagaku Kogyo Kabushiki Kaisha, 491-100, Oka, Kaminakacho, Anan-shi, TOKUSHIMA 774 JAPAN

Full Name of Fourth Inventor, if any: see above

GIVEN NAME / FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
Toshio MORIGUCHI	Toshio Moriguchi	07/22/1997

Residence (City, State & Country)	CITIZENSHIP
Anan-shi, Tokushima, Japan	Japan

POST OFFICE ADDRESS (Complete Street Address including City, State & Country)
c/o Nichia Kagaku Kogyo Kabushiki Kaisha, 491-100, Oka, Kaminakacho, Anan-shi, TOKUSHIMA 774 JAPAN

Full Name of Fifth Inventor, if any: see above

GIVEN NAME / FAMILY NAME	INVENTOR'S SIGNATURE	DATE*

Residence (City, State & Country)	CITIZENSHIP

POST OFFICE ADDRESS (Complete Street Address including City, State & Country)

*Note: Must be completed — date this document is signed.

Page 2 of 2
(USPTO Approved 3-90)

Electronic Acknowledgement Receipt

EFS ID:	10843325
Application Number:	12942792
International Application Number:	
Confirmation Number:	2357
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimizu
Customer Number:	02292
Filer:	David Richard Anderson/Patti Young
Filer Authorized By:	David Richard Anderson
Attorney Docket Number:	0020-5147PUS12
Receipt Date:	30-AUG-2011
Filing Date:	09-NOV-2010
Time Stamp:	14:30:26
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		20110830IDS.pdf	3315794 1650e556d2ec1b841c69cbcaf2f6b318006575ff	yes	7

	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Transmittal Letter		1	5	
	Information Disclosure Statement (IDS) Form (SB08)		6	7	
Warnings:					
Information:					
2	Non Patent Literature	USOA12548614dated062711.pdf	507237 a5076505182cab4462d0a0f6ad2ffe9817fc1043	no	13
Warnings:					
Information:					
3	Non Patent Literature	USOA12689681dated062311.pdf	3229187 7dbca5459fc1d6aa01231cdaaf7c7308dc281d89	no	8
Warnings:					
Information:					
4	Miscellaneous Incoming Letter	20110830Response.pdf	3066182 794f8629df60baa7ecf348bed7bee07ecf46e8a4	no	6
Warnings:					
Information:					
		Total Files Size (in bytes):	10118400		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
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New International Application Filed with the USPTO as a Receiving Office
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Docket No.: 0020-5147PUS12
(Patent)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application of: Yoshinori SHIMIZU et al.			
Application No.:	12/942,792	Confirmation No.:	2357
Filed:	November 09, 2010	Art Unit:	2812
For: LIGHT EMITTING DEVICE AND DISPLAY		Examiner:	Not Yet Assigned

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Applicant(s) hereby submit(s) an Information Disclosure Statement for consideration by the Examiner.

I. LIST OF PATENTS, PUBLICATIONS OR OTHER INFORMATION

The patents, publications, or other information submitted for consideration by the Office are listed on the attached PTO/SB/08.

II. COPIES

☑ a. Copies of foreign patent documents, non-patent literature and other information.

☐ b. REFERENCES PREVIOUSLY CITED OR SUBMITTED: Copies of any information not provided can be found in one or more of the following applications which has been relied upon for an earlier filing date under 35 U.S.C. § 120:

U.S. Application No. and U.S. Filing Date

12/548,614 filed August 27, 2009

III. CONCISE EXPLANATION OF THE RELEVANCE/OTHER INFORMATION

☐ a. NON-ENGLISH LANGUAGE DOCUMENTS: A concise explanation of the relevance of all non-English language patents, publications, or other information listed is as follows:

☐ b. ENGLISH LANGUAGE SEARCH REPORT OR FOREIGN PATENT OFFICE COMMUNICATION: An English language version of the search report or Foreign Patent Office communication that indicates the degree of relevance is attached.

☑ c. OTHER: The following additional information is provided.
U.S. 3,623,867, U.S. 3,842,306 and U.S. 5,816,677 were cited in a U.S. Office Action issued in co-pending application 12/689,681 on June 23, 2011; and U.S. 5,670,797 and U.S. 5,640,216 were cited in a U.S. Office Action issued in co-pending application 12/548,614 on June 27, 2011.

IV. STATEMENT UNDER 37 C.F.R. § 1.97(e)

The undersigned hereby states that:

☐ a. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **30 days** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☐ b. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☐ c. No item of information contained in the IDS was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of IDS was known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of the IDS.

☐ d. Some of the items of information in the IDS were cited in a communication from a foreign patent office. Such items were first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office. As to the remaining items of information, to the knowledge of the person signing the certification after making reasonable inquiry, such remaining items were not known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of this statement.

V. FEES

☐ a. This Information Disclosure Statement is being filed concurrently with the filing of a new patent application or Request for Continued Examination. No fee is required.

☐ b. This Information Disclosure Statement is being filed within three months of the filing date of an application. No fee is required.

☑ c. This Information Disclosure Statement is being filed before the mailing date of a first Action on the merits. No fee is required. If a first Office Action on the merits has issued, please consider this IDS under 37 C.F.R. § 1.97(c) and see the statement under 37 C.F.R. § 1.97(e) above. If no statement has been made, charge our deposit account for the required fee.

☐ d. This Information Disclosure Statement is being filed before the mailing date of a Final Office Action or before the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(c)(1)).

☐ No statement. The fee as required by 37 C.F.R. § 1.17(p) is provided.

or

☐ See the above statement. No fee is required.

☐ e. This Information Disclosure Statement is being filed after the mailing date of a Final Office Action or after the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(d)), see the statement above. The fee as required by 37 C.F.R. § 1.17(p) is provided.

VI. PAYMENT OF FEES

☐ The required fee is listed on the attached Fee Transmittal.

☑ No fee is required.

If the Examiner has any questions concerning this IDS, please contact the undersigned. If it is determined that this IDS has been filed under the wrong rule, the USPTO is requested to consider this IDS under the proper rule and charge the appropriate fee to Deposit Account No. 02-2448.

Dated: August 30, 2011

Respectfully submitted,

By ____________________

D. Richard Anderson
Registration No.: 40,439
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road, Suite 100 East
P.O. Box 747
Falls Church, VA 22040-0747
703-205-8000

Attachment(s):
- ☑ PTO/SB/08
- ☑ Document(s)
- ☐ Foreign Patent Office Communication
- ☐ Foreign Search Report
- ☐ Fee
- ☐ Other:

PTO/SB/08b (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE
Under the Paperwork reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number

Substitute for form 1449B/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Complete if Known	
Application Number	12/942,792
Filing Date	11-09-10
First Named Inventor	Yoshinori Shimizu
Art Unit	2812
Examiner Name	Not Yet Assigned
Attorney Docket Number	0020-5147PUS12

Sheet 1 of 1

NON PATENT LITERATURE DOCUMENTS

Examiner Initial *	Cite No. [1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T [2]
	1	U.S. Office Action issued in co-pending Application No. 12/575,155, dated April 19, 2011.	

Examiner Signature		Date Considered	

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

1 Applicant's unique citation designation number. (optional) 2. Applicant is to place a check mark here if English language Translation is attached.

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Cheif Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450 Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS.
SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Acknowledgement Receipt

EFS ID:	10375325
Application Number:	12942792
International Application Number:	
Confirmation Number:	2357
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimizu
Customer Number:	02292
Filer:	David Richard Anderson/Patti Young
Filer Authorized By:	David Richard Anderson
Attorney Docket Number:	0020-5147PUS12
Receipt Date:	23-JUN-2011
Filing Date:	09-NOV-2010
Time Stamp:	16:46:17
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		20110623IDS.pdf	2562207 5b6eddcc7eff98b253b605b017c169ed434af29b	yes	6

	Multipart Description/PDF files in .zip description				
	Document Description		**Start**	**End**	
	Transmittal Letter		1	5	
	Information Disclosure Statement (IDS) Form (SB08)		6	6	
Warnings:					
Information:					
2	Non Patent Literature	USOA04192011.pdf	3827626 00eb2900654f1c54de8c1d07baf9dd9d1e75b997	no	8
Warnings:					
Information:					
		Total Files Size (in bytes):	6389833		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Docket No.: 0020-5147PUS12
(Patent)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application of:
Yoshinori SHIMIZU et al.

Application No.: 12/942,792 Confirmation No.: 2357

Filed: November 09, 2010 Art Unit: 2812

For: LIGHT EMITTING DEVICE AND DISPLAY Examiner: Not Yet Assigned

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Applicant(s) hereby submit(s) an Information Disclosure Statement for consideration by the Examiner.

I. LIST OF PATENTS, PUBLICATIONS OR OTHER INFORMATION

The patents, publications, or other information submitted for consideration by the Office are listed on the attached PTO/SB/08.

II. COPIES

☑ a. Copies of foreign patent documents, non-patent literature and other information.

☐ b. REFERENCES PREVIOUSLY CITED OR SUBMITTED: Copies of any information not provided can be found in one or more of the following applications which has been relied upon for an earlier filing date under 35 U.S.C. § 120:

U.S. Application No. and U.S. Filing Date

12/548,614 filed 08-27-2009

III. CONCISE EXPLANATION OF THE RELEVANCE/OTHER INFORMATION

☐ a. NON-ENGLISH LANGUAGE DOCUMENTS: A concise explanation of the relevance of all non-English language patents, publications, or other information listed is as follows:

☐ b. ENGLISH LANGUAGE SEARCH REPORT OR FOREIGN PATENT OFFICE COMMUNICATION: An English language version of the search report or Foreign Patent Office communication that indicates the degree of relevance is attached.

☑ c. OTHER: The following additional information is provided.

A U.S. Office Acton issued in co-pending Application No. 12/575,155, dated April 19, 2011 is submitted herein. All references cited in the Office Action have previously been submitted to USPTO.

IV. STATEMENT UNDER 37 C.F.R. § 1.97(e)

The undersigned hereby states that:

☐ a. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **30 days** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☐ b. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☑ c. No item of information contained in the IDS was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of IDS was known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of the IDS.

☐ d. Some of the items of information in the IDS were cited in a communication from a foreign patent office. Such items were first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office. As to the remaining items of information, to the knowledge of the person signing the certification after making reasonable inquiry, such remaining items were not known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of this statement.

V. <u>FEES</u>

☐ a. This Information Disclosure Statement is being filed concurrently with the filing of a new patent application or Request for Continued Examination. No fee is required.

☐ b. This Information Disclosure Statement is being filed within three months of the filing date of an application. No fee is required.

☑ c. This Information Disclosure Statement is being filed before the mailing date of a first Action on the merits. No fee is required. If a first Office Action on the merits has issued, please consider this IDS under 37 C.F.R. § 1.97(c) and see the statement under 37 C.F.R. § 1.97(e) above. If no statement has been made, charge our deposit account for the required fee.

☐ d. This Information Disclosure Statement is being filed <u>before</u> the mailing date of a Final Office Action or <u>before</u> the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(c)(1)).

☐ No statement. The fee as required by 37 C.F.R. § 1.17(p) is provided.

or

☐ See the above statement. No fee is required.

☐ e. This Information Disclosure Statement is being filed <u>after</u> the mailing date of a Final Office Action or <u>after</u> the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(d)), see the statement above. The fee as required by 37 C.F.R. § 1.17(p) is provided.

VI. <u>PAYMENT OF FEES</u>

☐ The required fee is listed on the attached Fee Transmittal.

☑ No fee is required.

If the Examiner has any questions concerning this IDS, please contact the undersigned. If it is determined that this IDS has been filed under the wrong rule, the USPTO is requested to consider this IDS under the proper rule and charge the appropriate fee to Deposit Account No. 02-2448.

Dated: June 23, 2011

Respectfully submitted,

By ______________________

D. Richard Anderson
Registration No.: 40,439
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road, Suite 100 East
P.O. Box 747
Falls Church, VA 22040-0747
703-205-8000

Attachment(s):

- ☑ PTO/SB/08
- ☑ Document(s)
- ☐ Foreign Patent Office Communication
- ☐ Foreign Search Report
- ☐ Fee
- ☐ Other:

cet

Doc Code: TRAN.LET

Document Description: Transmittal Letter

PTO/SB/21 (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	12/942,792 Conf. No.: 2357
Filing Date	November 09, 2010
First Named Inventor	Yoshinori SHIMIZU
Art Unit	2812
Examiner Name	Not Yet Assigned
Total Number of Pages in This Submission	
Attorney Docket Number	0020-5147PUS12

ENCLOSURES *(Check all that apply)*

- [ ] Fee Transmittal Form
  - [ ] Fee Attached
- [ ] Amendment/Reply
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Reply to Missing Parts/ Incomplete Application
  - [ ] Reply to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) ____________
  - [ ] Landscape Table on CD
- [ ] After Allowance Communication to TC
- [ ] Appeal Communication to Board of Appeals and Interferences
- [ ] Appeal Communication to TC (Appeal Notice, Brief, Reply Brief)
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) (please Identify below):

Request for Corrected Official Filing Receipt; Supplemental ADS to correct first inventor's name on U.S. Publication No. 2011/0053299

Remarks

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name	BIRCH, STEWART, KOLASCH & BIRCH, LLP		
Signature			
Printed name	D. Richard Anderson		
Date	April 29, 2011	Reg. No.	40,439

CERTIFICATE OF TRANSMISSION/MAILING

I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:

Signature			
Typed or printed name		Date	

Docket No.: 020-5147PUS12
(Patent)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application of:
Yoshinori SHIMIZU et al.

Application No.: 12/942,792 Confirmation No.: 2357

Filed: November 09, 2010 Art Unit: 2812

For: LIGHT EMITTING DEVICE AND DISPLAY Examiner: Not Yet Assigned

REQUEST FOR CORRECTED OFFICIAL FILING RECEIPT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Attached is the Official Filing Receipt for the above-identified application.

THE FOLLOWING CORRECTION IS RESPECTFULLY REQUESTED:

First inventor's last name should be changed from Shimieu to --**Shimizu**--.

Support for the correction(s) is readily apparent on the attached copy of the Declaration and Power of Attorney. It is respectfully requested that the USPTO provide a new Official Filing Receipt with the correction indicated above.

If necessary, the Director is hereby authorized in this, concurrent, and future replies to charge any fees required during the pendency of the above-identified application or credit any overpayment to Deposit Account No. 02-2448.

Dated: April 29, 2011

Respectfully submitted,

By

D. Richard Anderson
Registration No.: 40,439
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road, Suite 100 East
P.O. Box 747
Falls Church, VA 22040-0747
703-205-8000

Attachments: marked-up Filing Receipt
Copy of Declaration
Supplemental ADS

Supplemental Application Data Sheet

Application Information

Application Type::	Regular
Subject Matter::	Utility
Suggested Group Art Unit::	2812
CD-ROM or CD-R?::	None
Sequence submission?::	None
Computer Readable Form (CRF)?::	No
Title::	LIGHT EMITTING DEVICE AND DISPLAY
Attorney Docket Number::	0020-5147PUS12
Request for Early Publication?::	No
Request for Non-Publication?::	No
Small Entity?::	No
Petition included?::	No
Secrecy Order in Parent Appl.?::	No

Applicant Information

Applicant 1

Applicant Authority Type::	Inventor
Primary Citizenship Country::	Japan
Status::	Full Capacity
Given Name::	Yoshinori
Family name::	SHIMIZU
City of Residence::	Anan-shi
State or Province of Residence::	Tokushima
Country of Residence::	Japan
Street of Mailing address::	c/o Nichia Kagaku Kogyo Kabushiki Kaisha 491-100, Oka, Kaminakacho
City of Mailing Address::	Anan-shi
State or Province of Mailing Address::	Tokushima

Country of Mailing Address::	Japan
Postal or Zip Code of Mailing Address::	774

Applicant 2

Applicant Authority Type::	Inventor
Primary Citizenship Country::	Japan
Status::	Full Capacity
Given Name::	Kensho
Family name::	SAKANO
City of Residence::	Anan-shi
State or Province of Residence::	Tokushima
Country of Residence::	Japan
Street of Mailing address::	c/o Nichia Kagaku Kogyo Kabushiki Kaisha 491-100, Oka, Kaminakacho
City of Mailing Address::	Anan-shi
State or Province of Mailing Address::	Tokushima
Country of Mailing Address::	Japan
Postal or Zip Code of Mailing Address::	774

Applicant 3

Applicant Authority Type::	Inventor
Primary Citizenship Country::	Japan
Status::	Full Capacity
Given Name::	Yasunobu
Family name::	NOGUCHI
City of Residence::	Anan-shi
State or Province of Residence::	Tokushima
Country of Residence::	Japan
Street of Mailing address::	c/o Nichia Kagaku Kogyo Kabushiki Kaisha 491-100, Oka, Kaminakacho
City of Mailing Address::	Anan-shi

State or Province of Mailing Address::	Tokushima
Country of Mailing Address::	Japan
Postal or Zip Code of Mailing Address::	774

Applicant 4

Applicant Authority Type::	Inventor
Primary Citizenship Country::	Japan
Status::	Full Capacity
Given Name::	Toshio
Family name::	MORIGUCHI
City of Residence::	Anan-shi
State or Province of Residence::	Tokushima
Country of Residence::	Japan
Street of Mailing address::	c/o Nichia Kagaku Kogyo Kabushiki Kaisha 491-100, Oka, Kaminakacho
City of Mailing Address::	Anan-shi
State or Province of Mailing Address::	Tokushima
Country of Mailing Address::	Japan
Postal or Zip Code of Mailing Address::	774

Correspondence Information

Correspondence Customer Number:: 02292

Representative Information

Representative Customer Number:: 02292

Domestic Priority Information

Application::	Continuity Type::	Parent Application::	Parent Filing Date::
This Application	Division of	12/548,614	08/27/09
12/548,614	Division of	12/028,062	02/08/08
12/028,062	Division of	10/609,402	07/01/03
10/609,402	Division of	09/458,024	12/10/99
09/458,024	Division of	09/300,315	04/28/99
09/300,315	Division of	08/902,725	07/29/97

Foreign Priority Information

Country::	Application number::	Filing Date::	
Japan	P 08-198585	07/29/96	Yes
Japan	P 08-244339	09/17/96	Yes
Japan	P 08-245381	09/18/96	Yes
Japan	P 08-359004	12/27/96	Yes
Japan	P 09-081010	03/31/97	Yes

Assignee Information

Assignee 1

Assignee Name:: NICHIA CORPORATION

Street of Mailing address:: 491-100, Oka, Kaminaka-cho

City of Mailing Address:: Anan-shi

State or Province of Mailing Address:: Tokushima

Country of Mailing Address:: Japan

Postal or Zip Code of Mailing Address:: 774-0044

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
12/942,792	11/09/2010	2879	1090	0020-5147PUS12	19	1

CONFIRMATION NO. 2357

FILING RECEIPT

2292
BIRCH STEWART KOLASCH & BIRCH
PO BOX 747
FALLS CHURCH, VA 22040-0747

OC000000044585610

Date Mailed: 11/23/2010

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Shimizu

Yoshinori ~~Shimieu~~, Naka-gun, JAPAN;
Kensho Sakano, Anan-shi, JAPAN;
Yasunobu Noguchi, Naka-gun, JAPAN;
Toshio Moriguchi, Anan-shi, JAPAN;

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a DIV of 12/548,614 08/27/2009
which is a DIV of 12/028,062 02/08/2008 PAT 7,682,848
which is a DIV of 10/609,402 07/01/2003 PAT 7,362,048
which is a DIV of 09/458,024 12/10/1999 PAT 6,614,179
which is a DIV of 09/300,315 04/28/1999 PAT 6,069,440
which is a DIV of 08/902,725 07/29/1997 PAT 5,998,925

Foreign Applications

JAPAN P 08-198585 07/29/1996
JAPAN P 08-244339 09/17/1996
JAPAN P 08-245381 09/18/1996
JAPAN P 08-359004 12/27/1996
JAPAN P 09-081010 03/31/1997

Request to Retrieve - This application either claims priority to one or more applications filed in an intellectual property Office that participates in the Priority Document Exchange (PDX) program or contains a proper **Request to**

Retrieve Electronic Priority Application(s) (PTO/SB/38 or its equivalent). Consequently, the USPTO will attempt to electronically retrieve these priority documents.

If Required, Foreign Filing License Granted: 11/19/2010

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 12/942,792**

Projected Publication Date: 03/03/2011

Non-Publication Request: No

Early Publication Request: No
Title

LIGHT EMITTING DEVICE AND DISPLAY

Preliminary Class

313

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

COPY

BIRCH, STEWART, KOLASCH & BIRCH, LLP

COMBINED DECLARATION AND POWER OF ATTORNEY

FOR PATENT AND DESIGN APPLICATIONS

ATTORNEY DOCKET NO.

20-4260P

PLEASE NOTE: YOU MUST COMPLETE THE FOLLOWING:

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated next to my name; that I verily believe that I am the original, first and sole inventor (if only one inventor is named below) or an original, first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:*

Insert Title: LIGHT EMITTING DEVICE AND DISPLAY

Check Box If Appropriate - For Use Without Specification Attached

the specification of which is attached hereto unless the following box is checked:

☐ was filed on ______ as United States Application Number ______ or PCT International Application Number ______ and was amended on ______ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I do not know and do not believe the same was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof, or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (six months for designs) prior to this application, and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States of America prior to this application by me or my legal representatives or assigns, except as follows.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 (a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

Insert Priority Information (if appropriate)

(Number)	(Country)	(Month/Day/Year Filed)	Priority Claimed Yes	No
P 08-198585	Japan	07/29/1996	☒	☐
P 08-244339	Japan	09/17/1996	☒	☐
P 08-245381	Japan	09/18/1996	☒	☐
P 08-359004	Japan	12/27/1996	☒	☐
P 09-081010	Japan	03/31/1997	☒	☐

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

(Application Number) ______ (Filing Date) ______

(Application Number) ______ (Filing Date) ______

All Foreign Applications, if any, for any Patent or Inventor's Certificate Filed More Than 12 Months (6 Months for Designs) Prior To The Filing Date of This Application:

Country ______ Application No. ______ Date of Filing (Month/Day/Year) ______

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Number) ______ (Filing Date) ______ (Status -- patented, pending, abandoned) ______

*NOTE: Must be completed.

I hereby a[illegible] t the following attorneys to prosecute [illegible] application and/or an international application based [illegible] this application and to transact all busi[illegible] in the Patent and Trademark Office connected therewith and in connection with the resulting paten[illegible] sed on instructions received from the entity who first sent the application papers to the attorneys identified below, unless the inventor(s) or assignee provides said attorneys with a written notice to the contrary:

RAYMOND C. STEWART (Reg. No. 21,066)
JOSEPH A. KOLASCH (Reg. No. 22,463)
JAMES M. SLATTERY (Reg. No. 28,380)
[redacted]
CHARLES GORENSTEIN (Reg. No. 29,271)
LEONARD R. SVENSSON (Reg. No. 30,330)
MARC S. WEINER (Reg. No. 32,181)
JOE McKINNEY MUNCY (Reg. No. 32,334)
C. JOSEPH FARACI (Reg. No. 32,350)
TERRELL C. BIRCH (Reg. No. 19,382)
ANTHONY L. BIRCH (Reg. No. 26,122)
BERNARD L. SWEENEY (Reg. No. 24,448)
MICHAEL K. MUTTER (Reg. No. 29,680)
GERALD M. MURPHY, JR. (Reg. No. 28,977)
TERRY L. CLARK (Reg. No. 32,644)
ANDREW D. MEIKLE (Reg. No. 32,868)
ANDREW F. REISH (Reg. No. 33,443)

PLEASE NOTE: YOU MUST COMPLETE THE FOLLOWING:

Send Correspondence to: **BIRCH, STEWART, KOLASCH AND BIRCH, LLP**

P.O. Box 747
Falls Church, Virginia 22040-0747
Telephone: (703) 205-8000
Facsimile: (703) 205-8050

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of First or Sole Inventor / Insert Name of Inventor / Insert Date This Document Is Signed / Insert Residence / Insert Citizenship / Insert Post Office Address

GIVEN NAME FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
Yoshinori SHIMIZU	Yoshinori Shimizu	07/22/1997
Residence (City, State & Country): Naka-gun, Tokushima, Japan	CITIZENSHIP: Japan	
POST OFFICE ADDRESS (Complete Street Address including City, State & Country): c/o Nichia Kagaku Kogyo Kabushiki Kaisha, 491-100, Oka, Kaminakacho, Anan-shi, TOKUSHIMA 774 JAPAN		

Full Name of Second Inventor, if any: see above

GIVEN NAME FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
Kensho SAKANO	Kensho Sakano	07/22/1997
Residence (City, State & Country): Anan-shi, Tokushima, Japan	CITIZENSHIP: Japan	
POST OFFICE ADDRESS (Complete Street Address including City, State & Country): c/o Nichia Kagaku Kogyo Kabushiki Kaisha, 491-100, Oka, Kaminakacho, Anan-shi, TOKUSHIMA 774 JAPAN		

Full Name of Third Inventor, if any: see above

GIVEN NAME FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
Yasunobu NOGUCHI	Yasunobu Noguchi	07/22/1997
Residence (City, State & Country): Naka-gun, Tokushima, Japan	CITIZENSHIP: Japan	
POST OFFICE ADDRESS (Complete Street Address including City, State & Country): c/o Nichia Kagaku Kogyo Kabushiki Kaisha, 491-100, Oka, Kaminakacho, Anan-shi, TOKUSHIMA 774 JAPAN		

Full Name of Fourth Inventor, if any: see above

GIVEN NAME FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
Toshio MORIGUCHI	Toshio Moriguchi	07/22/1997
Residence (City, State & Country): Anan-shi, Tokushima, Japan	CITIZENSHIP: Japan	
POST OFFICE ADDRESS (Complete Street Address including City, State & Country): c/o Nichia Kagaku Kogyo Kabushiki Kaisha, 491-100, Oka, Kaminakacho, Anan-shi, TOKUSHIMA 774 JAPAN		

Full Name of Fifth Inventor, if any: see above

GIVEN NAME FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
Residence (City, State & Country):	CITIZENSHIP:	
POST OFFICE ADDRESS (Complete Street Address including City, State & Country):		

*Note: Must be completed — date this document is signed.

(USPTO Approved 3.00)

Electronic Acknowledgement Receipt

EFS ID:	9990212
Application Number:	12942792
International Application Number:	
Confirmation Number:	2357
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimizu
Customer Number:	02292
Filer:	David Richard Anderson/Patti Young
Filer Authorized By:	David Richard Anderson
Attorney Docket Number:	0020-5147PUS12
Receipt Date:	29-APR-2011
Filing Date:	09-NOV-2010
Time Stamp:	16:45:22
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		20110429SupplementalADS.pdf	6200798 08eedd0bed5f3db67b4bf0e9f36820a99da8349d	yes	12

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Miscellaneous Incoming Letter	1	1
	Request for Corrected Filing Receipt	2	3
	Application Data Sheet	4	12

Warnings:	
Information:	
Total Files Size (in bytes):	6200798

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/08a (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE
Under the Paperwork reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449A/PTO				*Complete if Known*	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	12/942,792
				Filing Date	11-09-10
				First Named Inventor	Yoshinori Shimizu
				Art Unit	2812
(Use as many sheets as necessary)				Examiner Name	Not Yet Assigned
Sheet	1	of	2	Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

Examiner Initial *	Cite No	Document Number Number - Kind Code [2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	US-4,992,704	02-12-1991	Stinson	

FOREIGN PATENT DOCUMENTS

Examiner Initial *	Cite No. [1]	Foreign Patent Document Country [3] Code Number [4] Kind Code (if known) [5]	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear	T [6]

Examiner Signature		Date Considered	

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not Considered. Include copy of this form with next communication to applicant. 1 Applicant's unique citation design number (optional). 2 See Kinds Codes of USPTO patent Documents at www.uspto.gov or MPEP 901.04. 3 Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4. For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5. Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. 6. Applicant is to place a check mark here if English language Translation is attached.

Substitute for form 1449B/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	2	of	2

Complete if Known	
Application Number	12/942,792
Filing Date	11-09-10
First Named Inventor	Yoshinori Shimizu
Art Unit	2812
Examiner Name	Not Yet Assigned
Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

Examiner Initial *	Cite No. 1	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T 2
	2	U.S. Office Action issued in Application No. 12/559,042 on March 15, 2011.	

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

1 Applicant's unique citation designation number. (optional) 2. Applicant is to place a check mark here if English language Translation is attached.

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450 Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS.

SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Acknowledgement Receipt

EFS ID:	9863382
Application Number:	12942792
International Application Number:	
Confirmation Number:	2357
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimieu
Customer Number:	02292
Filer:	David Richard Anderson/Patti Young
Filer Authorized By:	David Richard Anderson
Attorney Docket Number:	0020-5147PUS12
Receipt Date:	12-APR-2011
Filing Date:	09-NOV-2010
Time Stamp:	16:04:19
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		20110412IDS.pdf	3234344 66ac1a60bf5f42bb48e0620179fbfe6363ea4aac	yes	7

	Multipart Description/PDF files in .zip description				
	Document Description		Start		End
	Transmittal Letter		1		5
	Information Disclosure Statement (IDS) Filed (SB/08)		6		7
Warnings:					
Information:					
2	NPL Documents	USOA12559042.pdf	888635 a537372abdad9f254504d7ab09f2279e555d82c3	no	21
Warnings:					
Information:					
		Total Files Size (in bytes):	4122979		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Docket No.: 0020-5147PUS12
(Patent)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application of:
Yoshinori SHIMIZU et al.

Application No.:	12/942,792	Confirmation No.:	2357
Filed:	November 09, 2010	Art Unit:	2812
For: LIGHT EMITTING DEVICE AND DISPLAY		Examiner:	Not Yet Assigned

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Applicant(s) hereby submit(s) an Information Disclosure Statement for consideration by the Examiner.

I. LIST OF PATENTS, PUBLICATIONS OR OTHER INFORMATION

The patents, publications, or other information submitted for consideration by the Office are listed on the attached PTO/SB/08.

II. COPIES

☑ a. Copies of foreign patent documents, non-patent literature and other information.

☐ b. REFERENCES PREVIOUSLY CITED OR SUBMITTED: Copies of any information not provided can be found in one or more of the following applications which has been relied upon for an earlier filing date under 35 U.S.C. § 120:

U.S. Application No. and U.S. Filing Date

12/548,614 filed August 27, 2009

III. CONCISE EXPLANATION OF THE RELEVANCE/OTHER INFORMATION

☐ a. NON-ENGLISH LANGUAGE DOCUMENTS: A concise explanation of the relevance of all non-English language patents, publications, or other information listed is as follows:

☐ b. ENGLISH LANGUAGE SEARCH REPORT OR FOREIGN PATENT OFFICE COMMUNICATION: An English language version of the search report or Foreign Patent Office communication that indicates the degree of relevance is attached.

☑ c. OTHER: The following additional information is provided.

U.S. Patent No. 4,992,704 cited in the present IDS was cited in a U.S. Office Action issued in co-pending Application No. 12/559,042 on March 16, 2011 which is also submitted herein.

IV. STATEMENT UNDER 37 C.F.R. § 1.97(e)

The undersigned hereby states that:

☐ a. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **30 days** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☐ b. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☑ c. No item of information contained in the IDS was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of IDS was known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of the IDS.

☐ d. Some of the items of information in the IDS were cited in a communication from a foreign patent office. Such items were first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office. As to the remaining items of information, to the knowledge of the person signing the certification after making reasonable inquiry, such remaining items were not known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of this statement.

V. FEES

☐ a. This Information Disclosure Statement is being filed concurrently with the filing of a new patent application or Request for Continued Examination. No fee is required.

☐ b. This Information Disclosure Statement is being filed within three months of the filing date of an application. No fee is required.

☑ c. This Information Disclosure Statement is being filed before the mailing date of a first Action on the merits. No fee is required. If a first Office Action on the merits has issued, please consider this IDS under 37 C.F.R. § 1.97(c) and see the statement under 37 C.F.R. § 1.97(e) above. If no statement has been made, charge our deposit account for the required fee.

☐ d. This Information Disclosure Statement is being filed before the mailing date of a Final Office Action or before the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(c)(1)).

☐ No statement. The fee as required by 37 C.F.R. § 1.17(p) is provided.

or

☐ See the above statement. No fee is required.

☐ e. This Information Disclosure Statement is being filed after the mailing date of a Final Office Action or after the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(d)), see the statement above. The fee as required by 37 C.F.R. § 1.17(p) is provided.

VI. PAYMENT OF FEES

☐ The required fee is listed on the attached Fee Transmittal.

☑ No fee is required.

If the Examiner has any questions concerning this IDS, please contact the undersigned. If it is determined that this IDS has been filed under the wrong rule, the USPTO is requested to consider this IDS under the proper rule and charge the appropriate fee to Deposit Account No. 02-2448.

Dated: April 12, 2011

Respectfully submitted,

By ______________________

D. Richard Anderson
Registration No.: 40,439
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road, Suite 100 East
P.O. Box 747
Falls Church, VA 22040-0747
703-205-8000

Attachment(s):

- ☑ PTO/SB/08
- ☑ Document(s)
- ☐ Foreign Patent Office Communication
- ☐ Foreign Search Report
- ☐ Fee
- ☐ Other:

Cat

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/942,792	11/09/2010	Yoshinori Shimieu	0020-5147PUS12

CONFIRMATION NO. 2357

PUBLICATION NOTICE

OC000000046316306

2292
BIRCH STEWART KOLASCH & BIRCH
PO BOX 747
FALLS CHURCH, VA 22040-0747

Title:LIGHT EMITTING DEVICE AND DISPLAY

Publication No.US-2011-0053299-A1
Publication Date:03/03/2011

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PTO/SB/08a (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known	
Application Number	12/942,792
Filing Date	11-09-10
First Named Inventor	Yoshinori Shimizu
Art Unit	2812
Examiner Name	Not Yet Assigned
Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

Examiner initial *	Cite No.	Document Number Number - Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	US-2009/0315014-A1	12-24-2009	SHIMIZU et al.	
	2	US-5,045,867-A	09-03-1991	FUSE	

FOREIGN PATENT DOCUMENTS

Examiner Initial *	Cite No. 1	Foreign Patent Document Country[3] Code Number[4] Kind Code (if known)[5]	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, columns, Lines, Where Relevant Passages or Relevant Figures Appear	T

Examiner Signature		Date Considered	

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not Considered. Include copy of this form with next communication to applicant. 1. Applicant's unique citation design number (optional). 2 See Kinds Codes of USPTO patent Documents. at www.uspto.gov or MPEP 901.04. 3. Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). 4. For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. 5. Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST. 16 if possible. 6. Applicant is to place a check mark here if English language Translation is attached.

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PTO/SB/08b (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Substitute for form 1449B/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	2	of	2

Complete if Known	
Application Number	12/942,792
Filing Date	11-09-10
First Named Inventor	Yoshinori Shimizu
Art Unit	2812
Examiner Name	Not Yet Assigned
Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

Examiner initial *	Cite No. [1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T [2]
	3	Office Action dated July 7, 2010 for US Application No. 12/548,614.	
	4	Office Action dated June 16, 2010 for US Application No. 12/548,621.	
	5	Office Action dated November 10, 2010 for US Application No. 12/575,162.	
	6	Office Action dated November 15, 2010 for US Application No. 12/548,614.	

Examiner Signature		Date Considered	

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.
1. Applicants unique citation designation number. (optional) 2. Applicant is to place a check mark here if English language Translation is attached.

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Docket No.: 0020-5147PUS12
(Patent)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application of:
Yoshinori SHIMIZU et al.

Application No.:	12/942,792	Confirmation No.:	2357
Filed:	November 09, 2010	Art Unit:	2812
For:	LIGHT EMITTING DEVICE AND DISPLAY	Examiner:	Not Yet Assigned

LETTER REGARDING COPENDING APPLICATIONS

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Under the provisions of MPEP § 2001.06(b), the Examiner is hereby advised of the following copending U.S. Applications:

Appl. No.	Filing Date	Group
12/575,155	October 7, 2009	2811
12/947,470	November 16, 2010	2812
12/831,586	July 7, 2010	2811
12/689,681	January 19, 2010	2812
12/559,042	September 14, 2009	2814
12/548,618	August 27, 2009	2822
12/548,614	August 27, 2009	2812
12/548,620	August 27, 2009	2811
12/575,162	October 7, 2009	2892
12/548,621	August 27, 2009	2812

The subject matter contained in the above-listed copending U.S. applications may be deemed to relate to the present application, and thus may be material to the prosecution of this instant application.

The above-listed co-pending applications are not to be construed as prior art. By bringing the above-listed applications to the attention of the Examiner, Applicants do NOT waive any confidentiality concerning the above-listed co-pending applications or this application. See MPEP § 101.

If necessary, the Director is hereby authorized in this, concurrent, and future replies to charge any fees required during the pendency of the above-identified application or credit any overpayment to Deposit Account No. 02-2448.

Dated: DEC 23 2010

Respectfully submitted,

By ________________________

D. Richard Anderson
Registration No.: 40439
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road, Suite 100 East
P.O. Box 747
Falls Church, VA 22040-0747
703-205-8000

Cek

Docket No.: 0020-5147PUS12
(Patent)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application of:
Yoshinori SHIMIZU et al.

Application No.:	12/942,792	Confirmation No.:	2357
Filed:	November 09, 2010	Art Unit:	2812
For:	LIGHT EMITTING DEVICE AND DISPLAY	Examiner:	Not Yet Assigned

LETTER REGARDING COPENDING APPLICATIONS

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This letter submits potential relevant information advising the Examiner of the following co-pending U.S. Applications which claim the benefit of U.S. Patent 6,600,175 (by Baretz et al., issued on 07/29/2003) which was submitted to USPTO in an IDS on November 9, 2010.

Appl. No.	Filing Date	Group
90/010,940 (Reexamination of USP 6,600,175)	May 6, 2010	3992
11/264,124	November 1, 2005	2814
12/131,118	June 1, 2008	2814
12/131,119	June 1, 2008	2879

The subject matter contained in the above-listed copending U.S. applications may be deemed to relate to the present application, and thus may be material to the prosecution of this instant application.

The above-listed co-pending applications are not to be construed as prior art. By bringing the above-listed applications to the attention of the Examiner, Applicants do NOT waive any confidentiality concerning the above-listed co-pending applications or this application. See MPEP § 101.

If necessary, the Director is hereby authorized in this, concurrent, and future replies to charge any fees required during the pendency of the above-identified application or credit any overpayment to Deposit Account No. 02-2448.

Dated: DEC 23 2010

Respectfully submitted,

By ______________________

D. Richard Anderson
Registration No.: 40439
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road, Suite 100 East
P.O. Box 747
Falls Church, VA 22040-0747
703-205-8000

Electronic Acknowledgement Receipt

EFS ID:	9109314
Application Number:	12942792
International Application Number:	
Confirmation Number:	2357
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori Shimieu
Customer Number:	02292
Filer:	David Richard Anderson
Filer Authorized By:	
Attorney Docket Number:	0020-5147PUS12
Receipt Date:	23-DEC-2010
Filing Date:	09-NOV-2010
Time Stamp:	16:44:57
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		00205147PUS12IDS.PDF	363257 cee347a13a5236c4bd0608f193a216854f036b58	yes	7

	Multipart Description/PDF files in .zip description				
	Document Description		Start		End
	Transmittal Letter		1		5
	Information Disclosure Statement (IDS) Filed (SB/08)		6		7
Warnings:					
Information:					
2	Miscellaneous Incoming Letter	00205147PUS12LTR.PDF	60237 06ed18e1e96360b5637678e3f7dedf10b97c92ae	no	2
Warnings:					
Information:					
3	Miscellaneous Incoming Letter	00205147PUS12LTR2.PDF	58647 8a1bed46bd5171606fa71a59d8b7f5facbfe0fe0	no	2
Warnings:					
Information:					
4	NPL Documents	OfficeActionUS12548614dated 2010July7.pdf	941491 2af61e61edb21d155d31c7cbde8b095d838b11c2	no	19
Warnings:					
Information:					
5	NPL Documents	OfficeActionUS12548621.pdf	907741 56bca57646256469bb927db584bcf273aa1e862a	no	16
Warnings:					
Information:					
6	NPL Documents	OfficeActionUS12575162.pdf	1362575 0af490c589fa2f913d0069f3315adef625fa9c49	no	21
Warnings:					
Information:					
7	NPL Documents	OfficeActionUS12548614dated 2010Nov15.pdf	634006 9c971c994ae88d09f8a24f2c62a6a4f5248442fb	no	16
Warnings:					
Information:					
		Total Files Size (in bytes):	4327954		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Docket No.: 0020-5147PUS12
(Patent)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application of:
Yoshinori SHIMIZU et al.

Application No.:	12/942,792	Confirmation No.:	2357
Filed:	November 09, 2010	Art Unit:	2812
For:	LIGHT EMITTING DEVICE AND DISPLAY	Examiner:	Not Yet Assigned

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Applicant(s) hereby submit(s) an Information Disclosure Statement for consideration by the Examiner.

I. LIST OF PATENTS, PUBLICATIONS OR OTHER INFORMATION

The patents, publications, or other information submitted for consideration by the Office are listed on the attached PTO/SB/08.

II. COPIES

☑ a. Copies of foreign patent documents, non-patent literature and other information.

☐ b. REFERENCES PREVIOUSLY CITED OR SUBMITTED: Copies of any information not provided can be found in one or more of the following applications which has been relied upon for an earlier filing date under 35 U.S.C. § 120:

ok

III. CONCISE EXPLANATION OF THE RELEVANCE/OTHER INFORMATION

☐ a. NON-ENGLISH LANGUAGE DOCUMENTS: A concise explanation of the relevance of all non-English language patents, publications, or other information listed is as follows:

☐ b. ENGLISH LANGUAGE SEARCH REPORT OR FOREIGN PATENT OFFICE COMMUNICATION: An English language version of the search report or Foreign Patent Office communication that indicates the degree of relevance is attached.

☑ c. OTHER: The following additional information is provided.

Copies of the Office Actions dated July 7, 2010 and November 15, 2010 for US Application No. 12/548,614, a copy of the Office Action dated June 16, 2010 for US Application No. 12/548,621 and a copy of the Office Action dated November 10, 2010 for US Application No. 12/575,162 are attached.

All of the references cited in the attached US Office Actions except US-5,045,867-A and US-2009/0315014-A1 were previously cited in the IDS filed November 19, 2010.

IV. STATEMENT UNDER 37 C.F.R. § 1.97(e)

The undersigned hereby states that:

☐ a. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **30 days** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☐ b. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☐ c. No item of information contained in the IDS was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of IDS was known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of the IDS.

☐ d. Some of the items of information in the IDS were cited in a communication from a foreign patent office. Such items were first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office. As to the remaining items of information, to the knowledge of the person signing the certification after making reasonable inquiry, such remaining items were not known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of this statement.

V. <u>FEES</u>

☐ a. This Information Disclosure Statement is being filed concurrently with the filing of a new patent application or Request for Continued Examination. No fee is required.

☑ b. This Information Disclosure Statement is being filed within three months of the filing date of an application. No fee is required.

☐ c. This Information Disclosure Statement is being filed before the mailing date of a first Action on the merits. No fee is required. If a first Office Action on the merits has issued, please consider this IDS under 37 C.F.R. § 1.97(c) and see the statement under 37 C.F.R. § 1.97(e) above. If no statement has been made, charge our deposit account for the required fee.

☐ d. This Information Disclosure Statement is being filed before the mailing date of a Final Office Action or before the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(c)(1)).

☐ No statement. The fee as required by 37 C.F.R. § 1.17(p) is provided.

or

☐ See the above statement. No fee is required.

☐ e. This Information Disclosure Statement is being filed after the mailing date of a Final Office Action or after the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(d)), see the statement above. The fee as required by 37 C.F.R. § 1.17(p) is provided.

VI. PAYMENT OF FEES

☐ The required fee is listed on the attached Fee Transmittal.

☑ No fee is required.

If the Examiner has any questions concerning this IDS, please contact the undersigned. If it is determined that this IDS has been filed under the wrong rule, the USPTO is requested to consider this IDS under the proper rule and charge the appropriate fee to Deposit Account No. 02-2448.

Dated: DEC 23 2010

Respectfully submitted,

By ______________________

D. Richard Anderson
Registration No.: 40439
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road, Suite 100 East
P.O. Box 747
Falls Church, VA 22040-0747
703-205-8000

Attachment(s):

- ☑ PTO/SB/08
- ☑ Document(s)
- ☐ Foreign Patent Office Communication
- ☐ Foreign Search Report
- ☐ Fee
- ☑ Other: Four (4) US Office Actions

日　本　国　特　許　庁
JAPAN PATENT OFFICE

別紙添付の書類に記載されている事項は下記の出願書類に記載されている事項と同一であることを証明する。

This is to certify that the annexed is a true copy of the following application as filed with this Office.

出 願 年 月 日 Date of Application:	１９９６年　７月２９日
出 願 番 号 Application Number:	平成　８年特許願第１９８５８５号
パリ条約による外国への出願に用いる優先権の主張の基礎となる出願の国コードと出願番号 The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is	ＪＰ１９９６－１９８５８５
出 願 人 Applicant(s):	口亜化学工業株式会社

２０１０年１１月２４日

特許庁長官
Commissioner,
Japan Patent Office

岩井良行

【書類名】特許願
【整理番号】P96ST13
【提出日】平成 8年 7月29日
【あて先】特許庁長官　荒川　寿光　殿
【国際特許分類】
H01L 33/00
【発明の名称】発光ダイオード及びそれを用いた表示装置
【請求項の数】　4
【発明者】
　【住所又は居所】徳島県阿南市上中町岡４９１番地１００　日亜化学工業株式会社内
　【氏名】清水　義則
【発明者】
　【住所又は居所】徳島県阿南市上中町岡４９１番地１００　日亜化学工業株式会社内
　【氏名】阪野　顕正
【特許出願人】
　【識別番号】000226057
　【郵便番号】774
　【住所又は居所】徳島県阿南市上中町岡４９１番地１００
　【氏名又は名称】日亜化学工業株式会社
　【代表者】小川　英治
　【電話番号】0884-22-2311
【手数料の表示】
　【予納台帳番号】010526
　【納付金額】21,000
【提出物件の目録】
　【物件名】明細書　1
　【物件名】図面　1

【物件名】要約書　1

【プルーフの要否】要

【書類名】　明細書

【発明の名称】　発光ダイオード及びそれを用いた表示装置

【特許請求の範囲】

【請求項１】

発光層が窒化ガリウム系化合物半導体であるＬＥＤチップと、該ＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光するフォトルミネセンス蛍光体と、を有する発光ダイオードであって、

前記ＬＥＤチップの発光スペクトルのピークが４００ｎｍから５３０ｎｍの発光波長を有すると共に、前記フォトルミネセンス蛍光体が$RE_3(Al, Ga)_5O_{12}:Ce$であることを特徴とする発光ダイオード。

但し、ＲＥは、Ｙ，Ｇｄ，Ｓｍから選択される少なくとも一種である。

【請求項２】

マウント・リードのカップ内に配置させたＬＥＤチップと、該ＬＥＤチップと導電性ワイヤーを用いて電気的に接続させたインナー・リードと、前記カップ内に充填させたコーティング部材と、該コーティング部材、ＬＥＤチップ、導電性ワイヤー及びマウント・リードとインナー・リードの少なくとも一部を被覆するモールド部材と、を有する発光ダイオードであって、

前記ＬＥＤチップが窒化ガリウム系化合物半導体であり、且つ前記コーティング部材が$RE_3(Al, Ga)_5O_{12}:Ce$フォトルミネセンス蛍光体を有する透光性樹脂であることを特徴とする発光ダイオード。

但し、ＲＥは、Ｙ，Ｇｄ，Ｓｍから選択される少なくとも一種である。

【請求項３】

前記フォトルミネセンス蛍光体の組成が次の一般式で示されることを特徴とする請求項１又は請求項２記載の発光ダイオード。

$$(Y_{1-p-q-r}Gd_pCe_qSm_r)_3(Al_{1-s}Ga_s)_5O_{12}$$

但し、
$$0 \leqq p \leqq 0.8$$
$$0.003 \leqq q \leqq 0.2$$
$$0.0003 \leqq r \leqq 0.08$$
$$0 \leqq s \leqq 1$$

【請求項４】

請求項２記載の発光ダイオードをマトリックス状に配置したＬＥＤ表示器と、該ＬＥＤ表示器と電気的に接続させた駆動回路と、を有するＬＥＤ表示装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】

本願発明は、ＬＥＤディスプレイ、バックライト光源、信号機、照光式スイッチ及び各種インジケータなどに利用される発光ダイオードに係わり、特に発光素子であるＬＥＤチップからの発光を変換して発光させるフォトルミネセンス蛍光体を有し使用環境によらず高輝度、高効率な発光ダイオード及びそれを用いた表示装置に関する。

【０００２】

【従来技術】

発光ダイオード（以下、ＬＥＤともいう）は、小型で効率が良く鮮やかな色の発光をする。また、半導体素子であるため球切れなどの心配がない。初期駆動特性が優れ、振動やON／OFF点灯の繰り返しに強いという特徴を有する。そのため各種インジケータや種々の光源として利用されている。最近、超高輝度高効率な発光ダイオードとしてＲＧＢ（赤、緑、青色）などの発光ダイオードがそれぞれ開発された。これに伴いＲＧＢの三原色を利用したＬＥＤディスプレイが省電力、長寿命、軽量などの特長を生かして飛躍的に発展を遂げつつある。

【０００３】

発光ダイオードは使用される発光層の半導体材料、形成条件などによって紫外から赤外まで種々の発光波長を放出させることが可能である。また、優れた単色性ピーク波長を有する。

【０００４】

しかしながら、発光ダイオードは優れた単色性ピーク波長を有するが故に白色系発光光源などとさせるためには、ＲＧＢなどが発光可能な各ＬＥＤチップをそれぞれ近接して発光させ拡散混色させる必要がある。このような発光ダイオードは、種々の色を自由に発光させる発光装置としては有効であるが、白色系などの

色のみを発光させる場合においても赤色系、緑色系及び青色系の発光ダイオード、或いは青緑色系及び黄色系の発光ダイオードをそれぞれ使用せざるを得ない。ＬＥＤチップは、半導体であり色調や輝度のバラツキもまだ相当ある。また、半導体発光素子であるＬＥＤチップがそれぞれ異なる材料を用いて形成されている場合、各ＬＥＤチップの駆動電力などが異なり個々に電源を確保する必要がある。そのため、各半導体ごとに電流などを調節して白色系を発光させなければならない。同様に、半導体発光素子であるため個々の温度特性の差や経時変化が異なり、色調が種々変化してしまう。さらに、ＬＥＤチップからの発光を均一に混色させなければ色むらを生ずる場合がある。

【０００５】

そこで、本出願人は先にＬＥＤチップの発光色を蛍光体で色変換させた発光ダイオードとして特開平５－１５２６０９号公報、特開平７－９９３４５号公報などに記載された発光ダイオードを開発した。これらの発光ダイオードによって、１種類のＬＥＤチップを用いて白色系など他の発光色を発光させることができる。

【０００６】

具体的には、発光層のエネルギーバンドギャップが大きいＬＥＤチップをリードフレームの先端に設けられたカップ上などに配置する。ＬＥＤチップは、ＬＥＤチップが設けられたメタルステムやメタルポストとそれぞれ電気的に接続させる。そして、ＬＥＤチップを被覆する樹脂モールド部材中などにＬＥＤチップからの光を吸収し波長変換する蛍光体を含有させて形成させてある。

【０００７】

ＬＥＤチップからの発光を波長変換した発光ダイオードとして、青色系の発光ダイオードの発光と、その発光を吸収し黄色系を発光する蛍光体からの発光との混色により白色系が発光可能な発光ダイオードなどとすることができる。これらの発光ダイオードは、白色系を発光する発光ダイオードとして利用した場合においても十分な輝度を発光する発光ダイオードとすることができる。

【０００８】

【発明が解決する課題】

発光ダイオードによって励起される蛍光体は、蛍光染料、蛍光顔料さらには有機、無機化合物などから様々なものが挙げられる。また、蛍光体は、発光素子からの発光波長を波長の短いものから長い波長へと変換する、或いは発光素子からの発光波長を波長の長いものから短い波長へと変換するものとがある。

【０００９】

しかしながら、波長の長いものから短い波長へと変換する場合、変換効率が極めて悪く実用に向かない。また、ＬＥＤチップ周辺に近接して配置された蛍光体は、太陽光よりも約３０倍から４０倍にも及ぶ強照射強度の光線にさらされる。特に、発光素子であるＬＥＤチップを高エネルギーバンドギャップを有する半導体を用い蛍光体の変換効率向上や蛍光体の使用量を減らした場合においては、ＬＥＤチップから発光した光が可視光域にあるといっても光エネルギーが必然的に高くなる。この場合、発光強度を更に高め長期に渡って使用すると、蛍光体自体が劣化しやすい。蛍光体が劣化すると色調がずれる、或いは蛍光体が黒ずみ光の外部取り出し効率が低下する場合がある。同様にＬＥＤチップの近傍に設けられた蛍光体は、ＬＥＤチップの昇温や外部環境からの加熱など高温にもさらされる。さらに、発光ダイオードは、一般的に樹脂モールドに被覆されてはいるものの外部環境からの水分の進入などを完全に防ぐことや製造時に付着した水分を完全に除去することはできない。蛍光体によっては、このような水分が発光素子からの高エネルギー光や熱によって蛍光体物質の劣化を促進する場合もある。また、イオン性の有機染料に至ってはチップ近傍では直流電界により電気泳動を起こし、色調が変化する可能性がある。したがって、本願発明は上記課題を解決し、より高輝度、長時間の使用環境下においても発光光率の低下や色ずれの極めて少ない発光ダイオードを提供することを目的とする。

【００１０】

【課題を解決するための手段】

本願発明は、発光層が窒化ガリウム系化合物半導体であるＬＥＤチップと、該ＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光するフォトルミネセンス蛍光体と、を有する発光ダイオードであって、前記ＬＥＤチップの発光スペクトルのピークが４００ｎｍから５３０ｎｍの発光波長を有すると共に

、前記フォトルミネセンス蛍光体が$RE_3(Al, Ga)_5O_{12}:Ce$である。但し、REは、Y，Gd，Smから選択される少なくとも一種である。

【0011】

また、マウント・リードのカップ内に配置させたＬＥＤチップと、該ＬＥＤチップと導電性ワイヤーを用いて電気的に接続させたインナー・リードと、前記カップ内に充填させたコーティング部材と、該コーティング部材、ＬＥＤチップ、導電性ワイヤー及びマウント・リードとインナー・リードの少なくとも一部を被覆するモールド部材と、を有する発光ダイオードであって、前記ＬＥＤチップが窒化ガリウム系化合物半導体であり、且つ前記コーティング部材が$RE_3(Al, Ga)_5O_{12}:Ce$フォトルミネセンス蛍光体を有する透光性樹脂でもある。但し、REは、Y，Gd，Smから選択される少なくとも一種である。

【0012】

さらに、前記フォトルミネセンス蛍光体の組成が次の一般式で示される発光ダイオードでもある。$(Y_{1-p-q-r}Gd_pCe_qSm_r)_3(Al_{1-s}Ga_s)_5O_{12}$　但し、$0 \leqq p \leqq 0.8$、$0.003 \leqq q \leqq 0.2$、$0.0003 \leqq r \leqq 0.08$、$0 \leqq s \leqq 1$

【0013】

また、請求項２記載の発光ダイオードをマトリックス状に配置したＬＥＤ表示器と、該ＬＥＤ表示器と電気的に接続させた駆動回路と、を有するＬＥＤ表示装置である。

【0014】

【発明の実施の態様】

本願発明者は、種々の実験の結果、可視光域における光エネルギーが比較的高いＬＥＤチップからの発光光をフォトルミネセンス蛍光体によって色変換させる発光ダイオードにおいて、特定の半導体及び蛍光体を選択することにより高輝度、長時間の使用時における光効率低下や色ずれを防止できることを見出し本願発明を成すに至った。

【0015】

即ち、発光ダイオードに用いられるフォトルミネセンス蛍光体としては、

１．耐光性に優れていることが要求される。特に、半導体発光素子などの微小領域から強放射されるために太陽光の約３０倍から４０倍にもおよぶ強照射強度にも十分耐える必要がある。２．発光素子との混色を利用するため紫外線ではなく青色系発光で効率よく発光すること。３．混色を考慮して緑色系から赤色系の光が発光可能なこと。４．発光素子近傍に配置されるため温度特性が良好であること。５．色調が組成比或いは複数の蛍光体の混合比で連続的に変えられること。６．発光ダイオードの利用環境に応じて耐候性があることなどの特徴を有することが求められる。

【００１６】

これらの条件を満たすものとして本願発明は、発光素子として発光層に高エネルギーバンドギャップを有する窒化ガリウム系化合物半導体素子を、フォトルミネセンス蛍光体として$RE_3(Al, Ga)_5O_{12}$：Ｃｅ蛍光体を用いる。これにより発光素子から放出された可視光域における高エネルギー光を長時間近傍で高輝度に照射した場合であっても発光色の色ずれや発光輝度の低下が極めて少ない発光ダイオードとすることができるものである。

【００１７】

具体的な発光ダイオードの一例として、チップタイプＬＥＤを図２に示す。チップタイプＬＥＤの筐体２０４内に窒化ガリウム系半導体を用いたＬＥＤチップ２０２をエポキシ樹脂などを用いて固定させてある。導電性ワイヤー２０３として金線をＬＥＤチップ２０２の各電極と筐体に設けられた各電極２０５とにそれぞれ電気的に接続させてある。$RE_3(Al, Ga)_5O_{12}$：Ｃｅ蛍光体をエポキシ樹脂中に混合分散させたものをＬＥＤチップ、導電性ワイヤーなどを外部応力などから保護するモールド部材２０１として均一に硬化形成させる。このような発光ダイオードに電力を供給させることによってＬＥＤチップ２０２を発光させる。ＬＥＤチップ２０２からの発光と、その発光によって励起されたフォトルミネセンス蛍光体からの発光光との混色により白色系などが発光可能な発光ダイオードとすることができる。以下、本願発明の構成部材について詳述する。

【００１８】

（蛍光体）

本願発明に用いられるフォトルミネセンス蛍光体としては、半導体発光層から発光された可視光及び紫外線で励起されて発光するフォトルミネセンス蛍光体をいう。具体的なフォトルミネセンス蛍光体としては、$RE_3(Al, Ga)_5O_{12}$：Ｃｅ（但し、ＲＥは、Ｙ，Ｇｄ，Ｓｍから選択される少なくとも一種）である。窒化ガリウム系化合物半導体を用いたＬＥＤチップから発光した光と、ボディーカラーが黄色でありフォトルミネセンス蛍光体から発光する光が補色関係などにある場合、ＬＥＤチップからの発光と、フォトルミネセンス蛍光体からの発光と、を混色表示させると白色系の発光色表示を行うことができる。そのため発光ダイオード外部には、ＬＥＤチップからの発光とフォトルミネセンス蛍光体からの発光とがモールド部材を透過する必要がある。したがって、フォトルミネセンス蛍光体のバルク層内などにＬＥＤチップを閉じこめ、フォトルミネセンス蛍光体層にＬＥＤチップからの光が透過する開口部を１乃至２以上有する構成の発光ダイオードとしても良い。また、フォトルミネセンス蛍光体の粉体を樹脂や硝子中に含有させＬＥＤチップからの光が透過する程度に薄く形成させても良い。フォトルミネセンス蛍光体と樹脂などとの比率や塗布、充填量を種々調整すること及び発光素子の発光波長を選択することにより白色を含め電球色など任意の色調を提供させることができる。

【００１９】

さらに、フォトルミネセンス蛍光体の含有分布は、混色性や耐久性にも影響する。すなわち、フォトルミネセンス蛍光体が含有されたコーティング部やモールド部材の表面側からＬＥＤチップに向かってフォトルミネセンス蛍光体の分布濃度が高い場合は、外部環境からの水分などの影響をより受けにくく水分による劣化を抑制しやすい。他方、フォトルミネセンス蛍光体の含有分布をＬＥＤチップからモールド部材表面側に向かって分布濃度が高くなると外部環境からの水分の影響を受けやすいがＬＥＤチップからの発熱、照射強度などの影響がより少なくフォトルミネセンス蛍光体の劣化を抑制することができる。このような、フォトルミネセンス蛍光体の分布は、フォトルミネセンス蛍光体を含有する部材、形成温度、粘度やフォトルミネセンス蛍光体の形状、粒度分布などを調整させることによって種々形成させることができる。したがって、使用条件などにより蛍光体

の分布濃度を、種々選択することができる。

【００２０】

本願発明のフォトルミネセンス蛍光体は、特にＬＥＤチップと接する或いは近接して配置され放射照度として（Ｅｅ）＝３Ｗ・ｃｍ$^{-2}$以上１０Ｗ・ｃｍ$^{-2}$以下においても高効率に十分な耐光性有する発光ダイオードとすることができる。

【００２１】

本願発明に用いられるフォトルミネセンス蛍光体は、ガーネット構造のため、熱、光及び水分に強く、励起スペクトルのピークが４５０ｎｍ付近にさせることができる。また、発光ピークも５３０ｎｍ付近にあり７００ｎｍまで裾を引くブロードな発光スペクトルを持つ。しかも、組成のＡｌの一部をＧａで置換することで発光波長が短波長にシフトし、また組成のＹの一部をＧｄで置換することで、発光波長が短波長へシフトする。このように組成を変化することで発光色を連続的に調節することが可能である。したがって、長波長側の強度がＧｄの組成比で連続的に変えられるなど窒化物半導体の青色系発光を白色系発光に変換するための理想条件を備えている。

【００２２】

また、窒化ガリウム系半導体を用いたＬＥＤチップと、セリウムで付活されたイットリウム・アルミニウム・ガーネット蛍光体（ＹＡＧ）に希土類元素のサマリウム（Ｓｍ）を含有させたフォトルミネセンス蛍光体と、を有する発光ダイオードとすることによりさらに光効率を向上させることができる。

【００２３】

このようなフォトルミネセンス蛍光体は、Ｙ、Ｇｄ、Ｃｅ、Ｓｍ、Ａｌ及びＧａの原料として酸化物、又は高温で容易に酸化物になる化合物を使用し、それらを化学量論比で十分に混合して原料を得る。又は、Ｙ、Ｇｄ、Ｃｅ、Ｓｍの希土類元素を化学量論比で酸に溶解した溶解液を蓚酸で共沈したものを焼成して得られる共沈酸化物と、酸化アルミニウム、酸化ガリウムとを混合して混合原料を得る。これにフラックスとしてフッ化アンモニウム等のフッ化物を適量混合して坩堝に詰め、空気中１３５０～１４５０°Ｃの温度範囲で２～５時間焼成して焼成品を得、次に焼成品を水中でボールミルして、洗浄、分離、乾燥、最後に篩を通

すことで得ることができる。

【0024】

（$Y_{1-p-q-r}Gd_pCe_qSm_r$）$_3Al_5O_{12}$フォトルミネセンス蛍光体は、結晶中にＧｄを含有することにより、特に４６０ｎｍ以上の長波長域の励起発光効率を高くすることができる。ガドリニウムの含有量の増加により、発光ピーク波長が、５３０ｎｍから５７０ｎｍまで長波長に移動し、全体の発光波長も長波長側にシフトする。赤みの強い発光色が必要な場合、Ｇｄの置換量を多くすることで達成できる。一方、Ｇｄが増加すると共に、青色光によるフォトルミネセンスの発光輝度は徐々に低下する。したがって、ｐは０．８以下であることが好ましく、０．７以下であることがより好ましい。さらに好ましくは０．６以下である。

【0025】

Ｓｍを含有する（$Y_{1-p-q-r}Gd_pCe_qSm_r$）$_3Al_5O_{12}$蛍光体は、Ｇｄの含有量の増加に関わらず温度特性の低下が少ない。このようにＳｍを含有させることにより、高温度におけるフォトルミネセンス蛍光体の発光輝度は大幅に改善される。その改善される程度はＧｄの含有量が高くなるほど大きくなる。すなわち、Ｇｄを増加してフォトルミネセンス蛍光体の発光色調に赤みを付与した組成ほどＳｍの含有による温度特性改善に効果的であることが分かった。（なお、ここでの温度特性とは、４５０ｎｍの青色光による常温（２５°Ｃ）における励起発光輝度に対する、同蛍光体の高温（２００°Ｃ）における発光輝度の相対値（％）で表している。）

【0026】

Ｓｍの含有量は０．０００３≦ｒ≦０．０８の範囲で温度特性が６０％以上となり好ましい。この範囲よりｒが小さいと、温度特性改良の効果が小さくなる。また、この範囲よりｒが大きくなると温度特性は逆に低下してくる。０．０００７≦ｒ≦０．０２の範囲では温度特性は８０％以上となり最も好ましい。

【0027】

Ｃｅは０．００３≦ｑ≦０．２の範囲で相対発光輝度が７０％以上となる。ｑが０．００３以下では、Ｃｅによるフォトルミネセンスの励起発光中心の数が減少することで輝度低下し、逆に、０．２より大きくなると濃度消光が生ずる。

【００２８】

本願発明の発光ダイオードにおいてこのようなフォトルミネセンス蛍光体は、２種類以上のＲＥ$_3$（Ａｌ，Ｇａ）$_5$Ｏ$_{12}$：Ｃｅフォトルミネセンス蛍光体を混合させてもよい。即ち、Ａｌ、Ｇａ、Ｙ及びＧｄやＳｍの含有量が異なる２種類以上のＲＥ$_3$（Ａｌ，Ｇａ）$_5$Ｏ$_{12}$：Ｃｅフォトルミネセンス蛍光体を混合させてＲＧＢの波長成分を増やすことができる。これに、カラーフィルターを用いることによりフルカラー液晶表示装置用としても利用できる。

【００２９】

（ＬＥＤチップ１０２、２０２、７０２）

本願発明に用いられるＬＥＤチップとは、ＲＥ$_3$（Ａｌ，Ｇａ）$_5$Ｏ$_{12}$：Ｃｅ蛍光体を効率良く励起できる窒化物系化合物半導体が挙げられる。発光素子であるＬＥＤチップは、ＭＯＣＶＤ法等により基板上にＩｎＧａＮ等の半導体を発光層として形成させる。半導体の構造としては、ＭＩＳ接合、ＰＩＮ接合やＰＮ接合などを有するホモ構造、ヘテロ構造あるいはダブルヘテロ構成のものが挙げられる。半導体層の材料やその混晶度によって発光波長を種々選択することができる。また、半導体活性層を量子効果が生ずる薄膜に形成させた単一量子井戸構造や多重量子井戸構造とすることもできる。

【００３０】

窒化ガリウム系化合物半導体を使用した場合、半導体基板にはサファイヤ、スピネル、ＳｉＣ、Ｓｉ、ＺｎＯ等の材料が用いられる。結晶性の良い窒化ガリウムを形成させるためにはサファイヤ基板を用いることが好ましい。このサファイヤ基板上にＧａＮ、ＡｌＮ等のバッファー層を形成しその上にＰＮ接合を有する窒化ガリウム半導体を形成させる。窒化ガリウム系半導体は、不純物をドープしない状態でＮ型導電性を示す。発光効率を向上させるなど所望のＮ型窒化ガリウム半導体を形成させる場合は、Ｎ型ドーパントとしてＳｉ、Ｇｅ、Ｓｅ、Ｔｅ、Ｃ等を適宜導入することが好ましい。一方、Ｐ型窒化ガリウム半導体を形成させる場合は、Ｐ型ドーパンドであるＺｎ、Ｍｇ、Ｂｅ、Ｃａ、Ｓｒ、Ｂａ等をドープさせる。窒化ガリウム系化合物半導体は、Ｐ型ドーパントをドープしただけではＰ型化しにくいためＰ型ドーパント導入後に、低電子線照射させたり、プラズ

マ照射等によりアニールすることでＰ型化させることが好ましい。エッチングなどによりＰ型半導体及びＮ型半導体の露出面を形成させた後、半導体層上にスパッタリング法や真空蒸着法などを用いて所望の形状の各電極を形成させる。

【００３１】

次に、形成された半導体ウエハー等をダイヤモンド製の刃先を有するブレードが回転するダイシングソーにより直接フルカットするか、又は刃先幅よりも広い幅の溝を切り込んだ後（ハーフカット）、外力によって半導体ウエハーを割る。あるいは、先端のダイヤモンド針が往復直線運動するスクライバーにより半導体ウエハーに極めて細いスクライブライン（経線）を例えば碁盤目状に引いた後、外力によってウエハーを割り半導体ウエハーからチップ状にカットする。このようにして窒化ガリウム系化合物半導体であるＬＥＤチップを形成させることができる。

【００３２】

本願発明の発光ダイオードにおいて白色系を発光させる場合は、フォトルミネセンス蛍光体との補色等を考慮して発光素子の発光波長は４００ｎｍ以上５３０ｎｍ以下が好ましく、４２０ｎｍ以上４９０ｎｍ以下がより好ましい。ＬＥＤチップとフォトルミネセンス蛍光体との効率をそれぞれより向上させるためには、４５０ｎｍ以上４７５ｎｍ以下がさらに好ましい。本願発明の白色系発光ダイオードの発光スペクトルを図３に示す。４５０ｎｍ付近にピークを持つ発光がＬＥＤチップからの発光であり、５７０ｎｍ付近にピークを持つ発光がＬＥＤチップによって励起されたフォトルミネセンスの発光である。

【００３３】

（導電性ワイヤー１０３、２０３）

導電性ワイヤー１０３、２０３としては、ＬＥＤチップ１０２、２０２の電極とのオーミック性、機械的接続性、電気伝導性及び熱伝導性がよいものが求められる。熱伝導度としては０．０１ｃａｌ／ｃｍ^{2}／ｃｍ／℃以上が好ましく、より好ましくは０．５ｃａｌ／ｃｍ^{2}／ｃｍ／℃以上である。また、作業性などを考慮して導電性ワイヤーの直径は、好ましくは、Φ１０μｍ以上、Φ４５μｍ以下である。このような導電性ワイヤーとして具体的には、金、銅、白金、アルミ

ニウム等の金属及びそれらの合金を用いた導電性ワイヤーが挙げられる。このような導電性ワイヤーは、各ＬＥＤチップの電極と、インナー・リード及びマウント・リードなどと、をワイヤーボンディング機器によって容易に接続させることができる。

【００３４】

（マウント・リード１０５）

マウント・リード１０５としては、ＬＥＤチップ１０２を配置させるものであり、ダイボンド機器などで積載するのに十分な大きさがあれば良い。また、ＬＥＤチップを複数設置しマウント・リードをＬＥＤチップの共通電極として利用する場合においては、十分な電気伝導性とボンディングワイヤー等との接続性が求められる。また、マウント・リード上のカップ内にＬＥＤチップを配置すると共に蛍光体を内部に充填させる場合は、近接して配置させた別の発光ダイオードからの光により疑似点灯することを防止することができる。

【００３５】

ＬＥＤチップ１０２とマウント・リード１０５のカップとの接着は熱硬化性樹脂などによって行うことができる。具体的には、エポキシ樹脂、アクリル樹脂やイミド樹脂などが挙げられる。また、フェースダウンＬＥＤチップなどによりマウント・リードと接着させると共に電気的に接続させるためにはＡｇペースト、カーボンペースト、金属バンプ等を用いることができる。さらに、発光ダイオードの光利用効率を向上させるためにＬＥＤチップが配置されるマウント・リードの表面を鏡面状とし、表面に反射機能を持たせても良い。この場合の表面粗さは、０．１Ｓ以上０．８Ｓ以下が好ましい。また、マウント・リードの具体的な電気抵抗としては３００μΩ－ｃｍ以下が好ましく、より好ましくは、３μΩ－ｃｍ以下である。また、マウント・リード上に複数のＬＥＤチップを積置する場合は、ＬＥＤチップからの発熱量が多くなるため熱伝導度がよいことが求められる。具体的には、０．０１ｃａｌ／ｃｍ^2／ｃｍ／℃以上が好ましくより好ましくは ０．５ｃａｌ／ｃｍ^2／ｃｍ／℃以上である。これらの条件を満たす材料としては、鉄、銅、鉄入り銅、錫入り銅、メタライズパターン付きセラミック等が挙げられる。

【００３６】
（インナー・リード１０６）
インナー・リード１０６としては、マウント・リード１０５上に配置されたＬＥＤチップ１０２と接続された導電性ワイヤー１０３との接続を図るものである。マウント・リード上に複数のＬＥＤチップを設けた場合は、各導電性ワイヤー同士が接触しないよう配置できる構成とする必要がある。具体的には、マウント・リードから離れるに従って、インナー・リードのワイヤーボンディングさせる端面の面積を大きくすることなどによってマウント・リードからより離れたインナー・リードと接続させる導電性ワイヤーの接触を防ぐことができる。導電性ワイヤーとの接続端面の粗さは、密着性を考慮して１．６Ｓ以上１０Ｓ以下が好ましい。インナー・リードの先端部を種々の形状に形成させるためには、あらかじめリードフレームの形状を型枠で決めて打ち抜き形成させてもよく、或いは全てのインナー・リードを形成させた後にインナー・リード上部の一部を削ることによって形成させても良い。さらには、インナ・リードを打ち抜き形成後、端面方向から加圧することにより所望の端面の面積と端面高さを同時に形成させることもできる。

【００３７】
インナー・リードは、導電性ワイヤーであるボンディングワイヤー等との接続性及び電気伝導性が良いことが求められる。具体的な電気抵抗としては、３００μΩ－ｃｍ以下が好ましく、より好ましくは３μΩ－ｃｍ以下である。これらの条件を満たす材料としては、鉄、銅、鉄入り銅、錫入り銅及び銅、金、銀をメッキしたアルミニウム、鉄、銅等が挙げられる。

【００３８】
（コーティング部１０１）
本願発明に用いられるコーティング部１０１とは、モールド部材１０４とは別にマウント・リードのカップに設けられるものでありＬＥＤチップの発光を変換するフォトルミネセンス蛍光体が含有されるものである。コーティング部の具体的材料としては、エポキシ樹脂、ユリア樹脂、シリコーンなどの耐候性に優れた透明樹脂や硝子などが好適に用いられる。また、フォトルミネセンス蛍光体と共

に拡散剤を含有させても良い。具体的な拡散剤としては、チタン酸バリウム、酸化チタン、酸化アルミニウム、酸化珪素等が好適に用いられる。

【００３９】

（モールド部材１０４）

モールド部材１０４は、発光ダイオードの使用用途に応じてＬＥＤチップ１０２、導電性ワイヤー１０３、フォトルミネセンス蛍光体が含有されたコーティング部１０１などを外部から保護するために設けることができる。モールド部材は、一般には樹脂を用いて形成させることができる。また、フォトルミネセンス蛍光体を含有させることによって視野角を増やすことができるが、樹脂モールドに拡散剤を含有させることによってＬＥＤチップ１０２からの指向性を緩和させ視野角をさらに増やすことができる。更にまた、モールド部材１０４を所望の形状にすることによってＬＥＤチップからの発光を集束させたり拡散させたりするレンズ効果を持たせることができる。従って、モールド部材１０４は複数積層した構造でもよい。具体的には、凸レンズ形状、凹レンズ形状さらには、発光観測面から見て楕円形状やそれらを複数組み合わせた物である。モールド部材１０４の具体的材料としては、主としてエポキシ樹脂、ユリア樹脂、シリコーンなどの耐候性に優れた透明樹脂や硝子などが好適に用いられる。また、拡散剤としては、チタン酸バリウム、酸化チタン、酸化アルミニウム、酸化珪素等が好適に用いられる。さらに、拡散剤に加えてモールド部材中にもフォトルミネセンス蛍光体を含有させることもできる。したがって、フォトルミネセンス蛍光体はモールド部材中に含有させてもそれ以外のコーティング部などに含有させて用いてもよい。また、コーティング部をフォトルミネセンス蛍光体が含有された樹脂、モールド部材を硝子などとした異なる部材を用いて形成させても良い。この場合、生産性良くより水分などの影響が少ない発光ダイオードとすることができる。また、屈折率を考慮してモールド部材とコーティング部とを同じ部材を用いて形成させても良い。

【００４０】

（表示装置）

本願発明の発光ダイオードをＬＥＤ表示器に利用した場合、ＲＧＢをそれぞれ

発光する発光ダイオードの組み合わせだけによるＬＥＤ表示器よりも、より高精細に白色系表示させることができる。すなわち、各発光ダイオードを組み合わせて白色系などを混色表示させるためにはＲＧＢの各発光ダイオードをそれぞれ同時に発光せざるを得ない。そのため赤色系、緑色系、青色系のそれぞれ単色表示した場合に比べて一画素あたりの表示が大きくなる。したがって、白色系の表示の場合においてはＲＧＢ単色表示と比較して高精細に表示させることができない。また、白色系の表示は各発光ダイオードを調節して表示させるため各半導体の温度特性などを考慮し種々調整しなければならない。さらに、混色による表示であるが故にＬＥＤ表示器の視認する方向や角度によって、ＲＧＢの発光ダイオードが部分的に遮光され表示色が変わる場合もある。本願発明の発光ダイオードをＲＧＢの発光ダイオードに加えて利用することにより、より高精細化が可能となると共に白色系の発光が安定し色むらをなくすこともできる。また、ＲＧＢの各発光ダイオードともに発光させることにより輝度を向上させることもできる。

【００４１】

本願発明の発光ダイオードを用いて表示装置の１つとして、ＲＧＢの各発光ダイオードに加えて白色系発光ダイオードを１絵素として利用し、標識やマトリクス状など任意の形状に配置させたＬＥＤ表示器の概略構成を示す。ＬＥＤ表示器は、駆動回路である点灯回路などと電気的に接続させる。駆動回路からの出力パルスによって種々の画像が表示可能なデイスプレイ等とすることができる。駆動回路としては、入力される表示データを一時的に記憶させるＲＡＭ（Ｒａｎｄｏｍ、Ａｃｃｅｓｓ、Ｍｅｍｏｒｙ）と、ＲＡＭに記憶されるデータから各発光ダイオードを所定の明るさに点灯させるための階調信号を演算する階調制御回路と、階調制御回路の出力信号でスイッチングされて、各発光ダイオードを点灯させるドライバーとを備える。階調制御回路は、ＲＡＭに記憶されるデータから発光ダイオードの点灯時間を演算してパルス信号を出力する。ここで、白色系の表示を行う場合は、ＲＧＢ各発光ダイオードのパルス信号を短くする、パルス高を低くする或いは全く点灯させない。他方、それを補償するように白色系発光ダイオードにパルス信号を出力する。これにより、ＬＥＤ表示器の白色を表示する。

【００４２】

したがって、白色系発光ダイオードを所望の輝度で点灯させるためのパルス信号を演算する階調制御回路としてＣＰＵを別途備えることが好ましい。階調制御回路から出力されるパルス信号は、白色系発光ダイオードのドライバーに入力されてドライバをスイッチングさせる。ドライバーがオンになると白色系発光ダイオードが点灯され、オフになると消灯される。

【００４３】

また、本願発明の発光ダイオードを用いた別のＬＥＤ表示器を示す。本願発明の白色系発光ダイオードのみを用い白黒用のＬＥＤ表示装置とすることもできる。白黒用のＬＥＤ表示器は、本願発明の発光ダイオード５０１のみをマトリックス状などに配置し構成することができる。ＲＧＢのそれぞれの駆動回路の代わりに白色発光可能な本願発明の発光ダイオード用駆動回路のみとしてＬＥＤ表示器を構成させることができる。ＬＥＤ表示器は、駆動回路である点灯回路などと電気的に接続させる。駆動回路からの出力パルスによって種々の画像が表示可能なデイスプレイ等とすることができる。駆動回路としては、入力される表示データを一時的に記憶させるＲＡＭ（Ｒａｎｄｏｍ、Ａｃｃｅｓｓ、Ｍｅｍｏｒｙ）と、ＲＡＭに記憶されるデータから発光ダイオードを所定の明るさに点灯させるための階調信号を演算する階調制御回路と、階調制御回路の出力信号でスイッチングされて、発光ダイオードを点灯させるドライバーとを備える。階調制御回路は、ＲＡＭに記憶されるデータから発光ダイオードの点灯時間を演算してパルス信号を出力する。

【００４４】

したがって、白黒用のＬＥＤ表示器はＲＧＢのフルカラー表示器と異なり当然回路構成を簡略化できると共に高精細化できる。そのため、安価にＲＧＢの発光ダイオードの特性に伴う色むらなどのないディスプレイとすることができるものである。また、従来の赤色、緑色のみを用いたＬＥＤ表示器に比べ人間の目に対する刺激が少なく長時間の使用に適している。

【００４５】

（信号機）

本願発明の発光ダイオードを表示装置の１種である信号機として利用した場合

、長時間安定して発光させることが可能であると共に発光ダイオードの一部が消灯しても色むらなどが生じないという特徴がある。本願発明の発光ダイオードを用いた信号機の概略構成として、導電性パターンが形成された基板上に白色系発光ダイオードを配置させる。このような発光ダイオードを直列又は直並列に接続された発光ダイオードの回路を発光ダイオード群として扱う。発光ダイオード群を２つ以上用いそれぞれ渦巻き状に発光ダイオードを配置させる。全ての発光ダイオードが配置されると円状に全面に配置される。各発光ダイオード及び基板から外部電力と接続させる電源コードをそれぞれ、ハンダにより接続させた後、鉄道用信号用の筐体内に固定させる。ＬＥＤ表示器は、遮光部材が付いたアルミダイキャストの筐体内に配置され表面にシリコーンゴムの充填材で封止されている。筐体の表示面は、白色レンズを設けてある。また、ＬＥＤ表示器の電気的配線は、筐体の裏面からゴムパッキンを通し筐体内を密閉する。これにより白色系信号機を形成することができる。本願発明の発光ダイオードを、複数の群に分け中心部から外側に向け輪を描く渦巻き状などに配置し、並列接続させることでより信頼性が高い信号機とさせることができる。中心部から外側に向け輪を描くとは連続的に輪を描くものも断続的に配置するものをも含む。したがって、ＬＥＤ表示器の表示面積などにより配置される発光ダイオードの数や発光ダイオード群の数を種々選択することができる。この信号機により、一方の発光ダイオード群や一部の発光ダイオードが何らかのトラブルにより消灯したとしても他方の発光ダイオード群や残った発光ダイオードにより信号機を円形状に均一に発光させることが可能となるものである。また、色ずれが生ずることもない。渦巻き状に配置してあることから中心部を密に配置することができ電球発光の信号と何ら違和感なく駆動させることができる。

【００４６】

（面状発光光源）

本願発明の発光ダイオードを用いて図７の如く面状発光光源を構成することができる。面状発光光源の場合、フォトルミネセンス蛍光体をコーティング部や導光板上の散乱シート７０６に含有させる。或いはバインダー樹脂と共に散乱シート７０６に塗布などさせシート状７０１に形成しモールド部材を省略しても良い

。具体的には、絶縁層及び導電性パターンが形成されたコの字形状の金属基板７０３内にＬＥＤチップ７０２を固定する。ＬＥＤチップと導電性パターンとの電気的導通を取った後、フォトルミネセンス蛍光体をエポキシ樹脂と混合撹拌しＬＥＤチップ７０２が積載された基板７０３上に充填させ発光ダイオードを形成させる。こうして形成された発光ダイオードは、アクリル性導光板７０４の端面にエポキシ樹脂などで固定される。導光板７０４の一方の主面上には、蛍現象防止のため白色散乱剤が含有されたフィルム状の反射部材７０７を配置させてある。同様に、導光板の裏面側全面や発光ダイオードが配置されていない端面上にも反射部材７０５を設け発光光率を向上させてある。これにより、ＬＣＤのバックライトとして十分な明るさを得られる面状発光光源とすることができる。液晶表示装置として利用する場合は、導光板７０４の主面上に不示図の透光性導電性パターンが形成された硝子基板間に注入された液晶装置を介して配された偏光板により構成させることができる。以下、本願発明の実施例について説明するが、本願発明は具体的実施例のみに限定されるものではないことは言うまでもない。

【００４７】

【実施例】

（実施例１）

発光素子として発光ピークが４５０ｎｍのＧａＩｎＮ半導体を用いた。ＬＥＤチップは、洗浄させたサファイヤ基板上にＴＭＧ（トリメチルガリウム）ガス、ＴＭＡ（トリメチルアルミニウム）ガス、窒素ガス及びドーパントガスをキャリアガスと共に流し、ＭＯＣＶＤ法で窒化ガリウム系化合物半導体を成膜させることにより形成させた。ドーパントガスとして$ＳｉＨ_4$と$Ｃｐ_2Ｍｇ$と、を切り替えることによってＮ型導電性を有する窒化ガリウム半導体とＰ型導電性を有する窒化ガリウム半導体を形成しＰＮ接合を形成させた。（なお、Ｐ型半導体は、成膜後４００℃以上でアニールさせてある。）

【００４８】

エッチングによりＰＮ各半導体表面を露出させた後、スパッタリングにより各電極をそれぞれ形成させた。こうして出来上がった半導体ウエハーをスクライブラインを引いた後、外力により分割させ発光素子としてＬＥＤチップを形成させ

た。

【００４９】

銀メッキした銅製リードフレームの先端にカップを有するマウント・リードにＬＥＤチップをエポキシ樹脂でダイボンディングした。ＬＥＤチップの各電極とマウント・リード及びインナー・リードと、をそれぞれ金線でワイヤーボンディングし電気的導通を取った。

【００５０】

一方、フォトルミネセンス蛍光体は、Ｙ、Ｇｄ、Ｃｅの希土類元素を化学量論比で酸に溶解した溶解液を蓚酸で共沈させた。これを焼成して得られる共沈酸化物と、酸化アルミニウム、酸化ガリウムと混合して混合原料を得る。これにフラックスとしてフッ化アンモニウムを混合して坩堝に詰め、空気中１４００°Ｃの温度範囲で３時間焼成して焼成品を得た。焼成品を水中でボールミルして、洗浄、分離、乾燥、最後に篩を通して形成させた。

【００５１】

形成された（$Y_{1.2}Gd_{0.8}$）Al_3O_{12}：Ｃｅ蛍光体８０重量部、エポキシ樹脂１００重量部をよく混合してスリラーとさせた。このスリラーをＬＥＤチップが配置されたマウント・リード上のカップ内に注入させた。注入後、フォトルミネセンス蛍光体が含有された樹脂を１３０℃１時間で硬化させた。こうしてＬＥＤチップ上に厚さ１２０μのフォトルミネセンス蛍光体が含有されたコーティング部が形成された。なお、コーティング部には、ＬＥＤチップに向かってフォトルミネセンス蛍光体が徐々に多くしてある。その後、さらにＬＥＤチップやフォトルミネセンス蛍光体を外部応力、水分及び塵芥などから保護する目的でモールド部材として透光性エポキシ樹脂を形成させた。モールド部材は、砲弾型の型枠の中にフォトルミネセンス蛍光体のコーティング部が形成されたリードフレームを挿入し透光性エポシキ樹脂を混入後、１５０℃５時間にて硬化させた。こうして形成された発光ダイオードは、発光観測正面から視認するとフォトルミネセンス蛍光体のボディーカラーにより中央部が黄色っぽく着色していた。

【００５２】

こうして得られた白色系が発光可能な発光ダイオードの色度点、色温度、演色

性指数を測定した。それぞれ、色度点（ｘ＝０．３０２、ｙ＝０．２８０）、色温度８０８０Ｋ、Ｒａ（演色性指数）＝８７．５と三波長型蛍光灯に近い性能を示した。また、発光光率は９．５ｌｍ／ｗと白色電球並であった。さらに耐侯試験として室温６０ｍＡ通電、室温２０ｍＡ通電、６０℃９０％ＲＨ下で２０ｍＡ通電の各試験においても蛍光体に起因する変化は観測されず通常の青色発光ダイオードと寿命特性に差がないことが確認できた。

【００５３】

（比較例１）

フォトルミネセンス蛍光体を$（Ｙ_{１．２}Ｇｄ_{０．８}）Ａｌ_{３}Ｏ_{１２}$：Ｃｅから（ＺｎＣｄ）Ｓ：Ｃｕ、Ａｌとした以外は、実施例１と同様にして発光ダイオードの形成及び耐侯試験を行った。形成された発光ダイオードは通電直後、実施例１と同様白色系の発光が確信されたが輝度が低かった。また、耐侯試験においては、約１００時間で出力がゼロになった。劣化原因を解析した結果、蛍光体が黒化していた。

【００５４】

これは、発光素子の発光光と蛍光体に付着していた水分或いは外部環境から進入した水分により光分解し蛍光体結晶表面にコロイド状亜鉛金属を析出し外観が黒色に変色したものと考えられる。

【００５５】

（実施例２）

ＬＥＤチップの窒化物系化合物半導体を実施例１よりもＩｎの含有量を増やし発光ピークを４６０ｎｍとした。同様にフォトルミネセンス蛍光体として実施例１よりもＧｄの含有量を増やした以外は実施例１と同様にして発光ダイオードを１００個形成し耐侯試験を行った。

【００５６】

こうして得られた白色系が発光可能な発光ダイオードの色度点、色温度、演色性指数を測定した。それぞれ、色度点（ｘ＝０．３７５、ｙ＝０．３７０）、色温度４４００Ｋ、Ｒａ（演色性指数）＝８６．０であった。さらに耐侯試験においては、形成させた発光ダイオード１００個平均で行った。耐候性試験前の光度

を１００％とし１０００時間経過後における平均光度を調べた。耐候性試験後も９８．８％であり特性に差がないことが確認できた。

【００５７】

（実施例３）

フォトルミネセンス蛍光体をＹ、Ｇｄ、Ｃｅの希土類元素に加えＳｍを含有させ$(Y_{0.39}Gd_{0.57}Ce_{0.03}Sm_{0.01})_3Al_5O_{12}$蛍光体とした以外は、実施例１と同様にして発光ダイオードを１００個形成した。この発光ダイオードを１３０℃の高温下において点灯させても実施例１の発光ダイオードと比較して平均温度特性が８％ほど良好であった。

【００５８】

（実施例４）

本願発明の発光ダイオードを図５の如くＬＥＤ表示器の１つであるディスプレイに利用した。実施例１と同様にして形成させた発光ダイオードを銅パターンを形成させたセラミックス基板上に、１６×１６のマトリックス状に配置させた。基板と発光ダイオードとは自動ハンダ実装装置を用いてハンダ付けを行った。次にフェノール樹脂によって形成された筐体５０４内部に配置し固定させた。遮光部材５０５は、筐体と一体成形させてある。発光ダイオードの先端部を除いて筐体、発光ダイオード、基板及び遮光部材の一部をピグメントにより黒色に着色したシリコンゴム４０６によって充填させた。その後、常温、７２時間でシリコンゴムを硬化させＬＥＤ表示器を形成させた。このＬＥＤ表示器と、入力される表示データを一時的に記憶させるＲＡＭ（Ｒａｎｄｏｍ、Ａｃｃｅｓｓ、Ｍｅｍｏｒｙ）及びＲＡＭに記憶されるデータから発光ダイオードを所定の明るさに点灯させるための階調信号を演算する階調制御回路と階調制御回路の出力信号でスイッチングされて発光ダイオードを点灯させるドライバーとを備えたＣＰＵの駆動手段と、を電気的に接続させてＬＥＤ表示装置を構成した。ＬＥＤ表示器を駆動させ白黒ＬＥＤ表示装置として駆動できることを確認した。

【００５９】

【発明の効果】

本願発明の構成とすることにより高出力の窒化物系化合物半導体の発光素子と

、ＲＥ$_3$（Ａｌ，Ｇａ）$_5$Ｏ$_{12}$：Ｃｅ蛍光体と、を利用した発光ダイオードとすることにより長時間高輝度時の使用においても発光効率が高い発光ダイオードとすることができる。さらに、信頼性や省電力化、小型化さらには色温度の可変性など車載や航空産業、一般電気機器に表示の他に照明として新たな用途を開くことができる。また、白色は人間の目で長時間視認する場合には刺激が少なく目に優しい発光ダイオードとすることができる。

【００６０】

特に、本願発明の請求項１に記載の構成とすることにより高輝度、長時間の使用においても色ずれ、発光光率の低下が極めて少ない白色系が発光可能な発光ダイオードなど種々の発光ダイオードとすることができる。

【００６１】

本願発明の請求項２の構成とすることにより、高輝度、長時間の使用においても色ずれ、発光光率の低下が極めて少ない発光ダイオードなど種々の発光ダイオードとすることができることに加えて、発光ダイオードを複数近接して配置した場合においても他方の発光ダイオードからの光により蛍光体が励起され疑似点灯されることを防止させることができる。また、ＬＥＤチップ自体の発光むらを蛍光体により分散することができるためより均一な発光光を有する発光ダイオードとすることができる。

【００６２】

本願発明の請求項３の構成とすることにより、より温度依存性の少ない発光ダイオードとすることができる。

【００６３】

本願発明の請求項４の構成とすることにより、比較的安価で高精細なＬＥＤ表示装置や視認角度によって色むらの少ないＬＥＤ表示装置とすることができる。

【００６４】

【図面の簡単な説明】

【図１】

図１は、本願発明の発光ダイオードの模式的断面図である。

【図２】

図２は、本願発明の他の発光ダイオードの模式的断面図である。

【図３】

図３は、本願発明の発光ダイオードの発光スペクトルの一例を示した図である。

【図４】

図４（Ａ）は、本願発明に使用されるフォトルミネセンス蛍光体の吸収スペクトルの一例を示し、図４（Ｂ）は、本願発明に使用されるフォトルミネセンス蛍光体の発光スペクトルの一例を示した図である。

【図５】

図５は、本願発明の発光ダイオードを用いたＬＥＤ表示装置の模式図である。

【図６】

図６は、図５に用いられるＬＥＤ表示装置のブロック図である。

【図７】

図７は、本願発明の発光ダイオードを用いた別のＬＥＤ表示装置の模式図である。

【符号の説明】

１０１、７０１・・・フォトルミネセンスが含有されたコーティング部

１０２、２０２、７０２・・・ＬＥＤチップ

１０３、２０３・・・導電性ワイヤー

１０４・・・モールド部材

１０５・・・マウント・リード

１０６・・・インナー・リード

２０１・・・フォトルミネセンスが含有されたモールド部材

２０４・・・筐体

２０５・・・筐体に設けられた電極

５０１・・・発光ダイオード

５０４・・・筐体

５０５・・・遮光部材

５０６・・・充填材

７０３・・・金属製基板

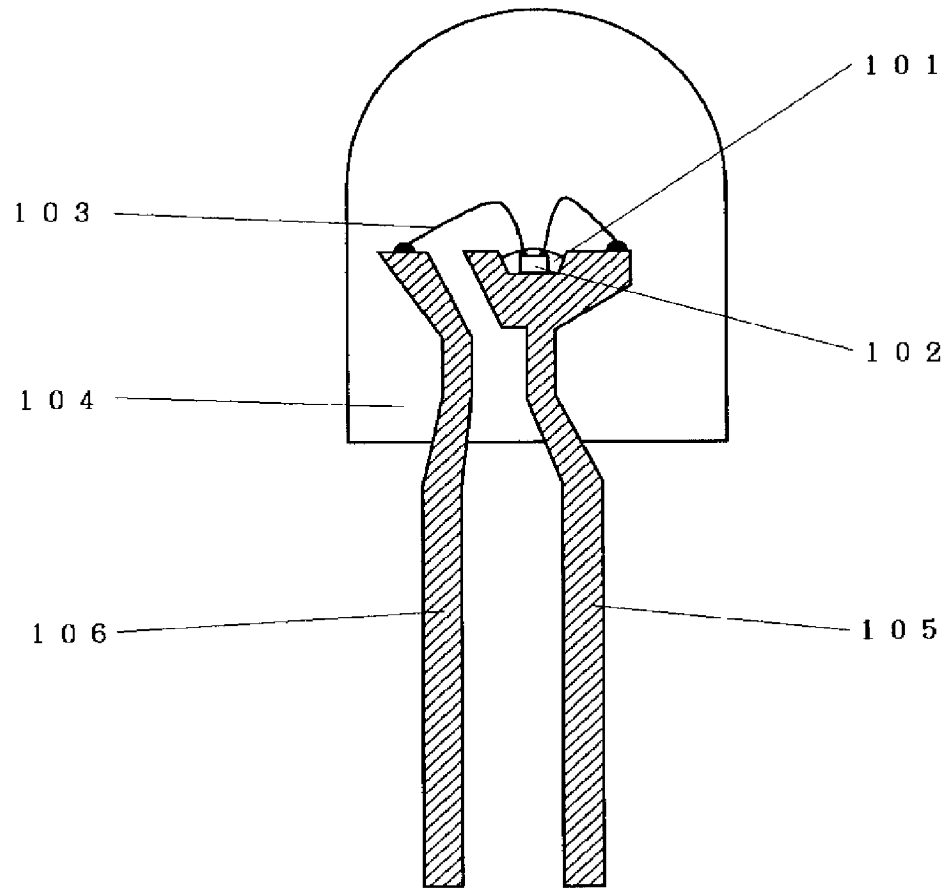
７０４・・・導光板

７０５、７０７・・・反射部材

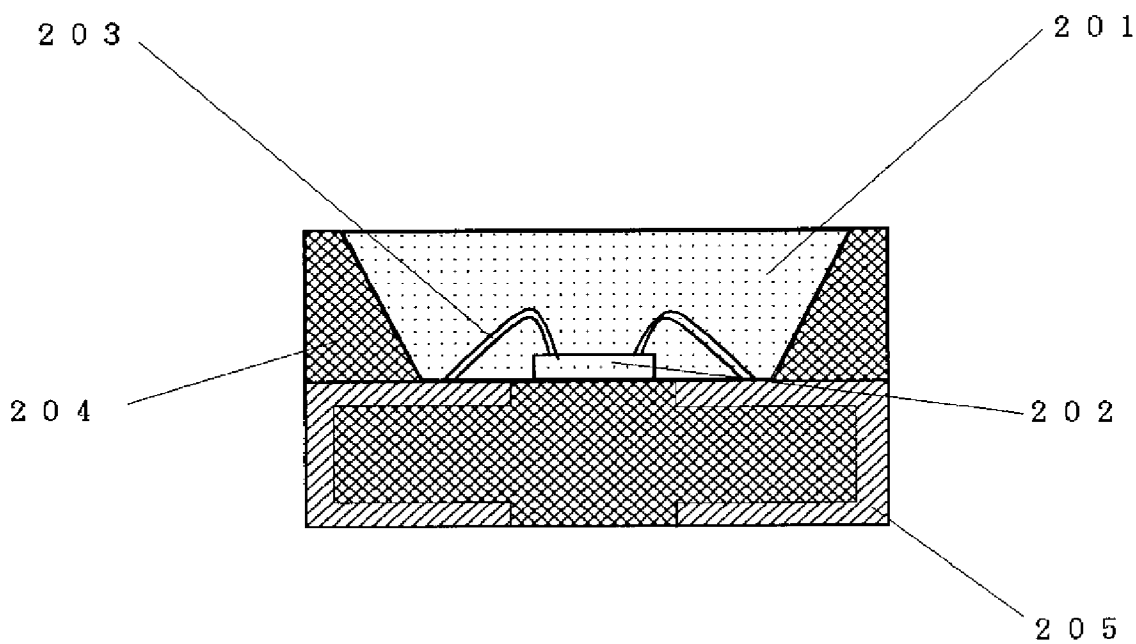
７０６・・・散乱シート

【書類名】　図面

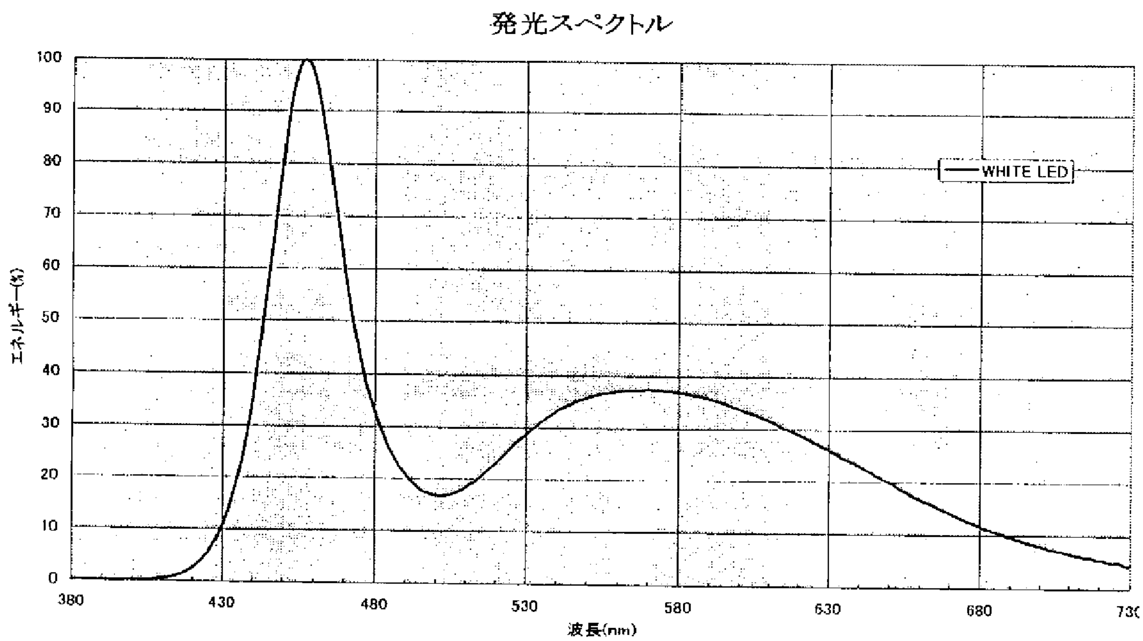
【図１】



【図２】

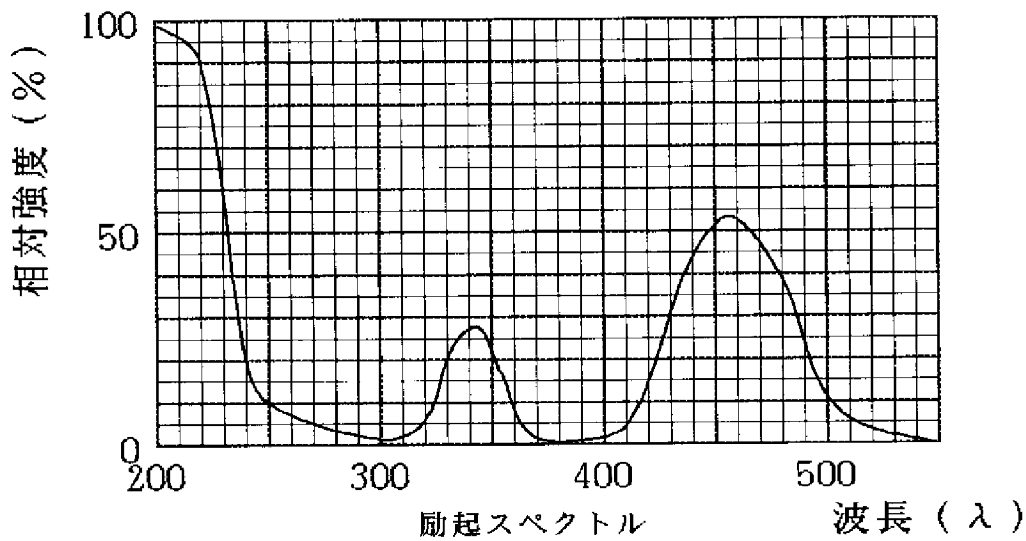


【図３】

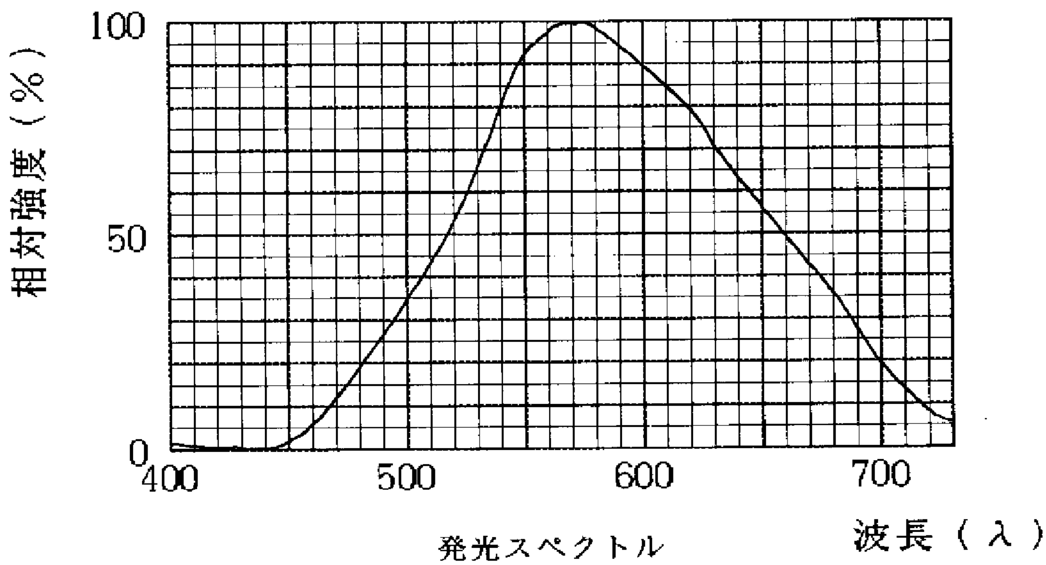


発光スペクトル
100
90
80
70
60
50
40
30
20
10
0
エネルギー(%)
380
430
480
530
580
630
680
730
波長(nm)
WHITE LED

【図４】

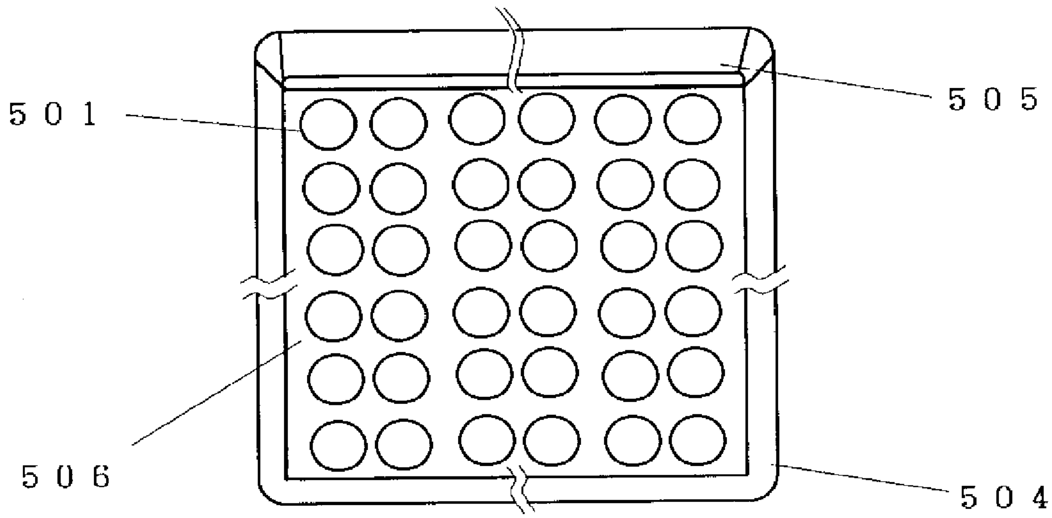


励起スペクトル
（Ａ）

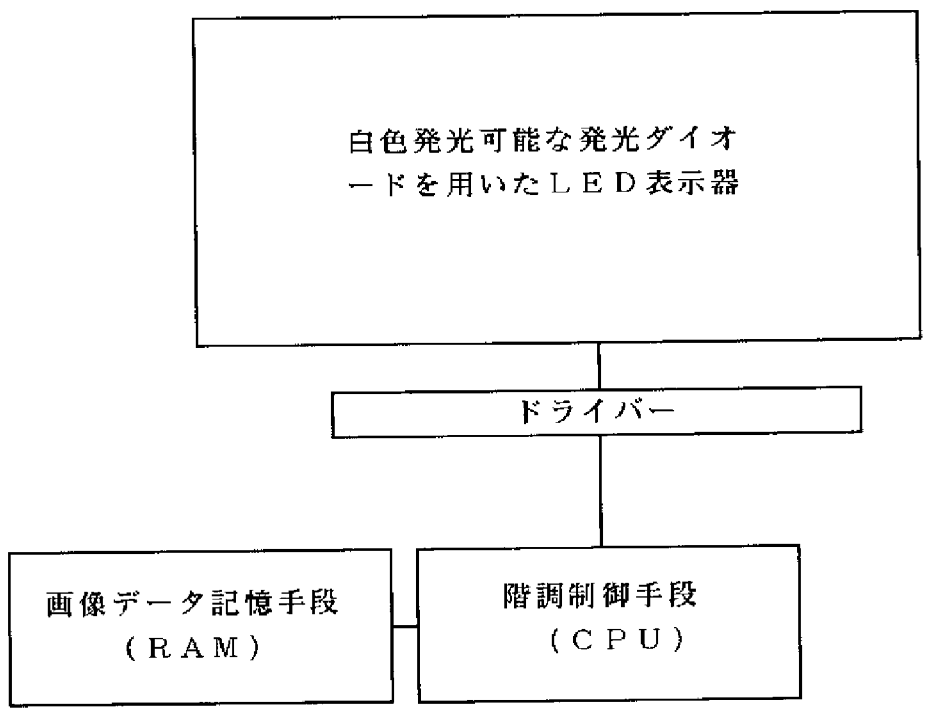


発光スペクトル
（Ｂ）

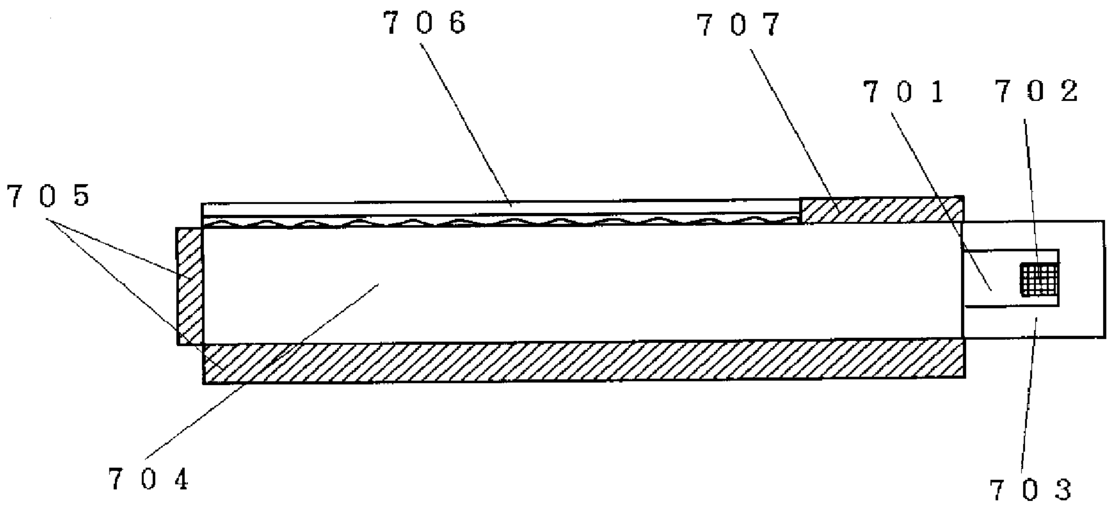
【図５】



【図６】


白色発光可能な発光ダイオードを用いたＬＥＤ表示器
ドライバー
画像データ記憶手段（ＲＡＭ）
階調制御手段（ＣＰＵ）

【図７】



【書類名】　要約書

【課題】

本願発明は、ＬＥＤチップからの発光を変換して発光させるフォトルミネセンス蛍光体を有し使用環境によらず高輝度、高効率に発光可能な発光ダイオード及びそれを用いた表示装置に関する。

【解決手段】

本願発明は、発光層が窒化ガリウム系化合物半導体であるＬＥＤチップと、該ＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光するフォトルミネセンス蛍光体と、を有する発光ダイオードであって、前記ＬＥＤチップの発光スペクトルのピークが４００ｎｍから５３０ｎｍの発光波長を有すると共に、前記フォトルミネセンス蛍光体がRE_3（Ａｌ，Ｇａ）$_5\mathrm{O}_{12}$：Ｃｅである発光ダイオード。但し、ＲＥは、Ｙ，Ｇａ，Ｓｍから選択される少なくとも一種である。

【選択図】図１

【書類名】　　　　　　職権訂正データ
【訂正書類】　　　　　特許願

<認定情報・付加情報>

【特許出願人】　　　　申請人
　【識別番号】　　　　000226057
　【住所又は居所】　　徳島県阿南市上中町岡４９１番地１００
　【氏名又は名称】　　日亜化学工業株式会社

出願人履歴

０００２２６０５７

19900818

新規登録

徳島県阿南市上中町岡４９１番地１００

日亜化学工業株式会社

日本国特許庁
JAPAN PATENT OFFICE

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This is to certify that the annexed is a true copy of the following application as filed with this Office.

出願年月日 Date of Application:	１９９６年　９月１７日
出願番号 Application Number:	平成　８年特許願第２４４３３９号
パリ条約による外国への出願に用いる優先権の主張の基礎となる出願の国コードと出願番号 The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is	ＪＰ１９９６－２４４３３９
出願人 Applicant(s):	日亜化学工業株式会社

２０１０年１１月２４日

特許庁長官
Commissioner,
Japan Patent Office

岩井良行

【書類名】特許願
【整理番号】P96ST30
【提出日】平成 8年 9月17日
【あて先】特許庁長官　荒井　寿光　殿
【国際特許分類】
H01L 33/00
【発明の名称】発光装置
【請求項の数】　5
【発明者】
【住所又は居所】徳島県阿南市上中町岡４９１番地１００　日亜化学工業株式会社内
【氏名】森口　敏生
【発明者】
【住所又は居所】徳島県阿南市上中町岡４９１番地１００　日亜化学工業株式会社内
【氏名】野口　泰延
【特許出願人】
【識別番号】000226057
【郵便番号】774
【住所又は居所】徳島県阿南市上中町岡４９１番地１００
【氏名又は名称】日亜化学工業株式会社
【代表者】小川　英治
【電話番号】0884-22-2311
【手数料の表示】
【予納台帳番号】010526
【納付金額】21,000
【提出物件の目録】
【物件名】明細書　1
【物件名】図面　1

【物件名】要約書　1

【プルーフの要否】要

【書類名】　明細書

【発明の名称】　発光装置

【特許請求の範囲】

【請求項１】

発光層が窒化ガリウム系化合物半導体であるＬＥＤチップと、該ＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光するフォトルミネセンス蛍光体と、を有する発光装置であって、

前記ＬＥＤチップの主発光ピークが４００ｎｍから５３０ｎｍ内であると共に、前記フォトルミネセンス蛍光体がY_3（Ａｌ，Ｇａ）$_5O_{12}$：Ｃｅである第１の蛍光体と、$RE_3Al_5O_{12}$：Ｃｅであって第１の蛍光体の主発光波長よりも長波長側に主発光波長がある第２の蛍光体とであることを特徴とする発光装置。

但し、ＲＥは、Ｙ，Ｇｄ，Ｌａから選択される少なくとも一種である。

【請求項２】

発光層が窒化ガリウム系化合物半導体であるＬＥＤチップと、該ＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光するフォトルミネセンス蛍光体と、を有する発光装置であって、

前記ＬＥＤチップの主発光ピークが４００ｎｍから５３０ｎｍ内であると共に、前記フォトルミネセンス蛍光体は$Y_3Al_5O_{12}$：Ｃｅの主発光波長よりも短波長側に主発光波長があるY_3（Ａｌ，Ｇａ）$_5O_{12}$：Ｃｅと$Y_3Al_5O_{12}$：Ｃｅの主発光波長よりも長波長側に主発光波長がある$RE_3Al_5O_{12}$：Ｃｅであることを特徴とする発光装置。

但し、ＲＥは、Ｙ，Ｇｄ，Ｌａから選択される少なくとも一種である。

【請求項３】

ＬＥＤチップからの発光により励起されて蛍光を発するフォトルミネセンス蛍光体が含有された蛍光体層を介して光学的に接続されたＬＥＤチップと、透光性導光板と、を有する面状光源であって、

前記ＬＥＤチップの発光層が４００ｎｍから５３０ｎｍ内に主発光波長を有する窒化ガリウム系化合物半導体であり、前記フォトルミネセンス蛍光体がY_3（Ａｌ，Ｇａ）$_5O_{12}$：Ｃｅである第１の蛍光体と、$RE_3Al_5O_{12}$：Ｃｅであっ

て前記第１の蛍光体の主発光波長よりも長波長側に主発光波長がある第２の蛍光体であることを特徴とする面状光源。
但し、ＲＥは、Ｙ，Ｇｄ，Ｌａから選択される少なくとも一種である。
【請求項４】
透光性導光板の端面の少なくとも一箇所にＬＥＤチップが光学的に接続されており、前記導光板の主面のいずれか一方に、前記ＬＥＤチップの発光により励起されて蛍光を発するフォトルミネセンス蛍光体が含有された蛍光部材を有する面状光源であって、
前記ＬＥＤチップの発光層が４００ｎｍから５３０ｎｍ内に主発光波長を有する窒化ガリウム系化合物半導体であり、前記フォトルミネセンス蛍光体が$Ｙ_3$（Ａｌ，Ｇａ）$_5Ｏ_{12}$：Ｃｅである第１の蛍光体と、$ＲＥ_3Ａｌ_5Ｏ_{12}$：Ｃｅであって前第１の蛍光体の主発光波長よりも長波長側に主発光波長がある第２の蛍光体とであることを特徴とする面状光源。
但し、ＲＥは、Ｙ，Ｇｄ,Ｌａから選択される少なくとも一種である。
【請求項５】
マウント・リードのカップ内に配置させたＬＥＤチップと、該ＬＥＤチップと導電性ワイヤーを用いて電気的に接続させたインナー・リードと、前記カップ内に充填させたコーティング部材と、該コーティング部材、ＬＥＤチップ、導電性ワイヤー及びマウント・リードとインナー・リードの少なくとも一部を被覆するモールド部材と、を有する発光ダイオードであって、
前記ＬＥＤチップが窒化ガリウム系化合物半導体であり、且つ前記コーティング部材が第１のフォトルミネセンス蛍光体である$Ｙ_3$（Ａｌ，Ｇａ）$_5Ｏ_{12}$：Ｃｅと、$ＲＥ_3Ａｌ_5Ｏ_{12}$：Ｃｅであって前記第１の蛍光体の主発光波長よりも長波長側に主発光波長を有する第２の蛍光体である$ＲＥ_3Ａｌ_5Ｏ_{12}$：Ｃｅとを有する透光性樹脂であることを特徴とする発光ダイオード。
但し、ＲＥは、Ｙ，Ｇｄ，Ｌａから選択される少なくとも一種である。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】

本願発明は、バックライト光源、照光式スイッチ、信号機、表示器、ＬＥＤディスプレイ及び各種インジケータなどに利用される発光装置に係わり、特に使用環境によらず高輝度、高効率にＲＧＢ（赤、緑、青色系）成分が発光可能な発光装置に関する。

【０００２】

【従来技術】

ＬＥＤチップを用いた発光装置は、小型で効率が良く鮮やかな色の発光をする。また、半導体素子であるため球切れなどの心配がない。初期駆動特性が優れ、振動やON／OFF点灯の繰り返しに強いという特徴を有する。そのため各種インジケータや種々の光源として利用されている。最近、超高輝度高効率な発光ダイオードとしてＲＧＢなどの発光ダイオードがそれぞれ開発された。これに伴いＲＧＢの三原色を利用した液晶用バックライトなどに使用可能なフルカラー用面状発光装置が省電力、長寿命、軽量などの特長を生かして研究されてきている。

【０００３】

ＬＥＤチップは使用される発光層の半導体材料、形成条件などによって紫外から赤外まで種々の発光波長を放出させることが可能である。また、優れた単色性ピーク波長を有する。

【０００４】

しかしながら、ＬＥＤチップを用いた発光装置は優れた単色性ピーク波長を有するが故に白色系発光光源などとさせるためには、ＲＧＢなどが発光可能な各ＬＥＤチップをそれぞれ近接して発光させ拡散混色させる必要がある。このような発光ダイオードは、種々の色を自由に発光させる発光装置としては有効であるが、白色系などの色のみを発光させる場合においても赤色系、緑色系及び青色系の発光ダイオードなどをそれぞれ使用せざるを得ない。ＬＥＤチップは、半導体であり色調や輝度のバラツキもまだ相当ある。また、同一半導体材料を用いて高輝度にＲＧＢが発光可能なＬＥＤチップが未だ開発されていない。そのため、それぞれ異なる材料を用いて形成させざるを得ず、各ＬＥＤチップの駆動電力などが異なるため個々に電源などを確保する必要がある。白色系を発光させるためには、各半導体ごとに電流などを調節して発光させなければならない。同様に、半導

体発光素子であるため個々の温度特性の差や経時変化が異なり、色調が種々変化してしまう。さらに、ＬＥＤチップからの発光を均一に混色させなければ、色むらを生ずる場合がある。

【０００５】

そこで、本出願人は先にＬＥＤチップの発光色を蛍光物質で色変換させた発光ダイオードや面状発光装置として特開平５－１５２６０９号公報、特開平７－１７６７９４号公報、特開平８－８６１４号公報などに記載された発光ダイオードや面状発光光源を開発した。これらの発光ダイオードや面状発光光源によって、１種類のＬＥＤチップを用いて白色系など他の発光色を発光させることができる。

具体的には、青色が発光可能なＬＥＤチップを透明な導光板の一端に接続させＬＥＤチップから発光された発光を導光板上に設けられた蛍光物質含有層によって緑色及び赤色などに色変換させ白色系の発光とさせるものである。これらは、ＲＧＢ発光成分を有する白色系が発光可能な発光装置として利用した場合においても十分な輝度を長時間に渡って発光する発光装置とすることができる。

【０００６】

【発明が解決しようとする課題】

ＬＥＤチップからの発光によって励起される蛍光物質は、蛍光染料、蛍光顔料さらには有機、無機化合物などから様々なものが挙げられる。蛍光体の励起波長や発光波長によっても種々のものが挙げられる。また、蛍光体は、発光素子からの発光波長を波長の短いものから長い波長へと変換する、或いは発光素子からの発光波長を波長の長いものから短い波長へと変換するものとがある。

【０００７】

しかしながら、波長の長いものから短い波長へと変換する場合、変換効率が極めて悪く実用に向かない。また、発光装置を直射日光など外部環境下で使用する場合や蛍光体をＬＥＤチップ周辺に近接して配置させた場合は、紫外線など様々な高エネルギー光が蛍光体などに長期間に渡って強照射され続ける。特に、発光素子であるＬＥＤチップを高エネルギーバンドギャップを有する半導体を用い蛍光体の変換効率向上や蛍光体の使用量を減らした場合においては、ＬＥＤチップ

から発光した光が可視光域にあるといっても光エネルギーが必然的に高くなり、太陽光などの外来光からとの相乗作用で蛍光体自体が劣化しやすい。

【０００８】

蛍光体が劣化すると色調がずれる、或いは蛍光体が黒ずみ光の外部取り出し効率が低下する場合がある。同様に蛍光体は、ＬＥＤチップの昇温や外部環境からの加熱など高温にもさらされる。さらに、発光装置は一般的に樹脂ケースに被覆されてはいるものの外部環境からの水分の進入などを完全に防ぐことや、製造時に付着した水分を完全に除去することはできない。蛍光体によっては、このような水分が発光素子からの高エネルギー光や熱によって蛍光体物質の劣化を促進する場合もある。また、イオン性の有機染料に至ってはチップ近傍では直流電界により電気泳動を起こし、色調が変化する可能性がある。したがって、本願発明は上記課題を解決し、野外の使用時などにおいてもより長時間、発光光率の低下や色ずれが極めて少なくＲＧＢの発光成分を高輝度に発光可能な発光装置を提供することを目的とする。

【０００９】

【課題を解決するための手段】

本願発明は、発光層が窒化ガリウム系化合物半導体であるＬＥＤチップと、該ＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光するフォトルミネセンス蛍光体と、を有する発光装置であって、前記ＬＥＤチップの主発光ピークが４００ｎｍから５３０ｎｍ内であると共に、前記フォトルミネセンス蛍光体が$Y_3(Al, Ga)_5O_{12}:Ce$である第１の蛍光体と、$RE_3Al_5O_{12}:Ce$であって第１の蛍光体の主発光波長よりも長波長側に主発光波長がある第２の蛍光体とである発光装置である。（但し、ＲＥは、Ｙ，Ｇｄ，Ｌａから選択される少なくとも一種である。）

【００１０】

また、発光層が窒化ガリウム系化合物半導体であるＬＥＤチップと、該ＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光するフォトルミネセンス蛍光体と、を有する発光装置であって、前記ＬＥＤチップの主発光ピークが４００ｎｍから５３０ｎｍ内であると共に、前記フォトルミネセンス蛍光体は

$Y_3Al_5O_{12}$：Ｃｅの主発光波長よりも短波長側に主発光波長があるY_3（Ａｌ，Ｇａ）$_5O_{12}$：Ｃｅと$Y_3Al_5O_{12}$：Ｃｅの主発光波長よりも長波長側に主発光波長がある$RE_3Al_5O_{12}$：Ｃｅである発光装置である。
但し、ＲＥは、Ｙ，Ｇｄ，Ｌａから選択される少なくとも一種である。

【００１１】

さらに、ＬＥＤチップからの発光により励起されて蛍光を発するフォトルミネセンス蛍光体が含有された蛍光体層を介して光学的に接続されたＬＥＤチップと、透光性導光板とを有する面状光源であって、前記ＬＥＤチップの発光層が４００ｎｍから５３０ｎｍ内に主発光波長を有する窒化ガリウム系化合物半導体であり、前記フォトルミネセンス蛍光体がY_3（Ａｌ，Ｇａ）$_5O_{12}$：Ｃｅである第１の蛍光体と、$RE_3Al_5O_{12}$：Ｃｅであって前記第１の蛍光体の主発光波長よりも長波長側に主発光波長がある第２の蛍光体とである面状光源である。（但し、ＲＥは、Ｙ，Ｇｄ，Ｌａから選択される少なくとも一種である。）

【００１２】

さらにまた、透光性導光板の端面の少なくとも一箇所にＬＥＤチップが光学的に接続されており、前記導光板の主面のいずれか一方に、前記ＬＥＤチップの発光により励起されて蛍光を発するフォトルミネセンス蛍光体が含有された蛍光部材を有する面状光源であって、前記ＬＥＤチップの発光層が４００ｎｍから５３０ｎｍ内に主発光波長を有する窒化ガリウム系化合物半導体であり、前記フォトルミネセンス蛍光体がY_3（Ａｌ，Ｇａ）$_5O_{12}$：Ｃｅである第１の蛍光体と、$RE_3Al_5O_{12}$：Ｃｅであって前第１の蛍光体の主発光波長よりも長波長側に主発光波長がある第２の蛍光体とである面状光源である。（但し、ＲＥは、Ｙ，Ｇｄ，Ｌａから選択される少なくとも一種である。）

【００１３】

また、マウント・リードのカップ内に配置させたＬＥＤチップと、該ＬＥＤチップと導電性ワイヤーを用いて電気的に接続させたインナー・リードと、前記カップ内に充填させたコーティング部材と、該コーティング部材、ＬＥＤチップ、導電性ワイヤー及びマウント・リードとインナー・リードの少なくとも一部を被覆するモールド部材と、を有する発光ダイオードであって、前記ＬＥＤチップが

窒化ガリウム系化合物半導体であり、且つ前記コーティング部材が第１のフォトルミネセンス蛍光体であるY_3（Ａｌ，Ｇａ）$_5O_{12}$：Ｃｅと、$RE_3Al_5O_{12}$：Ｃｅであって前記第１の蛍光体の主発光波長よりも長波長側に主発光波長を有する第２の蛍光体である$RE_3Al_5O_{12}$：Ｃｅとを有する透光性樹脂である発光ダイオードでもある。（但し、ＲＥは、Ｙ，Ｇｄ，Ｌａから選択される少なくとも一種である。）

【００１４】

【発明の実施の態様】

本願発明者は、種々の実験の結果、可視光域における光エネルギーが比較的高いＬＥＤチップからの発光光をフォトルミネセンス蛍光体によって緑系色及び赤系色に色変換させる発光装置において、特定の半導体及び蛍光体を選択することにより高輝度、長時間の使用時における光効率低下や色ずれを防止できることを見出し本願発明を成すに至った。

【００１５】

即ち、発光ダイオードに用いられるフォトルミネセンス蛍光体としては、

１．耐光性に優れていることが要求される。特に、様々な高エネルギー光が照射される直射日光などから長時間耐える必要がある。また、発光ダイオードとして使用する場合は半導体発光素子などの微小領域から強放射されるために（Ｅｅ）＝３Ｗ・cm^{-2}以上にも及ぶ強照射強度にも耐える必要がある。２．発光素子との混色を利用するため紫外線ではなく青色系発光で効率よく発光すること。３．混色を考慮して緑色系及び赤色系の光が高輝度に発光可能なこと。４．外部環境下や発光素子近傍に配置されるため温度特性が良好であること。５．色調が組成比或いは緑色系及び赤色系の蛍光体の混合比で連続的に変えられること。６．発光装置の利用環境に応じて耐候性があることなどの特徴を有することが求められる。

【００１６】

これらの条件を満たすものとして本願発明は、発光素子として発光層に高エネルギーバンドギャップを有する窒化ガリウム系化合物半導体素子を、フォトルミネセンス蛍光体としてY_3（Ａｌ，Ｇａ）$_5O_{12}$：Ｃｅ蛍光体及びRE_3（Ａｌ， Ｇａ）${}_{5}$Ｏ${}_{12}$：Ｃｅ蛍光体（但し、ＲＥは、Ｙ，Ｇｄ，Ｌａから選択される少なくとも一種である。）を用いる。これにより発光素子から放出された可視光域における高エネルギー光を長時間近傍で高輝度に照射した場合や外部環境の使用下においても発光色の色ずれや発光輝度の低下が極めて少ない高輝度にＲＧＢの発光成分を有する発光装置とすることができるものである。

【００１７】

具体的な発光装置の一例として、チップタイプＬＥＤを図１に示す。チップタイプＬＥＤの筐体内に窒化ガリウム系半導体を用いたＬＥＤチップをエポキシ樹脂などを用いて固定させてある。導電性ワイヤーとして金線１０３をＬＥＤチップ１０２の各電極と筐体に設けられた各電極１０５とにそれぞれ電気的に接続させてある。緑色系のフォトルミネセンス蛍光体としてＹ${}_{3}$（Ａｌ，Ｇａ）${}_{5}$Ｏ${}_{12}$：Ｃｅ蛍光体をまた赤色系のフォトルミネセンス蛍光体としてＲＥ${}_{3}$Ａｌ${}_{5}$Ｏ${}_{12}$：Ｃｅ蛍光体（但し、ＲＥは、Ｙ，Ｇｄ，Ｌａから選択される少なくとも一種である。）をアクリル樹脂中に混合分散させたものをＬＥＤチップ、導電性ワイヤーなどを外部応力などから保護するモールド部材１０１として均一に硬化形成させる。このような発光装置に電力を供給させることによってＬＥＤチップを発光させる。ＬＥＤチップからの青色系の発光と、その発光によって励起された緑色系及び赤色系をそれぞれ高輝度に発光可能な２種類以上のフォトルミネセンス蛍光体からの発光光との混色により白色系などが発光可能な発光装置の一例である発光ダイオードとすることができる。以下、本願発明の構成部材について詳述する。

【００１８】

（蛍光体）

本願発明に用いられるフォトルミネセンス蛍光体としては、半導体発光層から発光された可視光や紫外線で励起されて発光するフォトルミネセンス蛍光体をいう。フォトルミネセンス蛍光体として赤色系が高輝度に発光可能な蛍光体と緑色系が高輝度に発光可能な蛍光体とを用いる。具体的なフォトルミネセンス蛍光体としては、赤色系がＲＥ${}_{3}$Ａｌ${}_{5}$Ｏ${}_{12}$：Ｃｅ蛍光体（但し、ＲＥは、Ｙ，Ｇｄ，Ｌａから選択される少なくとも一種）であり、緑色系がＹ${}_{3}$（Ａｌ，Ｇａ）${}_{5}$Ｏ${}_{12}$：Ｃｅ蛍光体である。窒化ガリウム系化合物半導体を用いたＬＥＤチップから発光

した青色系の光と、ボディーカラーが黄色であるフォトルミネセンス蛍光体から発光する緑色系及び赤色系の光と、を混色表示させると白色系の発光色表示を行うことができる。発光装置はこの混色を起こさせるためにフォトルミネセンス蛍光体の粉体やバルクを樹脂や硝子中に含有させＬＥＤチップからの光が透過する程度に薄く形成させたドット状のものや層状ものなど用途に応じて種々用いることができる。フォトルミネセンス蛍光体と樹脂などとの比率や塗布、充填量を種々調整すること及び発光素子の発光波長を選択することにより白色を含め電球色など任意の色調を提供させることができる。

【００１９】

このような、フォトルミネセンス蛍光体の分布は、フォトルミネセンス蛍光体を含有する部材、形成温度、粘度やフォトルミネセンス蛍光体の形状、粒度分布などを調整させることによって種々形成させることができる。したがって、使用条件などにより蛍光体の分布濃度を、種々選択することができる。

【００２０】

本願発明のフォトルミネセンス蛍光体を使用すると、放射照度として（Ｅｅ）＝３Ｗ・ｃｍ$^{-2}$以上１０Ｗ・ｃｍ$^{-2}$以下のＬＥＤチップと接する或いは近接して配置された場合においても高効率に十分な耐光性を有する発光装置とすることができる。

【００２１】

本願発明に用いられる緑色系が発光可能な第１のフォトルミネセンス蛍光体は、ガーネット構造のため、熱、光及び水分に強く、図４（Ａ）の実線の例の如く励起スペクトルのピークが４５０ｎｍ付近にさせることができる。また、発光ピークも図４（Ｂ）の実線の例の如く５１０ｎｍ付近にあり７００ｎｍまで裾を引くブロードな発光スペクトルを持つ。一方、赤色系が発光可能な第２のフォトルミネセンス蛍光体も、ガーネット構造であり熱、光及び水分に強く、図４（Ａ）の波線の例の如く励起スペクトルのピークが４５０ｎｍ付近にさせることができる。また、発光ピークも図４（Ｂ）の波線の例の如く６００ｎｍ付近にあり７５０ｎｍまで裾を引くブロードな発光スペクトルを持つ。

【００２２】

ガーネット構造を持ったＹＡＧ蛍光体の組成の内、Ａｌの一部をＧａで置換することで発光波長が短波長にシフトし、また組成のＹの一部をＧｄ及び／又はＬａで置換することで、発光波長が短波長へシフトする。ＡｌのＧａへの置換は、発光効率と発光波長を考慮してＧａ：Ａｌ＝１：１から４：６が好ましい。同様に、Ｙの一部をＧｄ及び／又はＬａで置換することは、Ｙ：Ｇｄ及び／又はＬａ＝９：１から１：９であり、より好ましくは、Ｙ：Ｇｄ及び／又はＬａ＝２：３から１：４である。置換が６割未満では、緑色成分が大きく赤色成分が少なくなる。また、８割以上では、赤み成分が増えるものの輝度が急激に低下する。

【００２３】

このようなフォトルミネセンス蛍光体は、Ｙ、Ｇｄ、Ｃｅ、Ｌａ、Ａｌ及びＧａの原料として酸化物、又は高温で容易に酸化物になる化合物を使用し、それらを化学量論比で十分に混合して原料を得る。又は、Ｙ、Ｇｄ、Ｃｅ、Ｌａの希土類元素を化学量論比で酸に溶解した溶解液を蓚酸で共沈したものを焼成して得られる共沈酸化物と、酸化アルミニウム、酸化ガリウムとを混合して混合原料を得る。これにフラックスとしてフッ化アンモニウム等のフッ化物を適量混合して坩堝に詰め、空気中１３５０～１４５０°Ｃの温度範囲で２～５時間焼成して焼成品を得、次に焼成品を水中でボールミルして、洗浄、分離、乾燥、最後に篩を通すことで得ることができる。

【００２４】

（ＬＥＤチップ１０２、２０２、３０２）

本願発明に用いられるＬＥＤチップとは、第１及び第２のフォトルミネセンス蛍光体をそれぞれ効率良く励起できる窒化物系化合物半導体が挙げられる。発光素子であるＬＥＤチップは、ＭＯＣＶＤ法等により基板上にＩｎＧａＮ等の半導体を発光層として形成させる。半導体の構造としては、ＭＩＳ接合、ＰＩＮ接合やＰＮ接合などを有するホモ構造、ヘテロ構造あるいはダブルヘテロ構成のものが挙げられる。半導体層の材料やその混晶度によって発光波長を種々選択することができる。また、半導体活性層を量子効果が生ずる薄膜に形成させた単一量子井戸構造や多重量子井戸構造とすることもできる。

【００２５】

窒化ガリウム系化合物半導体を使用した場合、半導体基板にはサファイヤ、スピネル、ＳｉＣ、Ｓｉ、ＺｎＯ等の材料が用いられる。結晶性の良い窒化ガリウムを形成させるためにはサファイヤ基板を用いることが好ましい。このサファイヤ基板上にＧａＮ、ＡｌＮ等のバッファー層を形成しその上にＰＮ接合を有する窒化ガリウム系半導体を形成させる。窒化ガリウム系半導体は、不純物をドープしない状態でＮ型導電性を示す。発光効率を向上させるなど所望のＮ型窒化ガリウム半導体を形成させる場合は、Ｎ型ドーパントとしてＳｉ、Ｇｅ、Ｓｅ、Ｔｅ、Ｃ等を適宜導入することが好ましい。一方、Ｐ型窒化ガリウム半導体を形成させる場合は、Ｐ型ドーパンドであるＺｎ、Ｍｇ、Ｂｅ、Ｃａ、Ｓｒ、Ｂａ等をドープさせる。窒化ガリウム系化合物半導体は、Ｐ型ドーパントをドープしただけではＰ型化しにくいためＰ型ドーパント導入後に、低電子線照射させたり、プラズマ照射等によりアニールすることでＰ型化させることが好ましい。エッチングなどによりＰ型半導体及びＮ型半導体の露出面を形成させた後、半導体層上にスパッタリング法や真空蒸着法などを用いて所望の形状の各電極を形成させる。

【００２６】

次に、形成された半導体ウエハー等をダイヤモンド製の刃先を有するブレードが回転するダイシングソーにより直接フルカットするか、又は刃先幅よりも広い幅の溝を切り込んだ後（ハーフカット）、外力によって半導体ウエハーを割る。あるいは、先端のダイヤモンド針が往復直線運動するスクライバーにより半導体ウエハーに極めて細いスクライブライン（経線）を例えば碁盤目状に引いた後、外力によってウエハーを割り半導体ウエハーからチップ状にカットする。このようにして窒化ガリウム系化合物半導体であるＬＥＤチップを形成させることができる。

【００２７】

本願発明の発光ダイオードにおいて白色系を発光させる場合は、フォトルミネセンス蛍光体との混色等を考慮して発光素子の主発光波長は４００ｎｍ以上５３０ｎｍ以下内にあることが好ましく、４２０ｎｍ以上４９０ｎｍ以下内にあることがより好ましい。ＬＥＤチップとフォトルミネセンス蛍光体との効率をそれぞれより向上させるためには、４５０ｎｍ以上４７５ｎｍ以下内にあることがさら

に好ましい。

【００２８】

（導電性ワイヤー１０３、３０３）

導電性ワイヤーとしては、ＬＥＤチップ１０２、３０２の電極とのオーミック性、機械的接続性、電気伝導性及び熱伝導性がよいものが求められる。熱伝導度としては０．０１ｃａｌ／ｃｍ^2／ｃｍ／℃以上が好ましく、より好ましくは０．５ｃａｌ／ｃｍ^2／ｃｍ／℃以上である。また、作業性などを考慮して導電性ワイヤーの直径は、好ましくは、Φ１０μｍ以上、Φ４５μｍ以下である。このような導電性ワイヤーとして具体的には、金、銅、白金、アルミニウム等の金属及びそれらの合金を用いた導電性ワイヤーが挙げられる。このような導電性ワイヤーは、各ＬＥＤチップの電極と、インナー・リード３０６及びマウント・リード３０５などと、をワイヤーボンディング機器によって容易に接続させることができる。

【００２９】

（マウント・リード３０５）

マウント・リード３０５としては、ＬＥＤチップ３０２を配置させるものであり、ダイボンド機器などでＬＥＤチップ３０２を積載するのに十分な大きさがあれば良い。また、ＬＥＤチップを複数設置しマウント・リードをＬＥＤチップの共通電極として利用する場合においては、十分な電気伝導性とボンディングワイヤー等との接続性が求められる。また、マウント・リード上のカップ内にＬＥＤチップを配置すると共に蛍光体を内部に充填させる場合は、近接して配置させた別の発光ダイオードからの光により疑似点灯することを防止させることができる。

【００３０】

ＬＥＤチップ３０２とマウント・リード３０５のカップとの接着は熱硬化性樹脂などによって行うことができる。具体的には、エポキシ樹脂、アクリル樹脂やイミド樹脂などが挙げられる。また、フェースダウンＬＥＤチップなどによりマウント・リードと接着させると共に電気的に接続させるためにはＡｇペースト、カーボンペースト、金属バンプ等を用いることができる。

【００３１】

さらに、発光ダイオードの光利用効率を向上させるためにＬＥＤチップ３０２が配置されるマウント・リードの表面を鏡面状とし、表面に反射機能を持たせても良い。この場合の表面粗さは、０．１Ｓ以上０．８Ｓ以下が好ましい。また、マウント・リードの具体的な電気抵抗としては３００μΩ－ｃｍ以下が好ましく、より好ましくは、３μΩ－ｃｍ以下である。

【００３２】

また、マウント・リード上に複数のＬＥＤチップを積置する場合は、ＬＥＤチップからの発熱量が多くなるため熱伝導度がよいことが求められる。具体的には、０．０１ｃａｌ／ｃｍ^2／ｃｍ／℃以上が好ましく、より好ましくは ０．５ｃａｌ／ｃｍ^2／ｃｍ／℃以上である。これらの条件を満たす材料としては、鉄、銅、鉄入り銅、錫入り銅、メタライズパターン付きセラミック等が挙げられる。

【００３３】

（インナー・リード３０６）

インナー・リード３０６としては、マウント・リード３０５上に配置されたＬＥＤチップと接続された導電性ワイヤーとの接続を図るものである。マウント・リード上に複数のＬＥＤチップ３０２を設けた場合は、各導電性ワイヤー同士が接触しにくい構成とすることが好ましい。

【００３４】

具体的には、マウント・リード３０５から離れるに従って、インナー・リード３０６のワイヤーボンディングさせる端面の面積を大きくすることなどによってマウント・リードからより離れたインナー・リードと接続させる導電性ワイヤーの接触を防ぐことができる。

【００３５】

また、導電性ワイヤーとの接続端面の粗さは、密着性を考慮して１．６Ｓ以上１０Ｓ以下が好ましい。インナー・リードの先端部を種々の形状に形成させるためには、あらかじめリードフレームの形状を型枠で決めて打ち抜き形成させてもよく、或いは全てのインナー・リードを形成させた後にインナー・リード上部の一部を削ることによって形成させても良い。さらには、インナ・リードを打ち抜

き形成後、端面方向から加圧することにより所望の端面の面積と端面高さを同時に形成させることもできる。

【００３６】

インナー・リードは、導電性ワイヤーであるボンディングワイヤー等との接続性及び電気伝導性が良いことが求められる。具体的な電気抵抗としては、３００μΩ－ｃｍ以下が好ましく、より好ましくは３μΩ－ｃｍ以下である。これらの条件を満たす材料としては、鉄、銅、鉄入り銅、錫入り銅及び銅、金、銀をメッキしたアルミニウム、鉄、銅等が挙げられる。

【００３７】

（コーティング部材３０１）

本願発明に用いられるコーティング部材３０１とは、モールド部材３０４とは別にマウント・リード３０５のカップに設けられるものでありＬＥＤチップ３０２の発光を変換するフォトルミネセンス蛍光体が含有されるものである。コーティング部の具体的材料としては、エポキシ樹脂、ユリア樹脂、シリコーンやアクリル樹脂などの耐候性に優れた透明樹脂や硝子などが好適に用いられる。また、フォトルミネセンス蛍光体と共に拡散剤を含有させても良い。具体的な拡散剤としては、チタン酸バリウム、酸化チタン、酸化アルミニウム、酸化珪素等が好適に用いられる。

【００３８】

（モールド部材１０１、２１０、３０４）

モールド部材は、発光装置の使用用途に応じてＬＥＤチップ、導電性ワイヤー、フォトルミネセンス蛍光体が含有されたコーティング部材などを外部から保護するために設けることができる。モールド部材は、樹脂や硝子を用いて形成させることができる。モールド部材中にフォトルミネセンス蛍光体を含有させることによって視野角を増やすことができる。また、拡散剤を加えることによってＬＥＤチップからの指向性を緩和させ視野角をさらに増やすこともできる。

【００３９】

更に、モールド部材を所望の形状にすることによってＬＥＤチップからの発光を集束させたり拡散させたりするレンズ効果を持たせることができる。従って、

モールド部材は複数積層した構造でもよい。具体的には、凸レンズ形状、凹レンズ形状さらには、発光観測面から見て楕円形状やそれらを複数組み合わせた物である。

【００４０】

モールド部材の具体的材料としては、主としてエポキシ樹脂、ユリア樹脂、シリコーン、アクリル樹脂などの耐候性に優れた透明樹脂や低融点硝子などが好適に用いられる。また、拡散剤としては、チタン酸バリウム、酸化チタン、酸化アルミニウム、酸化珪素等が好適に用いられる。フォトルミネセンス蛍光体はモールド部材中に含有させてもそれ以外のコーティング部などに含有させて用いてもよい。また、コーティング部をフォトルミネセンス蛍光体が含有された樹脂、モールド部材を硝子などとした異なる部材を用いて形成させても良い。この場合、生産性良くより水分などの影響が少ない発光ダイオードとすることができる。屈折率を考慮してモールド部材とコーティング部とを同じ部材を用いて形成させても良い。

【００４１】

（面状光源）

本願発明の発光装置の一つである面状光源の場合、図２（Ａ）の如く白色光を発光させるためには白色光を導光板によって面状とさせ方法と、図２（Ｂ）の如く面状に発光したＬＥＤチップからの青色系光を白色光に変換させる方法がある。

【００４２】

白色光を導光板によって面状とさせる場合には、フォトルミネセンス蛍光体が含有された色変換層２０１を介して青色系が発光可能な発光ダイオード２０２と、導光板２０４と、を配置させた構成、或いはモールド部材中２１０などにフォトルミネセンス蛍光体を含有させ青色系が発光可能な窒化物半導体発光素子を有する発光ダイオード２０２と導光板２０４を光学的に接続させた構成をとることができる。

【００４３】

他方、面状に発光したＬＥＤチップ２０２からの青色系光を白色光に変換させ

る場合は、窒化物半導体を発光層に有する青色系が発光可能な発光ダイオード２０２と導光板２０４とを光学的に接続させた後、導光板２０４上の散乱シート２０６に含有させる。或いはバインダー樹脂と共に散乱シートに塗布などさせシート状に形成させる。さらには、導光板上にフォトルミネセンス蛍光体含有のバインダーをドット状に直接形成させる構成をとることができる。

【００４４】

具体的には、絶縁層及び導電性パターンが形成されたコの字形状の金属基板２０３内などにＬＥＤチップを固定する。ＬＥＤチップと導電性パターンとの電気的導通を取った後、エポキシ樹脂をＬＥＤチップ２０２が積載された基板上に充填させアクリル性導光板２０４の端面と光学的に接続させる。導光板２０４の発光主面上には、フォトルミネセンス蛍光体をエポキシ樹脂中に混合撹拌し予め拡散シート上に均一塗布したシート部材２０１を積置させてある。この拡散シート部材２０６は、アクリル樹脂をベースに拡散剤として酸化アルミニウム、酸化珪素、酸化チタン、チタン酸バリウムの粒子などを含有させたエポキシ樹脂を塗布させた層と、フォトルミネセンス蛍光体を含有させた層とに分かれている。

【００４５】

導光板の一方の主面上には、蛍現象防止のため白色散乱剤が含有されたフィルム状の反射部材２０７を配置させてあることが好ましい。同様に、導光板２０４の裏面側全面や発光ダイオードが配置されていない端面上にも反射部材２０５を設け発光光率を向上させてある。これにより、ＬＣＤのバックライトなどとして使用した場合においても十分な明るさを得られる面状光源とすることができる。液晶表示装置として利用する場合は、導光板の主面上に不示図の透光性導電性パターンが形成された硝子基板間に注入された液晶を介して配された偏光板により構成させることができる。以下、本願発明の実施例について説明するが、本願発明は具体的実施例のみに限定されるものではないことは言うまでもない。

【００４６】

【実施例】

（実施例１）

発光素子として発光ピークが４５０ｎｍのＧａＩｎＮ半導体を用いた。ＬＥＤ

チップは、洗浄させたサファイヤ基板上にＴＭＧ（トリメチルガリウム）ガス、ＴＭＡ（トリメチルアルミニウム）ガス、窒素ガス及びドーパントガスをキャリアガスと共に流し、ＭＯＣＶＤ法で窒化ガリウム系化合物半導体を成膜させることにより形成させた。ドーパントガスとしてSiH_4とCp_2Mgと、を切り替えることによってＮ型導電性を有する窒化ガリウム半導体とＰ型導電性を有する窒化ガリウム半導体を形成しＰＮ接合を形成させた。（なお、Ｐ型半導体は、成膜後４００℃以上でアニールさせてある。）

【００４７】

エッチングによりＰＮ各半導体表面を露出させた後、スパッタリングにより各電極をそれぞれ形成させた。こうして出来上がった半導体ウエハーをスクライブラインを引いた後、外力により分割させ発光素子としてＬＥＤチップを形成させた。

【００４８】

銀メッキした銅製リードフレームの先端にカップを有するマウント・リードにＬＥＤチップをエポキシ樹脂でダイボンディングした。ＬＥＤチップの各電極とマウント・リード及びインナー・リードと、をそれぞれ金線でワイヤーボンディングし電気的導通を取った。

【００４９】

モールド部材は、砲弾型の型枠の中にＬＥＤチップが配置されたリードフレームを挿入し透光性エポシキ樹脂を混入後、１５０℃５時間にて硬化させ青色系発光ダイオードを形成させた。青色系発光ダイオードを端面が全て研磨されたアクリル性導光板の一端面に接続させた。アクリル板の片面及び側面は、白色反射部材としてチタン酸バリウムをアクリル系バインダー中に分散したものでスクリーン印刷及び硬化させるた。

【００５０】

一方、フォトルミネセンス蛍光体は、緑色系及び赤色系をそれぞれ必要なＹ、Ｇｄ、Ｃｅ、Ｌａの希土類元素を化学量論比で酸に溶解した溶解液を蓚酸で共沈させた。これを焼成して得られる共沈酸化物と、酸化アルミニウム、酸化ガリウムと混合して混合原料をそれぞれ得る。これにフラックスとしてフッ化アンモ

ニウムを混合して坩堝に詰め、空気中１４００°Ｃの温度範囲で３時間焼成して焼成品を得た。焼成品をそれぞれ水中でボールミルして、洗浄、分離、乾燥、最後に篩を通して形成させた。

【００５１】

形成された組成が$Y_{3}(Al_{0.6}Ga_{0.4})_{5}O_{12}$：Ｃｅであり緑色系が発光可能な第１の蛍光体１２０重量部と同様の工程で形成され組成が$(Y_{0.4}Gd_{0.6})_{3}Al_{5}O_{12}$：Ｃｅであり赤色系が発光可能な第２の蛍光体１００重量部を、エポキシ樹脂１００重量部とよく混合してスリラーとさせた。このスリラーを厚さ０．５ｍｍのアクリル層上にマルチコーターを用いて均等に塗布、乾燥し、厚さ約３０μｍの色変換層として蛍光体層を形成させた。蛍光体層を導光板の主発光面と同じ大きさに切断し導光板上に配置させることにより発光装置を形成させた。発光装置の色度点、色温度、演色性指数を測定した。それぞれ、色度点（ｘ＝０．２9，ｙ＝０．３４）、色温度７０００Ｋ、Ｒａ（演色性指数）＝８０と三波長型蛍光灯に近い性能を示した。また、発光光率は１２ｍ／ｗと白色電球並であった。さらに耐侯試験として室温６０ｍＡ通電、室温２０ｍＡ通電、６０℃９０％ＲＨ下で２０ｍＡ通電の各試験においても蛍光体に起因する変化は観測されなかった。

【００５２】

（比較例１）

第１及び第２のフォトルミネセンス蛍光体をそれぞれペリレン系誘導体である緑色有機蛍光顔料（シンロイヒ化学製ＦＡ－００１）と赤色有機蛍光顔料（シンロイヒ化学製ＦＡ－００５）として同量で混合撹拌した以外は、実施例１と同様にして発光ダイオードの形成及び耐侯試験を行った。形成された発光ダイオードの色度座標は、(X,Y)＝（０．３４，０．３５）であった。耐侯性試験として、カーボンアークで紫外線量を２００ｈｒで太陽光の１年分とほぼ同等とさせ時間と共に輝度の保持率及び色調を測定した。また、信頼性試験としてＬＥＤチップを発光させ７０℃一定における時間と共に発光輝度及び色調を測定した。この結果を実施例１と共に図６及び図７にそれぞれ示す。

【００５３】

（実施例２）

発光素子として発光ピークが４５０ｎｍのＧａＩｎＮ半導体を用いた。ＬＥＤチップは、洗浄させたサファイヤ基板上にＴＭＧ（トリメチルガリウム）ガス、ＴＭＡ（トリメチルアルミニウム）ガス、窒素ガス及びドーパントガスをキャリアガスと共に流し、ＭＯＣＶＤ法で窒化ガリウム系化合物半導体を成膜させることにより形成させた。ドーパントガスとしてSiH_4とCp_2Mgと、を切り替えることによってＮ型導電性を有する窒化ガリウム半導体とＰ型導電性を有する窒化ガリウム半導体を形成しＰＮ接合を形成させた。（なお、Ｐ型半導体は、成膜後４００℃以上でアニールさせてある。）

【００５４】

エッチングによりＰＮ各半導体表面を露出させた後、スパッタリングにより各電極をそれぞれ形成させた。こうして出来上がった半導体ウエハーをスクライブラインを引いた後、外力により分割させ発光素子としてＬＥＤチップを形成させた。

【００５５】

銀メッキした銅製リードフレームの先端にカップを有するマウント・リードにＬＥＤチップをエポキシ樹脂でダイボンディングした。ＬＥＤチップの各電極とマウント・リード及びインナー・リードと、をそれぞれ金線でワイヤーボンディングし電気的導通を取った。

【００５６】

一方、フォトルミネセンス蛍光体は、緑色系及び赤色系をそれぞれ必要なＹ、Ｇｄ、Ｃｅの希土類元素を化学量論比で酸に溶解した溶解液を蓚酸で共沈させた。これを焼成して得られる共沈酸化物と、酸化アルミニウム、酸化ガリウムと混合して混合原料をそれぞれ得る。これにフラックスとしてフッ化アンモニウムを混合して坩堝に詰め、空気中１４００°Ｃの温度範囲で３時間焼成してそれぞれ焼成品を得た。焼成品を水中でボールミルして、洗浄、分離、乾燥、最後に篩を通して形成させた。

【００５７】

形成された組成が$Y_3(Al_{0.5}Ga_{0.5})_5O_{12}$：Ｃｅであり緑色系が発光可能

な第１の蛍光体と（$Y_{0.2}Gd_{0.8}$）$_3Al_5O_{12}$：Ｃｅであり赤色系が発光可能な第２の蛍光体をそれぞれ４０重量部、エポキシ樹脂１００重量部をよく混合してスリラーとさせた。このスリラーをＬＥＤチップが配置されたマウント・リード上のカップ内に注入させた。注入後、フォトルミネセンス蛍光体が含有された樹脂を１３０℃１時間で硬化させた。こうしてＬＥＤチップ上に厚さ１２０μのフォトルミネセンス蛍光体が含有されたコーティング部材が形成された。なお、コーティング部材には、ＬＥＤチップに向かってフォトルミネセンス蛍光体が徐々に多くしてある。その後、さらにＬＥＤチップやフォトルミネセンス蛍光体を外部応力、水分及び塵芥などから保護する目的でモールド部材として透光性エポキシ樹脂を形成させた。モールド部材は、砲弾型の型枠の中にフォトルミネセンス蛍光体のコーティング部が形成されたリードフレームを挿入し透光性エポキシ樹脂を混入後、１５０℃５時間にて硬化させた。こうして形成された発光ダイオードは、発光観測正面から視認するとフォトルミネセンス蛍光体のボディーカラーにより中央部が黄色っぽく着色していた。

【００５８】

こうして得られた白色系が発光可能な発光ダイオードの色度点、色温度、演色性指数を測定した。それぞれ、色度点（ｘ＝０．３２，ｙ＝０．３４）、色温度６０００Ｋ、Ｒａ（演色性指数）＝７２、発光光率は１０１ｍ／ｗであった。さらに耐侯試験として室温６０ｍＡ通電、室温２０ｍＡ通電、６０℃９０％ＲＨ下で２０ｍＡ通電の各試験においてもフォトルミネセンス蛍光体に起因する変化は観測されず通常の青色系発光ダイオードと寿命特性に差がないことが確認できた。

【００５９】

【発明の効果】

本願発明の構成とすることにより高出力の窒化物系化合物半導体の発光素子と、赤色系及び緑色系が発光可能なフォトルミネセンス蛍光体と、を利用した発光装置とすることにより長時間高輝度時の使用においても発光効率が高い発光ダイオードとすることができる。さらに、信頼性や省電力化、小型化さらには色温度の可変性など車載や航空産業、一般電気機器に港内のブイ表示用や高速道路の標

識照明など屋外での表示や照明として新たな用途を開くことができる。また、白色は人間の目で長時間視認する場合には刺激が少なく目に優しい発光ダイオードとすることができる。

【００６０】

特に、本願発明の請求項１に記載の構成とすることにより長時間の使用においても色ずれ、発光光率の低下が極めて少なく高輝度にＲＧＢの発光成分を有する白色系が発光可能な発光装置とすることができる。

【００６１】

本願発明の請求項２に記載の構成とすることにより長時間の使用においても色ずれ、発光光率の低下が極めて少なくより白昼色に近い光が発光可能な発光装置とすることができる。

【００６２】

本願発明の請求項３に記載の構成とすることにより長時間の使用においても色ずれ、発光光率の低下が極めて少なく白色系の光を面状に発光させることができる。

【００６３】

本願発明の請求項４に記載の構成とすることにより長時間の使用においても色ずれ、発光光率の低下が極めて少なく白色系の光をより均一に面状に発光させることができる。

【００６４】

本願発明の請求項５に記載の構成とすることにより外部環境下においても長時間の使用においても色ずれ、発光光率の低下が極めて少なく高輝度にＲＧＢの発光成分を有する白色系が発光可能な発光ダイオードとすることができる。

【００６５】

【図面の簡単な説明】

【図１】

図１は、本願発明の発光装置の模式的断面図である。

【図２】

図２は、本願発明の他の発光装置である面状光源の模式的断面図を示し、（Ａ

）は、導光板と発光ダイオードとの間にフォトルミネセンス蛍光体を有する面状光源であり、（Ｂ）は、導光板の主面上にフォトルミネセンス蛍光体を有する面状光源である。

【図３】

図３は、本願発明の他の発光装置である発光ダイオードの模式的断面図である。

【図４】

図４（Ａ）は、本願発明に用いられる第１及び第２のフォトルミネセンス蛍光体の吸収スペクトルの一例を示し、図５（Ｂ）は、本願発明に使用される第１及び第２のフォトルミネセンス蛍光体の発光スペクトルの一例を示した図である。

【図５】

図５は、本願発明に用いられる発光素子の発光スペクトル例を示した図である。

【図６】

図６は、本願発明と、比較のために示した発光装置との耐候性試験における結果を示し（Ａ）は輝度保持率と時間との関係、（Ｂ）は色調と時間との関係を示したグラフである。

【図７】

図７は、本願発明と、比較のために示した発光装置との信頼性試験における結果を示し（Ａ）は輝度保持率と時間との関係、（Ｂ）は色調と時間との関係を示したグラフである。

【符号の説明】

１０１、２１０・・・フォトルミネセンス蛍光体が含有されたモールド部材

１０２、２０２、３０２・・・ＬＥＤチップ

１０３、３０３・・・導電性ワイヤー

１０４・・・筐体

１０５・・・外部電極

２０１・・・色変換層

２０３・・・基板

２０４・・・導光板

２０５、２０７・・・反射部材

２０６・・・散乱シート

３０１・・・フォトルミネセンス蛍光体が含有されたコーティング部材

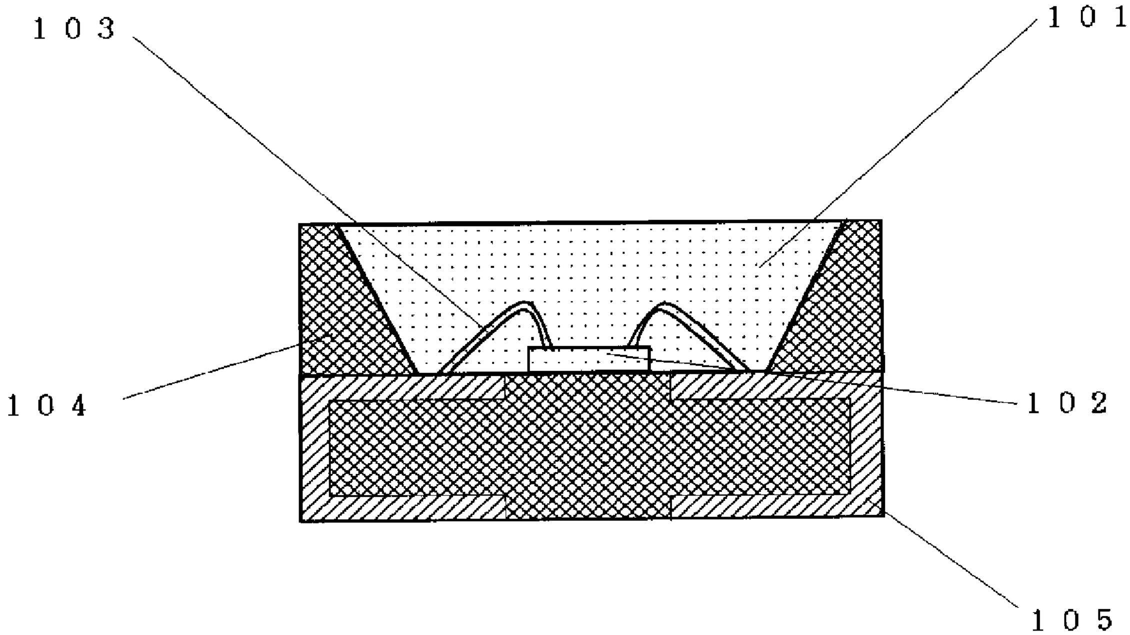
３０４・・・モールド部材

３０５・・・マウント・リード

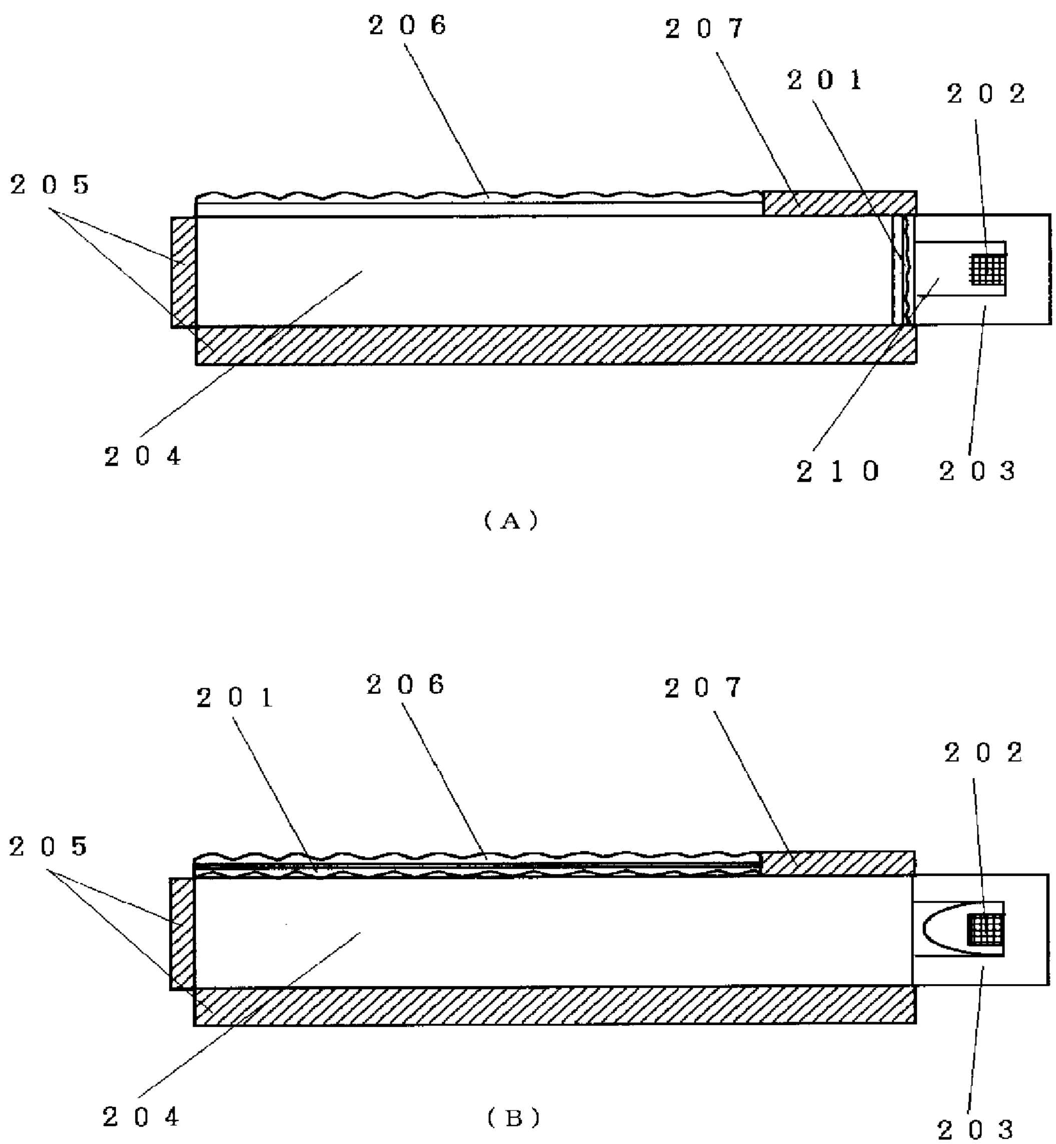
３０６・・・インナー・リード

【書類名】　図面

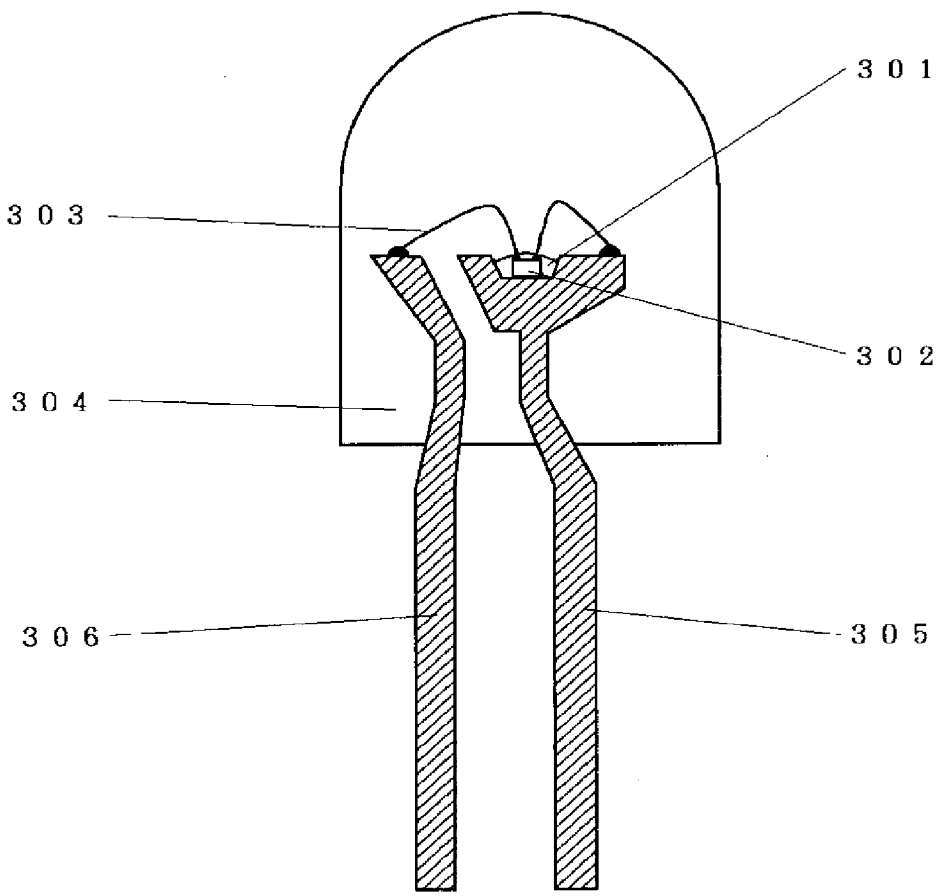
【図１】



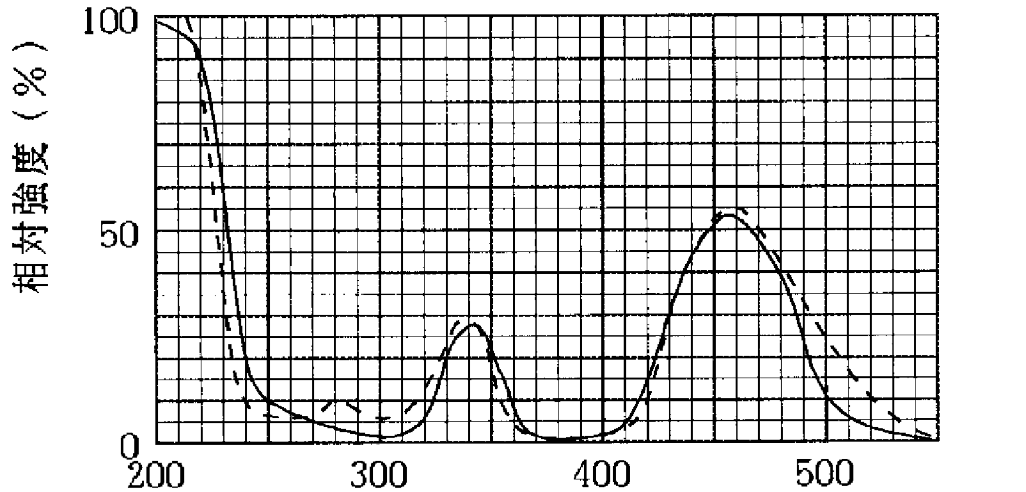
【図２】



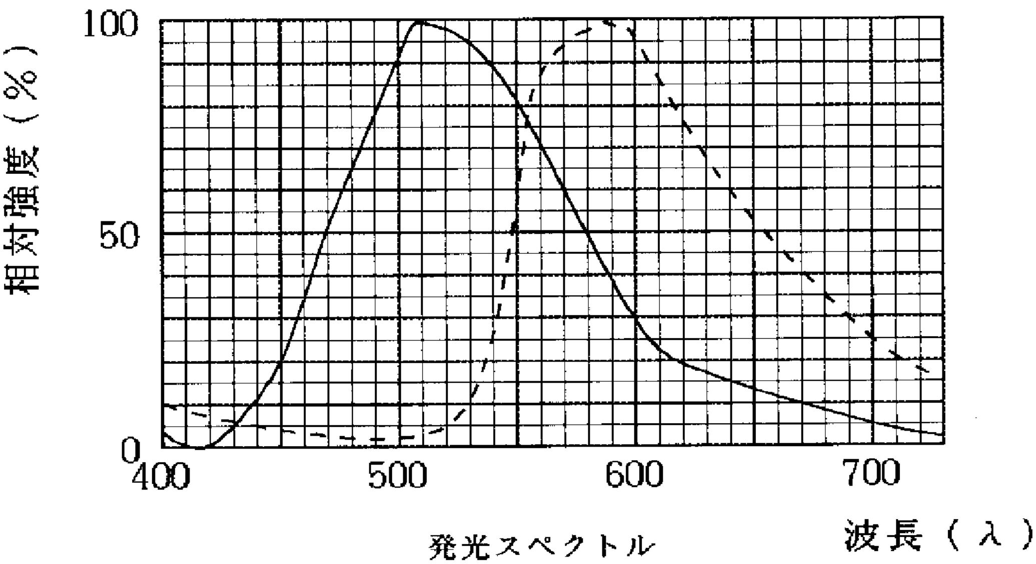
【図３】



【図４】

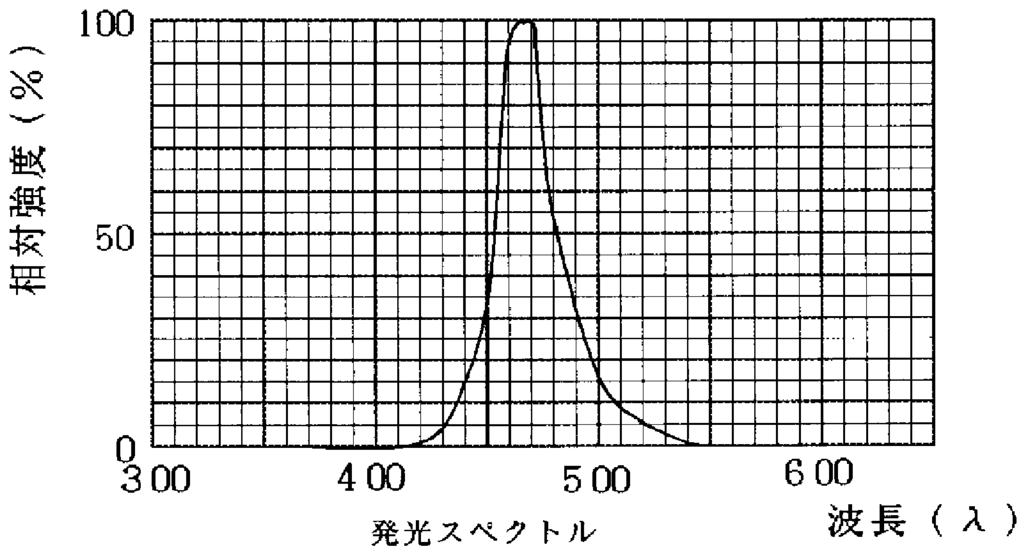


励起スペクトル
（Ａ）

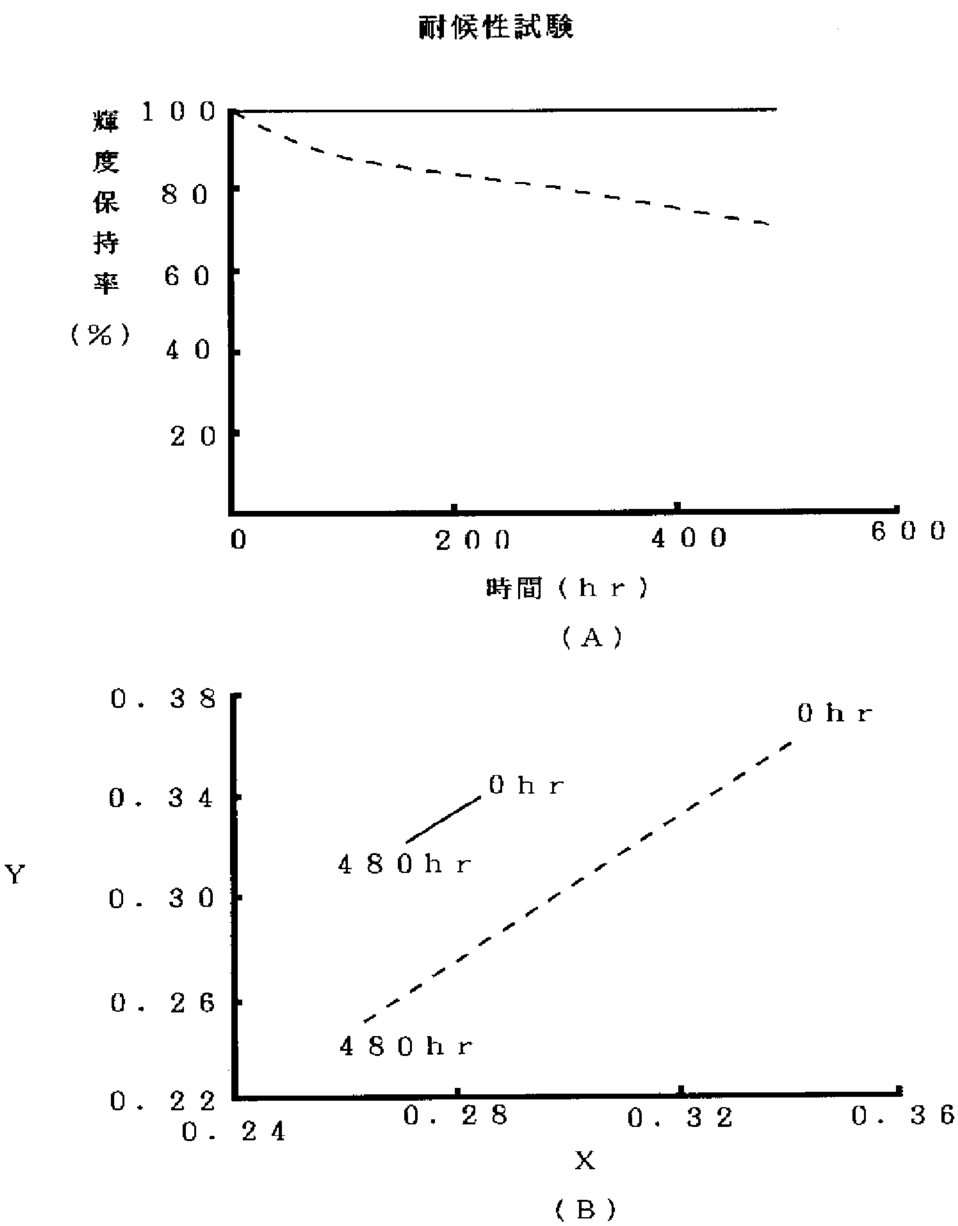


発光スペクトル
（Ｂ）

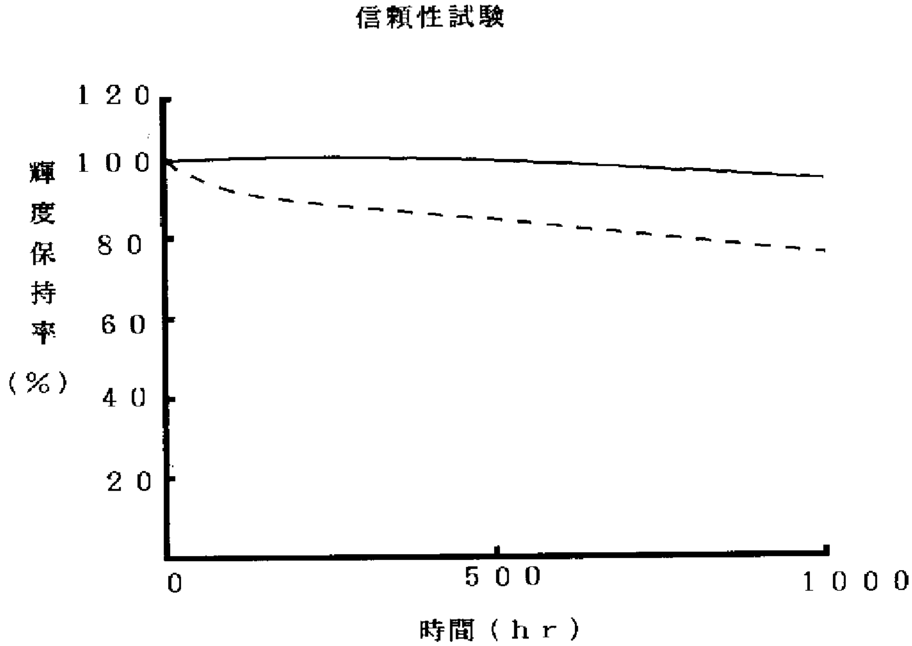
【図５】



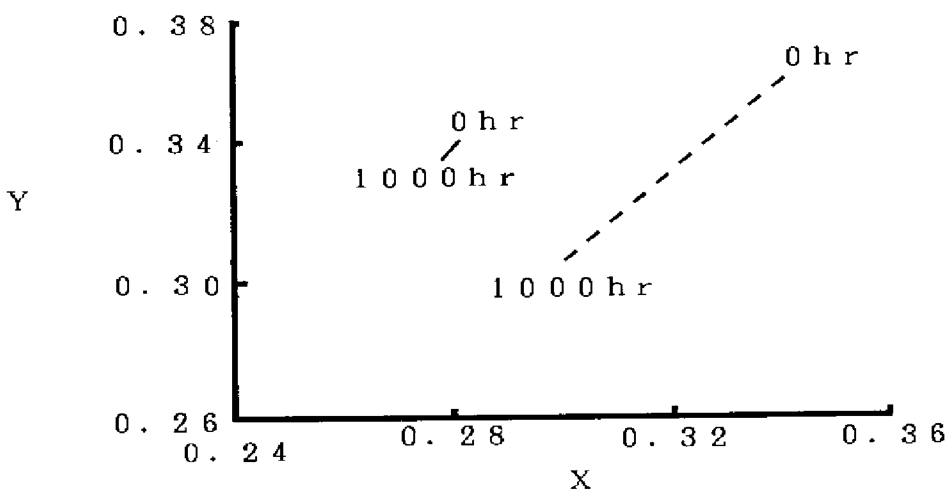
【図６】


耐候性試験
輝度保持率（％）
１００
８０
６０
４０
２０
０
２００
４００
６００
時間（ｈｒ）
（Ａ）
Ｙ
０．３８
０．３４
０．３０
０．２６
０．２２
０．２４
０．２８
０．３２
０．３６
Ｘ
０ｈｒ
４８０ｈｒ
０ｈｒ
４８０ｈｒ
（Ｂ）

【図７】


信頼性試験
１２０
１００
輝度保持率（％）
８０
６０
４０
２０
０
５００
１０００
時間（ｈｒ）

（Ａ）


０．３８
０．３４
Ｙ
０．３０
０．２６
０．２４
０．２８
０．３２
０．３６
Ｘ
０ｈｒ
１０００ｈｒ
０ｈｒ
１０００ｈｒ

（Ｂ）

【書類名】　要約書

【課題】

　本願発明は、使用環境によらず高輝度、高効率にＲＧＢ（赤、緑、青色系）成分が発光可能な発光装置を提供することにある。

【解決手段】

　本願発明は、発光層が窒化ガリウム系化合物半導体であるＬＥＤチップと、該ＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光するフォトルミネセンス蛍光体と、を有する発光装置であって、前記ＬＥＤチップの主発光ピークが４００ｎｍから５３０ｎｍ内であると共に、前記フォトルミネセンス蛍光体が$Y_3(Al,Ga)_5O_{12}:Ce$である第１の蛍光体と、$RE_3Al_5O_{12}:Ce$であって第１の蛍光体の主発光波長よりも長波長側に主発光波長がある第２の蛍光体とである発光装置である。（但し、ＲＥは、Ｙ，Ｇｄ，Ｌａから選択される少なくとも一種）

【選択図】図１

【書類名】　　　　　職権訂正データ
【訂正書類】　　　　特許願

<認定情報・付加情報>
【特許出願人】　　　　申請人
　【識別番号】　　　　000226057
　【住所又は居所】　　徳島県阿南市上中町岡４９１番地１００
　【氏名又は名称】　　日亜化学工業株式会社

【書類名】手続補正書
【提出日】平成 8年11月25日
【あて先】特許庁長官　荒井　寿光　殿
【事件の表示】
【出願番号】平成 8年特許願第244339号
【補正をする者】
【事件との関係】特許出願人
【識別番号】000226057
【郵便番号】774
【住所又は居所】徳島県阿南市上中町岡４９１番地１００
【氏名又は名称】日亜化学工業株式会社
【代表者】小川　英治
【電話番号】0884-22-2311
【発送番号】032481
【手続補正　1】
【補正対象書類名】明細書
【補正対象項目名】図面の簡単な説明
【補正方法】変更
【補正の内容】1
【プルーフの要否】要

【図面の簡単な説明】

【図１】

図１は、本願発明の発光装置の模式的断面図である。

【図２】

図２は、本願発明の他の発光装置である面状光源の模式的断面図を示し、（Ａ）は、導光板と発光ダイオードとの間にフォトルミネセンス蛍光体を有する面状光源であり、（Ｂ）は、導光板の主面上にフォトルミネセンス蛍光体を有する面状光源である。

【図３】

図３は、本願発明の他の発光装置である発光ダイオードの模式的断面図である。

【図４】

図４（Ａ）は、本願発明に用いられる第１及び第２のフォトルミネセンス蛍光体の吸収スペクトルの一例を示し、図４（Ｂ）は、本願発明に使用される第１及び第２のフォトルミネセンス蛍光体の発光スペクトルの一例を示した図である。

【図５】

図５は、本願発明に用いられる発光素子の発光スペクトル例を示した図である。

【図６】

図６は、本願発明と、比較のために示した発光装置との耐候性試験における結果を示し（Ａ）は輝度保持率と時間との関係、（Ｂ）は色調と時間との関係を示したグラフである。

【図７】

図７は、本願発明と、比較のために示した発光装置との信頼性試験における結果を示し（Ａ）は輝度保持率と時間との関係、（Ｂ）は色調と時間との関係を示したグラフである。

【書類名】　職権訂正データ
【訂正書類】　手続補正書

＜認定情報・付加情報＞
【補正をする者】　申請人
【識別番号】　000226057
【住所又は居所】　徳島県阿南市上中町岡４９１番地１００
【氏名又は名称】　日亜化学工業株式会社

出願人履歴

０００２２６０５７

19900818

新規登録

徳島県阿南市上中町岡４９１番地１００

日亜化学工業株式会社

日本国特許庁
JAPAN PATENT OFFICE

別紙添付の書類に記載されている事項は下記の出願書類に記載されている事項と同一であることを証明する。

This is to certify that the annexed is a true copy of the following application as filed with this Office.

出願年月日 Date of Application:	１９９６年　９月１８日
出願番号 Application Number:	平成　８年特許願第２４５３８１号
パリ条約による外国への出願に用いる優先権の主張の基礎となる出願の国コードと出願番号 The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is	ＪＰ１９９６－２４５３８１
出願人 Applicant(s):	口亜化学工業株式会社

２０１０年１１月２４日

特許庁長官
Commissioner,
Japan Patent Office

岩井良行

【書類名】特許願

【整理番号】P96ST13-2

【提出日】平成 8年 9月18日

【あて先】特許庁長官　荒川　寿光　殿

【国際特許分類】

H01L 33/00

【発明の名称】発光ダイオード及びそれを用いた表示装置

【請求項の数】　4

【発明者】

【住所又は居所】徳島県阿南市上中町岡４９１番地１００　日亜化学工業株式会社内

【氏名】清水　義則

【発明者】

【住所又は居所】徳島県阿南市上中町岡４９１番地１００　日亜化学工業株式会社内

【氏名】阪野　顕正

【特許出願人】

【識別番号】000226057

【郵便番号】774

【住所又は居所】徳島県阿南市上中町岡４９１番地１００

【氏名又は名称】日亜化学工業株式会社

【代表者】小川　英治

【電話番号】0884-22-2311

【先の出願に基づく優先権の主張】

【出願番号】平成 8年特許願第198585号

【出願日】平成 8年 7月29日

【手数料の表示】

【予納台帳番号】010526

【納付金額】21,000

【提出物件の目録】
　【物件名】明細書　1
　【物件名】図面　1
　【物件名】要約書　1
【プルーフの要否】要

【書類名】　明細書

【発明の名称】　発光ダイオード及びそれを用いた表示装置

【特許請求の範囲】

【請求項１】

発光層が窒化ガリウム系化合物半導体であるＬＥＤチップと、該ＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光するフォトルミネセンス蛍光体と、を有する発光ダイオードであって、

前記ＬＥＤチップの発光スペクトルの主ピークが４００ｎｍから５３０ｎｍ内の発光波長を有すると共に、前記フォトルミネセンス蛍光体が$RE_3(Al, Ga)_5O_{12}:Ce$であることを特徴とする発光ダイオード。

但し、ＲＥは、Ｙ，Ｇｄ，Ｓｍから選択される少なくとも一種である。

【請求項２】

マウント・リードのカップ内に配置させたＬＥＤチップと、該ＬＥＤチップと導電性ワイヤーを用いて電気的に接続させたインナー・リードと、前記カップ内に充填させたコーティング部材と、該コーティング部材、ＬＥＤチップ、導電性ワイヤー及びマウント・リードとインナー・リードの少なくとも一部を被覆するモールド部材と、を有する発光ダイオードであって、

前記ＬＥＤチップが窒化ガリウム系化合物半導体であり、且つ前記コーティング部材が$RE_3(Al, Ga)_5O_{12}:Ce$フォトルミネセンス蛍光体を有する透光性樹脂であることを特徴とする発光ダイオード。

但し、ＲＥは、Ｙ，Ｇｄ，Ｓｍから選択される少なくとも一種である。

【請求項３】

前記フォトルミネセンス蛍光体の組成が次の一般式で示されることを特徴とする請求項１又は請求項２記載の発光ダイオード。

$$(Y_{1-p-q-r}Gd_pCe_qSm_r)_3(Al_{1-s}Ga_s)_5O_{12}$$

但し、　$0 \leqq p \leqq 0.8$

$0.003 \leqq q \leqq 0.2$

$0.0003 \leqq r \leqq 0.08$

$0 \leqq s \leqq 1$

【請求項４】

請求項２記載の発光ダイオードをマトリックス状に配置したＬＥＤ表示器と、該ＬＥＤ表示器と電気的に接続させた駆動回路と、を有するＬＥＤ表示装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】

本願発明は、ＬＥＤディスプレイ、バックライト光源、信号機、照光式スイッチ及び各種インジケータなどに利用される発光ダイオードに係わり、特に発光素子であるＬＥＤチップからの発光を変換して発光させるフォトルミネセンス蛍光体を有し使用環境によらず高輝度、高効率な発光装置である発光ダイオード及びそれを用いた表示装置に関する。

【０００２】

【従来技術】

発光ダイオード（以下、ＬＥＤともいう）は、小型で効率が良く鮮やかな色の発光をする。また、半導体素子であるため球切れなどの心配がない。初期駆動特性が優れ、振動やON／OFF点灯の繰り返しに強いという特徴を有する。そのため各種インジケータや種々の光源として利用されている。最近、超高輝度高効率な発光ダイオードとしてＲＧＢ（赤、緑、青色）などの発光ダイオードがそれぞれ開発された。これに伴いＲＧＢの三原色を利用したＬＥＤディスプレイが省電力、長寿命、軽量などの特長を生かして飛躍的に発展を遂げつつある。

【０００３】

発光ダイオードは使用される発光層の半導体材料、形成条件などによって紫外から赤外まで種々の発光波長を放出させることが可能である。また、優れた単色性ピーク波長を有する。

【０００４】

しかしながら、発光ダイオードは優れた単色性ピーク波長を有するが故に白色系発光光源などとさせるためには、ＲＧＢなどが発光可能な各ＬＥＤチップをそれぞれ近接して発光させ拡散混色させる必要がある。このような発光ダイオードは、種々の色を自由に発光させる発光装置としては有効であるが、白色系などの

色のみを発光させる場合においても赤色系、緑色系及び青色系の発光ダイオード、或いは青緑色系及び黄色系の発光ダイオードをそれぞれ使用せざるを得ない。ＬＥＤチップは、半導体であり色調や輝度のバラツキもまだ相当ある。また、半導体発光素子であるＬＥＤチップがそれぞれ異なる材料を用いて形成されている場合、各ＬＥＤチップの駆動電力などが異なり個々に電源を確保する必要がある。そのため、各半導体ごとに電流などを調節して白色系を発光させなければならない。同様に、半導体発光素子であるため個々の温度特性の差や経時変化が異なり、色調が種々変化してしまう。さらに、ＬＥＤチップからの発光を均一に混色させなければ色むらを生ずる場合がある。

【０００５】

そこで、本出願人は先にＬＥＤチップの発光色を蛍光体で色変換させた発光ダイオードとして特開平５－１５２６０９号公報、特開平７－９９３４５号公報などに記載された発光ダイオードを開発した。これらの発光ダイオードによって、１種類のＬＥＤチップを用いて白色系など他の発光色を発光させることができる。

【０００６】

具体的には、発光層のエネルギーバンドギャップが大きいＬＥＤチップをリードフレームの先端に設けられたカップ上などに配置する。ＬＥＤチップは、ＬＥＤチップが設けられたメタルステムやメタルポストとそれぞれ電気的に接続させる。そして、ＬＥＤチップを被覆する樹脂モールド部材中などにＬＥＤチップからの光を吸収し波長変換する蛍光体を含有させて形成させてある。

【０００７】

ＬＥＤチップからの発光を波長変換した発光ダイオードとして、青色系の発光ダイオードの発光と、その発光を吸収し黄色系を発光する蛍光体からの発光との混色により白色系が発光可能な発光ダイオードなどとすることができる。これらの発光ダイオードは、白色系を発光する発光ダイオードとして利用した場合においても十分な輝度を発光する発光ダイオードとすることができる。

【０００８】

【発明が解決する課題】

発光ダイオードによって励起される蛍光体は、蛍光染料、蛍光顔料さらには有機、無機化合物などから様々なものが挙げられる。また、蛍光体は、発光素子からの発光波長を波長の短いものから長い波長へと変換する、或いは発光素子からの発光波長を波長の長いものから短い波長へと変換するものとがある。

【０００９】

しかしながら、波長の長いものから短い波長へと変換する場合、変換効率が極めて悪く実用に向かない。また、ＬＥＤチップ周辺に近接して配置された蛍光体は、太陽光よりも約３０倍から４０倍にも及ぶ強照射強度の光線にさらされる。特に、発光素子であるＬＥＤチップを高エネルギーバンドギャップを有する半導体を用い蛍光体の変換効率向上や蛍光体の使用量を減らした場合においては、ＬＥＤチップから発光した光が可視光域にあるといっても光エネルギーが必然的に高くなる。この場合、発光強度を更に高め長期に渡って使用すると、蛍光体自体が劣化しやすい。蛍光体が劣化すると色調がずれる、或いは蛍光体が黒ずみ光の外部取り出し効率が低下する場合がある。同様にＬＥＤチップの近傍に設けられた蛍光体は、ＬＥＤチップの昇温や外部環境からの加熱など高温にもさらされる。さらに、発光ダイオードは、一般的に樹脂モールドに被覆されてはいるものの外部環境からの水分の進入などを完全に防ぐことや製造時に付着した水分を完全に除去することはできない。蛍光体によっては、このような水分が発光素子からの高エネルギー光や熱によって蛍光体物質の劣化を促進する場合もある。また、イオン性の有機染料に至ってはチップ近傍では直流電界により電気泳動を起こし、色調が変化する可能性がある。したがって、本願発明は上記課題を解決し、より高輝度、長時間の使用環境下においても発光光率の低下や色ずれの極めて少ない発光ダイオードを提供することを目的とする。

【００１０】

【課題を解決するための手段】

本願発明は、発光層が窒化ガリウム系化合物半導体であるＬＥＤチップと、該ＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光するフォトルミネセンス蛍光体と、を有する発光ダイオードであって、前記ＬＥＤチップの発光スペクトルの主ピークが４００ｎｍから５３０ｎｍ内の発光波長を有すると

共に、前記フォトルミネセンス蛍光体が$RE_3(Al, Ga)_5O_{12}:Ce$である。但し、REは、Y，Gd，Smから選択される少なくとも一種である。

【0011】

また、マウント・リードのカップ内に配置させたＬＥＤチップと、該ＬＥＤチップと導電性ワイヤーを用いて電気的に接続させたインナー・リードと、前記カップ内に充填させたコーティング部材と、該コーティング部材、ＬＥＤチップ、導電性ワイヤー及びマウント・リードとインナー・リードの少なくとも一部を被覆するモールド部材と、を有する発光ダイオードであって、前記ＬＥＤチップが窒化ガリウム系化合物半導体であり、且つ前記コーティング部材が$RE_3(Al, Ga)_5O_{12}:Ce$フォトルミネセンス蛍光体を有する透光性樹脂でもある。但し、REは、Y，Gd，Smから選択される少なくとも一種である。

【0012】

さらに、前記フォトルミネセンス蛍光体の組成が次の一般式で示される発光ダイオードでもある。$(Y_{1-p-q-r}Gd_pCe_qSm_r)_3(Al_{1-s}Ga_s)_5O_{12}$ 但し、$0 \leqq p \leqq 0.8$、$0.003 \leqq q \leqq 0.2$、$0.0003 \leqq r \leqq 0.08$、$0 \leqq s \leqq 1$

【0013】

また、請求項２記載の発光ダイオードをマトリックス状に配置したＬＥＤ表示器と、該ＬＥＤ表示器と電気的に接続させた駆動回路と、を有するＬＥＤ表示装置である。

【0014】

【発明の実施の形態】

本願発明者は、種々の実験の結果、可視光域における光エネルギーが比較的高いＬＥＤチップからの発光光をフォトルミネセンス蛍光体によって色変換させる発光ダイオードにおいて、特定の半導体及び蛍光体を選択することにより高輝度、長時間の使用時における光効率低下や色ずれを防止できることを見出し本願発明を成すに至った。

【0015】

即ち、発光ダイオードに用いられるフォトルミネセンス蛍光体としては、

１．耐光性に優れていることが要求される。特に、半導体発光素子などの微小領域から強放射されるために太陽光の約３０倍から４０倍にもおよぶ強照射強度にも十分耐える必要がある。２．発光素子との混色を利用するため紫外線ではなく青色系発光で効率よく発光すること。３．混色を考慮して緑色系から赤色系の光が発光可能なこと。４．発光素子近傍に配置されるため温度特性が良好であること。５．色調が組成比或いは複数の蛍光体の混合比で連続的に変えられること。６．発光ダイオードの利用環境に応じて耐候性があることなどの特徴を有することが求められる。

【００１６】

これらの条件を満たすものとして本願発明は、発光素子として発光層に高エネルギーバンドギャップを有する窒化ガリウム系化合物半導体素子を、フォトルミネセンス蛍光体として$RE_3(Al,Ga)_5O_{12}$：Ｃｅ蛍光体を用いる。これにより発光素子から放出された可視光域における高エネルギー光を長時間近傍で高輝度に照射した場合であっても発光色の色ずれや発光輝度の低下が極めて少ない発光ダイオードとすることができるものである。

【００１７】

具体的な発光ダイオードの一例として、チップタイプＬＥＤを図２に示す。チップタイプＬＥＤの筐体２０４内に窒化ガリウム系半導体を用いたＬＥＤチップ２０２をエポキシ樹脂などを用いて固定させてある。導電性ワイヤー２０３として金線をＬＥＤチップ２０２の各電極と筐体に設けられた各電極２０５とにそれぞれ電気的に接続させてある。$RE_3(Al,Ga)_5O_{12}$：Ｃｅ蛍光体をエポキシ樹脂中に混合分散させたものをＬＥＤチップ、導電性ワイヤーなどを外部応力などから保護するモールド部材２０１として均一に硬化形成させる。このような発光ダイオードに電力を供給させることによってＬＥＤチップ２０２を発光させる。ＬＥＤチップ２０２からの発光と、その発光によって励起されたフォトルミネセンス蛍光体からの発光光との混色により白色系などが発光可能な発光ダイオードとすることができる。以下、本願発明の構成部材について詳述する。

【００１８】

（蛍光体）

本願発明に用いられるフォトルミネセンス蛍光体としては、半導体発光層から発光された可視光及び紫外線で励起されて発光するフォトルミネセンス蛍光体をいう。具体的なフォトルミネセンス蛍光体としては、$RE_3(Al, Ga)_5O_{12}$：Ｃｅ（但し、ＲＥは、Ｙ，Ｇｄ，Ｓｍから選択される少なくとも一種）である。窒化ガリウム系化合物半導体を用いたＬＥＤチップから発光した光と、ボディーカラーが黄色でありフォトルミネセンス蛍光体から発光する光が補色関係などにある場合、ＬＥＤチップからの発光と、フォトルミネセンス蛍光体からの発光と、を混色表示させると白色系の発光色表示を行うことができる。そのため発光ダイオード外部には、ＬＥＤチップからの発光とフォトルミネセンス蛍光体からの発光とがモールド部材を透過する必要がある。したがって、フォトルミネセンス蛍光体のバルク層内などにＬＥＤチップを閉じこめ、フォトルミネセンス蛍光体層にＬＥＤチップからの光が透過する開口部を１乃至２以上有する構成の発光ダイオードとしても良い。また、フォトルミネセンス蛍光体の粉体を樹脂や硝子中に含有させＬＥＤチップからの光が透過する程度に薄く形成させても良い。フォトルミネセンス蛍光体と樹脂などとの比率や塗布、充填量を種々調整すること及び発光素子の発光波長を選択することにより白色を含め電球色など任意の色調を提供させることができる。

【００１９】

さらに、フォトルミネセンス蛍光体の含有分布は、混色性や耐久性にも影響する。すなわち、フォトルミネセンス蛍光体が含有されたコーティング部やモールド部材の表面側からＬＥＤチップに向かってフォトルミネセンス蛍光体の分布濃度が高い場合は、外部環境からの水分などの影響をより受けにくく水分による劣化を抑制しやすい。他方、フォトルミネセンス蛍光体の含有分布をＬＥＤチップからモールド部材表面側に向かって分布濃度が高くなると外部環境からの水分の影響を受けやすいがＬＥＤチップからの発熱、照射強度などの影響がより少なくフォトルミネセンス蛍光体の劣化を抑制することができる。このような、フォトルミネセンス蛍光体の分布は、フォトルミネセンス蛍光体を含有する部材、形成温度、粘度やフォトルミネセンス蛍光体の形状、粒度分布などを調整させることによって種々形成させることができる。したがって、使用条件などにより蛍光体

の分布濃度を、種々選択することができる。

【００２０】

本願発明のフォトルミネセンス蛍光体は、特にＬＥＤチップと接する或いは近接して配置され放射照度として（Ｅｅ）＝３Ｗ・ｃｍ$^{-2}$以上１０Ｗ・ｃｍ$^{-2}$以下においても高効率に十分な耐光性有する発光ダイオードとすることができる。

【００２１】

本願発明に用いられるフォトルミネセンス蛍光体は、ガーネット構造のため、熱、光及び水分に強く、励起スペクトルのピークが４５０ｎｍ付近にさせることができる。また、発光ピークも５３０ｎｍ付近にあり７００ｎｍまで裾を引くブロードな発光スペクトルを持つ。しかも、組成のＡｌの一部をＧａで置換することで発光波長が短波長にシフトし、また組成のＹの一部をＧｄで置換することで、発光波長が長波長へシフトする。このように組成を変化することで発光色を連続的に調節することが可能である。したがって、長波長側の強度がＧｄの組成比で連続的に変えられるなど窒化物半導体の青色系発光を白色系発光に変換するための理想条件を備えている。

【００２２】

また、窒化ガリウム系半導体を用いたＬＥＤチップと、セリウムで付活されたイットリウム・アルミニウム・ガーネット蛍光体（ＹＡＧ）に希土類元素のサマリウム（Ｓｍ）を含有させたフォトルミネセンス蛍光体と、を有する発光ダイオードとすることによりさらに光効率を向上させることができる。

【００２３】

このようなフォトルミネセンス蛍光体は、Ｙ、Ｇｄ、Ｃｅ、Ｓｍ、Ａｌ及びＧａの原料として酸化物、又は高温で容易に酸化物になる化合物を使用し、それらを化学量論比で十分に混合して原料を得る。又は、Ｙ、Ｇｄ、Ｃｅ、Ｓｍの希土類元素を化学量論比で酸に溶解した溶解液を蓚酸で共沈したものを焼成して得られる共沈酸化物と、酸化アルミニウム、酸化ガリウムとを混合して混合原料を得る。これにフラックスとしてフッ化アンモニウム等のフッ化物を適量混合して坩堝に詰め、空気中１３５０～１４５０°Ｃの温度範囲で２～５時間焼成して焼成品を得、次に焼成品を水中でボールミルして、洗浄、分離、乾燥、最後に篩を通

すことで得ることができる。

【００２４】

（$Y_{1-p-q-r}Gd_{p}Ce_{q}Sm_{r}$）$_{3}Al_{5}O_{12}$フォトルミネセンス蛍光体は、結晶中にＧｄを含有することにより、特に４６０ｎｍ以上の長波長域の励起発光効率を高くすることができる。ガドリニウムの含有量の増加により、発光ピーク波長が、５３０ｎｍから５７０ｎｍまで長波長に移動し、全体の発光波長も長波長側にシフトする。赤みの強い発光色が必要な場合、Ｇｄの置換量を多くすることで達成できる。一方、Ｇｄが増加すると共に、青色光によるフォトルミネセンスの発光輝度は徐々に低下する。したがって、ｐは０．８以下であることが好ましく、０．７以下であることがより好ましい。さらに好ましくは０．６以下である。

【００２５】

Ｓｍを含有する（$Y_{1-p-q-r}Gd_{p}Ce_{q}Sm_{r}$）$_{3}Al_{5}O_{12}$蛍光体は、Ｇｄの含有量の増加に関わらず温度特性の低下が少ない。このようにＳｍを含有させることにより、高温度におけるフォトルミネセンス蛍光体の発光輝度は大幅に改善される。その改善される程度はＧｄの含有量が高くなるほど大きくなる。すなわち、Ｇｄを増加してフォトルミネセンス蛍光体の発光色調に赤みを付与した組成ほどＳｍの含有による温度特性改善に効果的であることが分かった。（なお、ここでの温度特性とは、４５０ｎｍの青色光による常温（２５°Ｃ）における励起発光輝度に対する、同蛍光体の高温（２００°Ｃ）における発光輝度の相対値（％）で表している。）

【００２６】

Ｓｍの含有量は０．０００３≦ｒ≦０．０８の範囲で温度特性が６０％以上となり好ましい。この範囲よりｒが小さいと、温度特性改良の効果が小さくなる。また、この範囲よりｒが大きくなると温度特性は逆に低下してくる。０．０００７≦ｒ≦０．０２の範囲では温度特性は８０％以上となり最も好ましい。

【００２７】

Ｃｅは０．００３≦ｑ≦０．２の範囲で相対発光輝度が７０％以上となる。ｑが０．００３以下では、Ｃｅによるフォトルミネセンスの励起発光中心の数が減少することで輝度低下し、逆に、０．２より大きくなると濃度消光が生ずる。

【００２８】
本願発明の発光ダイオードにおいてこのようなフォトルミネセンス蛍光体は、２種類以上のRE_3（Ａｌ，Ｇａ）$_5O_{12}$：Ｃｅフォトルミネセンス蛍光体を混合させてもよい。即ち、Ａｌ、Ｇａ、Ｙ及びＧｄやＳｍの含有量が異なる２種類以上のRE_3（Ａｌ，Ｇａ）$_5O_{12}$：Ｃｅフォトルミネセンス蛍光体を混合させてＲＧＢの波長成分を増やすことができる。これに、カラーフィルターを用いることによりフルカラー液晶表示装置用としても利用できる。

【００２９】
（ＬＥＤチップ１０２、２０２、７０２）
本願発明に用いられるＬＥＤチップとは、RE_3（Ａｌ，Ｇａ）$_5O_{12}$：Ｃｅ蛍光体を効率良く励起できる窒化物系化合物半導体が挙げられる。発光素子であるＬＥＤチップは、ＭＯＣＶＤ法等により基板上にＩｎＧａＮ等の半導体を発光層として形成させる。半導体の構造としては、ＭＩＳ接合、ＰＩＮ接合やＰＮ接合などを有するホモ構造、ヘテロ構造あるいはダブルヘテロ構成のものが挙げられる。半導体層の材料やその混晶度によって発光波長を種々選択することができる。また、半導体活性層を量子効果が生ずる薄膜に形成させた単一量子井戸構造や多重量子井戸構造とすることもできる。

【００３０】
窒化ガリウム系化合物半導体を使用した場合、半導体基板にはサファイヤ、スピネル、ＳｉＣ、Ｓｉ、ＺｎＯ等の材料が用いられる。結晶性の良い窒化ガリウムを形成させるためにはサファイヤ基板を用いることが好ましい。このサファイヤ基板上にＧａＮ、ＡｌＮ等のバッファー層を形成しその上にＰＮ接合を有する窒化ガリウム半導体を形成させる。窒化ガリウム系半導体は、不純物をドープしない状態でＮ型導電性を示す。発光効率を向上させるなど所望のＮ型窒化ガリウム半導体を形成させる場合は、Ｎ型ドーパントとしてＳｉ、Ｇｅ、Ｓｅ、Ｔｅ、Ｃ等を適宜導入することが好ましい。一方、Ｐ型窒化ガリウム半導体を形成させる場合は、Ｐ型ドーパンドであるＺｎ、Ｍｇ、Ｂｅ、Ｃａ、Ｓｒ、Ｂａ等をドープさせる。窒化ガリウム系化合物半導体は、Ｐ型ドーパントをドープしただけではＰ型化しにくいためＰ型ドーパント導入後に、炉による加熱、低速電子線照射

やプラズマ照射等によりアニールすることでＰ型化させることが好ましい。エッチングなどによりＰ型半導体及びＮ型半導体の露出面を形成させた後、半導体層上にスパッタリング法や真空蒸着法などを用いて所望の形状の各電極を形成させる。

【００３１】

次に、形成された半導体ウエハー等をダイヤモンド製の刃先を有するブレードが回転するダイシングソーにより直接フルカットするか、又は刃先幅よりも広い幅の溝を切り込んだ後（ハーフカット）、外力によって半導体ウエハーを割る。あるいは、先端のダイヤモンド針が往復直線運動するスクライバーにより半導体ウエハーに極めて細いスクライブライン（経線）を例えば碁盤目状に引いた後、外力によってウエハーを割り半導体ウエハーからチップ状にカットする。このようにして窒化ガリウム系化合物半導体であるＬＥＤチップを形成させることができる。

【００３２】

本願発明の発光ダイオードにおいて白色系を発光させる場合は、フォトルミネセンス蛍光体との補色関係や樹脂劣化等を考慮して発光素子の発光波長は４００ｎｍ以上５３０ｎｍ以下が好ましく、４２０ｎｍ以上４９０ｎｍ以下がより好ましい。ＬＥＤチップとフォトルミネセンス蛍光体との効率をそれぞれより向上させるためには、４５０ｎｍ以上４７５ｎｍ以下がさらに好ましい。本願発明の白色系発光ダイオードの発光スペクトルを図３に示す。４５０ｎｍ付近にピークを持つ発光がＬＥＤチップからの発光であり、５７０ｎｍ付近にピークを持つ発光がＬＥＤチップによって励起されたフォトルミネセンスの発光である。

【００３３】

（導電性ワイヤー１０３、２０３）

導電性ワイヤー１０３、２０３としては、ＬＥＤチップ１０２、２０２の電極とのオーミック性、機械的接続性、電気伝導性及び熱伝導性がよいものが求められる。熱伝導度としては０．０１ｃａｌ／ｃｍ^2／ｃｍ／℃以上が好ましく、より好ましくは０．５ｃａｌ／ｃｍ^2／ｃｍ／℃以上である。また、作業性などを考慮して導電性ワイヤーの直径は、好ましくは、Φ１０μｍ以上、Φ４５μｍ以

下である。このような導電性ワイヤーとして具体的には、金、銅、白金、アルミニウム等の金属及びそれらの合金を用いた導電性ワイヤーが挙げられる。このような導電性ワイヤーは、各ＬＥＤチップの電極と、インナー・リード及びマウント・リードなどと、をワイヤーボンディング機器によって容易に接続させることができる。

【００３４】

（マウント・リード１０５）

マウント・リード１０５としては、ＬＥＤチップ１０２を配置させるものであり、ダイボンド機器などで積載するのに十分な大きさがあれば良い。また、ＬＥＤチップを複数設置しマウント・リードをＬＥＤチップの共通電極として利用する場合においては、十分な電気伝導性とボンディングワイヤー等との接続性が求められる。また、マウント・リード上のカップ内にＬＥＤチップを配置すると共に蛍光体を内部に充填させる場合は、近接して配置させた別の発光ダイオードからの光により疑似点灯することを防止することができる。

【００３５】

ＬＥＤチップ１０２とマウント・リード１０５のカップとの接着は熱硬化性樹脂などによって行うことができる。具体的には、エポキシ樹脂、アクリル樹脂やイミド樹脂などが挙げられる。また、フェースダウンＬＥＤチップなどによりマウント・リードと接着させると共に電気的に接続させるためにはＡｇペースト、カーボンペースト、金属バンプ等を用いることができる。さらに、発光ダイオードの光利用効率を向上させるためにＬＥＤチップが配置されるマウント・リードの表面を鏡面状とし、表面に反射機能を持たせても良い。この場合の表面粗さは、０．１Ｓ以上０．８Ｓ以下が好ましい。また、マウント・リードの具体的な電気抵抗としては３００μΩ－ｃｍ以下が好ましく、より好ましくは、３μΩ－ｃｍ以下である。また、マウント・リード上に複数のＬＥＤチップを積置する場合は、ＬＥＤチップからの発熱量が多くなるため熱伝導度がよいことが求められる。具体的には、０．０１ｃａｌ／ｃｍ^2／ｃｍ／℃以上が好ましくより好ましくは ０．５ｃａｌ／ｃｍ^2／ｃｍ／℃以上である。これらの条件を満たす材料としては、鉄、銅、鉄入り銅、錫入り銅、メタライズパターン付きセラミック等が挙

げられる。

【００３６】

（インナー・リード１０６）

インナー・リード１０６としては、マウント・リード１０５上に配置されたＬＥＤチップ１０２と接続された導電性ワイヤー１０３との接続を図るものである。マウント・リード上に複数のＬＥＤチップを設けた場合は、各導電性ワイヤー同士が接触しないよう配置できる構成とする必要がある。具体的には、マウント・リードから離れるに従って、インナー・リードのワイヤーボンディングさせる端面の面積を大きくすることなどによってマウント・リードからより離れたインナー・リードと接続させる導電性ワイヤーの接触を防ぐことができる。導電性ワイヤーとの接続端面の粗さは、密着性を考慮して１．６Ｓ以上１０Ｓ以下が好ましい。インナー・リードの先端部を種々の形状に形成させるためには、あらかじめリードフレームの形状を型枠で決めて打ち抜き形成させてもよく、或いは全てのインナー・リードを形成させた後にインナー・リード上部の一部を削ることによって形成させても良い。さらには、インナ・リードを打ち抜き形成後、端面方向から加圧することにより所望の端面の面積と端面高さを同時に形成させることもできる。

【００３７】

インナー・リードは、導電性ワイヤーであるボンディングワイヤー等との接続性及び電気伝導性が良いことが求められる。具体的な電気抵抗としては、３００μΩ－ｃｍ以下が好ましく、より好ましくは３μΩ－ｃｍ以下である。これらの条件を満たす材料としては、鉄、銅、鉄入り銅、錫入り銅及び銅、金、銀をメッキしたアルミニウム、鉄、銅等が挙げられる。

【００３８】

（コーティング部１０１）

本願発明に用いられるコーティング部１０１とは、モールド部材１０４とは別にマウント・リードのカップに設けられるものでありＬＥＤチップの発光を変換するフォトルミネセンス蛍光体が含有されるものである。コーティング部の具体的材料としては、エポキシ樹脂、ユリア樹脂、シリコーンなどの耐候性に優れた

透明樹脂や硝子などが好適に用いられる。また、フォトルミネセンス蛍光体と共に拡散剤を含有させても良い。具体的な拡散剤としては、チタン酸バリウム、酸化チタン、酸化アルミニウム、酸化珪素等が好適に用いられる。

【００３９】

（モールド部材１０４）

モールド部材１０４は、発光ダイオードの使用用途に応じてＬＥＤチップ１０２、導電性ワイヤー１０３、フォトルミネセンス蛍光体が含有されたコーティング部１０１などを外部から保護するために設けることができる。モールド部材は、一般には樹脂を用いて形成させることができる。また、フォトルミネセンス蛍光体を含有させることによって視野角を増やすことができるが、樹脂モールドに拡散剤を含有させることによってＬＥＤチップ１０２からの指向性を緩和させ視野角をさらに増やすことができる。更にまた、モールド部材１０４を所望の形状にすることによってＬＥＤチップからの発光を集束させたり拡散させたりするレンズ効果を持たせることができる。従って、モールド部材１０４は複数積層した構造でもよい。具体的には、凸レンズ形状、凹レンズ形状さらには、発光観測面から見て楕円形状やそれらを複数組み合わせた物である。モールド部材１０４の具体的材料としては、主としてエポキシ樹脂、ユリア樹脂、シリコーンなどの耐候性に優れた透明樹脂や硝子などが好適に用いられる。また、拡散剤としては、チタン酸バリウム、酸化チタン、酸化アルミニウム、酸化珪素等が好適に用いられる。さらに、拡散剤に加えてモールド部材中にもフォトルミネセンス蛍光体を含有させることもできる。したがって、フォトルミネセンス蛍光体はモールド部材中に含有させてもそれ以外のコーティング部などに含有させて用いてもよい。また、コーティング部をフォトルミネセンス蛍光体が含有された樹脂、モールド部材を硝子などとした異なる部材を用いて形成させても良い。この場合、生産性良くより水分などの影響が少ない発光ダイオードとすることができる。また、屈折率を考慮してモールド部材とコーティング部とを同じ部材を用いて形成させても良い。

【００４０】

（表示装置）

本願発明の発光ダイオードをＬＥＤ表示器に利用した場合、ＲＧＢをそれぞれ発光する発光ダイオードの組み合わせだけによるＬＥＤ表示器よりも、より高精細に白色系表示させることができる。すなわち、各発光ダイオードを組み合わせて白色系などを混色表示させるためにはＲＧＢの各発光ダイオードをそれぞれ同時に発光せざるを得ない。そのため赤色系、緑色系、青色系のそれぞれ単色表示した場合に比べて一画素あたりの表示が大きくなる。したがって、白色系の表示の場合においてはＲＧＢ単色表示と比較して高精細に表示させることができない。また、白色系の表示は各発光ダイオードを調節して表示させるため各半導体の温度特性などを考慮し種々調整しなければならない。さらに、混色による表示であるが故にＬＥＤ表示器の視認する方向や角度によって、ＲＧＢの発光ダイオードが部分的に遮光され表示色が変わる場合もある。本願発明の発光ダイオードをＲＧＢの発光ダイオードに加えて利用することにより、より高精細化が可能となると共に白色系の発光が安定し色むらをなくすこともできる。また、ＲＧＢの各発光ダイオードともに発光させることにより輝度を向上させることもできる。

【００４１】

本願発明の発光ダイオードを用いて表示装置の１つとして、ＲＧＢの各発光ダイオードに加えて白色系発光ダイオードを１絵素として利用し、標識やマトリクス状など任意の形状に配置させたＬＥＤ表示器の概略構成を示す。ＬＥＤ表示器は、駆動回路である点灯回路などと電気的に接続させる。駆動回路からの出力パルスによって種々の画像が表示可能なデイスプレイ等とすることができる。駆動回路としては、入力される表示データを一時的に記憶させるＲＡＭ（Ｒａｎｄｏｍ、Ａｃｃｅｓｓ、Ｍｅｍｏｒｙ）と、ＲＡＭに記憶されるデータから各発光ダイオードを所定の明るさに点灯させるための階調信号を演算する階調制御回路と、階調制御回路の出力信号でスイッチングされて、各発光ダイオードを点灯させるドライバーとを備える。階調制御回路は、ＲＡＭに記憶されるデータから発光ダイオードの点灯時間を演算してパルス信号を出力する。ここで、白色系の表示を行う場合は、ＲＧＢ各発光ダイオードのパルス信号を短くする、パルス高を低くする或いは全く点灯させない。他方、それを補償するように白色系発光ダイオードにパルス信号を出力する。これにより、ＬＥＤ表示器の白色を表示する。

【００４２】

したがって、白色系発光ダイオードを所望の輝度で点灯させるためのパルス信号を演算する階調制御回路としてＣＰＵを別途備えることが好ましい。階調制御回路から出力されるパルス信号は、白色系発光ダイオードのドライバーに入力されてドライバをスイッチングさせる。ドライバーがオンになると白色系発光ダイオードが点灯され、オフになると消灯される。

【００４３】

また、本願発明の発光ダイオードを用いた別のＬＥＤ表示器を示す。本願発明の白色系発光ダイオードのみを用い白黒用のＬＥＤ表示装置とすることもできる。白黒用のＬＥＤ表示器は、本願発明の発光ダイオード５０１のみをマトリックス状などに配置し構成することができる。ＲＧＢのそれぞれの駆動回路の代わりに白色発光可能な本願発明の発光ダイオード用駆動回路のみとしてＬＥＤ表示器を構成させることができる。ＬＥＤ表示器は、駆動回路である点灯回路などと電気的に接続させる。駆動回路からの出力パルスによって種々の画像が表示可能なデイスプレイ等とすることができる。駆動回路としては、入力される表示データを一時的に記憶させるＲＡＭ（Ｒａｎｄｏｍ、Ａｃｃｅｓｓ、Ｍｅｍｏｒｙ）と、ＲＡＭに記憶されるデータから発光ダイオードを所定の明るさに点灯させるための階調信号を演算する階調制御回路と、階調制御回路の出力信号でスイッチングされて、発光ダイオードを点灯させるドライバーとを備える。階調制御回路は、ＲＡＭに記憶されるデータから発光ダイオードの点灯時間を演算してパルス信号を出力する。

【００４４】

したがって、白黒用のＬＥＤ表示器はＲＧＢのフルカラー表示器と異なり当然回路構成を簡略化できると共に高精細化できる。そのため、安価にＲＧＢの発光ダイオードの特性に伴う色むらなどのないディスプレイとすることができるものである。また、従来の赤色、緑色のみを用いたＬＥＤ表示器に比べ人間の目に対する刺激が少なく長時間の使用に適している。

【００４５】

（信号機）

本願発明の発光ダイオードを表示装置の１種である信号機として利用した場合、長時間安定して発光させることが可能であると共に発光ダイオードの一部が消灯しても色むらなどが生じないという特徴がある。本願発明の発光ダイオードを用いた信号機の概略構成として、導電性パターンが形成された基板上に白色系発光ダイオードを配置させる。このような発光ダイオードを直列又は直並列に接続された発光ダイオードの回路を発光ダイオード群として扱う。発光ダイオード群を２つ以上用いそれぞれ渦巻き状に発光ダイオードを配置させる。全ての発光ダイオードが配置されると円状に全面に配置される。各発光ダイオード及び基板から外部電力と接続させる電源コードをそれぞれ、ハンダにより接続させた後、鉄道用信号用の筐体内に固定させる。ＬＥＤ表示器は、遮光部材が付いたアルミダイキャストの筐体内に配置され表面にシリコーンゴムの充填材で封止されている。筐体の表示面は、白色レンズを設けてある。また、ＬＥＤ表示器の電気的配線は、筐体の裏面からゴムパッキンを通し筐体内を密閉する。これにより白色系信号機を形成することができる。本願発明の発光ダイオードを、複数の群に分け中心部から外側に向け輪を描く渦巻き状などに配置し、並列接続させることでより信頼性が高い信号機とさせることができる。中心部から外側に向け輪を描くとは連続的に輪を描くものも断続的に配置するものをも含む。したがって、ＬＥＤ表示器の表示面積などにより配置される発光ダイオードの数や発光ダイオード群の数を種々選択することができる。この信号機により、一方の発光ダイオード群や一部の発光ダイオードが何らかのトラブルにより消灯したとしても他方の発光ダイオード群や残った発光ダイオードにより信号機を円形状に均一に発光させることが可能となるものである。また、色ずれが生ずることもない。渦巻き状に配置してあることから中心部を密に配置することができ電球発光の信号と何ら違和感なく駆動させることができる。

【００４６】

（面状発光光源）

本願発明の発光ダイオードを用いて図７の如く面状発光光源を構成することができる。面状発光光源の場合、フォトルミネセンス蛍光体をコーティング部や導光板上の散乱シート７０６に含有させる。或いはバインダー樹脂と共に散乱シー

ト７０６に塗布などさせシート状７０１に形成しモールド部材を省略しても良い。具体的には、絶縁層及び導電性パターンが形成されたコの字形状の金属基板７０３内にＬＥＤチップ７０２を固定する。ＬＥＤチップと導電性パターンとの電気的導通を取った後、フォトルミネセンス蛍光体をエポキシ樹脂と混合撹拌しＬＥＤチップ７０２が積載された基板７０３上に充填させ発光ダイオードを形成させる。こうして形成された発光ダイオードは、アクリル性導光板７０４の端面にエポキシ樹脂などで固定される。導光板７０４の一方の主面上には、蛍現象防止のため白色散乱剤が含有されたフィルム状の反射部材７０７を配置させてある。同様に、導光板の裏面側全面や発光ダイオードが配置されていない端面上にも反射部材７０５を設け発光光率を向上させてある。これにより、ＬＣＤのバックライトとして十分な明るさを得られる面状発光光源とすることができる。液晶表示装置として利用する場合は、導光板７０４の主面上に不示図の透光性導電性パターンが形成された硝子基板間に注入された液晶装置を介して配された偏光板により構成させることができる。以下、本願発明の実施例について説明するが、本願発明は具体的実施例のみに限定されるものではないことは言うまでもない。

【００４７】

【実施例】

（実施例１）

発光素子として発光ピークが４５０ｎｍのＧａＩｎＮ半導体を用いた。ＬＥＤチップは、洗浄させたサファイヤ基板上にＴＭＧ（トリメチルガリウム）ガス、ＴＭＡ（トリメチルアルミニウム）ガス、窒素ガス及びドーパントガスをキャリアガスと共に流し、ＭＯＣＶＤ法で窒化ガリウム系化合物半導体を成膜させることにより形成させた。ドーパントガスとしてSiH_4とCp_2Mgと、を切り替えることによってＮ型導電性を有する窒化ガリウム半導体とＰ型導電性を有する窒化ガリウム半導体を形成しＰＮ接合を形成させた。（なお、Ｐ型半導体は、成膜後４００℃以上でアニールさせてある。）

【００４８】

エッチングによりＰＮ各半導体表面を露出させた後、スパッタリングにより各電極をそれぞれ形成させた。こうして出来上がった半導体ウエハーをスクライブ

ラインを引いた後、外力により分割させ発光素子としてＬＥＤチップを形成させた。

【００４９】

銀メッキした銅製リードフレームの先端にカップを有するマウント・リードにＬＥＤチップをエポキシ樹脂でダイボンディングした。ＬＥＤチップの各電極とマウント・リード及びインナー・リードと、をそれぞれ金線でワイヤーボンディングし電気的導通を取った。

【００５０】

一方、フォトルミネセンス蛍光体は、Ｙ、Ｇｄ、Ｃｅの希土類元素を化学量論比で酸に溶解した溶解液を蓚酸で共沈させた。これを焼成して得られる共沈酸化物と、酸化アルミニウム、酸化ガリウムと混合して混合原料を得る。これにフラックスとしてフッ化アンモニウムを混合して坩堝に詰め、空気中１４００°Ｃの温度で３時間焼成して焼成品を得た。焼成品を水中でボールミルして、洗浄、分離、乾燥、最後に篩を通して形成させた。

【００５１】

形成された$(Y_{0.8}Gd_{0.2})_3Al_5O_{12}$：Ｃｅ蛍光体８０重量部、エポキシ樹脂１００重量部をよく混合してスリラーとさせた。このスリラーをＬＥＤチップが配置されたマウント・リード上のカップ内に注入させた。注入後、フォトルミネセンス蛍光体が含有された樹脂を１３０℃１時間で硬化させた。こうしてＬＥＤチップ上に厚さ１２０μのフォトルミネセンス蛍光体が含有されたコーティング部が形成された。なお、コーティング部には、ＬＥＤチップに向かってフォトルミネセンス蛍光体が徐々に多くしてある。その後、さらにＬＥＤチップやフォトルミネセンス蛍光体を外部応力、水分及び塵芥などから保護する目的でモールド部材として透光性エポキシ樹脂を形成させた。モールド部材は、砲弾型の型枠の中にフォトルミネセンス蛍光体のコーティング部が形成されたリードフレームを挿入し透光性エポシキ樹脂を混入後、１５０℃５時間にて硬化させた。こうして形成された発光ダイオードは、発光観測正面から視認するとフォトルミネセンス蛍光体のボディーカラーにより中央部が黄色っぽく着色していた。

【００５２】

こうして得られた白色系が発光可能な発光ダイオードの色度点、色温度、演色性指数を測定した。それぞれ、色度点（ｘ＝０．３０２、ｙ＝０．２８０）、色温度８０８０Ｋ、Ｒａ（演色性指数）＝８７．５と三波長型蛍光灯に近い性能を示した。また、発光光率は９．５ｌｍ／ｗと白色電球並であった。さらに寿命試験として温度２５℃６０ｍＡ通電、温度２５℃２０ｍＡ通電、温度６０℃９０％ＲＨ下で２０ｍＡ通電の各試験においても蛍光体に起因する変化は観測されず通常の青色発光ダイオードと寿命特性に差がないことが確認できた。

【００５３】

（比較例１）

フォトルミネセンス蛍光体を$(Y_{0.8}Gd_{0.2})_3Al_5O_{12}$：Ｃｅから（ＺｎＣｄ）Ｓ：Ｃｕ、Ａｌとした以外は、実施例１と同様にして発光ダイオードの形成及び寿命試験を行った。形成された発光ダイオードは通電直後、実施例１と同様白色系の発光が確信されたが輝度が低かった。また、寿命試験においては、約１００時間で出力がゼロになった。劣化原因を解析した結果、蛍光体が黒化していた。

【００５４】

これは、発光素子の発光光と蛍光体に付着していた水分或いは外部環境から進入した水分により光分解し蛍光体結晶表面にコロイド状亜鉛金属を析出し外観が黒色に変色したものと考えられる。温度２５℃２０ｍＡ通電、温度６０℃９０％ＲＨ下で２０ｍＡ通電の寿命試験結果を実施例１と共に図８に示す。輝度は初期値を基準にしそれぞれの相対値を示す。また、実線が実施例１であり波線が比較例１を示す。

【００５５】

（実施例２）

ＬＥＤチップの窒化物系化合物半導体を実施例１よりもＩｎの含有量を増やし発光ピークを４６０ｎｍとした。同様にフォトルミネセンス蛍光体として実施例１よりもＧｄの含有量を増やし$(Y_{0.6}Gd_{0.4})_3Al_5O_{12}$：Ｃｅとした以外は実施例１と同様にして発光ダイオードを１００個形成し寿命試験を行った。

【００５６】

こうして得られた白色系が発光可能な発光ダイオードの色度点、色温度、演色性指数を測定した。それぞれ、色度点（ｘ＝０．３７５、ｙ＝０．３７０）、色温度４４００Ｋ、Ｒａ（演色性指数）＝８６．０であった。さらに寿命試験においては、形成させた発光ダイオード１００個平均で行った。寿命試験前の光度を１００％とし１０００時間経過後における平均光度を調べた。寿命試験後も９８．８％であり特性に差がないことが確認できた。

【００５７】

（実施例３）

フォトルミネセンス蛍光体をＹ、Ｇｄ、Ｃｅの希土類元素に加えＳｍを含有させ$(Y_{0.39}Gd_{0.57}Ce_{0.03}Sm_{0.01})_3Al_5O_{12}$蛍光体とした以外は、実施例１と同様にして発光ダイオードを１００個形成した。この発光ダイオードを１３０℃の高温下において点灯させても実施例１の発光ダイオードと比較して平均温度特性が８％ほど良好であった。

【００５８】

（実施例４）

本願発明の発光ダイオードを図５の如くＬＥＤ表示器の１つであるディスプレイに利用した。実施例１と同様にして形成させた発光ダイオードを銅パターンを形成させたセラミックス基板上に、１６×１６のマトリックス状に配置させた。基板と発光ダイオードとは自動ハンダ実装装置を用いてハンダ付けを行った。次にフェノール樹脂によって形成された筐体５０４内部に配置し固定させた。遮光部材５０５は、筐体と一体成形させてある。発光ダイオードの先端部を除いて筐体、発光ダイオード、基板及び遮光部材の一部をピグメントにより黒色に着色したシリコンゴム４０６によって充填させた。その後、常温、７２時間でシリコンゴムを硬化させＬＥＤ表示器を形成させた。このＬＥＤ表示器と、入力される表示データを一時的に記憶させるＲＡＭ（Ｒａｎｄｏｍ、Ａｃｃｅｓｓ、Ｍｅｍｏｒｙ）及びＲＡＭに記憶されるデータから発光ダイオードを所定の明るさに点灯させるための階調信号を演算する階調制御回路と階調制御回路の出力信号でスイッチングされて発光ダイオードを点灯させるドライバーとを備えたＣＰＵの駆動手段と、を電気的に接続させてＬＥＤ表示装置を構成した。ＬＥＤ表示器を駆動

させ白黒ＬＥＤ表示装置として駆動できることを確認した。

【００５９】

【発明の効果】

本願発明の構成とすることにより高出力の窒化物系化合物半導体の発光素子と、$\mathrm{RE_3(Al, Ga)_5O_{12}}$：Ｃｅ蛍光体と、を利用した発光ダイオードとすることにより長時間高輝度時の使用においても発光効率が高い発光ダイオードとすることができる。さらに、信頼性や省電力化、小型化さらには色温度の可変性など車載や航空産業、一般電気機器に表示の他に照明として新たな用途を開くことができる。また、白色は人間の目で長時間視認する場合には刺激が少なく目に優しい発光ダイオードとすることができる。

【００６０】

特に、本願発明の請求項１に記載の構成とすることにより高輝度、長時間の使用においても色ずれ、発光光率の低下が極めて少ない白色系が発光可能な発光ダイオードなど種々の発光ダイオードとすることができる。また、樹脂劣化に伴う輝度の低下も抑制させることができる。

【００６１】

本願発明の請求項２の構成とすることにより、高輝度、長時間の使用においても色ずれ、発光光率の低下が極めて少ない発光ダイオードなど種々の発光ダイオードとすることができることに加えて、発光ダイオードを複数近接して配置した場合においても他方の発光ダイオードからの光により蛍光体が励起され疑似点灯されることを防止させることができる。また、ＬＥＤチップ自体の発光むらを蛍光体により分散することができるためより均一な発光光を有する発光ダイオードとすることができる。

【００６２】

本願発明の請求項３の構成とすることにより、より温度依存性の少ない発光ダイオードとすることができる。

【００６３】

本願発明の請求項４の構成とすることにより、比較的安価で高精細なＬＥＤ表示装置や視認角度によって色むらの少ないＬＥＤ表示装置とすることができる。

【００６４】

【図面の簡単な説明】

【図１】

図１は、本願発明の発光ダイオードの模式的断面図である。

【図２】

図２は、本願発明の他の発光ダイオードの模式的断面図である。

【図３】

図３は、本願発明の発光ダイオードの発光スペクトルの一例を示した図である。

【図４】

図４（Ａ）は、本願発明に使用されるフォトルミネセンス蛍光体の吸収スペクトルの一例を示し、図４（Ｂ）は、本願発明に使用されるフォトルミネセンス蛍光体の発光スペクトルの一例を示した図である。

【図５】

図５は、本願発明の発光ダイオードを用いたＬＥＤ表示装置の模式図である。

【図６】

図６は、図５に用いられるＬＥＤ表示装置のブロック図である。

【図７】

図７は、本願発明の発光ダイオードを用いた別のＬＥＤ表示装置の模式図である。

【図８】

図８（Ａ）は、本願発明の実施例１と比較のために示した比較例１の発光ダイオードとの温度２５℃２０ｍＡ通電における寿命試験を示し、図８（Ｂ）は、本願発明の実施例１と比較のために示した比較例１の発光ダイオードとの温度６０℃９０％ＲＨ下で２０ｍＡ通電における寿命試験を示したグラフである。

【符号の説明】

１０１、７０１・・・フォトルミネセンスが含有されたコーティング部

１０２、２０２、７０２・・・ＬＥＤチップ

１０３、２０３・・・導電性ワイヤー

１０４・・・モールド部材

１０５・・・マウント・リード

１０６・・・インナー・リード

２０１・・・フォトルミネセンスが含有されたモールド部材

２０４・・・筐体

２０５・・・筐体に設けられた電極

５０１・・・発光ダイオード

５０４・・・筐体

５０５・・・遮光部材

５０６・・・充填材

７０３・・・金属製基板

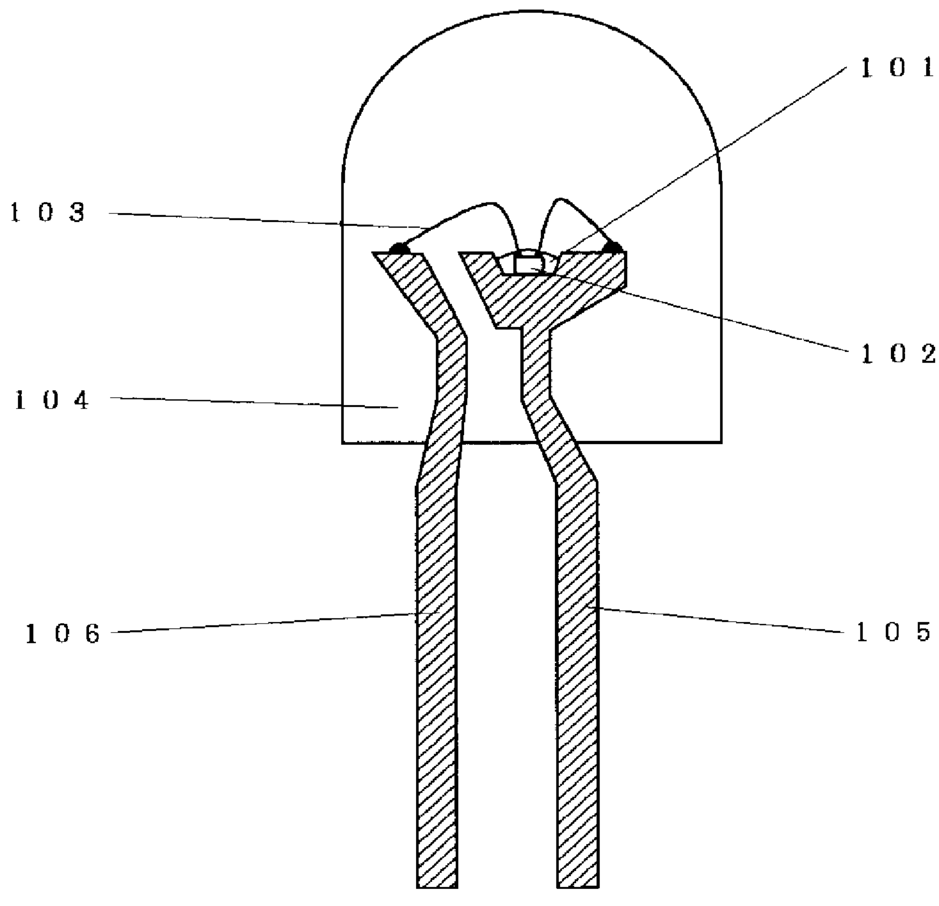
７０４・・・導光板

７０５、７０７・・・反射部材

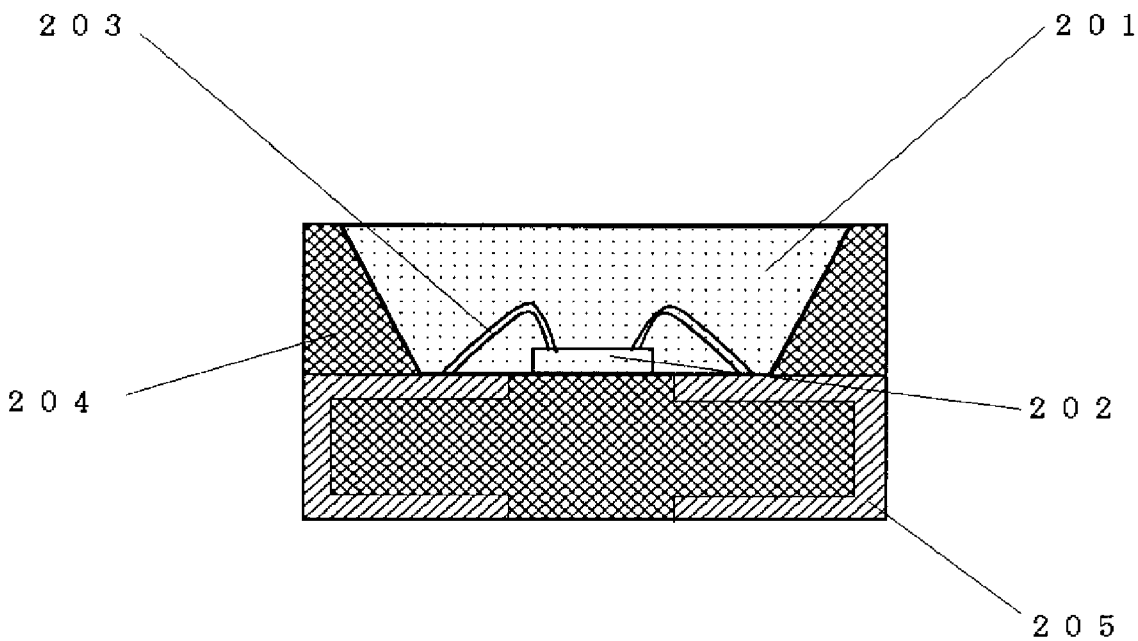
７０６・・・散乱シート

【書類名】　図面

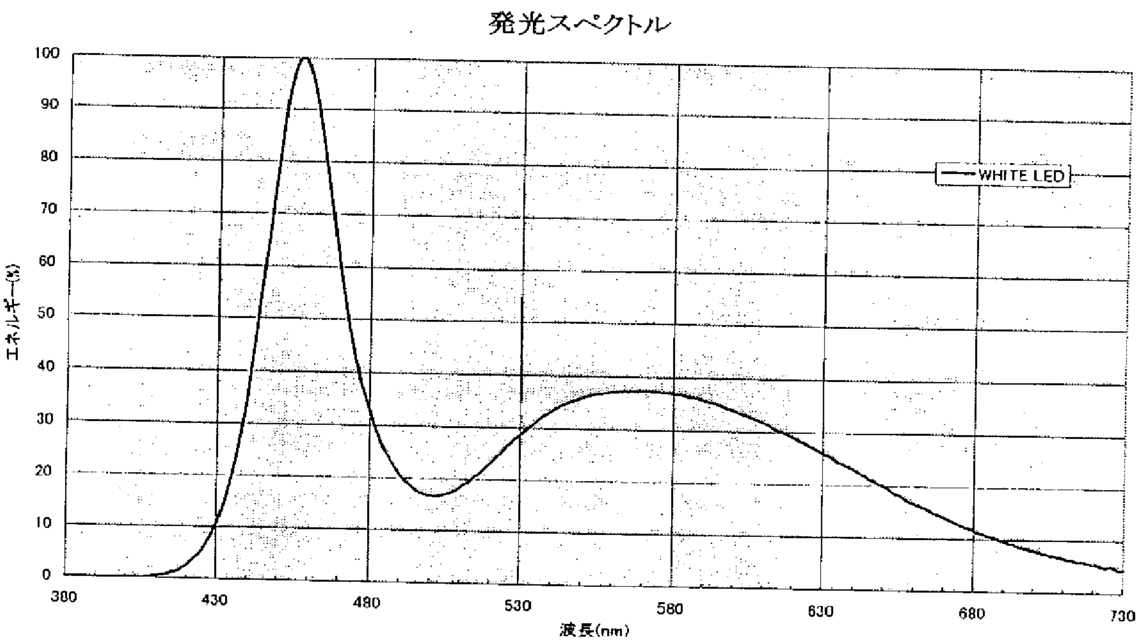
【図１】



【図２】

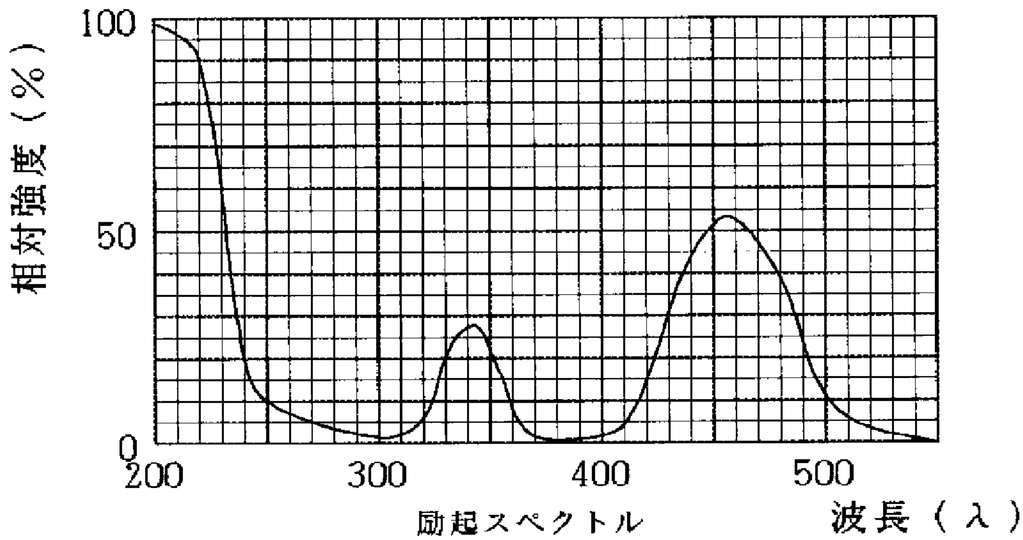


【図３】

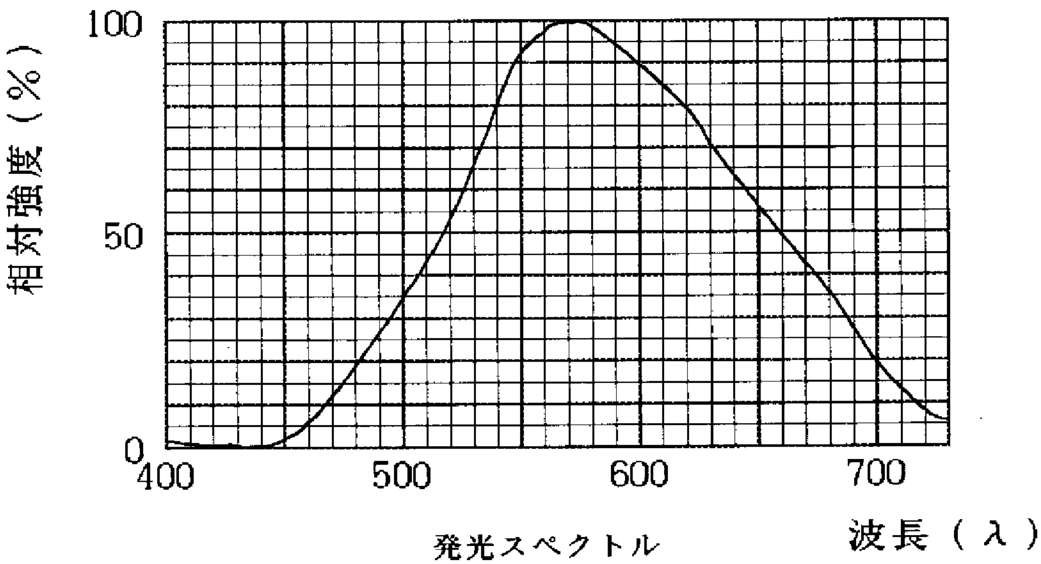


発光スペクトル
100
90
80
70
60
50
40
30
20
10
0
エネルギー(%)
380
430
480
530
580
630
680
730
波長(nm)
WHITE LED

【図4】

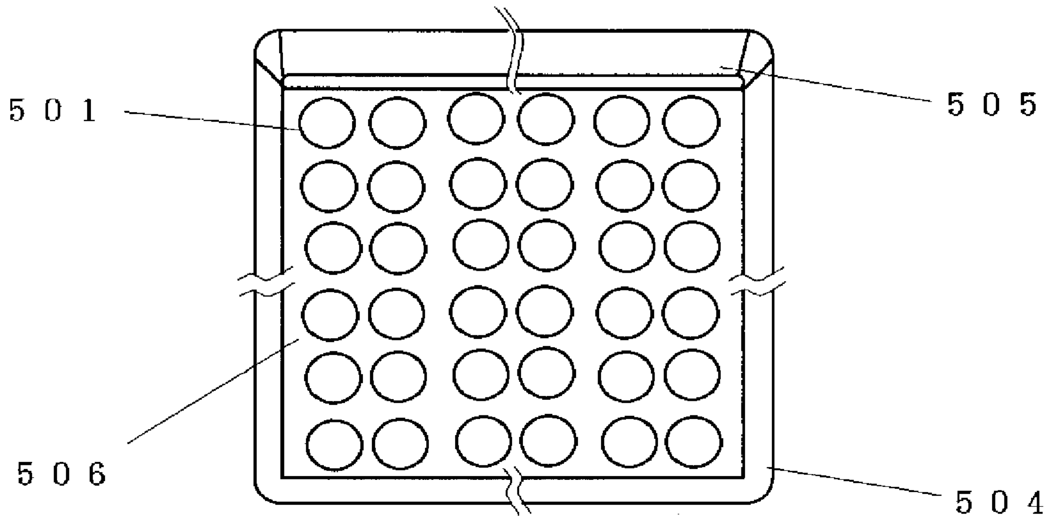

100
50
0
相対強度（%）
200
300
400
500
励起スペクトル
波長（λ）

（A）

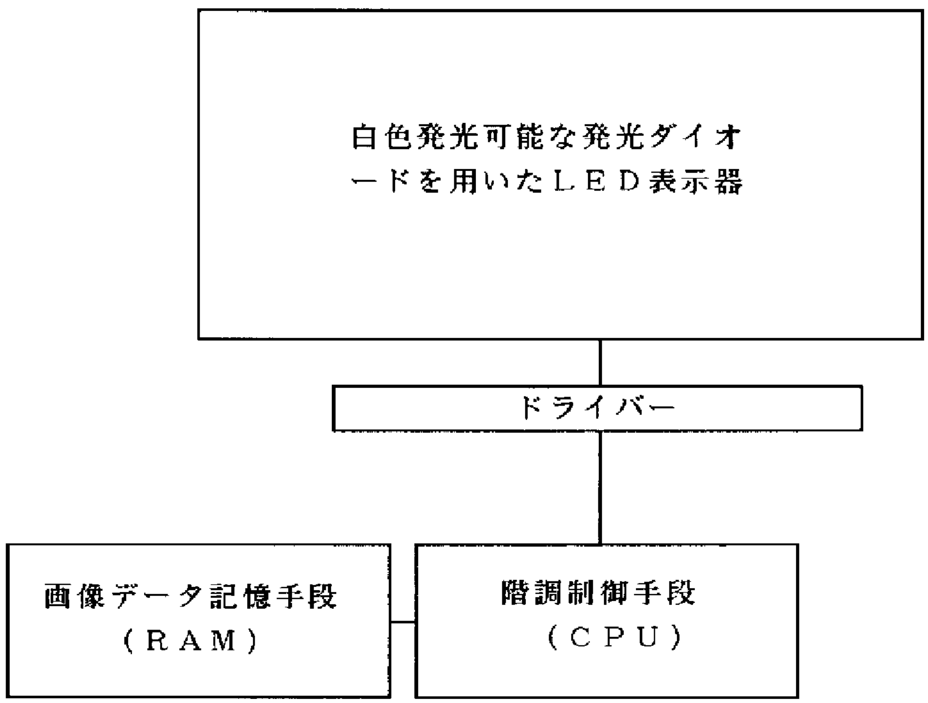

100
50
0
相対強度（%）
400
500
600
700
発光スペクトル
波長（λ）

（B）

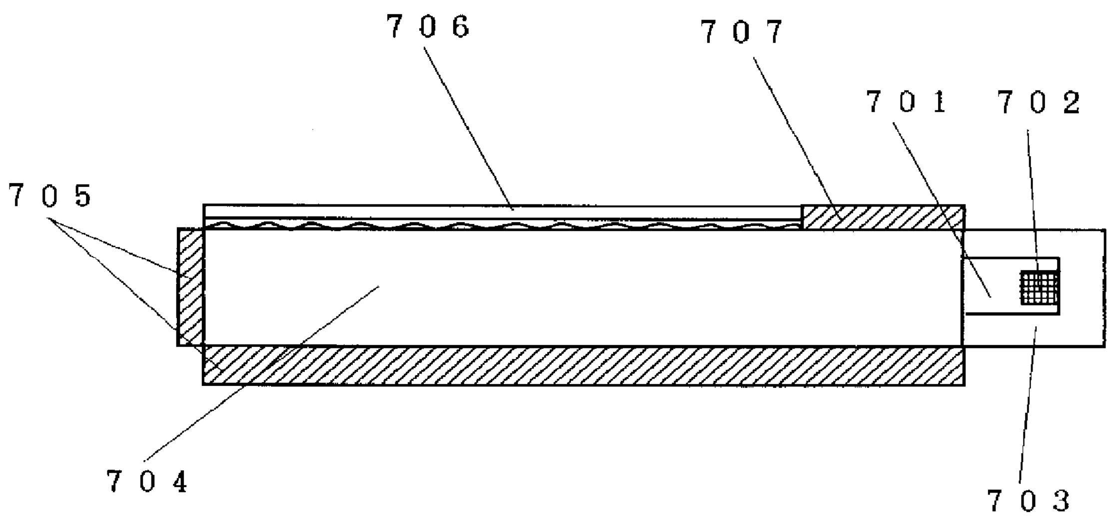
【図５】



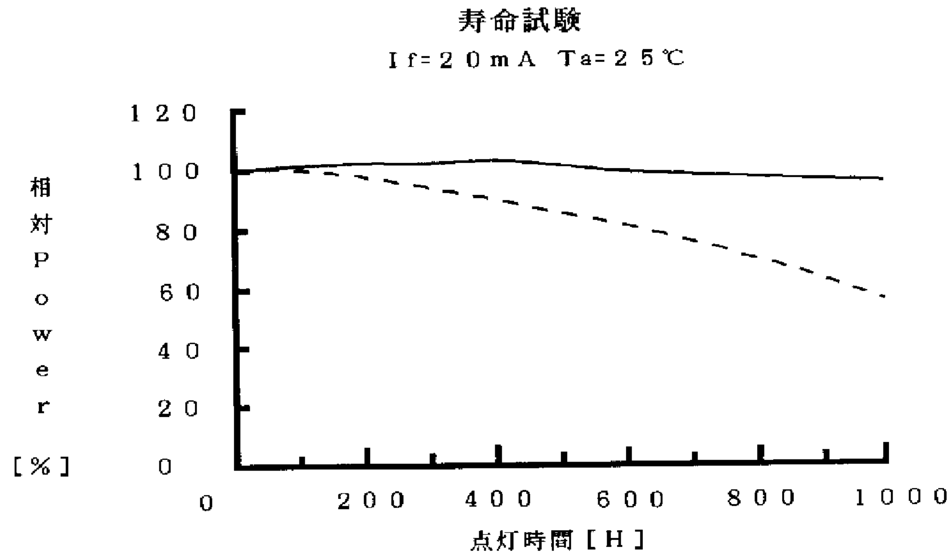
【図６】


白色発光可能な発光ダイオードを用いたＬＥＤ表示器
ドライバー
画像データ記憶手段（ＲＡＭ）
階調制御手段（ＣＰＵ）

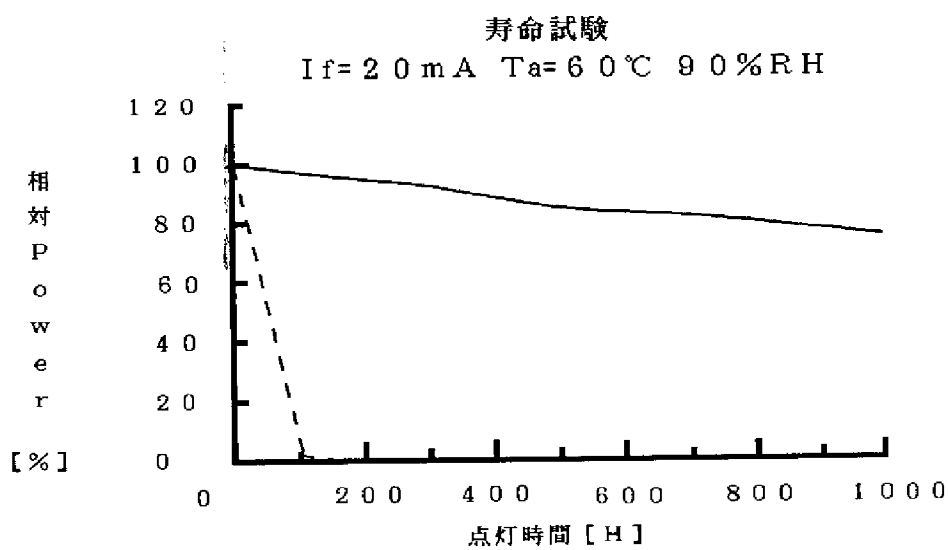
【図７】



【図８】


寿命試験
If=20mA Ta=25℃
120
100
80
60
40
20
0
相対Power [%]
0
200
400
600
800
1000
点灯時間 [H]

(A)


寿命試験
If=20mA Ta=60℃ 90%RH
120
100
80
60
40
20
0
相対Power [%]
0
200
400
600
800
1000
点灯時間 [H]

(B)

【書類名】　要約書

【課題】

本願発明は、ＬＥＤチップからの発光を変換して発光させるフォトルミネセンス蛍光体を有し使用環境によらず高輝度、高効率に発光可能な発光ダイオード及びそれを用いた表示装置に関する。

【解決手段】

本願発明は、発光層が窒化ガリウム系化合物半導体であるＬＥＤチップと、該ＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光するフォトルミネセンス蛍光体と、を有する発光ダイオードであって、前記ＬＥＤチップの発光スペクトルの主ピークが４００ｎｍから５３０ｎｍ内の発光波長を有すると共に、前記フォトルミネセンス蛍光体が$RE_3(Al,Ga)_5O_{12}:Ce$である発光ダイオード。但し、ＲＥは、Ｙ，Ｇａ，Ｓｍから選択される少なくとも一種である。

【選択図】図１

【書類名】　　　　　　　職権訂正データ
【訂正書類】　　　　　　特許願

<認定情報・付加情報>

【特許出願人】　　　　　申請人
　【識別番号】　　　　　000226057
　【住所又は居所】　　　徳島県阿南市上中町岡４９１番地１００
　【氏名又は名称】　　　日亜化学工業株式会社

出願人履歴

０００２２６０５７

19900818

新規登録

徳島県阿南市上中町岡４９１番地１００

日亜化学工業株式会社

日本国特許庁
JAPAN PATENT OFFICE

別紙添付の書類に記載されている事項は下記の出願書類に記載されている事項と同一であることを証明する。

This is to certify that the annexed is a true copy of the following application as filed with this Office.

出願年月日 Date of Application:	１９９６年１２月２７日
出願番号 Application Number:	平成　８年特許願第３５９００４号
パリ条約による外国への出願に用いる優先権の主張の基礎となる出願の国コードと出願番号 The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is	ＪＰ１９９６－３５９００４
出願人 Applicant(s):	日亜化学工業株式会社

２０１０年１１月２４日

特許庁長官
Commissioner,
Japan Patent Office

岩井良行

【書類名】特許願

【整理番号】P6270

【提出日】平成 8年12月27日

【あて先】特許庁長官　荒井　寿光　殿

【国際特許分類】

H01L 33/00

【発明の名称】発光ダイオード及びそれを用いた表示装置

【請求項の数】　7

【発明者】

【住所又は居所】徳島県阿南市上中町岡４９１番地１００　日亜化学工業株式会社内

【氏名】清水　義則

【発明者】

【住所又は居所】徳島県阿南市上中町岡４９１番地１００　日亜化学工業株式会社内

【氏名】阪野　顕正

【特許出願人】

【識別番号】000226057

【氏名又は名称】日亜化学工業株式会社

【代表者】小川　英治

【代理人】

【識別番号】100074354

【弁理士】

【氏名又は名称】豊栖　康弘

【電話番号】0886-64-2277

【先の出願に基づく優先権の主張】

【出願番号】平成 8年特許願第198585号

【出願日】平成 8年 7月29日

【先の出願に基づく優先権の主張】

【出願番号】平成 8年特許願第245381号

【出願日】平成 8年 9月18日

【手数料の表示】

【予納台帳番号】015141

【納付金額】21,000

【提出物件の目録】

【物件名】明細書　1

【物件名】図面　1

【物件名】要約書　1

【包括委任状番号】9007362

【書類名】　明細書

【発明の名称】　発光ダイオード及びそれを用いた表示装置

【特許請求の範囲】

【請求項１】　ＬＥＤチップと、該ＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光するフォトルミネセンス蛍光体とを有する発光ダイオードにおいて、

前記ＬＥＤチップが窒化物系化合物半導体で、前記フォトルミネセンス蛍光体がセリウムで付活されたイットリウム・アルミニウム・ガーネット系蛍光体であることを特徴とする発光ダイオード。

【請求項２】　前記窒化物系化合物半導体であるＬＥＤチップの発光スペクトルの主ピークが４００ｎｍから５３０ｎｍ内の発光波長を有する請求項１に記載される発光ダイオード。

【請求項３】　ＬＥＤチップと、該ＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光するフォトルミネセンス蛍光体とを有する発光ダイオードにおいて、

前記ＬＥＤチップが窒化ガリウム系化合物半導体で、前記フォトルミネセンス蛍光体が$(RE_{1-x}Sm_{x})_{3}(Al_{y}Ga_{1-y})_{5}O_{12}:Ce$蛍光体であることを特徴とする発光ダイオード。

ただし、$0 \leqq x < 1$、$0 \leqq y \leqq 1$、ＲＥは、Ｙ、Ｇｄから選択される少なくとも一種である。

【請求項４】　前記窒化ガリウム系化合物半導体であるＬＥＤチップの発光スペクトルの主ピークが４００ｎｍから５３０ｎｍ内の発光波長を有する請求項３に記載される発光ダイオード。

【請求項５】　マウント・リードのカップ内に配置させたＬＥＤチップと、該ＬＥＤチップと導電性ワイヤーを用いて電気的に接続させたインナー・リードと、前記カップ内に充填させたコーティング部材と、該コーティング部材、ＬＥＤチップ、導電性ワイヤー及びマウント・リードとインナー・リードの少なくとも一部を被覆するモールド部材と、を有する発光ダイオードであって、

前記ＬＥＤチップが窒化ガリウム系化合物半導体であり、かつ前記コーティン

グ部材が（$(\mathrm{RE}_{1-x}\mathrm{Sm}_x)_3(\mathrm{Al}_y\mathrm{Ga}_{1-y})_5\mathrm{O}_{12}$：Ｃｅ蛍光体を有する透光性樹脂であることを特徴とする発光ダイオード。

ただし、$0 \leqq x < 1$、$0 \leqq y \leqq 1$、ＲＥは、Ｙ、Ｇｄから選択される少なくとも一種である。

【請求項６】　前記フォトルミネセンス蛍光体の組成が次の一般式で示されることを特徴とする請求項１、請求項３又は請求項５記載の発光ダイオード。

$$(\mathrm{Y}_{1-p-q-r}\mathrm{Gd}_p\mathrm{Ce}_q\mathrm{Sm}_r)_3(\mathrm{Al}_{1-s}\mathrm{Ga}_s)_5\mathrm{O}_{12}$$

ただし、
$$0 \leqq p \leqq 0.8$$
$$0.003 \leqq q \leqq 0.2$$
$$0.0003 \leqq r \leqq 0.08$$
$$0 \leqq s \leqq 1$$

【請求項７】　請求項５記載の発光ダイオードをマトリックス状に配置したＬＥＤ表示器と、該ＬＥＤ表示器と電気的に接続させた駆動回路と、を有するＬＥＤ表示装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】

本願発明は、ＬＥＤディスプレイ、バックライト光源、信号機、照光式スイッチ及び各種インジケータなどに利用される発光ダイオードに係わり、特に発光素子であるＬＥＤチップからの発光を変換して発光させるフォトルミネセンス蛍光体を有し使用環境によらず高輝度、高効率な発光装置である発光ダイオード及びそれを用いた表示装置に関する。

【０００２】

【従来の技術】

発光ダイオード（以下、ＬＥＤともいう）は、小型で効率が良く鮮やかな色の発光をする。また、半導体素子であるため球切れなどの心配がない。初期駆動特性が優れ、振動やON／OFF点灯の繰り返しに強いという特長を有する。そのため各種インジケータや種々の光源として利用されている。最近、超高輝度高効率な発光ダイオードとしてＲＧＢ（赤、緑、青色）などの発光ダイオードがそれぞれ

開発された。これに伴いＲＧＢの三原色を利用したＬＥＤディスプレイが省電力、長寿命、軽量などの特長を生かして飛躍的に発展を遂げつつある。

【０００３】

発光ダイオードは使用される発光層の半導体材料、形成条件などによって紫外から赤外まで種々の発光波長を放出させることが可能である。また、優れた単色性ピーク波長を有する。

【０００４】

しかしながら、発光ダイオードは優れた単色性ピーク波長を有するが故に白色系発光光源などとさせるためには、ＲＧＢなどが発光可能な各ＬＥＤチップをそれぞれ近接して発光させ拡散混色させる必要がある。このような発光ダイオードは、種々の色を自由に発光させる発光装置としては有効であるが、白色系などの色のみを発光させる場合においても赤色系、緑色系及び青色系の発光ダイオード、あるいは青緑色系及び黄色系の発光ダイオードをそれぞれ使用せざるを得ない。ＬＥＤチップは、半導体であり色調や輝度のバラツキもまだ相当ある。また、半導体発光素子であるＬＥＤチップがそれぞれ異なる材料を用いて形成されている場合、各ＬＥＤチップの駆動電力などが異なり個々に電源を確保する必要がある。そのため、各半導体ごとに電流などを調節して白色系を発光させなければならない。同様に、半導体発光素子であるため個々の温度特性の差や経時変化が異なり、色調が種々変化してしまう。さらに、ＬＥＤチップからの発光を均一に混色させなければ色むらを生ずる場合がある。

【０００５】

そこで、本出願人は先にＬＥＤチップの発光色を蛍光体で色変換させた発光ダイオードとして特開平５－１５２６０９号公報、特開平７－９９３４５号公報などに記載された発光ダイオードを開発した。これらの発光ダイオードによって、１種類のＬＥＤチップを用いて白色系など他の発光色を発光させることができる。

【０００６】

具体的には、発光層のエネルギーバンドギャップが大きいＬＥＤチップをリードフレームの先端に設けられたカップ上などに配置する。ＬＥＤチップは、ＬＥ

Ｄチップが設けられたメタルステムやメタルポストとそれぞれ電気的に接続させる。そして、ＬＥＤチップを被覆する樹脂モールド部材中などにＬＥＤチップからの光を吸収し波長変換する蛍光体を含有させて形成させてある。

【０００７】

ＬＥＤチップからの発光を波長変換した発光ダイオードとして、青色系の発光ダイオードの発光と、その発光を吸収し黄色系を発光する蛍光体からの発光との混色により白色系が発光可能な発光ダイオードなどとすることができる。これらの発光ダイオードは、白色系を発光する発光ダイオードとして利用した場合においても十分な輝度を発光する発光ダイオードとすることができる。

【０００８】

【発明が解決する課題】

発光ダイオードによって励起される蛍光体は、蛍光染料、蛍光顔料さらには有機、無機化合物などから様々なものが挙げられる。また、蛍光体は、発光素子からの発光波長を波長の短いものから長い波長へと変換する、あるいは発光素子からの発光波長を波長の長いものから短い波長へと変換するものとがある。

【０００９】

しかしながら、波長の長いものから短い波長へと変換する場合、変換効率が極めて悪く実用に向かない。また、ＬＥＤチップ周辺に近接して配置された蛍光体は、太陽光よりも約３０倍から４０倍にも及ぶ強照射強度の光線にさらされる。特に、発光素子であるＬＥＤチップを高エネルギーバンドギャップを有する半導体を用い蛍光体の変換効率向上や蛍光体の使用量を減らした場合においては、ＬＥＤチップから発光した光が可視光域にあるといっても光エネルギーが必然的に高くなる。この場合、発光強度を更に高め長期にわたって使用すると、蛍光体自体が劣化しやすい。蛍光体が劣化すると色調がずれる、あるいは蛍光体が黒ずみ光の外部取り出し効率が低下する場合がある。同様にＬＥＤチップの近傍に設けられた蛍光体は、ＬＥＤチップの昇温や外部環境からの加熱など高温にもさらされる。さらに、発光ダイオードは、一般的に樹脂モールドに被覆されてはいるものの外部環境からの水分の進入などを完全に防ぐことや製造時に付着した水分を完全に除去することはできない。蛍光体によっては、このような水分が発光素子

からの高エネルギー光や熱によって蛍光体物質の劣化を促進する場合もある。また、イオン性の有機染料に至ってはチップ近傍では直流電界により電気泳動を起こし、色調が変化する可能性がある。したがって、本願発明は上記課題を解決し、より高輝度、長時間の使用環境下においても発光光率の低下や色ずれの極めて少ない発光ダイオードを提供することを目的とする。

【００１０】

【課題を解決するための手段】

本願発明の請求項１の発光ダイオードは、ＬＥＤチップと、このＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光するフォトルミネセンス蛍光体とを有する。ＬＥＤチップは、窒化物系化合物半導体で、フォトルミネセンス蛍光体は、セリウムで付活されたイットリウム・アルミニウム・ガーネット系蛍光体である。

【００１１】

また、本発明の請求項３の発光ダイオードは、ＬＥＤチップを窒化ガリウム系化合物半導体とし、フォトルミネセンス蛍光体を、$(RE_{1-x}Sm_x)_3(Al_yGa_{1-y})_5O_{12}$：Ｃｅ蛍光体とする。ただし、$0 \leqq x < 1$、$0 \leqq y \leqq 1$、ＲＥは、Ｙ、Ｇｄから選択される少なくとも一種である。

【００１２】

さらにまた、本発明の請求項２と請求項４に記載する発光ダイオードは、窒化ガリウム系化合物半導体であるＬＥＤチップの発光スペクトルの主ピークを、４００ｎｍから５３０ｎｍ内の発光波長とする。

【００１３】

また、本発明の請求項５の発光ダイオードは、マウント・リードのカップ内に配置させたＬＥＤチップと、該ＬＥＤチップと導電性ワイヤーを用いて電気的に接続させたインナー・リードと、前記カップ内に充填させたコーティング部材と、該コーティング部材、ＬＥＤチップ、導電性ワイヤー及びマウント・リードとインナー・リードの少なくとも一部を被覆するモールド部材とを有する。この発光ダイオードは、前記ＬＥＤチップを窒化ガリウム系化合物半導体とし、かつ前記コーティング部材に、$(RE_{1-x}Sm_x)_3(Al_yGa_{1-y})_5O_{12}$：Ｃｅ蛍光体

を含む透光性樹脂を使用する。ただし、$0 \leqq x < 1$、$0 \leqq y \leqq 1$、ＲＥは、Ｙ、Ｇｄから選択される少なくとも一種である。

【００１４】

さらに、本発明の請求項６に記載する発光ダイオードは、前記フォトルミネセンス蛍光体を、次の組成のものとする。

$(Y_{1-p-q-r}Gd_pCe_qSm_r)_3(Al_{1-s}Ga_s)_5O_{12}$

ただし、　$0 \leqq p \leqq 0.8$

$0.003 \leqq q \leqq 0.2$

$0.0003 \leqq r \leqq 0.08$

$0 \leqq s \leqq 1$

【００１５】

また、請求項７記載の表示装置は、前記請求項５に記載する発光ダイオードをマトリックス状に配置したＬＥＤ表示器と、該ＬＥＤ表示器と電気的に接続させた駆動回路と、を有する。

【００１６】

【発明の実施の形態】

本願発明者は、種々の実験の結果、可視光域における光エネルギーが比較的高いＬＥＤチップからの発光光をフォトルミネセンス蛍光体によって色変換させる発光ダイオードにおいて、特定の半導体及び蛍光体を選択することにより高輝度、長時間の使用時における光効率低下や色ずれを防止できることを見出し本願発明を成すに至った。

【００１７】

すなわち、発光ダイオードに用いられるフォトルミネセンス蛍光体としては、

１．耐光性に優れていることが要求される。特に、半導体発光素子などの微小領域から強放射されるために太陽光の約３０倍から４０倍にもおよぶ強照射強度にも十分耐える必要がある。

２．発光素子との混色を利用するため紫外線ではなく青色系発光で効率よく発光すること。

３．混色を考慮して緑色系から赤色系の光が発光可能なこと。

４．発光素子近傍に配置されるため温度特性が良好であること。
５．色調が組成比あるいは複数の蛍光体の混合比で連続的に変えられること。
６．発光ダイオードの利用環境に応じて耐候性があることなどの特長を有することが求められる。

【００１８】

これらの条件を満たすものとして本願発明の発光ダイオードは、発光層に高エネルギーバンドギャップを有する窒化ガリウム系化合物半導体素子と、フォトルミネセンス蛍光体であるセリウムで付活されたイットリウム・アルミニウム・ガーネット系蛍光体とを組み合わせる。これにより発光素子から放出された可視光域における高エネルギー光を長時間その近傍で高輝度に照射した場合であっても発光色の色ずれや発光輝度の低下が極めて少ない発光ダイオードとすることができるものである。

【００１９】

具体的な発光ダイオードの一例を図１に示し、さらに、チップタイプＬＥＤのの断面図を図２に示す。チップタイプＬＥＤの筐体２０４内に窒化ガリウム系半導体を用いたＬＥＤチップ２０２をエポキシ樹脂などを用いて固定させてある。導電性ワイヤー２０３として金線をＬＥＤチップ２０２の各電極と筐体に設けられた各電極２０５とにそれぞれ電気的に接続させてある。$(RE_{1-x}Sm_x)_3(Al_yGa_{1-y})_5O_{12}$：Ｃｅ蛍光体をエポキシ樹脂中に混合分散させたものをＬＥＤチップ、導電性ワイヤーなどを外部応力などから保護するモールド部材２０１として均一に硬化形成させる。このような発光ダイオードに電力を供給させることによってＬＥＤチップ２０２を発光させる。ＬＥＤチップ２０２からの発光と、その発光によって励起されたフォトルミネセンス蛍光体からの発光光との混色により白色系などが発光可能な発光ダイオードとすることができる。以下、本願発明の構成部材について詳述する。

【００２０】

（蛍光体）

本願発明の発光ダイオードに用いられるフォトルミネセンス蛍光体は、半導体発光層から発光された可視光や紫外線で励起されて発光するフォトルミネセンス

蛍光体である。具体的なフォトルミネセンス蛍光体として、セリウムで付活されたイットリウム・アルミニウム・ガーネット系蛍光体である。更に詳しくは、（$(RE_{1-x}Sm_x)_3(Al_yGa_{1-y})_5O_{12}$：Ｃｅ（但し、$0 \leqq x < 1$、$0 \leqq y \leqq 1$、ＲＥは、Ｙ、Ｇｄから選択される少なくとも一種）である。窒化ガリウム系化合物半導体を用いたＬＥＤチップから発光した光と、ボディーカラーが黄色であるフォトルミネセンス蛍光体から発光する光が補色関係などにある場合、ＬＥＤチップからの発光と、フォトルミネセンス蛍光体からの発光とを混色表示させると、白色系の発光色表示を行うことができる。そのため発光ダイオード外部には、ＬＥＤチップからの発光とフォトルミネセンス蛍光体からの発光とがモールド部材を透過する必要がある。したがって、フォトルミネセンス蛍光体のバルク層内などにＬＥＤチップを閉じこめ、フォトルミネセンス蛍光体層にＬＥＤチップからの光が透過する開口部を１ないし２以上有する構成の発光ダイオードとしても良い。また、フォトルミネセンス蛍光体の粉体を樹脂や硝子中に含有させＬＥＤチップからの光が透過する程度に薄く形成させても良い。フォトルミネセンス蛍光体と樹脂などとの比率や塗布、充填量を種々調整すること及び発光素子の発光波長を選択することにより白色を含め電球色など任意の色調を提供させることができる。

【００２１】

さらに、フォトルミネセンス蛍光体の含有分布は、混色性や耐久性にも影響する。すなわち、フォトルミネセンス蛍光体が含有されたコーティング部やモールド部材の表面側からＬＥＤチップに向かってフォトルミネセンス蛍光体の分布濃度が高い場合は、外部環境からの水分などの影響をより受けにくく水分による劣化を抑制しやすい。他方、フォトルミネセンス蛍光体の含有分布をＬＥＤチップからモールド部材表面側に向かって分布濃度が高くなると外部環境からの水分の影響を受けやすいがＬＥＤチップからの発熱、照射強度などの影響がより少なくフォトルミネセンス蛍光体の劣化を抑制することができる。このような、フォトルミネセンス蛍光体の分布は、フォトルミネセンス蛍光体を含有する部材、形成温度、粘度やフォトルミネセンス蛍光体の形状、粒度分布などを調整させることによって種々形成させることができる。したがって、使用条件などにより蛍光体

の分布濃度を、種々選択することができる。

【００２２】

本願発明のフォトルミネセンス蛍光体は、特にＬＥＤチップと接する、あるいは近接して配置され放射照度として（Ｅｅ）＝３Ｗ・ｃｍ$^{-2}$以上１０Ｗ・ｃｍ$^{-2}$以下においても高効率に十分な耐光性を有し、優れた発光特性の発光ダイオードとすることができる。

【００２３】

本願発明に用いられるフォトルミネセンス蛍光体は、ガーネット構造のため、熱、光及び水分に強く、図４に示すように、励起スペクトルのピークを４５０ｎｍ付近にさせることができる。また、発光ピークも図４に示すように、５３０ｎｍ付近にあり７００ｎｍまで裾を引くブロードな発光スペクトルを持つ。しかも、組成のＡｌの一部をＧａで置換することで発光波長が短波長にシフトし、また組成のＹの一部をＧｄで置換することで、発光波長が長波長へシフトする。このように組成を変化することで発光色を連続的に調節することが可能である。また、２５４ｎｍや３６５ｎｍなどのＨｇ輝線ではほとんど励起されず４５０ｎｍ付近などの青色系ＬＥＤチップからの光による励起効率が高い。したがって、長波長側の強度がＧｄの組成比で連続的に変えられるなど窒化物半導体の青色系発光を白色系発光に変換するための理想条件を備えている。

【００２４】

また、窒化ガリウム系半導体を用いたＬＥＤチップと、セリウムで付活されたイットリウム・アルミニウム・ガーネット蛍光体（ＹＡＧ）に希土類元素のサマリウム（Ｓｍ）を含有させたフォトルミネセンス蛍光体と、を有する発光ダイオードとすることによりさらに光効率を向上させることができる。

【００２５】

このようなフォトルミネセンス蛍光体は、Ｙ、Ｇｄ、Ｃｅ、Ｓｍ、Ａｌ及びＧａの原料として酸化物、又は高温で容易に酸化物になる化合物を使用し、それらを化学量論比で十分に混合して原料を得る。又は、Ｙ、Ｇｄ、Ｃｅ、Ｓｍの希土類元素を化学量論比で酸に溶解した溶解液を蓚酸で共沈したものを焼成して得られる共沈酸化物と、酸化アルミニウム、酸化ガリウムとを混合して混合原料を得

る。これにフラックスとしてフッ化アンモニウム等のフッ化物を適量混合して坩堝に詰め、空気中１３５０～１４５０°Ｃの温度範囲で２～５時間焼成して焼成品を得、次に焼成品を水中でボールミルして、洗浄、分離、乾燥、最後に篩を通すことで得ることができる。

【００２６】

$(Y_{1-p-q-r}Gd_{p}Ce_{q}Sm_{r})_{3}Al_{5}O_{12}$フォトルミネセンス蛍光体は、結晶中にＧｄを含有することにより、特に４６０ｎｍ以上の長波長域の励起発光効率を高くすることができる。ガドリニウムの含有量の増加により、発光ピーク波長が、５３０ｎｍから５７０ｎｍまで長波長に移動し、全体の発光波長も長波長側にシフトする。赤みの強い発光色が必要な場合、Ｇｄの置換量を多くすることで達成できる。一方、Ｇｄが増加すると共に、青色光によるフォトルミネセンスの発光輝度は徐々に低下する。したがって、ｐは０．８以下であることが好ましく、０．７以下であることがより好ましい。さらに好ましくは０．６以下である。

【００２７】

Ｓｍを含有する$(Y_{1-p-q-r}Gd_{p}Ce_{q}Sm_{r})_{3}Al_{5}O_{12}$蛍光体は、Ｇｄの含有量の増加に関わらず温度特性の低下が少ない。このようにＳｍを含有させることにより、高温度におけるフォトルミネセンス蛍光体の発光輝度は大幅に改善される。その改善される程度はＧｄの含有量が高くなるほど大きくなる。すなわち、Ｇｄを増加してフォトルミネセンス蛍光体の発光色調に赤みを付与した組成ほどＳｍの含有による温度特性改善に効果的であることが分かった。（なお、ここでの温度特性とは、４５０ｎｍの青色光による常温（２５°Ｃ）における励起発光輝度に対する、同蛍光体の高温（２００°Ｃ）における発光輝度の相対値（％）で表している。）

【００２８】

Ｓｍの含有量は０．０００３≦ｒ≦０．０８の範囲で温度特性が６０％以上となり好ましい。この範囲よりｒが小さいと、温度特性改良の効果が小さくなる。また、この範囲よりｒが大きくなると温度特性は逆に低下してくる。０．０００７≦ｒ≦０．０２の範囲では温度特性は８０％以上となり最も好ましい。

【００２９】

Ｃｅは０．００３≦ｑ≦０．２の範囲で相対発光輝度が７０％以上となる。ｑが０．００３以下では、Ｃｅによるフォトルミネセンスの励起発光中心の数が減少することで輝度低下し、逆に、０．２より大きくなると濃度消光が生ずる。

【００３０】

本願発明の発光ダイオードにおいてこのようなフォトルミネセンス蛍光体は、２種類以上の（$\mathrm{RE}_{1-x}\mathrm{Sm}_{x}$）$_3$（$\mathrm{Al}_{y}\mathrm{Ga}_{1-y}$）$_5\mathrm{O}_{12}$：Ｃｅフォトルミネセンス蛍光体を混合させてもよい。すなわち、Ａｌ、Ｇａ、Ｙ及びＧｄやＳｍの含有量が異なる２種類以上の（$\mathrm{RE}_{1-x}\mathrm{Sm}_{x}$）$_3$（$\mathrm{Al}_{y}\mathrm{Ga}_{1-y}$）$_5\mathrm{O}_{12}$：Ｃｅフォトルミネセンス蛍光体を混合させてＲＧＢの波長成分を増やすことができる。これに、カラーフィルターを用いることによりフルカラー液晶表示装置用としても利用できる。

【００３１】

（ＬＥＤチップ１０２、２０２、７０２）

ＬＥＤチップは、図１に示すように、モールド部材１０４に埋設されることが好ましい。本願発明の発光ダイオードに用いられるＬＥＤチップとは、セリウムで付活されたイットリウム・アルミニウム・ガーネット系蛍光体を効率良く励起できる窒化物系化合物半導体である。発光素子であるＬＥＤチップは、ＭＯＣＶＤ法等により基板上にＩｎＧａＮ等の半導体を発光層として形成させる。半導体の構造としては、ＭＩＳ接合、ＰＩＮ接合やＰＮ接合などを有するホモ構造、ヘテロ構造あるいはダブルヘテロ構成のものが挙げられる。半導体層の材料やその混晶度によって発光波長を種々選択することができる。また、半導体活性層を量子効果が生ずる薄膜に形成させた単一量子井戸構造や多重量子井戸構造とすることもできる。特に、本願発明においては、ＬＥＤチップの活性層をＩｎＧａＮの単一量子井戸構造とすることにより、フォトルミネセンス蛍光体の劣化がなく、より高輝度に発光する発光ダイオードとして利用することができる。

【００３２】

窒化ガリウム系化合物半導体を使用した場合、半導体基板にはサファイヤ、スピネル、ＳｉＣ、Ｓｉ、ＺｎＯ等の材料が用いられる。結晶性の良い窒化ガリウムを形成させるためにはサファイヤ基板を用いることが好ましい。このサファイ

ヤ基板上にＧａＮ、ＡｌＮ等のバッファー層を形成しその上にＰＮ接合を有する窒化ガリウム半導体を形成させる。窒化ガリウム系半導体は、不純物をドープしない状態でＮ型導電性を示す。発光効率を向上させるなど所望のＮ型窒化ガリウム半導体を形成させる場合は、Ｎ型ドーパントとしてＳｉ、Ｇｅ、Ｓｅ、Ｔｅ、Ｃ等を適宜導入することが好ましい。一方、Ｐ型窒化ガリウム半導体を形成させる場合は、Ｐ型ドーパンドであるＺｎ、Ｍｇ、Ｂｅ、Ｃａ、Ｓｒ、Ｂａ等をドープさせる。窒化ガリウム系化合物半導体は、Ｐ型ドーパントをドープしただけではＰ型化しにくいためＰ型ドーパント導入後に、炉による加熱、低速電子線照射やプラズマ照射等によりＰ型化させることが好ましい。エッチングなどによりＰ型半導体及びＮ型半導体の露出面を形成させた後、半導体層上にスパッタリング法や真空蒸着法などを用いて所望の形状の各電極を形成させる。

【００３３】

次に、形成された半導体ウエハー等をダイヤモンド製の刃先を有するブレードが回転するダイシングソーにより直接フルカットするか、又は刃先幅よりも広い幅の溝を切り込んだ後（ハーフカット）、外力によって半導体ウエハーを割る。あるいは、先端のダイヤモンド針が往復直線運動するスクライバーにより半導体ウエハーに極めて細いスクライブライン（経線）を例えば碁盤目状に引いた後、外力によってウエハーを割り半導体ウエハーからチップ状にカットする。このようにして窒化ガリウム系化合物半導体であるＬＥＤチップを形成させることができる。

【００３４】

本願発明の発光ダイオードにおいて白色系を発光させる場合は、フォトルミネセンス蛍光体との補色関係や樹脂劣化等を考慮して発光素子の発光波長は４００ｎｍ以上５３０ｎｍ以下が好ましく、４２０ｎｍ以上４９０ｎｍ以下がより好ましい。ＬＥＤチップとフォトルミネセンス蛍光体との効率をそれぞれより向上させるためには、４５０ｎｍ以上４７５ｎｍ以下がさらに好ましい。本願発明の白色系発光ダイオードの発光スペクトルを図３に示す。４５０ｎｍ付近にピークを持つ発光がＬＥＤチップからの発光であり、５７０ｎｍ付近にピークを持つ発光がＬＥＤチップによって励起されたフォトルミネセンスの発光である。なお、本

願発明のＬＥＤチップに加えて、蛍光体を励起しないＬＥＤチップを一緒に用いることもできる。

【００３５】

（導電性ワイヤー１０３、２０３）

導電性ワイヤー１０３、２０３としては、ＬＥＤチップ１０２、２０２の電極とのオーミック性、機械的接続性、電気伝導性及び熱伝導性がよいものが求められる。熱伝導度としては０．０１ｃａｌ／ｃｍ^2／ｃｍ／℃以上が好ましく、より好ましくは０．５ｃａｌ／ｃｍ^2／ｃｍ／℃以上である。また、作業性などを考慮して導電性ワイヤーの直径は、好ましくは、Φ１０μｍ以上、Φ４５μｍ以下である。このような導電性ワイヤーとして具体的には、金、銅、白金、アルミニウム等の金属及びそれらの合金を用いた導電性ワイヤーが挙げられる。このような導電性ワイヤーは、各ＬＥＤチップの電極と、インナー・リード及びマウント・リードなどと、をワイヤーボンディング機器によって容易に接続させることができる。

【００３６】

（マウント・リード１０５）

マウント・リード１０５としては、ＬＥＤチップ１０２を配置させるものであり、ダイボンド機器などで積載するのに十分な大きさがあれば良い。また、ＬＥＤチップを複数設置しマウント・リードをＬＥＤチップの共通電極として利用する場合においては、十分な電気伝導性とボンディングワイヤー等との接続性が求められる。また、マウント・リード上のカップ内にＬＥＤチップを配置すると共に蛍光体を内部に充填させる場合は、近接して配置させた別の発光ダイオードからの光により疑似点灯することを防止することができる。

【００３７】

ＬＥＤチップ１０２とマウント・リード１０５のカップとの接着は熱硬化性樹脂などによって行うことができる。具体的には、エポキシ樹脂、アクリル樹脂やイミド樹脂などが挙げられる。また、フェースダウンＬＥＤチップなどによりマウント・リードと接着させると共に電気的に接続させるためにはＡｇペースト、カーボンペースト、金属バンプ等を用いることができる。さらに、発光ダイオー

ドの光利用効率を向上させるためにＬＥＤチップが配置されるマウント・リードの表面を鏡面状とし、表面に反射機能を持たせても良い。この場合の表面粗さは、０．１Ｓ以上０．８Ｓ以下が好ましい。また、マウント・リードの具体的な電気抵抗としては３００μΩ－ｃｍ以下が好ましく、より好ましくは、３μΩ－ｃｍ以下である。また、マウント・リード上に複数のＬＥＤチップを積置する場合は、ＬＥＤチップからの発熱量が多くなるため熱伝導度がよいことが求められる。具体的には、０．０１ｃａｌ／ｃｍ^2／ｃｍ／℃以上が好ましくより好ましくは０．５ｃａｌ／ｃｍ^2／ｃｍ／℃以上である。これらの条件を満たす材料としては、鉄、銅、鉄入り銅、錫入り銅、メタライズパターン付きセラミック等が挙げられる。

【００３８】

（インナー・リード１０６）

インナー・リード１０６としては、マウント・リード１０５上に配置されたＬＥＤチップ１０２と接続された導電性ワイヤー１０３との接続を図るものである。マウント・リード上に複数のＬＥＤチップを設けた場合は、各導電性ワイヤー同士が接触しないよう配置できる構成とする必要がある。具体的には、マウント・リードから離れるに従って、インナー・リードのワイヤーボンディングさせる端面の面積を大きくすることなどによってマウント・リードからより離れたインナー・リードと接続させる導電性ワイヤーの接触を防ぐことができる。導電性ワイヤーとの接続端面の粗さは、密着性を考慮して１．６Ｓ以上１０Ｓ以下が好ましい。インナー・リードの先端部を種々の形状に形成させるためには、あらかじめリードフレームの形状を型枠で決めて打ち抜き形成させてもよく、あるいは全てのインナー・リードを形成させた後にインナー・リード上部の一部を削ることによって形成させても良い。さらには、インナー・リードを打ち抜き形成後、端面方向から加圧することにより所望の端面の面積と端面高さを同時に形成させることもできる。

【００３９】

インナー・リードは、導電性ワイヤーであるボンディングワイヤー等との接続性及び電気伝導性が良いことが求められる。具体的な電気抵抗としては、３００

μΩ－ｃｍ以下が好ましく、より好ましくは３μΩ－ｃｍ以下である。これらの条件を満たす材料としては、鉄、銅、鉄入り銅、錫入り銅及び銅、金、銀をメッキしたアルミニウム、鉄、銅等が挙げられる。

【００４０】

（コーティング部１０１）

本願発明に用いられるコーティング部１０１とは、モールド部材１０４とは別にマウント・リードのカップに設けられるものでありＬＥＤチップの発光を変換するフォトルミネセンス蛍光体が含有されるものである。コーティング部の具体的材料としては、エポキシ樹脂、ユリア樹脂、シリコーンなどの耐候性に優れた透明樹脂や硝子などが好適に用いられる。また、フォトルミネセンス蛍光体と共に拡散剤を含有させても良い。具体的な拡散剤としては、チタン酸バリウム、酸化チタン、酸化アルミニウム、酸化珪素等が好適に用いられる。

【００４１】

（モールド部材１０４）

モールド部材１０４は、発光ダイオードの使用用途に応じてＬＥＤチップ１０２、導電性ワイヤー１０３、フォトルミネセンス蛍光体が含有されたコーティング部１０１などを外部から保護するために設けることができる。モールド部材は、一般には樹脂を用いて形成させることができる。また、フォトルミネセンス蛍光体を含有させることによって視野角を増やすことができるが、樹脂モールドに拡散剤を含有させることによってＬＥＤチップ１０２からの指向性を緩和させ視野角をさらに増やすことができる。更にまた、モールド部材１０４を所望の形状にすることによってＬＥＤチップからの発光を集束させたり拡散させたりするレンズ効果を持たせることができる。従って、モールド部材１０４は複数積層した構造でもよい。具体的には、凸レンズ形状、凹レンズ形状さらには、発光観測面から見て楕円形状やそれらを複数組み合わせた物である。モールド部材１０４の具体的材料としては、主としてエポキシ樹脂、ユリア樹脂、シリコーン樹脂などの耐候性に優れた透明樹脂や硝子などが好適に用いられる。また、拡散剤としては、チタン酸バリウム、酸化チタン、酸化アルミニウム、酸化珪素等が好適に用いられる。さらに、拡散剤に加えてモールド部材中にもフォトルミネセンス蛍光体

体を含有させることもできる。したがって、フォトルミネセンス蛍光体はモールド部材中に含有させてもそれ以外のコーティング部などに含有させて用いてもよい。また、コーティング部をフォトルミネセンス蛍光体が含有された樹脂、モールド部材を硝子などとした異なる部材を用いて形成させても良い。この場合、生産性良くより水分などの影響が少ない発光ダイオードとすることができる。また、屈折率を考慮してモールド部材とコーティング部とを同じ部材を用いて形成させても良い。本願発明においてモールド部材に拡散剤や着色剤を含有させることは、発光観測面側から見た蛍光体の着色を隠すことができると共により混色性を向上させることもできる。

【００４２】

（表示装置）

本願発明の発光ダイオードをＬＥＤ表示器に利用した場合、ＲＧＢをそれぞれ発光する発光ダイオードの組み合わせだけによるＬＥＤ表示器よりも、より高精細に白色系表示させることができる。従来の装置が、３個の発光ダイオードで白色表示するのに対して、本発明の装置は１個の発光ダイオードで白色表示できるからである。すなわち、従来の表示装置は、発光ダイオードを組み合わせて白色系などを混色表示させるためには、ＲＧＢの各発光ダイオードをそれぞれ同時に発光せざるを得ない。そのため赤色系、緑色系、青色系のそれぞれ単色表示した場合に比べて、一画素あたりの表示領域が大きくなる。したがって、白色系の表示の場合においては、ＲＧＢ単色のモノクローム表示に比較して、高精細に表示させることができない。また、白色系の表示は各発光ダイオードの発光出力を調節して表示させるため、各半導体の温度特性などを考慮し種々調整しなければならない。さらに、混色による表示であるが故にＬＥＤ表示器の視認する方向や角度によって、ＲＧＢの発光ダイオードが部分的に遮光され表示色が変わる場合もある。

本願発明の発光ダイオードをＲＧＢの発光ダイオードに代えて使用する表示装置は、より高精細化が可能となると共に、安定して白色系に発光でき、さらに、色むらを少なくできる特長がある。また、本発明の発光ダイオードは、ＲＧＢの各発光ダイオードとともに使用することもできる。この表示装置は、輝度を向上

させることができる。

【００４３】

また、本願発明の発光ダイオードを用いたＬＥＤ表示器を図５に示す。この図のＬＥＤ表示器は、本願発明の白色系発光ダイオードのみを用いて、白黒用のＬＥＤ表示装置に使用される。白黒用のＬＥＤ表示器は、本願発明の発光ダイオード５０１のみをマトリックス状などに配置している。この図のＬＥＤ表示器を備える表示装置は、ＲＧＢの発光ダイオードを備えない。このため、ＲＧＢ発光ダイオード用の複数の駆動回路を必要としない。複数の駆動回路に代わって、白色系発光ダイオード用の駆動回路で、ＬＥＤ表示器を駆動できる。

【００４４】

ＬＥＤ表示器は、駆動回路である点灯回路などと電気的に接続させる。駆動回路からの出力パルスによって種々の画像が表示可能なデイスプレイ等とすることができる。駆動回路を図６に示す。駆動回路は、入力される表示データを一時的に記憶させる画像データー記憶手段であるＲＡＭ（Ｒａｎｄｏｍ、Ａｃｃｅｓｓ、Ｍｅｍｏｒｙ）６０３と、ＲＡＭ６０３に記憶されるデータから、ＬＥＤ表示器１のそれぞれの発光ダイオードを所定の明るさに点灯させるための階調信号を演算する階調制御回路６０４と、階調制御回路６０４の出力信号でスイッチングされて、発光ダイオードを点灯させるドライバー６０２とを備える。階調制御回路６０４は、ＲＡＭ６０３に記憶されるデータからＬＥＤ表示器１の発光ダイオード点灯時間を演算して点滅させるパルス信号を出力する。

【００４５】

したがって、白黒用のＬＥＤ表示器は、ＲＧＢのフルカラー表示器と異なり、回路構成を簡略化できると共に高精細化できる。そのため、安価にＲＧＢの発光ダイオードの特性に伴う色むらなどのないディスプレイとすることができるものである。また、従来の赤色、緑色のみを用いたＬＥＤ表示器に比べ人間の目に対する刺激が少なく長時間の使用に適している。

【００４６】

本願発明の発光ダイオードは、ＲＧＢに発光する発光ダイオードに加えて使用することもできる。このＬＥＤ表示器は、駆動回路である点灯回路などと電気的

に接続させる。駆動回路からの出力パルスによって種々の画像が表示可能なディスプレイ等とすることができる。駆動回路は、モノクロームの表示装置と同じように、入力される表示データを一時的に記憶させる、画像データー記憶手段であるＲＡＭ（Ｒａｎｄｏｍ、Ａｃｃｅｓｓ、Ｍｅｍｏｒｙ）と、ＲＡＭに記憶されるデータから各発光ダイオードを所定の明るさに点灯させるための階調信号を演算する階調制御回路と、階調制御回路の出力信号でスイッチングされて、各発光ダイオードを点灯させるドライバーとを備える。ただし、この駆動回路は、ＲＧＢと白色系に発光する発光ダイオードに専用の回路を必要とする。階調制御回路は、ＲＡＭに記憶されるデータから、それぞれの発光ダイオードの点灯時間を演算して、点滅させるパルス信号を出力する。ここで、白色系の表示を行う場合は、ＲＧＢ各発光ダイオードを点灯するパルス信号のパルス幅を短く、あるいは、パルス信号のピーク値を低く、あるいは全くパルス信号を出力しない。他方、それを補償するように白色系発光ダイオードにパルス信号を出力する。これにより、ＬＥＤ表示器の白色を表示する。

【００４７】

したがって、白色系発光ダイオードを所望の輝度で点灯させるためのパルス信号を演算する階調制御回路としてＣＰＵを別途備えることが好ましい。階調制御回路から出力されるパルス信号は、白色系発光ダイオードのドライバーに入力されてドライバをスイッチングさせる。ドライバーがオンになると白色系発光ダイオードが点灯され、オフになると消灯される。

【００４８】

（信号機）

本願発明の発光ダイオードを表示装置の１種である信号機として利用した場合、長時間安定して発光させることが可能であると共に発光ダイオードの一部が消灯しても色むらなどが生じないという特長がある。本願発明の発光ダイオードを用いた信号機の概略構成として、導電性パターンが形成された基板上に白色系発光ダイオードを配置させる。このような発光ダイオードを直列又は直並列に接続された発光ダイオードの回路を発光ダイオード群として扱う。発光ダイオード群を２つ以上用いそれぞれ渦巻き状に発光ダイオードを配置させる。全ての発光ダ

イオードが配置されると円状に全面に配置される。各発光ダイオード及び基板から外部電力と接続させる電源コードをそれぞれ、ハンダにより接続させた後、鉄道用信号用の筐体内に固定させる。ＬＥＤ表示器は、遮光部材が付いたアルミダイキャストの筐体内に配置され表面にシリコーンゴムの充填材で封止されている。筐体の表示面は、白色レンズを設けてある。また、ＬＥＤ表示器の電気的配線は、筐体の裏面からゴムパッキンを通し筐体内を密閉する。これにより白色系信号機を形成することができる。本願発明の発光ダイオードを、複数の群に分け中心部から外側に向け輪を描く渦巻き状などに配置し、並列接続させることでより信頼性が高い信号機とさせることができる。中心部から外側に向け輪を描くとは連続的に輪を描くものも断続的に配置するものをも含む。したがって、ＬＥＤ表示器の表示面積などにより配置される発光ダイオードの数や発光ダイオード群の数を種々選択することができる。この信号機により、一方の発光ダイオード群や一部の発光ダイオードが何らかのトラブルにより消灯したとしても他方の発光ダイオード群や残った発光ダイオードにより信号機を円形状に均一に発光させることが可能となるものである。また、色ずれが生ずることもない。渦巻き状に配置してあることから中心部を密に配置することができ電球発光の信号と何ら違和感なく駆動させることができる。

【００４９】

（面状発光光源）

本願発明の発光ダイオードは、図７に示すように、面状発光光源とすることもできる。図に示す面状発光光源の発光ダイオードは、フォトルミネセンス蛍光体をコーティング部や導光板上の散乱シート７０６に含有させる。あるいはバインダー樹脂と共に散乱シート７０６に塗布などさせシート状７０１に形成しモールド部材を省略しても良い。具体的には、絶縁層及び導電性パターンが形成されたコの字形状の金属基板７０３内にＬＥＤチップ７０２を固定する。ＬＥＤチップと導電性パターンとの電気的導通を取った後、フォトルミネセンス蛍光体をエポキシ樹脂と混合撹拌しＬＥＤチップ７０２が積載された金属基板７０３上に充填させる。こうして固定されたＬＥＤチップは、アクリル性導光板７０４の端面にエポキシ樹脂などで固定される。導光板７０４の一方の主面上には、蛍現象防止

のため白色散乱剤が含有されたフィルム状の反射部材７０７を配置させてある。同様に、導光板の裏面側全面やＬＥＤチップが配置されていない端面上にも反射部材７０５を設け発光効率を向上させてある。これにより、ＬＣＤのバックライトとして十分な明るさを得られる面状発光光源の発光ダイオードとすることができる。液晶表示装置として利用する場合は、導光板７０４の主面上に不示図の透光性導電性パターンが形成された硝子基板間に注入された液晶装置を介して配された偏光板により構成させることができる。以下、本願発明の実施例について説明するが、本願発明は具体的実施例のみに限定されるものではないことは言うまでもない。

【００５０】

【実施例】

（実施例１）

発光素子として発光ピークが４５０ｎｍのＧａＩｎＮ半導体を用いた。ＬＥＤチップは、洗浄させたサファイヤ基板上にＴＭＧ（トリメチルガリウム）ガス、ＴＭＩ（トリメチルインジュウム）ガス、窒素ガス及びドーパントガスをキャリアガスと共に流し、ＭＯＣＶＤ法で窒化ガリウム系化合物半導体を成膜させることにより形成させた。ドーパントガスとしてSiH_4とCp_2Mgと、を切り替えることによってＮ型導電性を有する窒化ガリウム半導体とＰ型導電性を有する窒化ガリウム半導体を形成しＰＮ接合を形成させた。（なお、Ｐ型半導体は、成膜後４００℃以上でアニールさせてある。）

【００５１】

エッチングによりＰＮ各半導体表面を露出させた後、スパッタリングにより各電極をそれぞれ形成させた。こうして出来上がった半導体ウエハーをスクライブラインを引いた後、外力により分割させ発光素子としてＬＥＤチップを形成させた。

【００５２】

銀メッキした銅製リードフレームの先端にカップを有するマウント・リードにＬＥＤチップをエポキシ樹脂でダイボンディングした。ＬＥＤチップの各電極とマウント・リード及びインナー・リードと、をそれぞれ金線でワイヤーボンディ

ングし電気的導通を取った。

【００５３】

一方、フォトルミネセンス蛍光体は、Ｙ、Ｇｄ、Ｃｅの希土類元素を化学量論比で酸に溶解した溶解液を蓚酸で共沈させた。これを焼成して得られる共沈酸化物と、酸化アルミニウムを混合して混合原料を得る。これにフラックスとしてフッ化アンモニウムを混合して坩堝に詰め、空気中１４００°Ｃの温度で３時間焼成して焼成品を得た。焼成品を水中でボールミルして、洗浄、分離、乾燥、最後に篩を通して形成させた。

【００５４】

形成された（$Y_{0.8}Gd_{0.2}$）$_3Al_5O_{12}$：Ｃｅ蛍光体８０重量部、エポキシ樹脂１００重量部をよく混合してスラリーとさせた。このスラリーをＬＥＤチップが配置されたマウント・リード上のカップ内に注入させた。注入後、フォトルミネセンス蛍光体が含有された樹脂を１３０℃１時間で硬化させた。こうしてＬＥＤチップ上に厚さ１２０μのフォトルミネセンス蛍光体が含有されたコーティング部が形成された。なお、コーティング部には、ＬＥＤチップに向かってフォトルミネセンス蛍光体が徐々に多くしてある。その後、さらにＬＥＤチップやフォトルミネセンス蛍光体を外部応力、水分及び塵芥などから保護する目的でモールド部材として透光性エポキシ樹脂を形成させた。モールド部材は、砲弾型の型枠の中にフォトルミネセンス蛍光体のコーティング部が形成されたリードフレームを挿入し透光性エポシキ樹脂を混入後、１５０℃５時間にて硬化させた。こうして形成された発光ダイオードは、発光観測正面から視認するとフォトルミネセンス蛍光体のボディーカラーにより中央部が黄色っぽく着色していた。

【００５５】

こうして得られた白色系が発光可能な発光ダイオードの色度点、色温度、演色性指数を測定した。それぞれ、色度点（ｘ＝０．３０２、ｙ＝０．２８０）、色温度８０８０Ｋ、Ｒａ（演色性指数）＝８７．５と三波長型蛍光灯に近い性能を示した。また、発光効率は９．５ｌｍ／ｗと白色電球並であった。さらに寿命試験として温度２５℃６０ｍＡ通電、温度２５℃２０ｍＡ通電、温度６０℃９０％ＲＨ下で２０ｍＡ通電の各試験においても蛍光体に起因する変化は観測されず通

常の青色発光ダイオードと寿命特性に差がないことが確認できた。

【００５６】

（比較例１）

フォトルミネセンス蛍光体を$(Y_{0.8}Gd_{0.2})_3Al_5O_{12}$：Ｃｅから（ＺｎＣｄ）Ｓ：Ｃｕ、Ａｌとした以外は、実施例１と同様にして発光ダイオードの形成及び寿命試験を行った。形成された発光ダイオードは通電直後、実施例１と同様白色系の発光が確信されたが輝度が低かった。また、寿命試験においては、約１００時間で出力がゼロになった。劣化原因を解析した結果、蛍光体が黒化していた。

【００５７】

これは、発光素子の発光光と蛍光体に付着していた水分あるいは外部環境から進入した水分により光分解し蛍光体結晶表面にコロイド状亜鉛金属を析出し外観が黒色に変色したものと考えられる。温度２５℃２０ｍＡ通電、温度６０℃９０％ＲＨ下で２０ｍＡ通電の寿命試験結果を実施例１と共に図８に示す。輝度は初期値を基準にしそれぞれの相対値を示す。また、実線が実施例１であり波線が比較例１を示す。

【００５８】

（実施例２）

ＬＥＤチップの窒化物系化合物半導体を実施例１よりもＩｎの含有量を増やし発光ピークを４６０ｎｍとした。同様にフォトルミネセンス蛍光体として実施例１よりもＧｄの含有量を増やし$(Y_{0.6}Gd_{0.4})_3Al_5O_{12}$：Ｃｅとした以外は実施例１と同様にして発光ダイオードを１００個形成し寿命試験を行った。

【００５９】

こうして得られた白色系が発光可能な発光ダイオードの色度点、色温度、演色性指数を測定した。それぞれ、色度点（ｘ＝０．３７５、ｙ＝０．３７０）、色温度４４００Ｋ、Ｒａ（演色性指数）＝８６．０であった。さらに寿命試験においては、形成させた発光ダイオード１００個平均で行った。寿命試験前の光度を１００％とし１０００時間経過後における平均光度を調べた。寿命試験後も９８．８％であり特性に差がないことが確認できた。

【００６０】
（実施例３）
　フォトルミネセンス蛍光体をＹ、Ｇｄ、Ｃｅの希土類元素に加えＳｍを含有させ（$Y_{0.39}Gd_{0.57}Ce_{0.03}Sm_{0.01}$）$_3Al_5O_{12}$蛍光体とした以外は、実施例１と同様にして発光ダイオードを１００個形成した。この発光ダイオードを１３０℃の高温下において点灯させても実施例１の発光ダイオードと比較して平均温度特性が８％ほど良好であった。

【００６１】
（実施例４）
　本願発明の発光ダイオードを図５のごとくＬＥＤ表示器の１つであるディスプレイに利用した。実施例１と同様にして形成させた発光ダイオードを銅パターンを形成させたセラミックス基板上に、１６×１６のマトリックス状に配置させた。基板と発光ダイオードとは自動ハンダ実装装置を用いてハンダ付けを行った。次にフェノール樹脂によって形成された筐体５０４内部に配置し固定させた。遮光部材５０５は、筐体と一体成形させてある。発光ダイオードの先端部を除いて筐体、発光ダイオード、基板及び遮光部材の一部をピグメントにより黒色に着色したシリコンゴム４０６によって充填させた。その後、常温、７２時間でシリコンゴムを硬化させＬＥＤ表示器を形成させた。このＬＥＤ表示器と、入力される表示データを一時的に記憶させるＲＡＭ（Ｒａｎｄｏｍ、Ａｃｃｅｓｓ、Ｍｅｍｏｒｙ）及びＲＡＭに記憶されるデータから発光ダイオードを所定の明るさに点灯させるための階調信号を演算する階調制御回路と階調制御回路の出力信号でスイッチングされて発光ダイオードを点灯させるドライバーとを備えたＣＰＵの駆動手段と、を電気的に接続させてＬＥＤ表示装置を構成した。ＬＥＤ表示器を駆動させ白黒ＬＥＤ表示装置として駆動できることを確認した。

【００６２】
【発明の効果】
　本願発明の発光ダイオードは、窒化物系化合物半導体の発光素子と、セリウムで付活されたイットリウム・アルミニウム・ガーネット系蛍光体や（$RE_{1-x}Sm_x$）$_3$（Al_yGa_{1-y}）$_5O_{12}$：Ｃｅ蛍光体を組み合わせることにより長時間高

輝度時の使用においても発光効率が高い発光ダイオードを実現する。さらに、本願発明の発光ダイオードは、信頼性や省電力化、小型化さらには色温度の可変性など車載や航空産業、一般電気機器に表示の他に照明として新たな用途を開くことができる。特に、本願発明に用いられるフォトルミネセンス蛍光体は、短残光であり１２０ｎsecという応答速度を有する光源などとして利用することもできる。また、発光色を白色にして、人間の目で長時間視認する場合には刺激が少なく目に優しい発光ダイオードとすることができる。

【００６３】

特に、本願発明の請求項１または３に記載の構成とすることにより高輝度、長時間の使用においても色ずれ、発光効率の低下が極めて少ない白色系が発光可能な発光ダイオードなど種々の発光ダイオードとすることができる。また、樹脂劣化に伴う輝度の低下も抑制させることができる。

【００６４】

本願発明の請求項５の構成とすることにより、高輝度、長時間の使用においても色ずれ、発光効率の低下が極めて少ない発光ダイオードなど種々の発光ダイオードとすることができることに加えて、発光ダイオードを複数近接して配置した場合においても他方の発光ダイオードからの光により蛍光体が励起され疑似点灯されることを防止させることができる。また、ＬＥＤチップ自体の発光むらを蛍光体により分散することができるためより均一な発光光を有する発光ダイオードとすることができる。

【００６５】

本願発明の請求項６の構成とすることにより、より温度依存性の少ない発光ダイオードとすることができる。

【００６６】

本願発明の請求項７の構成とすることにより、比較的安価で高精細なＬＥＤ表示装置や視認角度によって色むらの少ないＬＥＤ表示装置とすることができる。

【００６７】

【図面の簡単な説明】

【図１】

図１は、本願発明の発光ダイオードの模式的断面図である。

【図２】

図２は、本願発明の他の発光ダイオードの模式的断面図である。

【図３】

図３は、本願発明の発光ダイオードの発光スペクトルの一例を示した図である。

【図４】

図４（Ａ）は、本願発明に使用されるフォトルミネセンス蛍光体の吸収スペクトルの一例を示し、図４（Ｂ）は、本願発明に使用されるフォトルミネセンス蛍光体の発光スペクトルの一例を示した図である。

【図５】

図５は、本願発明の発光ダイオードを用いたＬＥＤ表示装置の模式図である。

【図６】

図６は、図５に用いられるＬＥＤ表示装置のブロック図である。

【図７】

図７は、本願発明の発光ダイオードを用いた別のＬＥＤ表示装置の模式図である。

【図８】

図８（Ａ）は、本願発明の実施例１と比較のために示した比較例１の発光ダイオードとの温度２５℃２０ｍＡ通電における寿命試験を示し、図８（Ｂ）は、本願発明の実施例１と比較のために示した比較例１の発光ダイオードとの温度６０℃９０％ＲＨ下で２０ｍＡ通電における寿命試験を示したグラフである。

【符号の説明】

１０１、７０１・・・フォトルミネセンスが含有されたコーティング部

１０２、２０２、７０２・・・ＬＥＤチップ

１０３、２０３・・・導電性ワイヤー

１０４・・・モールド部材

１０５・・・マウント・リード

１０６・・・インナー・リード

２０１・・・フォトルミネセンスが含有されたモールド部材

２０４・・・筐体

２０５・・・筐体に設けられた電極

５０１・・・発光ダイオード

５０４・・・筐体

５０５・・・遮光部材

５０６・・・充填材

６０１・・・ＬＥＤ表示器

６０２・・・ドライバー

６０３・・・ＲＡＭ

６０４・・・階調制御手段

７０３・・・金属製基板

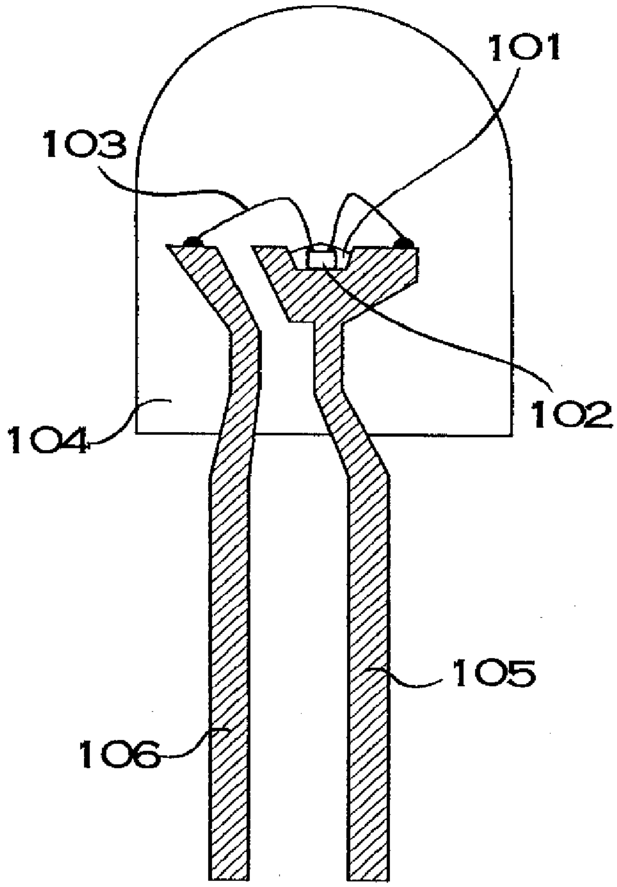
７０４・・・導光板

７０５、７０７・・・反射部材

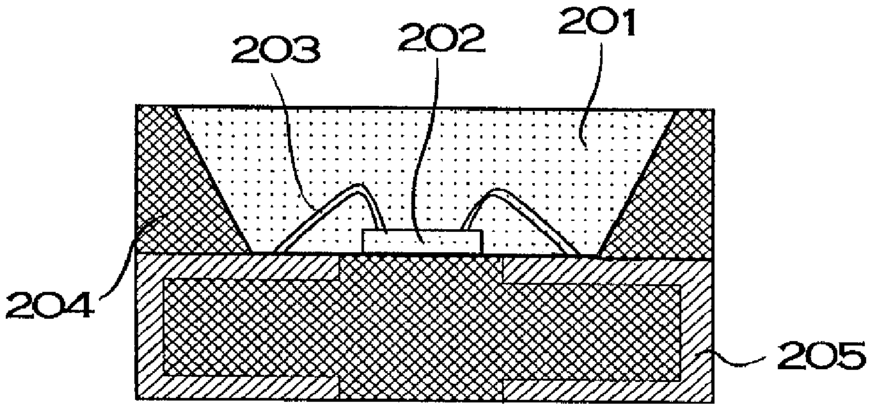
７０６・・・散乱シート

【書類名】　図面

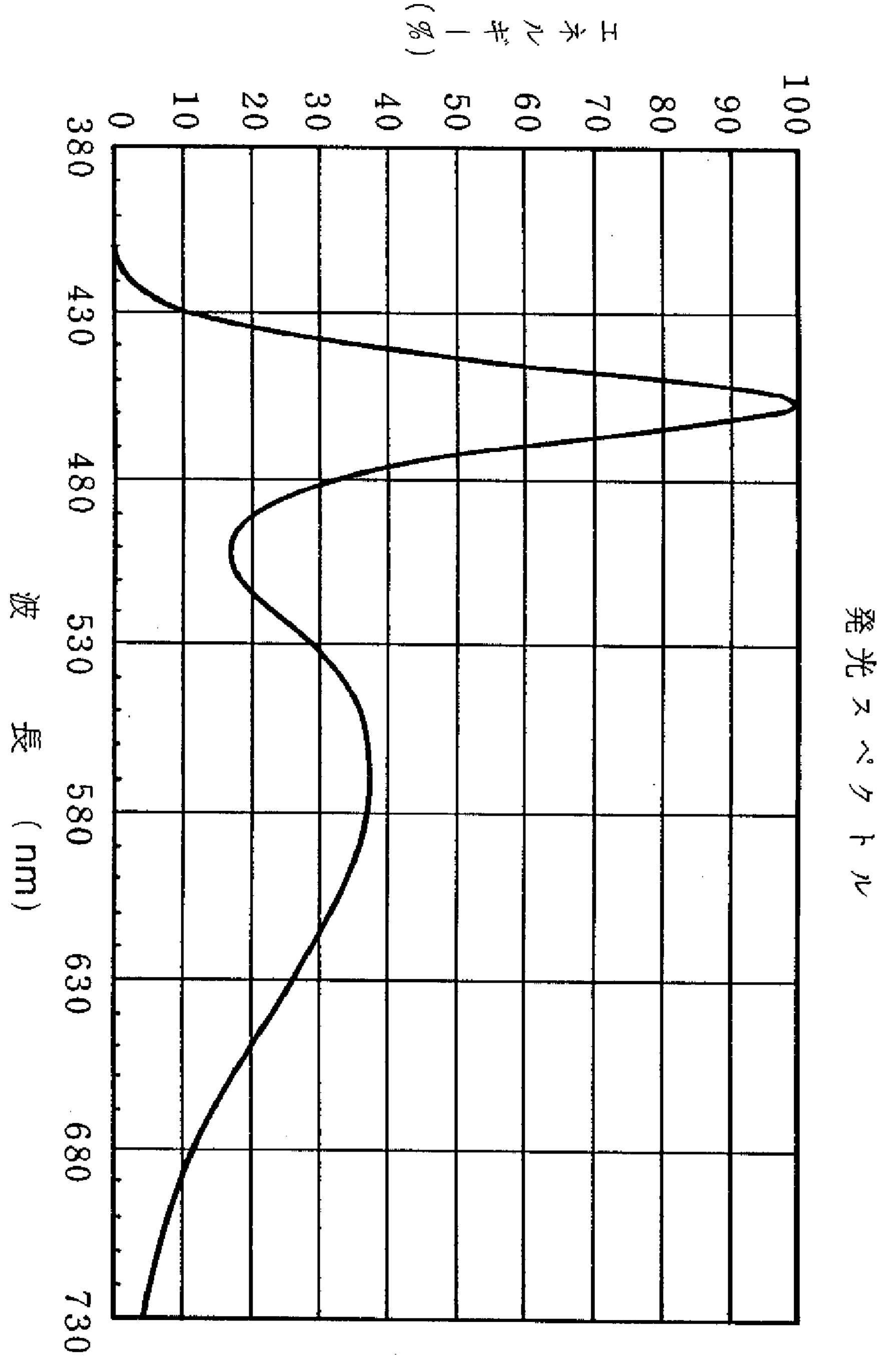
【図１】



【図２】

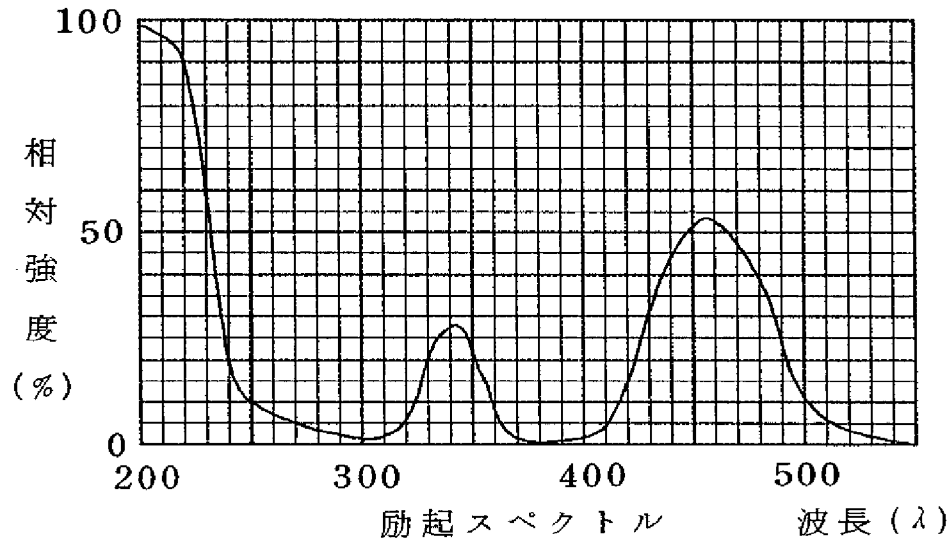


【図3】



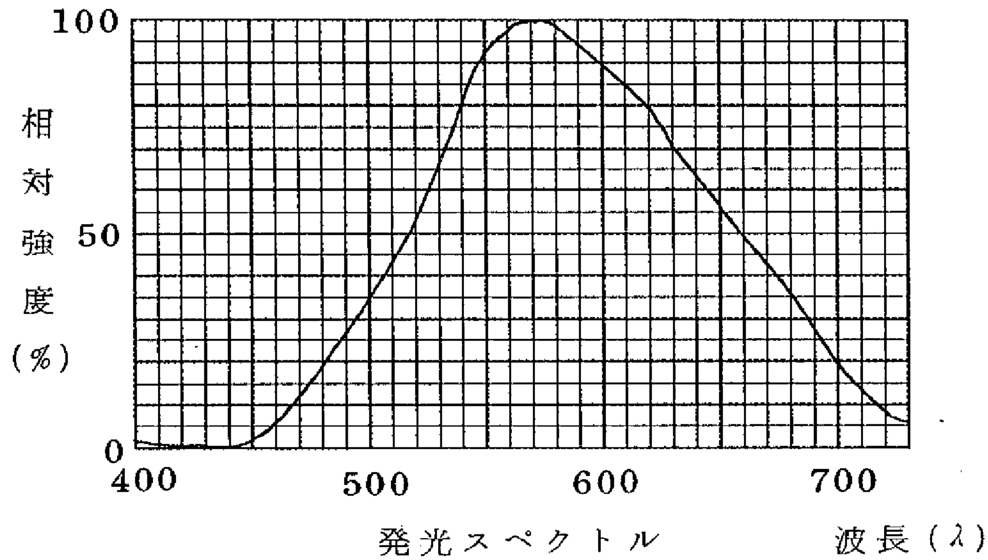
発光スペクトル
エネルギー(%)
0
10
20
30
40
50
60
70
80
90
100
380
430
480
530
580
630
680
730
波長 (nm)

【図４】



100
相
対
強
度
(%)
50
0
200
300
400
500
励起スペクトル
波長(λ)

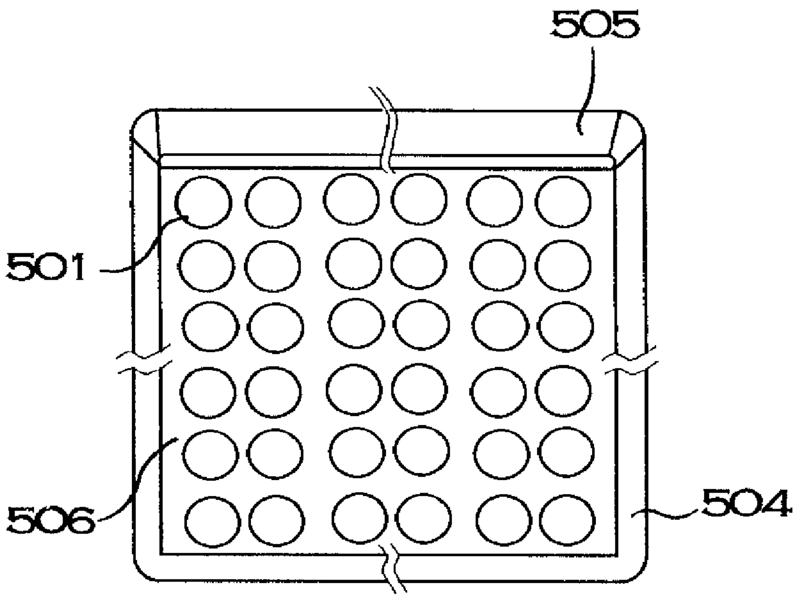
(A)



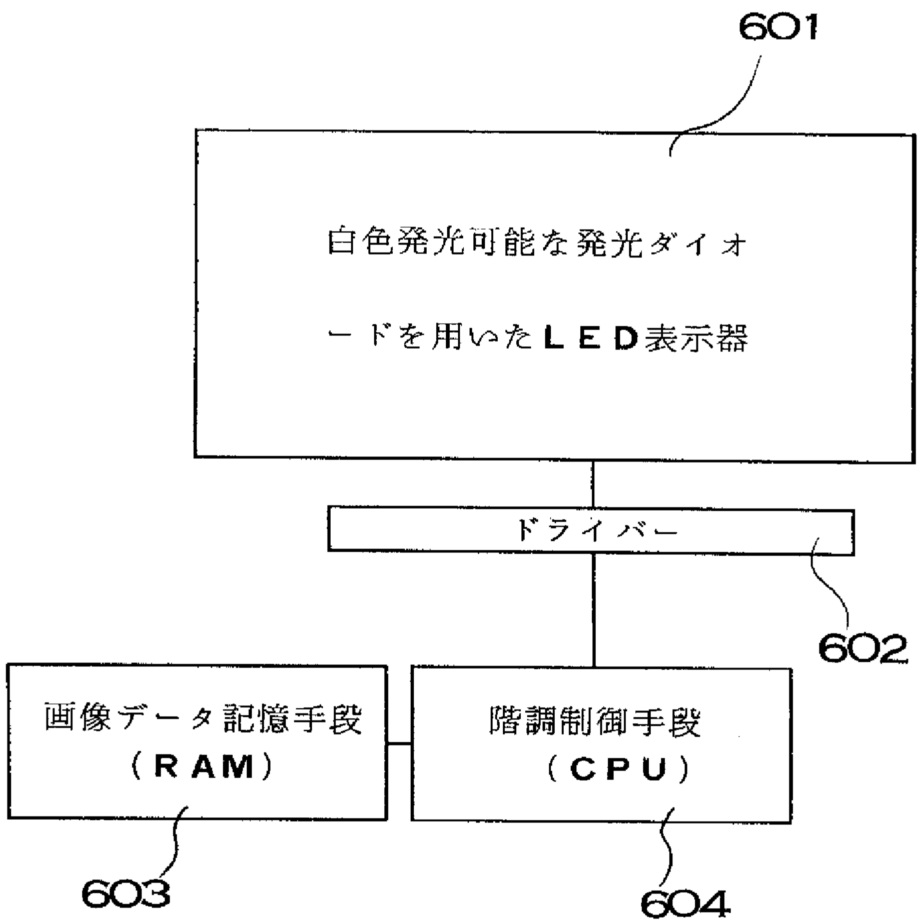
100
相
対
強
度
(%)
50
0
400
500
600
700
発光スペクトル
波長(λ)

(B)

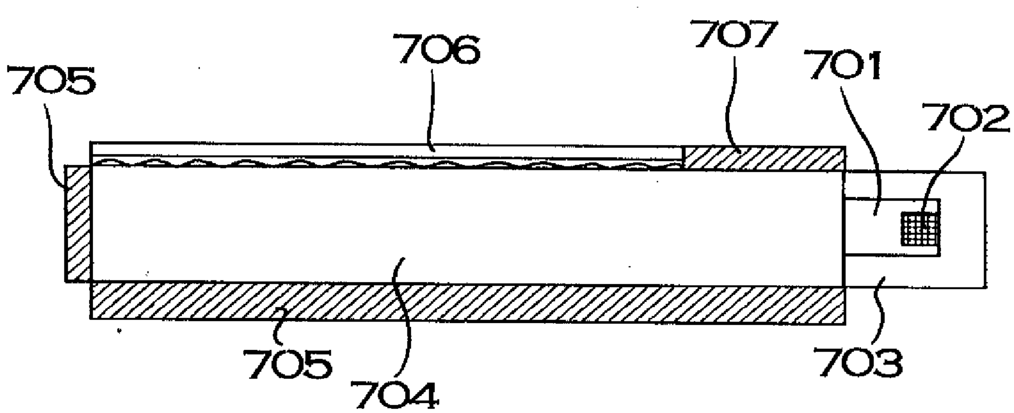
【図５】



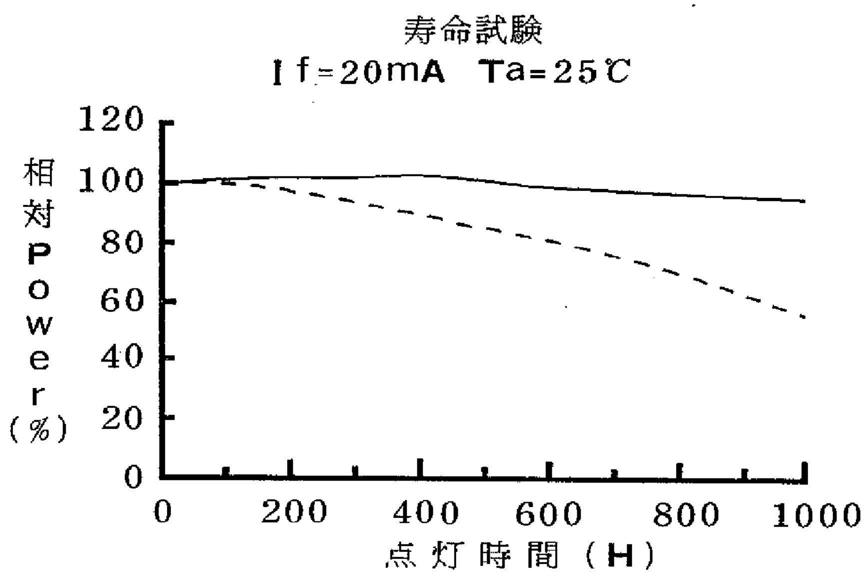
【図６】

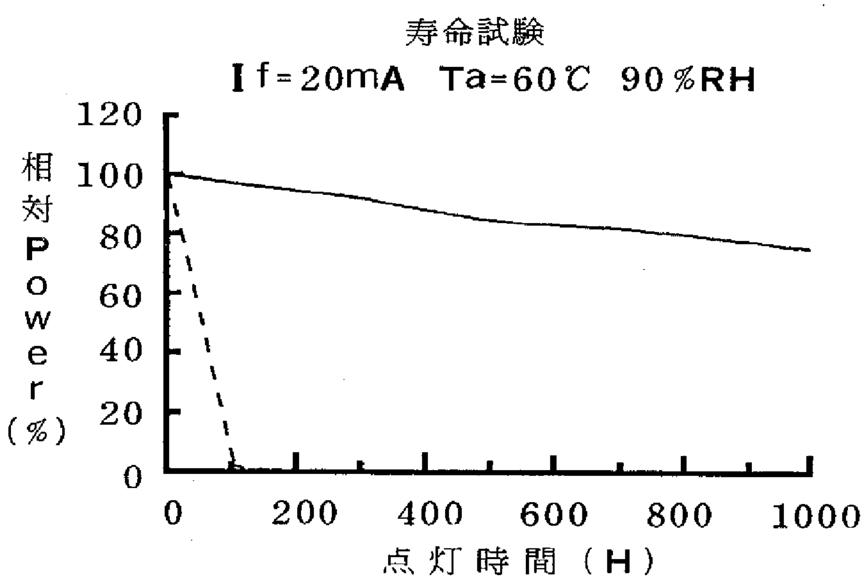

601
白色発光可能な発光ダイオ
ードを用いたＬＥＤ表示器
ドライバー
602
画像データ記憶手段
（ＲＡＭ）
階調制御手段
（ＣＰＵ）
603
604

【図７】


705
706
707
701
702
705
704
703

【図８】


寿命試験
If=20mA Ta=25℃
相対Power(%)
120
100
80
60
40
20
0
0
200
400
600
800
1000
点灯時間(H)
(A)


寿命試験
If=20mA Ta=60℃ 90%RH
相対Power(%)
120
100
80
60
40
20
0
0
200
400
600
800
1000
点灯時間(H)
(B)

【書類名】　要約書
【要約】
【課題】　高輝度、長時間の使用環境下においても発光光率の低下や色ずれを少なくする。
【解決手段】発光ダイオードは、ＬＥＤチップと、ＬＥＤチップからの発光の少なくとも一部を吸収し波長変換して発光するフォトルミネセンス蛍光体とを有する。ＬＥＤチップは、窒化物系化合物半導体で、フォトルミネセンス蛍光体がセリウムで付活されたイットリウム・アルミニウム・ガーネット系蛍光体である。

【書類名】　　　　　　　職権訂正データ
【訂正書類】　　　　　　特許願

<認定情報・付加情報>

【特許出願人】

　　【識別番号】　　　　000226057

　　【住所又は居所】　　徳島県阿南市上中町岡４９１番地１００

　　【氏名又は名称】　　日亜化学工業株式会社

【代理人】　　　　　　　申請人

　　【識別番号】　　　　100074354

　　【住所又は居所】　　徳島県徳島市金沢１丁目５番９号

　　【氏名又は名称】　　豊栖　康弘

出願人履歴

０００２２６０５７

19900818

新規登録

徳島県阿南市上中町岡４９１番地１００

日亜化学工業株式会社

日　本　国　特　許　庁
JAPAN PATENT OFFICE

別紙添付の書類に記載されている事項は下記の出願書類に記載されている事項と同一であることを証明する。

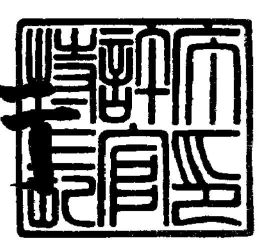
This is to certify that the annexed is a true copy of the following application as filed with this Office.

出願年月日 Date of Application:	１９９７年　３月３１日
出願番号 Application Number:	平成　９年特許願第０８１０１０号
パリ条約による外国への出願に用いる優先権の主張の基礎となる出願の国コードと出願番号 The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is	ＪＰ１９９７－０８１０１０
出願人 Applicant(s):	口亜化学工業株式会社

２０１０年１１月２４日

特許庁長官
Commissioner,
Japan Patent Office

岩井良行



【書類名】特許願
【整理番号】P96ST30-2
【提出日】平成 9年 3月31日
【あて先】特許庁長官　荒川　寿光　殿
【国際特許分類】
H01L 33/00
【発明の名称】発光装置
【請求項の数】　8
【発明者】
　【住所又は居所】徳島県阿南市上中町岡４９１番地１００　日亜化学工業株式会社内
　【氏名】森口　敏生
【発明者】
　【住所又は居所】徳島県阿南市上中町岡４９１番地１００　日亜化学工業株式会社内
　【氏名】野口　泰延
【特許出願人】
　【識別番号】000226057
　【郵便番号】774
　【住所又は居所】徳島県阿南市上中町岡４９１番地１００
　【氏名又は名称】日亜化学工業株式会社
　【代表者】小川　英治
　【電話番号】0884-22-2311
【先の出願に基づく優先権の主張】
　【出願番号】平成 8年特許願第244339号
　【出願日】平成 8年 9月17日
【手数料の表示】
　【予納台帳番号】010526
　【納付金額】21,000

【提出物件の目録】

　【物件名】明細書　1

　【物件名】図面　1

　【物件名】要約書　1

【プルーフの要否】要

【書類名】　明細書

【発明の名称】　発光装置

【特許請求の範囲】

【請求項１】

発光層が窒化物系化合物半導体である発光素子と、該発光素子からの発光の少なくとも一部を吸収し前記発光素子からの発光よりも長波長光を発光するフォトルミネセンス蛍光体と、を有する発光装置であって、

前記フォトルミネセンス蛍光体が組成の異なる２種類以上のセリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体であることを特徴とする発光装置。

【請求項２】

前記セリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体が$(Re_{x}Sm_{1-x})_{3}(Al_{y}Ga_{1-y})_{5}O_{12}:Ce$である請求項１記載の発光装置。

但し、$0<x\leqq 1$、$0\leqq y\leqq 1$、Ｒｅは、Ｙ、Ｇｄ、Ｌａから選択される少なくとも一種である。

【請求項３】

前記セリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体は、$Y_{3}Al_{5}O_{12}:Ce$の主発光波長よりも短波長側に主発光波長があるセリウムで付活されたイットリウム・アルニミウム酸化物系蛍光体と、$Y_{3}Al_{5}O_{12}:Ce$の主発光波長よりも長波長側に主発光波長があるセリウムで付活されたイットリウム・アルニミウム酸化物系蛍光体である請求項１記載の発光装置。

【請求項４】

前記セリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体は、$Y_{3}(Al_{y}Ga_{1-y})_{5}O_{12}:Ce$である第１の蛍光体と、$Re_{3}Al_{5}O_{12}:Ce$であって第１の蛍光体の主発光波長よりも長波長側に主発光波長がある第２の蛍光体である請求項１記載の発光装置。

但し、$0\leqq y\leqq 1$、Ｒｅは、Ｙ、Ｇｄ、Ｌａから選択される少なくとも一種である。

【請求項５】

前記組成が異なる２種類以上のセリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体は、Ｇｄを有する第３の蛍光体と、第３の蛍光体よりもＧｄの組成比が高い第４の蛍光体である請求項１記載の発光装置。

【請求項６】

前記発光素子の主発光ピークが４００ｎｍから５３０ｎｍ内にある請求項１記載の発光装置。

【請求項７】

前記発光素子と光学的に接続された導光板上に配置されたフォトルミネッセンス蛍光体を有する色変換部材、或いは前記フォトルミネッセンス蛍光体を有する色変換部材を介して発光素子と導光板とが光学的に接続されることによって面状に発光可能な請求項１記載の発光装置。

【請求項８】

マウント・リードのカップ内に配置させた発光素子と、該発光素子と導電性ワイヤーを用いて電気的に接続させたインナー・リードと、前記カップ内に充填させたコーティング部材と、該コーティング部材、発光素子、導電性ワイヤー及びマウント・リードとインナー・リードの少なくとも一部を被覆するモールド部材と、を有する発光ダイオードであって、

前記発光素子の発光層が窒化物系化合物半導体であり、且つ前記コーティング部材が前記発光素子からの発光の少なくとも一部を吸収し前記発光素子からの発光よりも長波長光を発光する組成の異なる２種類以上のセリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体を有することを特徴とする発光装置。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】

本願発明は、バックライト光源、照光式スイッチ、信号機、表示器、ＬＥＤディスプレイ及び各種インジケータなどに利用される発光装置に係わり、特に使用環境によらず高輝度、高効率に所望の色に発光可能な発光装置に関する。

【０００２】

【従来技術】

発光素子であるＬＥＤチップを用いた発光装置は、小型で効率が良く鮮やかな色の発光をする。また、半導体素子であるため球切れなどの心配がない。初期駆動特性が優れ、振動やON／OFF点灯の繰り返しに強いという特徴を有する。そのため各種インジケータ、センサーや種々の光源として利用されている。最近、超高輝度高効率な発光ダイオードとして１０００ｍｃｄにも及ぶ発光ダイオードがＲＧＢ（赤色系、緑色系、青色系）ともそれぞれ開発された。これに伴いＲＧＢの三原色を利用した液晶用バックライトなどに使用可能なフルカラー用面状発光装置が省電力、長寿命、軽量などの特長を生かして研究されてきている。

【０００３】

ＬＥＤチップは使用される発光層の半導体材料、形成条件などによって紫外から赤外まで種々の発光波長を放出させることが可能である。また、優れた単色性ピーク波長を有する。

【０００４】

しかしながら、ＬＥＤチップを用いた発光装置は優れた単色性ピーク波長を有するが故に白色系発光光源などとさせるためには、ＲＧＢなどが発光可能な各ＬＥＤチップをそれぞれ近接して発光させ拡散混色させる必要がある。このような発光ダイオードは、種々の色を自由に発光させる発光装置としては有効であるが、白色系などの色のみを発光させる場合においても赤色系、緑色系及び青色系の発光ダイオードなどをそれぞれ使用せざるを得ない。ＬＥＤチップは、半導体であり色調や輝度のバラツキもまだ相当ある。また、同一半導体材料を用いて高輝度にＲＧＢなどが発光可能なＬＥＤチップは、未だ開発されていない。そのため、それぞれ異なる材料を用いて形成させざるを得ず、各ＬＥＤチップの駆動電力などが異なるため個々に電源などを確保する必要がある。白色系を発光させるためには、各半導体ごとに電流などを調節して発光させなければならない。同様に、半導体発光素子であるため個々の温度特性の差や経時変化が異なり、色調が種々変化してしまう。さらに、ＬＥＤチップからの発光を均一に混色させなければ、色むらを生ずる場合がある。

【０００５】

そこで、本出願人は先にＬＥＤチップの発光色を蛍光物質で色変換させた発光

ダイオードや面状発光装置として特開平５－１５２６０９号公報、特開平７－１７６７９４号公報、特開平８－８６１４号公報などに記載された発光ダイオードや面状発光光源を開発した。これらの発光ダイオードや面状発光光源によって、１種類のＬＥＤチップを用いて白色系など他の発光色を発光させることができる。

【０００６】

具体的には、青色が発光可能なＬＥＤチップを透明な導光板の一端に接続させＬＥＤチップから発光された発光を導光板上に設けられた蛍光物質含有層によって緑色及び赤色などに色変換させ白色系の発光とさせるものである。これらは、ＲＧＢ発光成分を有する白色系が発光可能な発光装置として利用した場合においても十分な輝度を長時間に渡って発光する発光装置とすることができる。

【０００７】

【発明が解決しようとする課題】

ＬＥＤチップからの発光によって励起される蛍光物質は、蛍光染料、蛍光顔料さらには有機、無機化合物などから様々なものが挙げられる。蛍光体の励起波長や発光波長によっても種々のものが挙げられる。また、蛍光体は、発光素子からの発光波長を波長の短いものから長い波長へと変換する、或いは発光素子からの発光波長を波長の長いものから短い波長へと変換するものとがある。

【０００８】

しかしながら、波長の長いものから短い波長へと変換する場合、変換効率が極めて悪く実用に向かない。また、発光装置を直射日光など外部環境下で使用する場合や蛍光体をＬＥＤチップ周辺に近接して配置させた場合は、紫外線など様々な高エネルギー光が蛍光体などに長期間に渡って強照射され続ける。特に、蛍光物質を励起し且つ二次的な放出を行うのに十分に高いエネルギーを放出可能な高エネルギーバンドギャップを有する半導体発光素子からの光エネルギーは、必然的に高くなる。そのため、太陽光などの外来光からとの相乗作用でも蛍光物質自体が劣化しやすい。

【０００９】

蛍光物質が劣化すると色調がずれる、或いは蛍光物質が黒ずみ光の外部取り出

し効率が低下する場合がある。同様に蛍光物質は、ＬＥＤチップの昇温や外部環境からの加熱など高温にもさらされる。さらに、発光装置は一般的に樹脂ケースに被覆されてはいるものの外部環境からの水分の進入などを完全に防ぐことや、製造時に付着した水分を完全に除去することはできない。蛍光物質によっては、このような水分が発光素子からの高エネルギー光や熱によって蛍光物質の劣化を促進する場合もある。また、イオン性の有機染料に至ってはチップ近傍では直流電界により電気泳動を起こし、色調が変化する可能性がある。したがって、本願発明は上記課題を解決し、野外の使用時などにおいてもより長時間、発光効率の低下や色ずれが極めて少なく所望の発光成分を高輝度に発光可能な発光装置を提供することを目的とする。

【００１０】

【課題を解決するための手段】

本願発明の発光装置は、発光層が窒化物系化合物半導体である発光素子と、該発光素子からの発光の少なくとも一部を吸収し前記発光素子からの発光よりも長波長光を発光するフォトルミネセンス蛍光体と、を有すると共に、フォトルミネセンス蛍光体が組成の異なる２種類以上のセリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体である。

【００１１】

本願発明の請求項２に記載の発光装置は、前記セリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体が$(Re_xSm_{1-x})_3(Al_yGa_{1-y})_5O_{12}$：Ｃｅである。（但し、$0<x\leqq 1$、$0\leqq y\leqq 1$、Ｒｅは、Ｙ、Ｇｄ、Ｌａから選択される少なくとも一種である。）

本願発明の請求項３に記載の発光装置は、前記セリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体が、$Y_3Al_5O_{12}$：Ｃｅの主発光波長よりも短波長側に主発光波長があるセリウムで付活されたイットリウム・アルニミウム酸化物系蛍光体と、$Y_3Al_5O_{12}$：Ｃｅの主発光波長よりも長波長側に主発光波長があるセリウムで付活されたイットリウム・アルニミウム酸化物系蛍光体である。

【００１２】

本願発明の請求項４に記載の発光装置は、セリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体が、$Y_3(Al_yGa_{1-y})_5O_{12}$：Ｃｅである第１の蛍光体と、$Re_3Al_5O_{12}$：Ｃｅであって第１の蛍光体の主発光波長よりも長波長側に主発光波長がある第２の蛍光体である。（但し、０≦ｙ≦１、Ｒｅは、Ｙ、Ｇｄ、Ｌａから選択される少なくとも一種である。）

本願発明の請求項５記載の発光装置は、セリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体は、Ｇｄを有する第３の蛍光体と、第３の蛍光体よりもＧｄが多い第４の蛍光体である。

【００１３】

本願発明の請求項６に記載の発光装置は、発光素子の主発光ピークが４００ｎｍから５３０ｎｍ内である。

【００１４】

本願発明の請求項７に記載の発光装置は、発光素子と光学的に接続された導光板上に配置されたフォトルミネッセンス蛍光体を有する色変換部材、或いは前記フォトルミネッセンス蛍光体を有する色変換部材を介して発光素子と導光板とが光学的に接続されることによって面状に発光可能な発光装置である。

【００１５】

本願発明の請求項８に記載の発光装置は、マウント・リードのカップ内に配置させた発光素子と、該発光素子と導電性ワイヤーを用いて電気的に接続させたインナー・リードと、前記カップ内に充填させたコーティング部材と、該コーティング部材、発光素子、導電性ワイヤー及びマウント・リードとインナー・リードの少なくとも一部を被覆するモールド部材と、を有する発光ダイオードであって、

前記発光素子の発光層が窒化物系化合物半導体であり、且つ前記コーティング部材が前記発光素子からの発光の少なくとも一部を吸収し前記発光素子からの発光よりも長波長光を発光する組成の異なる２種類以上のセリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体を有する。

【００１６】

【作用】

本願発明の発光装置は、発光素子と、発光素子からの光によって励起されそれよりも長波長側の光を発光する蛍光物質とを有している。蛍光物質は、組成の異なる２種類以上のイットリウム・アルミニウム酸化物系蛍光体を用いている。これによって、所望の発光色が効率よく発光可能な発光装置とすることができる。即ち、半導体発光素子から放出される発光波長がその半導体発光素子毎によって図８のＡ点からＢ点の範囲であるとすると、組成の異なる２種類以上のイットリウム・アルミニウム酸化物系蛍光体の色度点である図８のＣ点及びＤ点で囲まれた斜線内にある任意の発光色を発光させることができる。特に、発光素子、蛍光体の組成或いはその量を種々選択させることによって調節させることができる。特に、発光素子の発光ばらつきを蛍光体を種々選択させることによって吸収させ所望の発光波長が得られる発光装置とすることができる。また、蛍光物質の発光波長を選択させることによってＲＧＢの発光成分を高輝度に含んだ発光装置とさせることができる。

【００１７】

さらに、イットリウム・アルミニウム酸化物系蛍光体は、長時間高輝度に発光可能な発光装置として利用することができる。また、発光素子からの光よりもより長波長側に発光する蛍光物質とさせることによって、効率よく発光可能である。また、変換された光は発光チップから放出される光よりも長波長側になっているために、発光チップのバンドギャップよりも小さく発光素子に吸収されにくい。そのため蛍光体が等方的に発光して発光素子側に向かったとしても発光素子に吸収されず効率よく発光可能となる。

【００１８】

【発明の実施の形態】

本願発明者は、種々の実験の結果、可視光域における光エネルギーが比較的高いＬＥＤチップからの発光光をフォトルミネセンス蛍光体によって色変換させる発光装置において、特定の半導体及び蛍光体を選択することにより高輝度、長時間の使用時における光効率低下や色ずれを防止できること及び歩留まりの高い発光装置が形成できることを見出し本願発明を成すに至った。

【００１９】

即ち、本願発明の発光装置に用いられるフォトルミネセンス蛍光体としては、１．耐光性に優れていることが要求される。特に、様々な高エネルギー光が照射される直射日光などから長時間耐える必要もある。また、発光ダイオードとして使用する場合、半導体発光素子などの微小領域から強放射されるために（Ｅｅ）＝３Ｗ・ｃｍ$^{-2}$以上にも及ぶ強照射強度にも耐える必要がある。２．発光素子との混色を利用するため紫外線ではなく青色系発光などの可視光で効率よく発光すること。３．混色を考慮して緑色系及び赤色系の光などが高輝度に発光可能なこと。４．外部環境下や発光素子近傍に配置されるため温度特性が良好であること。５．色調が組成比或いは緑色系や赤色系などの蛍光体の混合比で連続的に変えられること。６．発光装置の利用環境に応じて耐候性があることなどの特徴を有することが求められる。

【００２０】

上記の条件を満たすものとして本願発明は、発光素子として発光層に高エネルギーバンドギャップを有する窒化物系化合物半導体素子を、フォトルミネセンス蛍光体として組成の異なる２種類以上のフォトルミネセンス蛍光体が、セリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体を用いる。これにより本願発明は、発光素子の製造工程などによって発光素子から放出される発光波長が所望値からずれたとしても２種類以上の蛍光体を調節させることによって所望の色調を持った発光装置とできる。より具体的には、セリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体として$(Re_xSm_{1-x})_3(Al_yGa_{1-y})_5O_{12}$：Ｃｅを用いる。（但し、$0<x\leqq1$、$0\leqq y\leqq1$、Ｒｅは、Ｙ、Ｇｄ、Ｌａから選択される少なくとも一種である。）これにより発光素子から放出された可視光域における高エネルギー光を長時間近傍で高輝度に照射した場合や外部環境の使用下においても発光色の色ずれや発光輝度の低下が極めて少ない高輝度に所望の発光成分を有する発光装置とすることができるものである。

【００２１】

以下、具体的な発光装置の一例として、チップタイプＬＥＤを図１に示す。チップタイプＬＥＤの筐体内に窒化ガリウム系半導体を用いたＬＥＤチップ１０２をエポキシ樹脂などを用いて固定させてある。ＬＥＤチップ１０２は、４７０ｎ mのＩｎ$_{０．４}$Ｇａ$_{０．６}$Ｎ半導体発光層を有する発光素子を用いた。発光素子は、サファイア基板上にＮ型導電性を有する窒化ガリウム半導体であるコンタクト層、Ｐ型導電性を有する窒化ガリウムアルミニウム半導体であるクラッド層、Ｐ型導電性を有する窒化ガリウム半導体であるコンタクト層を形成させた。Ｎ型導電性を有するコンタクト層とＰ型導電性を有するクラッド層との間に厚さ約３ｎｍであり、単一量子井戸構造とされるノンドープＩｎＧａＮの活性層を形成させた。（なお、サファイア基板上には、低温で窒化ガリウム半導体を形成させバッファ層とさせてある。）このような発光素子１０２の電極と筐体に設けられた各電極１０５とを導電性ワイヤーである金線１０３でそれぞれ電気的に接続させてある。緑色系のフォトルミネセンス蛍光体としてＹ$_{３}$Ａｌ$_{５}$Ｏ$_{１２}$：Ｃｅ蛍光体をまた赤色系のフォトルミネセンス蛍光体として（Ｙ$_{０．８}$Ｇｄ$_{０．２}$）$_{３}$Ａｌ$_{５}$Ｏ$_{１２}$：Ｃｅ蛍光体をアクリル樹脂中に混合分散させたものを発光素子であるＬＥＤチップ、導電性ワイヤーなどを外部応力などから保護するモールド部材１０１として均一に硬化形成させる。このような発光装置に電力を供給させることによってＬＥＤチップを発光させる。ＬＥＤチップからの青色系の発光と、その発光によって励起されそれぞれ高輝度に発光可能な２種類以上のフォトルミネセンス蛍光体からの発光光との混色により白色系などが発光可能な発光装置の一例である発光ダイオードとすることができる。また、このように形成された発光ダイオードは、蛍光体が含有されない発光ダイオードにおいて通常発光時に見られる発光パターンがない。ＬＥＤチップの発光面状に形成された電極などが陰になることによって形成される発光パターンは、蛍光物質の散乱などによって均一にされる。そのためより均一発光が可能な発光ダイオードともなる。以下、本願発明の構成部材について詳述する。

【００２２】

（フォトルミネセンス蛍光体）

本願発明に用いられるフォトルミネセンス蛍光体としては、半導体発光素子から発光された可視光や紫外線で励起されて発光するフォトルミネセンス蛍光体をいう。特に本願発明においては、フォトルミネセンス蛍光体が組成の異なる２種類以上のセリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体を利

用する。発光層に窒化物系化合物半導体を用いた発光素子から発光した青色系の光と、青色光を吸収させるためボディーカラーが黄色であるフォトルミネセンス蛍光体から発光する緑色系及び赤色系の光と、或いは、黄色系の光であってより緑色系及びより赤色系の光を混色表示させると所望の白色系発光色表示を行うことができる。発光装置はこの混色を起こさせるためにフォトルミネセンス蛍光体の粉体やバルクをエポキシ樹脂、アクリル樹脂或いはシリコーン樹脂などの各種樹脂や酸化珪素、酸化アルミニウムなどの無機物中に含有させることが好ましい。このようにフォトルミネセンス蛍光体が含有されたものは、ＬＥＤチップからの光が透過する程度に薄く形成させたドット状のものや層状ものなど用途に応じて種々用いることができる。フォトルミネセンス蛍光体と樹脂などとの比率や塗布、充填量を種々調整すること及び発光素子の発光波長を選択することにより白色を含め電球色など任意の色調を提供させることができる。

【００２３】

また、フォトルミネセンス蛍光体の分布を種々変えることによって耐候性の強い発光装置など種々の特性を持たせることができる。このような分布はフォトルミネセンス蛍光体を含有する部材、形成温度、粘度やフォトルミネセンス蛍光体の形状、粒度分布などを調整させることによって種々調整させることができる。したがって、使用条件などにより蛍光体の分布濃度を、種々選択することができる。また、２種類以上の蛍光体をそれぞれ発光素子からの入射光に対して順に配置させることによって効率よく発光可能な発光装置とすることができる。即ち、反射部材を有する発光素子上には、長波長側に吸収波長があり長波長に発光可能な蛍光体が含有された色変換部材と、それよりも長波長側に吸収波長がありより長波長に発光可能な色変換部材とを積層などさせることで反射光を有効利用することができる。

【００２４】

本願発明のフォトルミネセンス蛍光体を使用すると、放射照度として（Ｅｅ）＝３Ｗ・ｃｍ$^{-2}$以上１０Ｗ・ｃｍ$^{-2}$以下のＬＥＤチップと接する或いは近接して配置された場合においても高効率に十分な耐光性を有する発光装置とすることができる。

【００２５】

本願発明に用いられるセリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体である緑色系が発光可能なＹＡＧ系蛍光体では、ガーネット構造のため、熱、光及び水分に強く、図４（Ａ）の実線の例の如く励起スペクトルのピークが４５０ｎｍ付近にさせることができる。また、発光ピークも図４（Ｂ）の実線の例の如く５１０ｎｍ付近にあり７００ｎｍまで裾を引くブロードな発光スペクトルを持つ。一方、セリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体である赤色系が発光可能なＹＡＧ系蛍光体でも、ガーネット構造であり熱、光及び水分に強く、図４（Ａ）の波線の例の如く励起スペクトルのピークが４５０ｎｍ付近にさせることができる。また、発光ピークも図４（Ｂ）の波線の例の如く６００ｎｍ付近にあり７５０ｎｍまで裾を引くブロードな発光スペクトルを持つ。

【００２６】

ガーネット構造を持ったＹＡＧ系蛍光体の組成の内、Ａｌの一部をＧａで置換することで発光波長が短波長側にシフトし、また組成のＹの一部をＧｄ及び／又はＬａで置換することで、発光波長が長波長側へシフトする。ＡｌのＧａへの置換は、発光効率と発光波長を考慮してＧａ：Ａｌ＝１：１から４：６が好ましい。同様に、Ｙの一部をＧｄ及び／又はＬａで置換することは、Ｙ：Ｇｄ及び／又はＬａ＝９：１から１：９であり、より好ましくは、Ｙ：Ｇｄ及び／又はＬａ＝１：４から２：３である。置換が２割未満では、緑色成分が大きく赤色成分が少なくなる。また、８割以上では、赤み成分が増えるものの輝度が急激に低下する。

【００２７】

このようなフォトルミネセンス蛍光体は、Ｙ、Ｇｄ、Ｃｅ、Ｌａ、Ａｌ、Ｓｍ及びＧａの原料として酸化物、又は高温で容易に酸化物になる化合物を使用し、それらを化学量論比で十分に混合して原料を得る。又は、Ｙ、Ｇｄ、Ｃｅ、Ｌａ、Ｓｍの希土類元素を化学量論比で酸に溶解した溶解液を蓚酸で共沈したものを焼成して得られる共沈酸化物と、酸化アルミニウム、酸化ガリウムとを混合して混合原料を得る。これにフラックスとしてフッ化アンモニウム等のフッ化物を適

量混合して坩堝に詰め、空気中１３５０～１４５０°Ｃの温度範囲で２～５時間焼成して焼成品を得、次に焼成品を水中でボールミルして、洗浄、分離、乾燥、最後に篩を通すことで得ることができる。

【００２８】

組成の異なる２種類以上のセリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体は、混合させて用いても良いし、それぞれ独立して配置させても良い。蛍光体をそれぞれ独立して配置させる場合、発光素子から光をより短波波長側で吸収発光しやすい蛍光体、それよりも長波長側で吸収発光しやすい蛍光体の順に配置させることが好ましい。これによって効率よく吸収及び発光させることができる。

【００２９】

（発光素子１０２、２０２、３０２）

本願発明に用いられる発光素子とは、組成の異なる２種類以上のセリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体をそれぞれ効率良く励起できる窒化物系化合物半導体が挙げられる。発光素子であるＬＥＤチップは、ＭＯＣＶＤ法等により基板上にＡｌＮ、ＩｎＮ、ＧａＮ、ＩｎＧａＮやＩｎＧａＡｌＮ等の半導体を発光層として形成させることができる。半導体の構造としては、ＭＩＳ接合、ＰＩＮ接合やＰＮ接合などを有するホモ構造、ヘテロ構造あるいはダブルヘテロ構成のものが挙げられる。また、半導体活性層を量子効果が生ずる薄膜に形成させた単一量子井戸構造や多重量子井戸構造とすることもできる。半導体層の材料、構造やその混晶度によって発光波長を種々選択することができるが、フォトルミネセンス蛍光物質を効率よく励起させるためにフォトルミネセンス蛍光物質の発光波長よりも短い発光波長を発光することが好ましい。

【００３０】

半導体基板にはサファイヤ、スピネル、ＳｉＣ、Ｓｉ、ＺｎＯ、ＧａＮ等の材料が好適に用いられる。結晶性の良い窒化物系化合物半導体を形成させるためにはサファイヤ基板を用いることが好ましい。このサファイヤ基板上にＧａＮ、ＡｌＮ等のバッファー層を形成しその上にＰＮ接合を有する窒化物系化合物半導体を形成させることができる。窒化ガリウム系半導体は、不純物をドープしない状

態でＮ型導電性を示す。発光効率を向上させるなど所望のＮ型窒化ガリウム半導体を形成させる場合は、Ｎ型ドーパントとしてＳｉ、Ｇｅ、Ｓｅ、Ｔｅ、Ｃ等を適宜導入することが好ましい。一方、Ｐ型窒化ガリウム半導体を形成させる場合は、Ｐ型ドーパンドであるＺｎ、Ｍｇ、Ｂｅ、Ｃａ、Ｓｒ、Ｂａ等をドープさせる。窒化ガリウム系化合物半導体は、Ｐ型ドーパントをドープしただけではＰ型化しにくいためＰ型ドーパント導入後に、炉による加熱、低電子線照射、プラズマ照射等によりアニールすることでＰ型化させることが好ましい。エッチングなどによりＰ型半導体及びＮ型半導体の露出面を形成させた後、半導体層上にスパッタリング法や真空蒸着法などを用いて所望の形状の各電極を形成させる。

【００３１】

次に、形成された半導体ウエハー等をダイヤモンド製の刃先を有するブレードが回転するダイシングソーにより直接フルカットするか、又は刃先幅よりも広い幅の溝を切り込んだ後（ハーフカット）、外力によって半導体ウエハーを割る。あるいは、先端のダイヤモンド針が往復直線運動するスクライバーにより半導体ウエハーに極めて細いスクライブライン（経線）を例えば碁盤目状に引いた後、外力によってウエハーを割り半導体ウエハーからチップ状にカットする。このようにして窒化ガリウム系化合物半導体である発光素子を形成させることができる。

【００３２】

本願発明の発光装置において白色系を発光させる場合は、フォトルミネセンス蛍光体との混色等を考慮して発光素子の主発光波長は４００ｎｍ以上５３０ｎｍ以下内にあることが好ましく、４２０ｎｍ以上４９０ｎｍ以下内にあることがより好ましい。ＬＥＤチップとフォトルミネセンス蛍光体との効率をそれぞれより向上させるためには、４５０ｎｍ以上４７５ｎｍ以下内にあることがさらに好ましい。このような発光素子は、単色性ピーク波長を持つといってもある程度のスペクトル幅を持つため演色性の高い発光装置を形成させることができる。

【００３３】

（導電性ワイヤー１０３、３０３）

導電性ワイヤーとしては、発光素子１０２、３０２の電極とのオーミック性、

機械的接続性、電気伝導性及び熱伝導性がよいものが求められる。熱伝導度としては０．０１ｃａｌ／ｃｍ^2／ｃｍ／℃以上が好ましく、より好ましくは０．５ｃａｌ／ｃｍ^2／ｃｍ／℃以上である。また、作業性などを考慮して導電性ワイヤーの直径は、好ましくは、Φ１０μｍ以上、Φ４５μｍ以下である。このような導電性ワイヤーとして具体的には、金、銅、白金、アルミニウム等の金属及びそれらの合金を用いた導電性ワイヤーが挙げられる。このような導電性ワイヤーは、各ＬＥＤチップの電極と、インナー・リード３０６及びマウント・リード３０５などと、をワイヤーボンディング機器によって容易に接続させることができる。

【００３４】

（マウント・リード３０５）

マウント・リード３０５としては、発光素子３０２を配置させるものであり、ダイボンド機器などで発光素子であるＬＥＤチップ３０２を積載するのに十分な大きさがあれば良い。また、ＬＥＤチップを複数設置しマウント・リードをＬＥＤチップの共通電極として利用する場合においては、十分な電気伝導性とボンディングワイヤー等との接続性が求められる。また、マウント・リード上のカップ内にＬＥＤチップを配置すると共に蛍光体を内部に充填させる場合は、近接して配置させた別の発光ダイオードからの光により疑似点灯することを防止させることができる。

【００３５】

ＬＥＤチップ３０２とマウント・リード３０５のカップとの接着は熱硬化性樹脂などによって行うことができる。具体的には、エポキシ樹脂、アクリル樹脂やイミド樹脂などが挙げられる。また、フェースダウンＬＥＤチップなどによりマウント・リードと接着させると共に電気的に接続させるためにはＡｇペースト、カーボンペースト、金属バンプ等を用いることができる。

【００３６】

さらに、発光ダイオードの光利用効率を向上させるためにＬＥＤチップ３０２が配置されるマウント・リードの表面を鏡面状とし、表面に反射機能を持たせても良い。この場合の表面粗さは、０．１Ｓ以上０．８Ｓ以下が好ましい。また、

マウント・リードの具体的な電気抵抗としては３００μΩ－ｃｍ以下が好ましく、より好ましくは、３μΩ－ｃｍ以下である。

【００３７】

また、マウント・リード上に複数のＬＥＤチップを積置する場合は、ＬＥＤチップからの発熱量が多くなるため熱伝導度がよいことが求められる。具体的には、０．０１ｃａｌ／ｃｍ^2／ｃｍ／℃以上が好ましく、より好ましくは ０．５ｃａｌ／ｃｍ^2／ｃｍ／℃以上である。これらの条件を満たす材料としては、鉄、銅、鉄入り銅、錫入り銅、メタライズパターン付きセラミック等が挙げられる。

【００３８】

（インナー・リード３０６）

インナー・リード３０６としては、マウント・リード３０５上に配置されたＬＥＤチップと接続された導電性ワイヤーとの接続を図るものである。マウント・リード上に複数のＬＥＤチップ３０２を設けた場合は、各導電性ワイヤー同士が接触しにくい構成とすることが好ましい。

【００３９】

具体的には、マウント・リード３０５から離れるに従って、インナー・リード３０６のワイヤーボンディングさせる端面の面積を大きくする或いは、マウント・リードから離れるに従って端面の高さを高くさせることなどによってマウント・リードからより離れたインナー・リードと接続させる導電性ワイヤーの接触を防ぐことができる。

【００４０】

また、導電性ワイヤーとの接続端面の粗さは、密着性を考慮して１．６Ｓ以上１０Ｓ以下が好ましい。インナー・リードの先端部を種々の形状に形成させるためには、あらかじめリードフレームの形状を型枠で決めて打ち抜き形成させてもよく、或いは全てのインナー・リードを形成させた後にインナー・リード上部の一部を削ることによって形成させても良い。さらには、インナー・リードを打ち抜き形成後、端面方向から加圧することにより所望の端面の面積と端面高さを同時に形成させることもできる。

【００４１】

インナー・リードは、導電性ワイヤーであるボンディングワイヤー等との接続性及び電気伝導性が良いことが求められる。具体的な電気抵抗としては、３００μΩ－ｃｍ以下が好ましく、より好ましくは３μΩ－ｃｍ以下である。これらの条件を満たす材料としては、鉄、銅、鉄入り銅、錫入り銅及び銅、金、銀をメッキしたアルミニウム、鉄、銅等が挙げられる。

【００４２】

（コーティング部材３０１）

本願発明に用いられるコーティング部材３０１とは、モールド部材３０４とは別にマウント・リード３０５のカップに設けられるものであり発光素子３０２の発光を変換するフォトルミネセンス蛍光体が含有されるものである。コーティング部の具体的材料としては、エポキシ樹脂、ユリア樹脂、シリコーンやアクリル樹脂などの耐候性に優れた透明樹脂やケイ化物である酸化珪素、酸化アルミなどの無機物質などが好適に用いられる。また、フォトルミネセンス蛍光体と共に拡散剤を含有させても良い。具体的な拡散剤としては、チタン酸バリウム、酸化チタン、酸化アルミニウム、酸化珪素等が好適に用いられる。さらに、光安定化剤として紫外線吸収剤を含有させても良い。

【００４３】

（モールド部材１０１、２１０、３０４）

モールド部材は、発光装置の使用用途に応じてＬＥＤチップ、導電性ワイヤー、フォトルミネセンス蛍光体が含有されたコーティング部材などを外部から保護するために設けることができる。モールド部材は、樹脂などの有機物質や硝子などの無機物質を用いて形成させることができる。モールド部材中にフォトルミネセンス蛍光体を含有させることによって視野角を増やすことができる。また、拡散剤を加えることによってＬＥＤチップからの指向性を緩和させ視野角をさらに増やすこともできる。さらに安定発光させるために紫外線吸収剤などの光安定化剤を含有させても良い。

【００４４】

更に、モールド部材を所望の形状にすることによってＬＥＤチップからの発光を集束させたり拡散させたりするレンズ効果を持たせることができる。従って、

モールド部材は複数積層した構造でもよい。具体的には、凸レンズ形状、凹レンズ形状さらには、発光観測面から見て楕円形状やそれらを複数組み合わせたものが挙げられる。

【００４５】

モールド部材の具体的材料としては、主としてエポキシ樹脂、ユリア樹脂、シリコーン、アクリル樹脂などの耐候性に優れた透明樹脂や低融点硝子などが好適に用いられる。また、拡散剤としては、チタン酸バリウム、酸化チタン、酸化アルミニウム、酸化珪素等が好適に用いられる。フォトルミネセンス蛍光体はモールド部材中に含有させてもそれ以外のコーティング部などに含有させて用いてもよい。また、コーティング部をフォトルミネセンス蛍光体が含有された樹脂、モールド部材を硝子などとした異なる部材を用いて形成させても良い。この場合、生産性良くより水分などの影響が少ない発光ダイオードとすることができる。屈折率を考慮してモールド部材とコーティング部とを同じ部材を用いて形成させても良い。

【００４６】

（面状光源）

本願発明の発光装置の一つである面状光源の場合、図２（Ａ）の如く白色光を発光させるためには白色光を導光板によって面状とさせ方法と、図２（Ｂ）の如く面状に発光したＬＥＤチップからの青色系光を白色光に変換させる方法がある。

【００４７】

白色光を導光板によって面状とさせる場合には、フォトルミネセンス蛍光体が含有された色変換部材２０１を介して青色系が発光可能な発光ダイオード２０２と、導光板２０４と、を配置させた構成、或いはモールド部材中２１０などにフォトルミネセンス蛍光体を含有させ青色系が発光可能な窒化物半導体発光素子を有する発光ダイオード２０２と導光板２０４を光学的に接続させた構成をとることができる。

【００４８】

面状に発光したＬＥＤチップ２０２からの青色系光を白色光に変換させる場合

は、窒化物半導体を発光層に有する青色系が発光可能な発光ダイオード２０２と導光板２０４とを光学的に接続させた後、導光板２０４上の散乱シート２０６に含有させる。或いはバインダー樹脂と共に散乱シートに塗布などさせシート状に形成させる。さらには、導光板上にフォトルミネセンス蛍光体含有のバインダーをドット状に直接形成させる構成をとることができる。

【００４９】

具体的には、絶縁層及び導電性パターンが形成されたコの字形状の金属基板２０３内などに発光素子であるＬＥＤチップを固定する。ＬＥＤチップと導電性パターンとの電気的導通を取った後、エポキシ樹脂をＬＥＤチップ２０２が積載された基板上に充填させアクリル性導光板２０４の端面と光学的に接続させる。導光板２０４の発光主面上には、フォトルミネセンス蛍光体をエポキシ樹脂中に混合撹拌し予め拡散シート上に均一塗布したシート部材２０１を積置させてある。この拡散シート部材２０６は、アクリル樹脂をベースに拡散剤として酸化アルミニウム、酸化珪素、酸化チタン、チタン酸バリウムの粒子などを含有させたエポキシ樹脂を塗布させた層と、フォトルミネセンス蛍光体を含有させた層とに分かれている。

【００５０】

導光板の一方の主面上には、発光ダイオード近傍からの光が強発光する蛍現象防止のため白色散乱剤が含有されたフィルム状の反射部材２０７を配置させてあることが好ましい。同様に、導光板２０４の裏面側全面や発光ダイオードが配置されていない端面上にも反射部材２０５を設け発光効率を向上させてある。これにより、液晶のバックライトなどとして使用した場合においても十分な明るさを得られる面状光源とすることができる。液晶表示装置として利用する場合は、導光板の主面上に不示図の透光性導電性パターンが形成された硝子基板間に注入された液晶を介して配された偏光板により構成させることができる。以下、本願発明の実施例について説明するが、本願発明は具体的実施例のみに限定されるものではないことは言うまでもない。

【００５１】

【実施例】

（実施例１）

発光素子として発光ピークが４５０ｎｍの$Ｉｎ_{０．０５}Ｇａ_{０．９５}$Ｎ半導体を用いた。ＬＥＤチップは、洗浄させたサファイヤ基板上にＴＭＧ（トリメチルガリウム）ガス、ＴＭＩ（トリメチルインジュウム）ガス、窒素ガス及びドーパントガスをキャリアガスと共に流し、ＭＯＣＶＤ法で窒化ガリウム系化合物半導体を成膜させることにより形成させた。ドーパントガスとして$ＳｉＨ_{４}$と$Ｃｐ_{２}Ｍｇ$と、を切り替えることによってＮ型導電性を有する窒化ガリウム半導体とＰ型導電性を有する窒化ガリウム半導体を形成しＰＮ接合を形成させる。半導体発光素子としては、Ｎ型導電性を有する窒化ガリウム半導体であるコンタクト層、Ｎ型導電性を有する窒化ガリウムアルミニウム半導体であるクラッド層、Ｐ型導電性を有する窒化ガリウムアルミニウム半導体であるクラッド層、Ｐ型導電性を有する窒化ガリウム半導体であるコンタクト層を形成させた。Ｎ型導電性を有するクラッド層とＰ型導電性を有するクラッド層との間にダブルヘテロ接合となるＺｎドープＩｎＧａＮの活性層を形成させた。（なお、サファイア基板上には、低温で窒化ガリウム半導体を形成させバッファ層とさせてある。Ｐ型半導体は、成膜後４００℃以上でアニールさせてある。）

エッチングによりＰＮ各半導体表面を露出させた後、スパッタリングにより各電極をそれぞれ形成させた。こうして出来上がった半導体ウエハーをスクライブラインを引いた後、外力により分割させ発光素子としてＬＥＤチップを形成させた。

【００５２】

銀メッキした銅製リードフレームの先端にカップを有するマウント・リードにＬＥＤチップをエポキシ樹脂でダイボンディングした。ＬＥＤチップの各電極とマウント・リード及びインナー・リードと、をそれぞれ金線でワイヤーボンディングし電気的導通を取った。

【００５３】

モールド部材は、砲弾型の型枠の中にＬＥＤチップが配置されたリードフレームを挿入し透光性エポシキ樹脂を混入後、１５０℃５時間にて硬化させ青色系発光ダイオードを形成させた。青色系発光ダイオードを端面が全て研磨されたアク

リル性導光板の一端面に接続させた。アクリル板の片面及び側面は、白色反射部材としてチタン酸バリウムをアクリル系バインダー中に分散したものでスクリーン印刷及び硬化させた。

【００５４】

一方、フォトルミネセンス蛍光体は、緑色系及び赤色系をそれぞれ必要なＹ、Ｇｄ、Ｃｅ、Ｌａの希土類元素を化学量論比で酸に溶解した溶解液を蓚酸で共沈させた。これを焼成して得られる共沈酸化物と、酸化アルミニウム、酸化ガリウムと混合して混合原料をそれぞれ得る。これにフラックスとしてフッ化アンモニウムを混合して坩堝に詰め、空気中１４００°Ｃの温度範囲で３時間焼成して焼成品を得た。焼成品をそれぞれ水中でボールミルして、洗浄、分離、乾燥、最後に篩を通して形成させた。

【００５５】

形成された組成が$Y_3(Al_{0.6}Ga_{0.4})_5O_{12}$：Ｃｅであり緑色系が発光可能な第１の蛍光体１２０重量部と同様の工程で形成され組成が$(Y_{0.4}Gd_{0.6})_3Al_5O_{12}$：Ｃｅであり赤色系が発光可能な第２の蛍光体１００重量部を、エポキシ樹脂１００重量部とよく混合してスラリーとさせた。このスラリーを厚さ０．５ｍｍのアクリル層上にマルチコーターを用いて均等に塗布、乾燥し、厚さ約３０μｍの色変換部材として蛍光体層を形成させた。蛍光体層を導光板の主発光面と同じ大きさに切断し導光板上に配置させることにより発光装置を形成させた。発光装置の色度点、演色性指数を測定した。それぞれ、色度点（ｘ＝０．２９，ｙ＝０．３４）、Ｒａ（演色性指数）＝９２．０と三波長型蛍光灯に近い性能を示した。また、発光効率は１２ ｌｍ／ｗと白色電球並であった。さらに耐侯試験として室温６０ｍＡ通電、室温２０ｍＡ通電、６０℃９０％ＲＨ下で２０ｍＡ通電の各試験においても蛍光体に起因する変化は観測されなかった。

【００５６】

（比較例１）

第１及び第２のフォトルミネセンス蛍光体をそれぞれペリレン系誘導体である緑色有機蛍光顔料（シンロイヒ化学製ＦＡ－００１）と赤色有機蛍光顔料（シンロイヒ化学製ＦＡ－００５）として同量で混合撹拌した以外は、実施例１と同様

にして発光ダイオードの形成及び耐侯試験を行った。形成された発光ダイオードの色度座標は、（X,Y）＝（０．３４，０．３５）であった。耐侯性試験として、カーボンアークで紫外線量を２００ｈｒで太陽光の１年分とほぼ同等とさせ時間と共に輝度の保持率及び色調を測定した。また、信頼性試験としてＬＥＤチップを発光させ７０℃一定における時間と共に発光輝度及び色調を測定した。この結果を実施例１と共に図６及び図７にそれぞれ示す。

【００５７】

（実施例２）

発光素子は、実施例１と同様にして発光ピークが４５０ｎｍの$Ｉｎ_{０．０５}Ｇａ_{０．９５}Ｎ$の発光層を有するＬＥＤチップを形成させた。銀メッキした銅製リードフレームの先端にカップを有するマウント・リードにＬＥＤチップをエポキシ樹脂でダイボンディングした。ＬＥＤチップの各電極とマウント・リード及びインナー・リードと、をそれぞれ金線でワイヤーボンディングし電気的導通を取った。

【００５８】

一方、フォトルミネセンス蛍光体は、緑色系及び赤色系をそれぞれ必要なＹ、Ｇｄ、Ｃｅの希土類元素を化学量論比で酸に溶解した溶解液を蓚酸で共沈させた。これを焼成して得られる共沈酸化物と、酸化アルミニウム、酸化ガリウムと混合して混合原料をそれぞれ得る。これにフラックスとしてフッ化アンモニウムを混合して坩堝に詰め、空気中１４００°Ｃの温度範囲で３時間焼成してそれぞれ焼成品を得た。焼成品を水中でボールミルして、洗浄、分離、乾燥、最後に篩を通して形成させた。

【００５９】

形成された組成が$Ｙ_{３}（Ａｌ_{０．５}Ｇａ_{０．５}）_{５}Ｏ_{１２}$：Ｃｅであり緑色系が発光可能な第１の蛍光体と$（Ｙ_{０．２}Ｇｄ_{０．８}）_{３}Ａｌ_{５}Ｏ_{１２}$：Ｃｅであり赤色系が発光可能な第２の蛍光体をそれぞれ４０重量部、エポキシ樹脂１００重量部をよく混合してスリラーとさせた。このスリラーをＬＥＤチップが配置されたマウント・リード上のカップ内に注入させた。注入後、フォトルミネセンス蛍光体が含有された樹脂を１３０℃１時間で硬化させた。こうしてＬＥＤチップ上に厚さ１２０μのフォトルミネセンス蛍光体が含有されたコーティング部材が形成された。なお、コ

ーティング部材には、ＬＥＤチップに向かってフォトルミネセンス蛍光体が徐々に多くしてある。その後、さらにＬＥＤチップやフォトルミネセンス蛍光体を外部応力、水分及び塵芥などから保護する目的でモールド部材として透光性エポキシ樹脂を形成させた。モールド部材は、砲弾型の型枠の中にフォトルミネセンス蛍光体のコーティング部が形成されたリードフレームを挿入し透光性エポキシ樹脂を混入後、１５０℃５時間にて硬化させた。こうして形成された発光ダイオードは、発光観測正面から視認するとフォトルミネセンス蛍光体のボディーカラーにより中央部が黄色っぽく着色していた。

【００６０】

こうして得られた白色系が発光可能な発光ダイオードの色度点、色温度、演色性指数を測定した。それぞれ、色度点（ｘ＝０．３２，ｙ＝０．３４）、Ｒａ（演色性指数）＝８９．０、発光効率は１０ｌｍ／ｗであった。さらに耐候試験として室温６０ｍＡ通電、室温２０ｍＡ通電、６０℃９０％ＲＨ下で２０ｍＡ通電の各試験においてもフォトルミネセンス蛍光体に起因する変化は観測されず通常の青色系発光ダイオードと寿命特性に差がないことが確認できた。

【００６１】

（実施例３）

発光素子として発光ピークが４７０ｎｍの$Ｉｎ_{０．４}Ｇａ_{０．６}$Ｎ半導体を用いた。ＬＥＤチップは、洗浄させたサファイヤ基板上にＴＭＧ（トリメチルガリウム）ガス、ＴＭＩ（トリメチルインジュウム）ガス、窒素ガス及びドーパントガスをキャリアガスと共に流し、ＭＯＣＶＤ法で窒化ガリウム系化合物半導体を成膜させることにより形成させた。ドーパントガスとして$ＳｉＨ_４$と$Ｃｐ_２Ｍｇ$と、を切り替えることによってＮ型導電性を有する窒化ガリウム半導体とＰ型導電性を有する窒化ガリウム半導体を形成しＰＮ接合を形成させる。半導体発光素子としては、Ｎ型導電性を有する窒化ガリウム半導体であるコンタクト層、Ｐ型導電性を有する窒化ガリウムアルミニウム半導体であるクラッド層、Ｐ型導電性を有する窒化ガリウム半導体であるコンタクト層を形成させた。Ｎ型導電性を有するコンタクト層とＰ型導電性を有するクラッド層との間に厚さ約３ｎｍであり、単一量子井戸構造とされるノンドープＩｎＧａＮの活性層を形成させた。（なお、サフ

ァイア基板上には、低温で窒化ガリウム半導体を形成させバッファ層とさせてある。）

エッチングによりＰＮ各半導体表面を露出させた後、スパッタリングにより各電極をそれぞれ形成させた。こうして出来上がった半導体ウエハーをスクライブラインを引いた後、外力により分割させ発光素子としてＬＥＤチップを形成させた。

【００６２】

銀メッキした銅製リードフレームの先端にカップを有するマウント・リードにＬＥＤチップをエポキシ樹脂でダイボンディングした。ＬＥＤチップの各電極とマウント・リード及びインナー・リードと、をそれぞれ金線でワイヤーボンディングし電気的導通を取った。

【００６３】

モールド部材は、砲弾型の型枠の中にＬＥＤチップが配置されたリードフレームを挿入し透光性エポシキ樹脂を混入後、１５０℃５時間にて硬化させ青色系発光ダイオードを形成させた。青色系発光ダイオードを端面が全て研磨されたアクリル性導光板の一端面に接続させた。アクリル板の片面及び側面は、白色反射部材としてチタン酸バリウムをアクリル系バインダー中に分散したものでスクリーン印刷及び硬化させた。

【００６４】

一方、フォトルミネセンス蛍光体は、組成の異なる２種類以上のセリウムで付活されたイットリウム・アルミニウム酸化物系蛍光物質として比較的短波長側の黄色系が発光可能な蛍光体と、比較的長波長側の黄色系が発光可能な蛍光体を用いた。それぞれ必要なＹ、Ｇｄ、Ｃｅの希土類元素を化学量論比で酸に溶解した溶解液を蓚酸で共沈させた。これを焼成して得られる共沈酸化物と、酸化アルミニウムと混合して混合原料をそれぞれ得る。これにフラックスとしてフッ化アンモニウムを混合して坩堝に詰め、空気中１４００゜Ｃの温度範囲で３時間焼成して焼成品を得た。焼成品をそれぞれ水中でボールミルして、洗浄、分離、乾燥、最後に篩を通して形成させた。

【００６５】

形成された組成が$(Y_{0.8}Gd_{0.2})_3Al_5O_{12}$：Ｃｅであり比較的短波長側の黄色系が発光可能な蛍光体１００重量部と同様の工程で形成され組成が$(Y_{0.4}Gd_{0.6})_3Al_5O_{12}$：Ｃｅであり比較的長波長側の黄色系が発光可能な蛍光体１００重量部を、アクリル樹脂１０００重量部とよく混合して押し出し成形させた。これにより厚さ約１８０μｍの色変換部材として蛍光体層を形成させた。蛍光体層を導光板の主発光面と同じ大きさに切断し導光板上に配置させることにより発光装置を形成させた。発光装置の色度点、演色性指数を測定した。それぞれ、色度点（ｘ＝０．３３，ｙ＝０．３４）、Ｒａ（演色性指数）＝８８．０を示した。また、発光効率は１０　ｌｍ／ｗであった。さらに耐侯試験として室温６０ｍＡ通電、室温２０ｍＡ通電、６０℃９０％ＲＨ下で２０ｍＡ通電の各試験においても蛍光体に起因する変化は観測されなかった。同様に、この蛍光体の含有量を種々変えることによって発光素子からの波長が変化しても所望の色度点を維持させることができる。

【００６６】

【発明の効果】

高出力の窒化物系化合物半導体の発光素子と、この発光素子からの光によって励起され発光する組成の異なる２種類以上のフォトルミネセンス蛍光体と、を利用した本願発明の発光装置とすることにより、長時間高輝度時の使用においても発光効率が高く所望の色が発光可能な発光装置とすることができる。特に、蛍光体を励起する発光素子の発光波長が短く効率的に蛍光体が励起可能であると共に蛍光体によって等法的に放出された光は発光素子の発光層に吸収されることなく発光可能である。そのため、発光素子が反射性の部材の上に配置されるとより効率よく発光可能となる。さらに、信頼性や省電力化、小型化さらには色温度の可変性など車載や航空産業、一般電気機器に港内のブイ表示用や高速道路の標識照明など屋外での表示や照明として新たな用途を開くことができる。また、白色は人間の目で長時間視認する場合には刺激が少なく目に優しい発光ダイオードとすることができる。

【００６７】

特に、本願発明の請求項１に記載の構成とすることにより長時間の使用におい

ても色ずれ、発光効率の低下が極めて少なく高輝度に所望の発光成分を有する白色系が発光可能な発光装置とすることができる。また、２種類以上の組成の異なる蛍光体を利用することによって演色性が高い発光装置とすることができる。さらに、発光素子の発光波長がずれたとしても蛍光体の組成や含有量を調整させることによって一定の発光色が発光可能な量産性の良い発光装置とすることができる。

【００６８】

本願発明の請求項２に記載のより具体的な構成とすることにより、長時間の使用においても色ずれ、発光効率の低下が極めて少なくより所望の光が発光可能な発光装置とすることができる。

【００６９】

本願発明の請求項３に記載の構成とすることにより、長時間の使用においても色ずれ、発光効率の低下が極めて少なく白色系の光を発光させることができる。

【００７０】

本願発明の請求項４に記載の構成とすることにより、長時間の使用においても色ずれ、発光効率の低下が極めて少なく白色系の光を発光させることができる。

【００７１】

本願発明の請求項５に記載の構成とすることにより、長時間の使用においても色ずれ、発光効率の低下が極めて少なくより所望の光が発光可能な発光装置とすることができる。

【００７２】

本願発明の請求項６に記載の構成とすることにより、より効率よく長時間の使用においても色ずれ、発光効率の低下が極めて少なく発光装置とすることができる。

【００７３】

本願発明の請求項７に記載の構成とすることにより、長時間の使用においても色ずれ、発光効率の低下が極めて少なく白色系の光をより均一に面状に発光させることができる。

【００７４】

本願発明の請求項８に記載の構成とすることにより、外部環境下においても長時間の使用においても色ずれ、発光効率の低下が極めて少なく高輝度にＲＧＢの発光成分を有する白色系が発光可能な発光ダイオードとすることができる。

【図面の簡単な説明】

【図１】

図１は、本願発明の発光装置の模式的断面図である。

【図２】

図２は、本願発明の他の発光装置である面状光源の模式的断面図を示し、（Ａ）は、導光板と発光ダイオードとの間にフォトルミネセンス蛍光体を有する面状光源であり、（Ｂ）は、導光板の主面上にフォトルミネセンス蛍光体を有する面状光源である。

【図３】

図３は、本願発明の他の発光装置である発光ダイオードの模式的断面図である。

【図４】

図４（Ａ）は、本願発明に用いられる第１及び第２のフォトルミネセンス蛍光体の吸収スペクトルの一例を示し、図４（Ｂ）は、本願発明に使用される第１及び第２のフォトルミネセンス蛍光体の発光スペクトルの一例を示した図である。

【図５】

図５は、本願発明に用いられる発光素子の発光スペクトル例を示した図である。

【図６】

図６は、本願発明と、比較のために示した発光装置との耐候性試験における結果を示し（Ａ）は輝度保持率と時間との関係、（Ｂ）は色調と時間との関係を示したグラフである。

【図７】

図７は、本願発明と、比較のために示した発光装置との信頼性試験における結果を示し（Ａ）は輝度保持率と時間との関係、（Ｂ）は色調と時間との関係を示したグラフである。

【図８】

図８は、本願発明の発光装置が発光可能な色度図を表す。Ａ及びＢ点は発光素子が発光する発光色を表し、Ｃ点、Ｄ点は、それぞれ２種類のフォトルミネッセンス蛍光体からの発光色を表す。

【符号の説明】

１０１、２１０・・・フォトルミネセンス蛍光体が含有されたモールド部材

１０２、２０２、３０２・・・発光素子

１０３、３０３・・・導電性ワイヤー

１０４・・・筐体

１０５・・・外部電極

２０１・・・色変換部材

２０３・・・支持体

２０４・・・導光板

２０５、２０７・・・反射部材

２０６・・・散乱シート

３０１・・・フォトルミネセンス蛍光体が含有されたコーティング部材

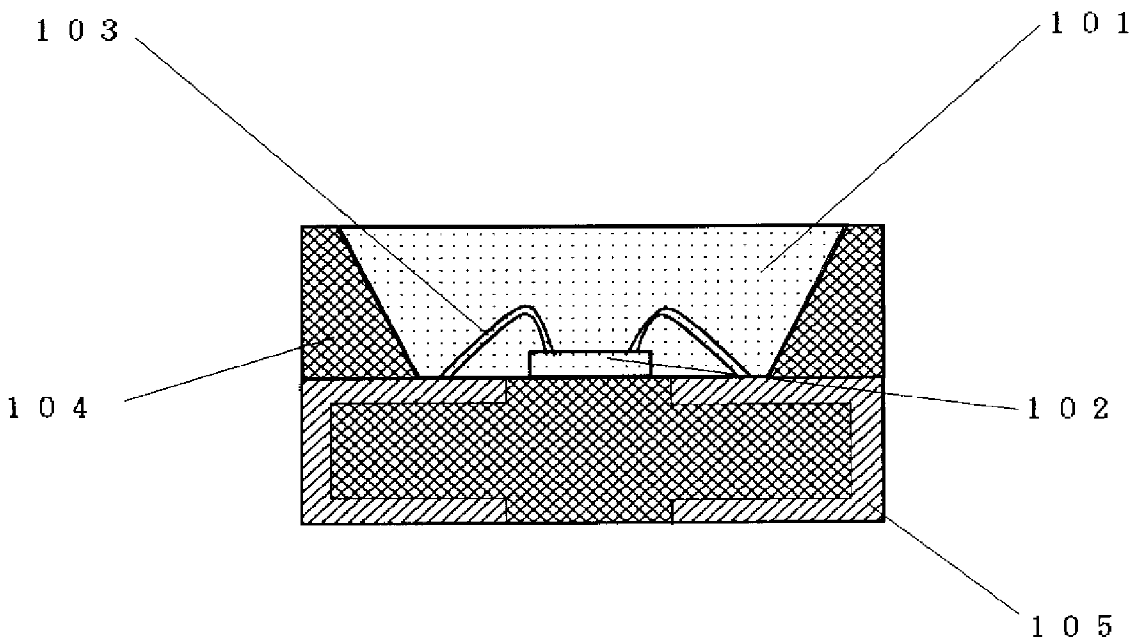
３０４・・・モールド部材

３０５・・・マウント・リード

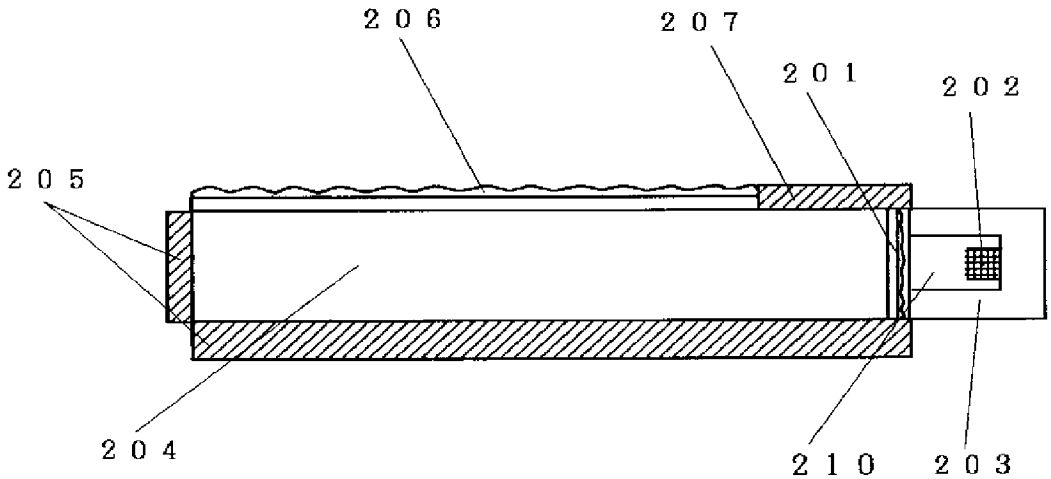
３０６・・・インナー・リード

【書類名】　図面

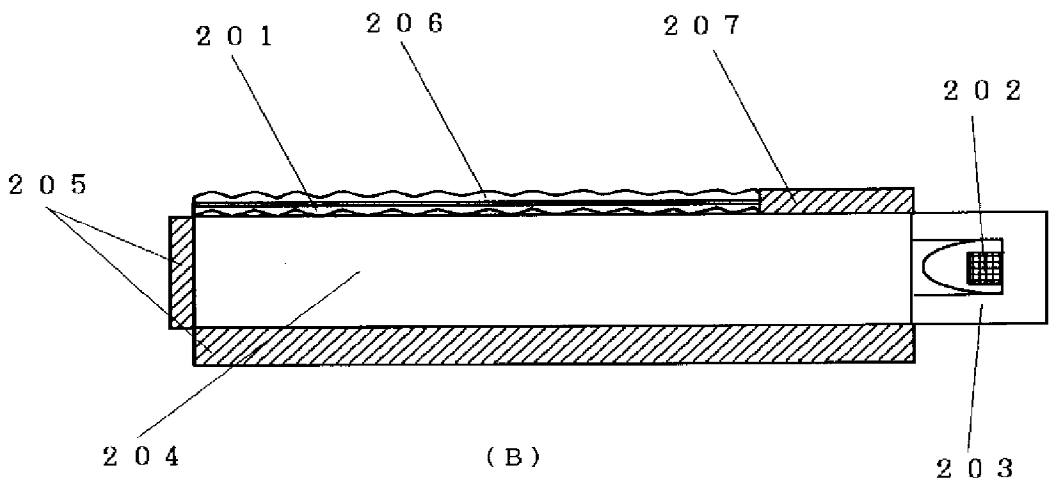
【図１】



【図２】

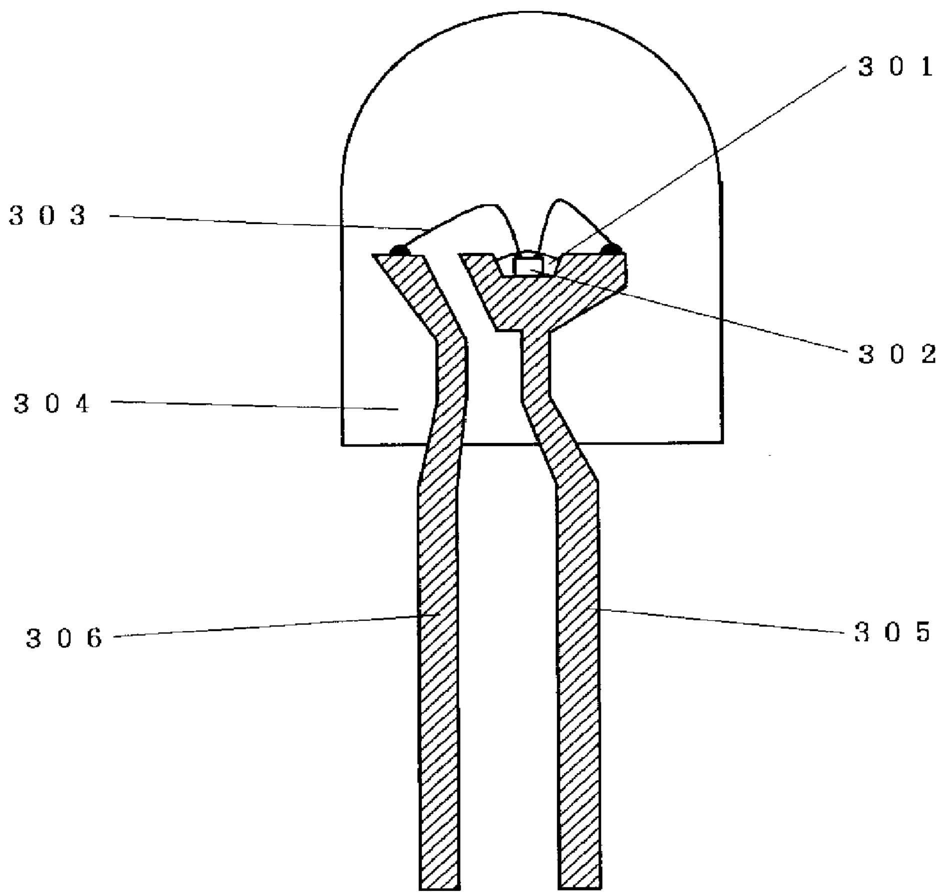


（Ａ）

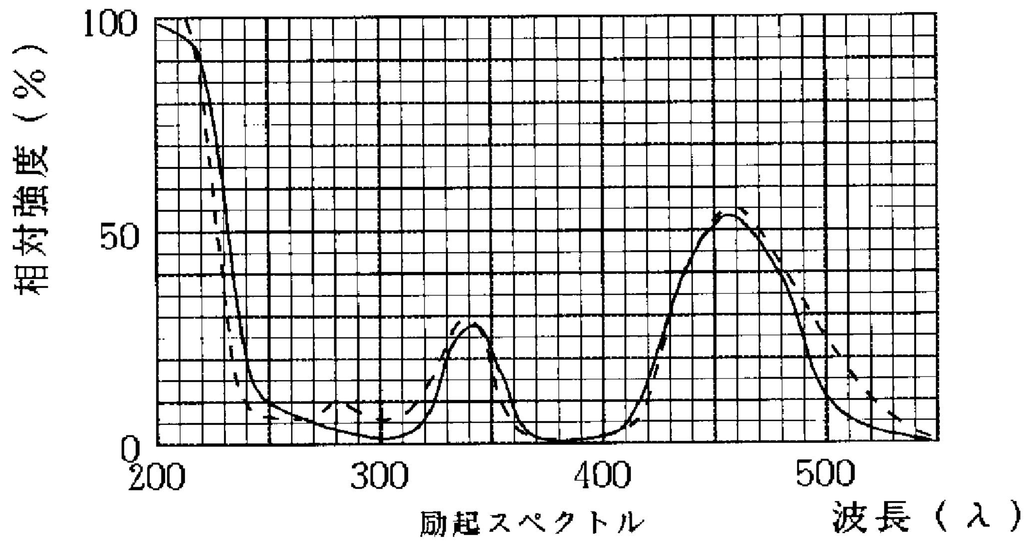


（Ｂ）

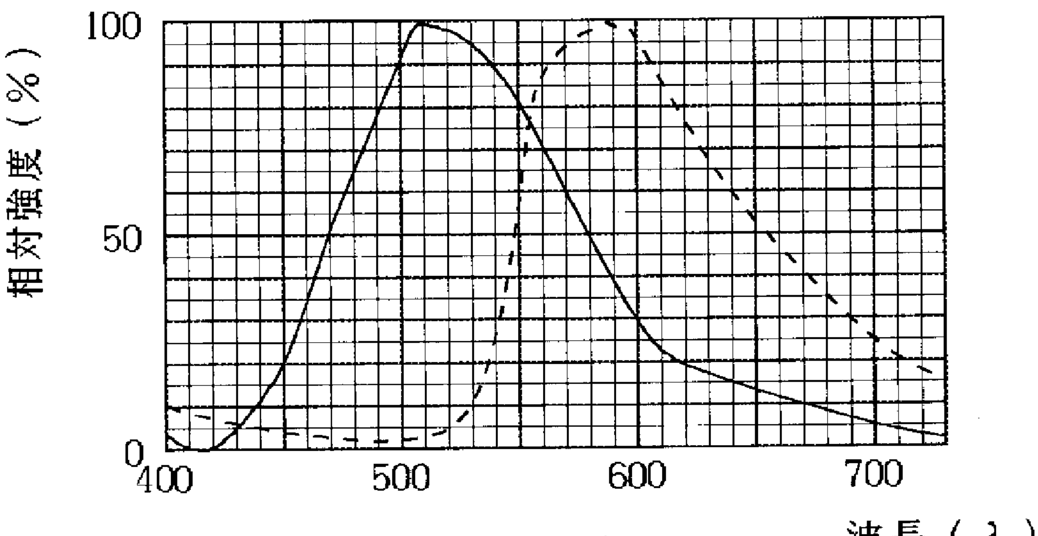
【図３】



【図４】

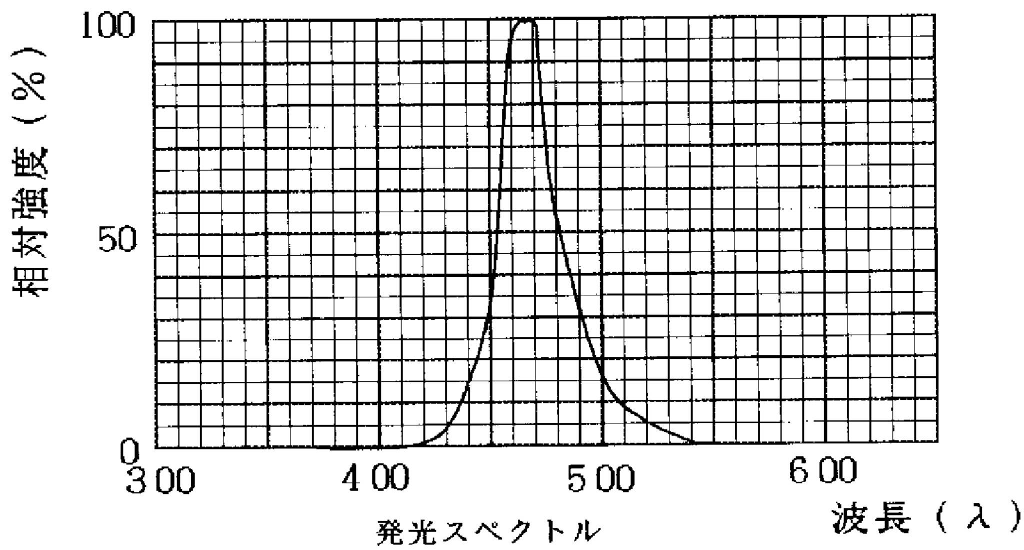


励起スペクトル
（Ａ）

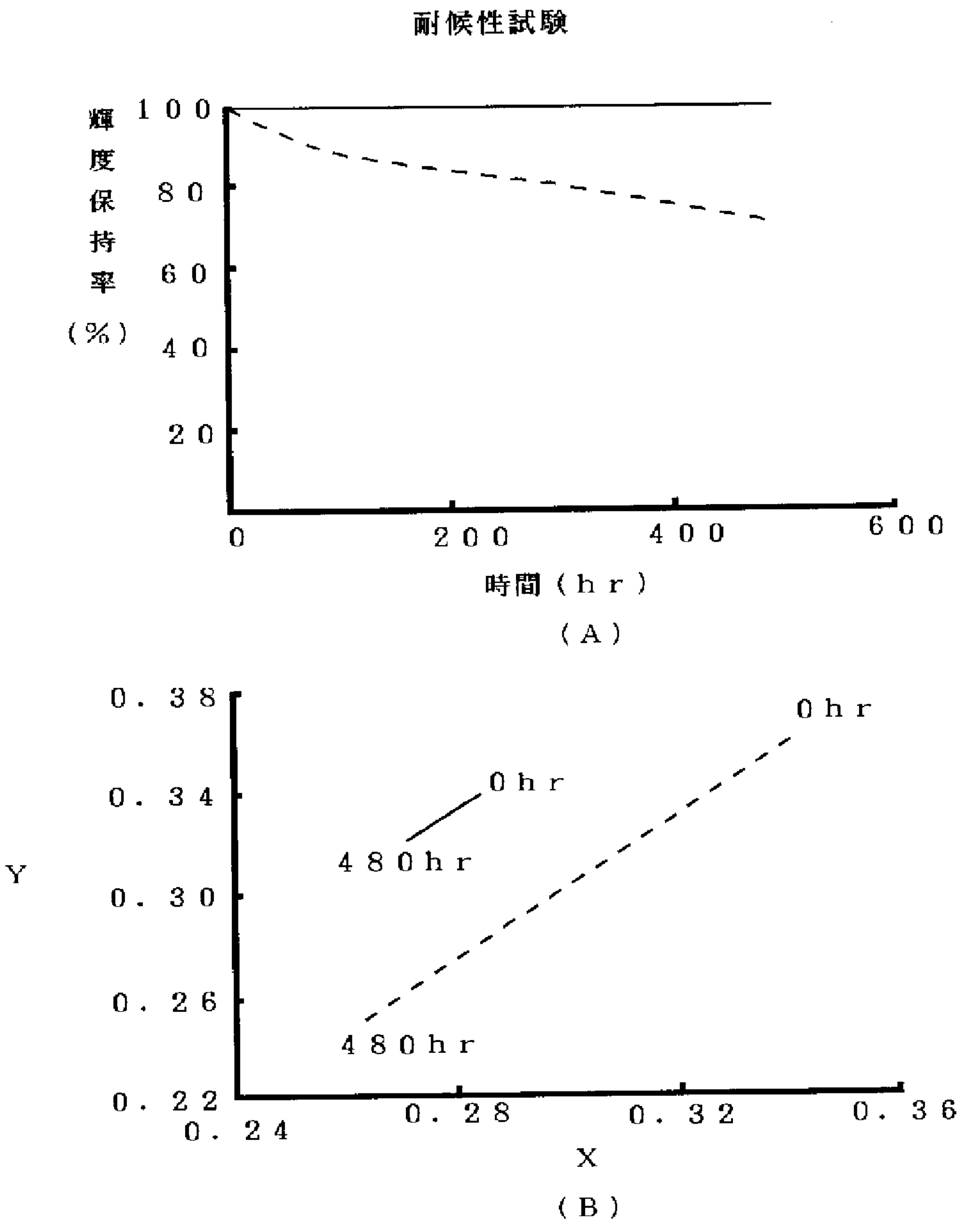


発光スペクトル
（Ｂ）

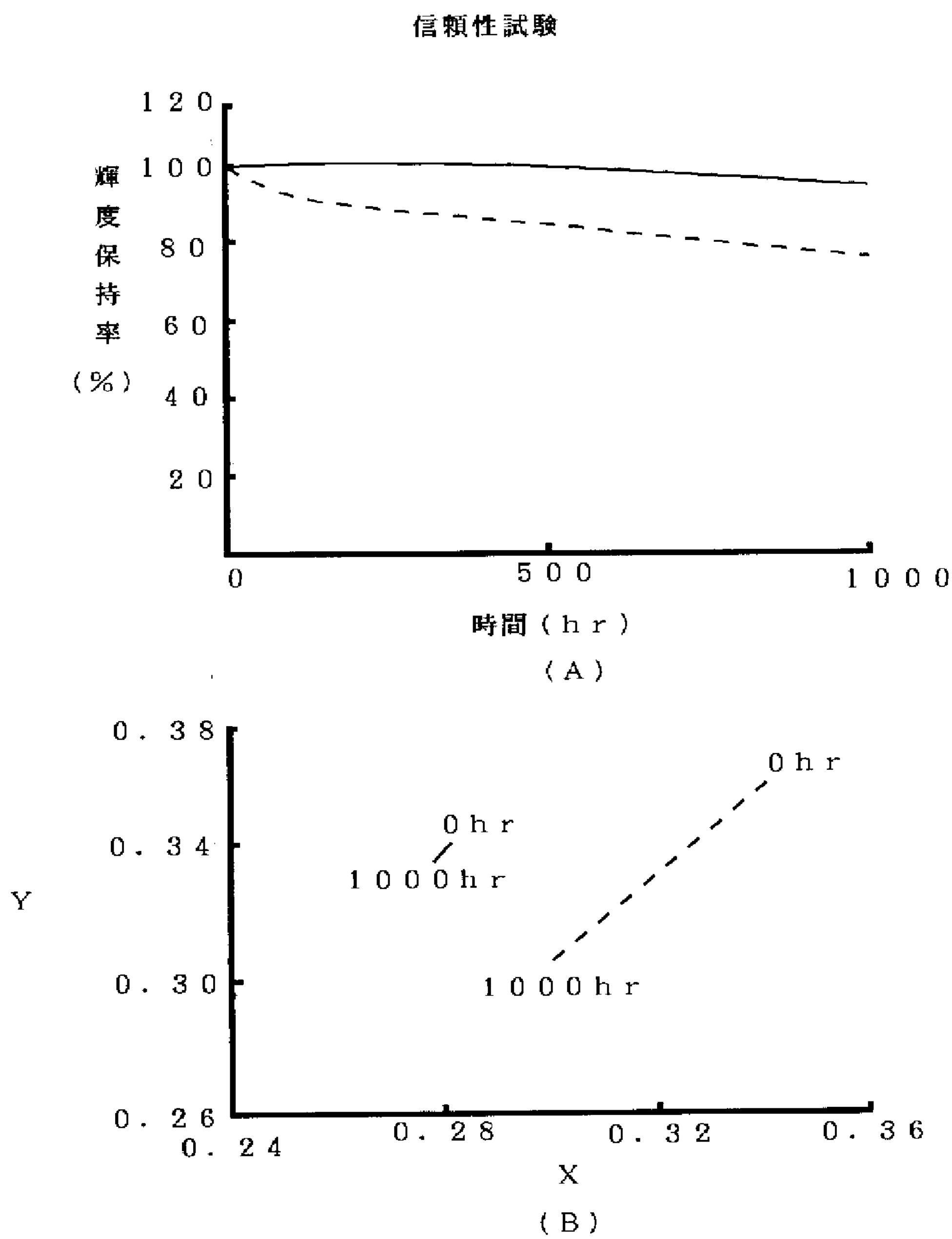
【図５】



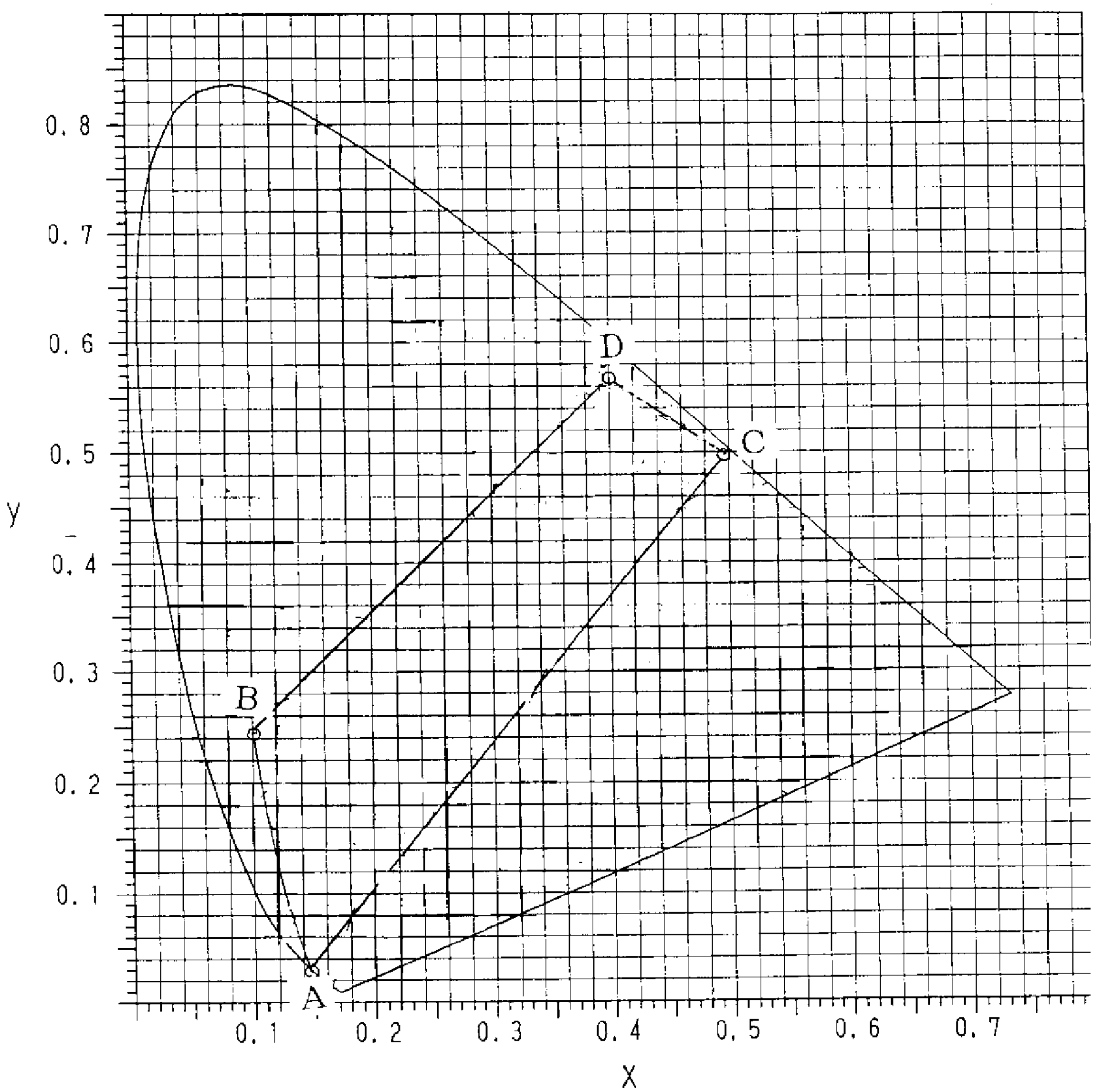
【図６】


耐候性試験
輝度保持率（％）
１００
８０
６０
４０
２０
０
２００
４００
６００
時間（ｈｒ）
（Ａ）
０．３８
０．３４
０．３０
０．２６
０．２２
Ｙ
０ｈｒ
４８０ｈｒ
０ｈｒ
４８０ｈｒ
０．２４
０．２８
０．３２
０．３６
Ｘ
（Ｂ）

【図７】


信頼性試験
120
100
80
60
40
20
輝度保持率（％）
0
500
1000
時間（hr）
（A）
0.38
0.34
0.30
0.26
Y
0hr
1000hr
0hr
1000hr
0.24
0.28
0.32
0.36
X
（B）

【図８】



【書類名】　要約書

【要約】

【課題】

本発明は、バックライト光源、照光式スイッチ、信号機、表示器、ＬＥＤディスプレイ及び各種インジケータなどに利用される発光装置に係わり、特に使用環境によらず高輝度、高効率に所望の色に発光可能な発光装置に関する。

【解決手段】

本発明は、発光層が窒化物系化合物半導体である発光素子と、該発光素子からの発光の少なくとも一部を吸収し前記発光素子からの発光よりも長波長光を発光するフォトルミネセンス蛍光体と、を有する発光装置である。フォトルミネセンス蛍光体は、組成の異なる２種類以上のセリウムで付活されたイットリウム・アルミニウム酸化物系蛍光体である。

【選択図】図１

【書類名】　　職権訂正データ
【訂正書類】　　特許願

<認定情報・付加情報>
【特許出願人】　　申請人
【識別番号】　　000226057
【住所又は居所】　　徳島県阿南市上中町岡４９１番地１００
【氏名又は名称】　　日亜化学工業株式会社

出願人履歴

０００２２６０５７

19900818

新規登録

徳島県阿南市上中町岡４９１番地１００

日亜化学工業株式会社

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
12/942,792	11/09/2010	2879	1090	0020-5147PUS12	19	1

CONFIRMATION NO. 2357

FILING RECEIPT

OC000000044586510

2292
BIRCH STEWART KOLASCH & BIRCH
PO BOX 747
FALLS CHURCH, VA 22040-0747

Date Mailed: 11/23/2010

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Yoshinori Shimieu, Naka-gun, JAPAN;
Kensho Sakano, Anan-shi, JAPAN;
Yasunobu Noguchi, Naka-gun, JAPAN;
Toshio Moriguchi, Anan-shi, JAPAN;

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a DIV of 12/548,614 08/27/2009
which is a DIV of 12/028,062 02/08/2008 PAT 7,682,848
which is a DIV of 10/609,402 07/01/2003 PAT 7,362,048
which is a DIV of 09/458,024 12/10/1999 PAT 6,614,179
which is a DIV of 09/300,315 04/28/1999 PAT 6,069,440
which is a DIV of 08/902,725 07/29/1997 PAT 5,998,925

Foreign Applications

JAPAN P 08-198585 07/29/1996
JAPAN P 08-244339 09/17/1996
JAPAN P 08-245381 09/18/1996
JAPAN P 08-359004 12/27/1996
JAPAN P 09-081010 03/31/1997

Request to Retrieve - This application either claims priority to one or more applications filed in an intellectual property Office that participates in the Priority Document Exchange (PDX) program or contains a proper **Request to**

Retrieve Electronic Priority Application(s) (PTO/SB/38 or its equivalent). Consequently, the USPTO will attempt to electronically retrieve these priority documents.

If Required, Foreign Filing License Granted: 11/19/2010

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 12/942,792**

Projected Publication Date: 03/03/2011

Non-Publication Request: No

Early Publication Request: No

Title

LIGHT EMITTING DEVICE AND DISPLAY

Preliminary Class

313

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/942,792	11/09/2010	Yoshinori Shimieu	0020-5147PUS12

CONFIRMATION NO. 2357

IMPROPER CPOA LETTER

OC000000044596554

2292
BIRCH STEWART KOLASCH & BIRCH
PO BOX 747
FALLS CHURCH, VA 22040-0747

Date Mailed: 11/23/2010

NOTICE REGARDING POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/09/2010. The Power of Attorney in this application is not accepted for the reason(s) listed below:

- The Power of Attorney you provided did not comply with the new Power of Attorney rules that became effective on June 25, 2004. See 37 CFR 1.32.

/cma/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PTO/SB/05 (08-08)
Approved for use through 06/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office. U.S. DEPARTMENT OF COMMERCE

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	0020-5147PUS12
First Inventor	Yoshinori SHIMIZU
Title	LIGHT EMITTING DEVICE AND DISPLAY
Express Mail Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: **Commissioner for Patents P.O. Box 1450 Alexandria VA 22313-1450**

1. [✔] **Fee Transmittal Form** (e.g., PTO/SB/17)
2. [ ] **Applicant claims small entity status.** See 37 CFR 1.27.
3. [✔] **Specification** [*Total Pages* 61]
   Both the claims and abstract must start on a new page
   (For information on the preferred arrangement, see MPEP 608.01(a))
4. [✔] **Drawing(s)** (*35 U.S.C. 113*) [*Total Sheets* 19]
5. **Oath or Declaration** [*Total Sheets* 2]
   a. [ ] Newly executed (original or copy)
   b. [✔] A copy from a prior application (37 CFR 1.63(d)) *(for continuation/divisional with Box 18 completed)*
   i. [ ] DELETION OF INVENTOR(S)
   Signed statement attached deleting inventor(s) name in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
6. [ ] **Application Data Sheet.** See 37 CFR 1.76
7. [ ] **CD-ROM or CD-R** in duplicate, large table or Computer Program *(Appendix)*
   [ ] Landscape Table on CD
8. **Nucleotide and/or Amino Acid Sequence Submission** *(if applicable, items a. – c. are required)*
   a. [ ] Computer Readable Form (CRF)
   b. Specification Sequence Listing on:
   i. [ ] CD-ROM or CD-R (2 copies); or
   ii. [ ] Paper
   c. [ ] Statements verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

9. [ ] **Assignment Papers** (cover sheet (PTO-1595) & document(s))
   Name of Assignee
10. [ ] **37 CFR 3.73(b) Statement** *(when there is an assignee)* [ ] **Power of Attorney**
11. [ ] **English Translation Document** *(if applicable)*
12. [✔] **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
    [ ] Copies of foreign patent documents, publications, & other information
13. [ ] **Preliminary Amendment**
14. [ ] **Return Receipt Postcard** (MPEP 503) (*Should be specifically itemized)*
15. [ ] **Certified Copy of Priority Document(s)** *(if foreign priority is claimed)*
16. [ ] **Nonpublication Request** under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
17. [✔] Other: Copy of Letter submitting priority documents from parent application.

18. If a CONTINUING APPLICATION, *check appropriate box, and supply the requisite information below and in the first sentence of the specification following the title, or in an Application Data Sheet under 37 CFR 1.76:*

[ ] Continuation [✔] Divisional [ ] Continuation-in-part (CIP) of prior application No.: 12/548,614

Prior application information: *Examiner* A. B. Mustapha *Art Unit:* 2812

19. CORRESPONDENCE ADDRESS

[✔] The address associated with Customer Number: 02292 **OR** [ ] Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone		Email	

Signature		Date	November 9, 2010
Name (Print/Type)	D. Richard Anderson	Registration No. (Attorney/Agent)	40,439

Docket No.: 0020-5147PUS12
(Patent)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application of:
Yoshinori SHIMIZU et al.

Application No.: NEW | Confirmation No.: N/A

Filed: November 9, 2010 | Art Unit: N/A

For: LIGHT EMITTING DEVICE AND DISPLAY | Examiner: N/A

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Applicant(s) hereby submit(s) an Information Disclosure Statement for consideration by the Examiner.

I. LIST OF PATENTS, PUBLICATIONS OR OTHER INFORMATION

The patents, publications, or other information submitted for consideration by the Office are listed on the attached PTO/SB/08.

II. COPIES

☑ a. Copies of foreign patent documents, non-patent literature and other information.

☑ b. REFERENCES PREVIOUSLY CITED OR SUBMITTED: Copies of any information not provided can be found in one or more of the following applications which has been relied upon for an earlier filing date under 35 U.S.C. § 120:

U.S. Application No. and U.S. Filing Date
12/548,614, filed August 27, 2009

12/028,062, filed February 8, 2008, now U.S. Patent 7,682,848
10/609,402, filed July 1, 2003, now U.S. Patent 7,362,048
09/458,024, filed December 10, 1999, now U.S. Patent 6,614,179
09/300,315, filed April 28, 1999, now U.S. Patent 6,069,440
08/902,725, filed July 29, 1997, now U.S. Patent 5,998,925.

III. CONCISE EXPLANATION OF THE RELEVANCE/OTHER INFORMATION

☐ a. NON-ENGLISH LANGUAGE DOCUMENTS: A concise explanation of the relevance of all non-English language patents, publications, or other information listed is as follows:

☐ b. ENGLISH LANGUAGE SEARCH REPORT OR FOREIGN PATENT OFFICE COMMUNICATION: An English language version of the search report or Foreign Patent Office communication that indicates the degree of relevance is attached.

☒ c. OTHER: The following additional information is provided.
All references were cited during prosecution of parent Application No. 12/548,614, filed August 27, 2009.

IV. STATEMENT UNDER 37 C.F.R. § 1.97(e)

The undersigned hereby states that:

☐ a. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **30 days** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☐ b. Each item of information contained in the IDS was first cited in any communication from a foreign patent office in a counterpart foreign application not more than **three months** prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office; or

☐ c. No item of information contained in the IDS was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of IDS was known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of the IDS.

☐ d. Some of the items of information in the IDS were cited in a communication from a foreign patent office. Such items were first cited in a communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this IDS. This statement does not relate to English language counterparts not listed in a communication from the foreign patent office. Such English language counterparts are provided to aid the Examiner's consideration of non-English items first cited in the communication from the foreign patent office. As to the remaining items of information, to the knowledge of the person signing the certification after making reasonable inquiry, such remaining items were not known to any individual designated in 37 C.F.R. § 1.56(c) more than three months prior to the filing of this statement.

V. FEES

☑ a. This Information Disclosure Statement is being filed concurrently with the filing of a new patent application or Request for Continued Examination. No fee is required.

☐ b. This Information Disclosure Statement is being filed within three months of the filing date of an application. No fee is required.

☐ c. This Information Disclosure Statement is being filed before the mailing date of a first Action on the merits. No fee is required. If a first Office Action on the merits has issued, please consider this IDS under 37 C.F.R. § 1.97(c) and see the statement under 37 C.F.R. § 1.97(e) above. If no statement has been made, charge our deposit account for the required fee.

☐ d. This Information Disclosure Statement is being filed before the mailing date of a Final Office Action or before the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(c)(1)).

☐ No statement. The fee as required by 37 C.F.R. § 1.17(p) is provided.

or

☑ See the above statement. No fee is required.

☐ e. This Information Disclosure Statement is being filed after the mailing date of a Final Office Action or after the mailing date of a Notice of Allowance (see 37 C.F.R. § 1.97(d)), see the statement above. The fee as required by 37 C.F.R. § 1.17(p) is provided.

VI. PAYMENT OF FEES

☐ The required fee is listed on the attached Fee Transmittal.

☑ No fee is required.

If the Examiner has any questions concerning this IDS, please contact the undersigned. If it is determined that this IDS has been filed under the wrong rule, the USPTO is requested to consider this IDS under the proper rule and charge the appropriate fee to Deposit Account No. 02-2448.

Dated: November 9, 2010

Respectfully submitted,

By

D. Richard Anderson
Registration No.: 40,439
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road, Suite 100 East
P.O. Box 747
Falls Church, VA 22040-0747
703-205-8000

Attachment(s):

- ☑ PTO/SB/08
- ☐ Document(s)
- ☐ Foreign Patent Office Communication
- ☐ Foreign Search Report
- ☐ Fee
- ☐ Other:

PTO/SB/08a (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	1	of	12

Complete if Known	
Application Number	NEW
Filing Date	Concurrently Herewith
First Named Inventor	Yoshinori SHIMIZU
Art Unit	N/A
Examiner Name	Not Yet Assigned
Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number: Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	AA*	US-5,700,713-A	12-23-1997	Yamazaki et al.	
	AB*	US-5,257,049	10-26-1993	Van Peteghem	
	AC*	US-6,812,500	11-02-2004	Reeh et al.	
	AD*	US-2001-0030326-A1	10-18-2001	Reeh et al.	
	AE*	US-6,576,930	06-10-2003	Reeh et al.	
	AF*	US-6,784,511	08-31-2004	Kunihara et al.	
	AG*	US-6,066,861	05-23-2000	Hohn et al.	
	AH*	US-5,959,316	09-28-1999	Lowery	
	AI*	US-5,118,985-A	06-02-1992	Patton et al.	
	AJ*	US-4,644,223	02-17-1987	de Hair et al.	
	AK*	US-6,538,371	03-25-2003	Duggal et al.	
	AL*	US-3,875,456	04-01-1975	Kano et al.	
	AM*	US-3,510,732	05-05-1970	R.L. Amans	
	AN*	US-5,550,657	08-27-1996	Tanaka et al.	
	AO*	US-5,578,839	11-26-1996	Nakamura et al.	
	AP*	US-6,004,001-A	12-21-1999	Noll	
	AQ*	US-4,905,060	02-27-1990	Chinone et al.	
	AR*	US-3,652,956	03-28-1972	Pinnow et al.	
	AS*	US-4,314,910	02-09-1982	Barnes	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document: Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
	BA	JP-2002-270020-A	09-20-2002	CASIO COMPUTER CO LTD		
	BB	JP-7-321407	12-08-1995	FUJI ELECTRIC CO LTD.		
	BC	JP-6-115158	04-26-1994	AGFA GEVAERT NV		
	BD	JP-61-158606	07-18-1986			
	BE	JP-2000-512806-A	09-26-2000			
	BF	JP-07-288341	10-31-1995	NICHIA CHEM IND LTD		

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. * CITE NO.: Those application(s) which are marked with an single asterisk (*) next to the Cite No. are not supplied (under 37 CFR 1.98(a)(2)(iii)) because that application was filed after June 30, 2003 or is available in the IFW. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

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Art Unit	N/A
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	AT*	US-5,006,908	04-09-1991	Matsuoka et al.	
	AU*	US-5,369,289	11-29-1994	Tamaki et al.	
	AV*	US-4,727,283	02-23-1988	van Kemenade et al.	
	AW*	US-4,298,820	11-03-1981	Bongers et al.	
	AX*	US-3,699,478	10-17-1972	Pinnow et al.	
	AY*	US-5,798,537	08-25-1998	Nitta	
	AZ*	US-5,202,777	04-13-1993	Sluzky et al.	
	AA1*	US-3,819,974	06-25-1974	Stevenson et al.	
	AB1*	US-5,847,507	12-08-1998	Butterworth et al.	
	AC1*	US-3,691,482	09-12-1972	Pinnow et al.	
	AD1*	US-4,550,256	10-29-1985	Berkstesser et al.	
	AE1*	US-4,716,337	12-29-1987	Huiskes et al.	
	AF1*	US-5,471,113	11-28-1995	De Backer et al.	
	AG1*	US-5,825,125-A	10-20-1998	Ligthart et al.	
	AH1*	US-5,602,418-A	02-11-1997	Imai et al.	
	AI1*	US-5,998,925-A	12-07-1999	Shimizu et al.	
	AJ1*	US-6,069,440-A	05-30-2000	Shimizu et al.	
	AK1*	US-6,608,332-B2	08-19-2003	Shimizu et al.	
	AL1*	US-6,614,179-B1	09-02-2003	Shimizu et al.	

FOREIGN PATENT DOCUMENTS

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	BG	JP-5-226676	03-09-1993	SHARP CORP.		
	BH	JP-49-122292	11-22-1974			
	BI	JP-11-500584	01-12-1999			
	BJ	JP-8-78727-A	03-22-1996			
	BK	JP-03-152898-A	06-28-1991			
	BL	JP-06-139973-A	05-20-1994			

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Sheet	3	of	12

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Application Number	NEW
Filing Date	Concurrently Herewith
First Named Inventor	Yoshinori SHIMIZU
Art Unit	N/A
Examiner Name	Not Yet Assigned
Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

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	AM1*	US-7,329,988-B2	02-12-2008	Shimizu et al.	
	AN1*	US-7,126,274-B2	10-24-2006	Shimizu et al.	
	AO1*	US-7,026,756-B2	04-11-2006	Shimizu et al.	
	AP1*	US-7,215,074-B2	05-08-2007	Shimizu et al.	
	AQ1*	US-7,071,616-B2	07-04-2006	Shimizu et al.	
	AR1*	US-7,531,960-B2	05-12-2009	Shimizu et al.	
	AS1*	US-7,362,048-B2	04-22-2008	Shimizu et al.	
	AT1*	US-5,949,182	09-07-1999	Shealy et al.	
	AU1*	US-3,748,548	07-24-1973	Haisty et al.	
	AV1*	US-5,512,210	04-30-1996	Sluzky et al.	
	AW1*	US-5,630,741	05-20-1997	Potter	
	AX1*	US-4,857,228	08-15-1989	Kabay et al.	
	AY1*	US-6,340,824	01-22-2002	Komoto et al.	
	AZ1*	US-4,001,628	01-04-1977	Ryan	
	AA2*	US-5,208,462	05-04-1993	O'Connor et al.	
	AB2*	US-5,706,022	01-06-1998	Hato	
	AC2*	US-5,743,629	04-28-1998	Helstern et al.	
	AD2*	US-6,600,175	07-29-2003	Baretz et al.	
	AE2*	US-20100001258	01-07-2010	Shimizu et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
	BM	EP-0 500 937-A1	09-02-1992			
	BN	JP-2001-320094-A	11-16-2001			
	BO	DE-3804293-A1	08-24-1989			
	BP	JP-06-231605-A	08-19-1994			
	BQ	GB-2 000 173	01-04-1979			
	BR	EP-0 383 215-A	08-22-1990			

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Sheet 4 of 12

Complete if Known	
Application Number	NEW
Filing Date	Concurrently Herewith
First Named Inventor	Yoshinori SHIMIZU
Art Unit	N/A
Examiner Name	Not Yet Assigned
Attorney Docket Number	0020-5147PUS12

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number: Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	AF2*	US-20090315015	12-24-2009	SHIMIZU et al.	
	AG2*	US-5,221,984	06-22-1993	Furuyama et al.	
	AH2*	US-5,594,751	01-14-1997	Scott	
	AI2*	US-5,801,435	09-01-1998	Otsuki	
	AJ2*	US-6,015,200	01-18-2000	Ogura	
	AK2*	US-7,682,848-A1	03-23-2010	Shimizu et al.	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document: Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
	BS	DE-9013615-U	01-24-1991			
	BT	JP-59-30107-U	02-24-1984			
	BU	JP-7-32638-U	06-16-1995			
	BV	JP-01-257993-A	10-16-1989			
	BW	JP-01-260707-A	10-18-1989			
	BX	JP-02-111922-A	04-24-1990			

Examiner Signature		Date Considered	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	5	of	12

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Application Number	NEW
Filing Date	Concurrently Herewith
First Named Inventor	Yoshinori SHIMIZU
Art Unit	N/A
Examiner Name	Not Yet Assigned
Attorney Docket Number	0020-5147PUS12

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
	BY	JP-05-142424-A	06-11-1993			
	BZ	JP-06-160635-A	06-07-1994			
	BA1	JP-06-027327-A	02-04-1994			
	BB1	JP-06-82633-A	03-25-1994			
	BC1	JP-07-114904-A	05-02-1995			
	BD1	JP-07-235207-A	09-05-1995			
	BE1	JP-53-7153	01-21-1978			
	BF1	JP-7-42152-A	07-21-1995			
	BG1	JP-55-4898-A	01-14-1980			
	BH1	JP-55-005533-A	01-16-1990			
	BI1	JP-60-185457	09-20-1985			
	BJ1	JP-62-20237-A	01-28-1987			
	BK1	JP-62-232827-A	10-13-1987			
	BL1	JP-01-189695-A	07-28-1989			
	BM1	JP-07-120754-A	05-12-1995			
	BN1	JP-06-177423-A	06-24-1994			
	BO1	JP-7-99345-A	04-11-1995			
	BP1	JP-09-027642-A	01-28-1997			
	BQ1	JP-05-63068-U	08-20-1993			
	BR1	EP-0 209 942-A1	01-28-1987			
	BS1	EP-0 541 373-A2	11-05-1992			
	BT1	JP-0 599 224-A1	06-01-1994			
	BU1	JP-01179471-A	07-17-1989			
	BV1	JP-5043913-C1	04-21-1975			
	BW1	JP-554898-A	01-14-1980			
	BX1	JP-09027642-A	01-28-1997			
	BY1	JP-08007614-A	01-12-1996			
	BZ1	JP-07176794-A	07-14-1995			
	BA2	JP-07099345-A	04-11-1995			
	BB2	JP-05152609	06-18-1993			
	BC2	JP-6220237-A	01-28-1987			
	BD2	WO-97/50132-A1	12-31-1997			
	BE2	WO-98/12757-A1	03-26-1998			
	BF2	JP-5079379	11-24-1973			
	BG2	JP-742152	07-21-1995			
	BH2	JP-4717684	09-09-1972			
	BI2	JP-491221	01-12-1974			
	BJ2	JP-49112577	10-26-1974			
	BK2	JP-62189770	02-15-1986			
	BL2	JP-291980	09-29-1988			
	BM2	JP-5152609-A	06-18-1993			
	BN2	JP-5-183189-A	07-23-1993	Nichia Kagaku Kogyo Kk		

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Sheet 6 of 12

Complete if Known	
Application Number	NEW
Filing Date	Concurrently Herewith
First Named Inventor	Yoshinori SHIMIZU
Art Unit	N/A
Examiner Name	Not Yet Assigned
Attorney Docket Number	0020-5147PUS12

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	BO2	JP-863119	03-08-1996			
	BP2	JP-10036835-A	02-10-1998			
	BQ2	JP-49106283	12-27-1972			
	BR2	JP-5245181	10-14-1977			
	BS2	GB-1589964	05-20-1981			
	BT2	JP-5441660	12-05-1979			
	BU2	JP-5472484	11-07-1978			
	BV2	JP-5950445	04-01-1984			
	BW2	JP-324692	03-14-1991			
	BX2	JP-463162	05-29-1992			
	BY2	JP-463163	05-29-1992			
	BZ2	JP-563068	08-20-1993			
	BA3	JP-8170077	07-02-1996			
	BB3	JP-5331584	03-24-1978			
	BC3	JP-60144381	07-30-1985			
	BD3	JP-62167387	07-23-1987			
	BE3	JP-6208845	07-26-1994			
	BF3	JP-06177423	06-24-1994			
	BG3	JP-06260680	09-16-1994			
	BH3	JP-06268257	09-22-1994			
	BI3	JP-4-234481-A	08-24-1992			
	BJ3	JP-4-80286-A	03-13-1992			
	BK3	GB-1 305 111	01-31-1973			
	BL3	EP-0 667 383-A2	08-16-1995			
	BM3	JP-6-296043-A	10-21-1994			
	BM4	EP-0-550-937-A1	09-02-1992			

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First Named Inventor	Yoshinori SHIMIZU
Art Unit	N/A
Examiner Name	Not Yet Assigned
Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	CA	"White LED lamp: Efficient light-emitting; Manufacture cost half", Nikkei Sangyo Shimbun, September 13, 1996, Published by Nihon Keizai Shimbunsha.	
	CB	"SIMENS SMT-TOPLED fur die Oberflachenmontage" Frank Mollmer et al. Simens Components, 29 (1991) Hfet 4.	
	CC	"Proceedings of the Institute of Phosphor Society", Translation of pages 1, 5 to 14 of the 264th Proceedings of the Institute of Phosphor Society, Nov. 29, 1996.	
	CD	"Nichia Chemical starts the sample shipment of white light emitting diode", News Report, translation of page 15 of Nikkei Electronics 1996.9.23 (No. 671).	
	CE	"GaNpn Contact Blue/Ultraviolet light Emitting Diode", H. Amano et al., Applied Physics, Vol. 20, No. 2, pp. 163-166 (1991)	
	CF	"Phosphors Based on Rare-Earths, A New Era in Fluorescent Lighting", B.M.J. Smets, Materials Chemistry and Physics, 16 pp. 283-299 (1987)	
	CG	"Proceedings of the Institute of Phosphor Society", Translation of pages 1, 5 to 14 of the 264th Proceedings of the Institute of Phosphor Society.	
	CH	"A New Phosphor for Flying-Spot Cathode-Ray Tubes for Color Television: Yellow Emitting..", G. Blasse et al., App. Phys. Lett. Vol. 11, No. 2, pp. 53-55 (1967)	
	CI	Y. Nayatani, Color Research & Application, Vol. 20, No. 3, June 1995, pp. 143-155.	
	CJ	WUSTLICH MIKRO-/OPTO-ELEKTRONIK GMBH (1994/1995)	

Examiner Signature		Date Considered	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Sheet 8 of 12

Complete if Known	
Application Number	NEW
Filing Date	Concurrently Herewith
First Named Inventor	Yoshinori SHIMIZU
Art Unit	N/A
Examiner Name	Not Yet Assigned
Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
	CK	W.W. Holloway, Jr. et at., "Optical Properties of Cerium-Activated Garnet Crystals", 1969 Journal of the Optical Society of America, Vol. 59, No. 1, pp. 60-63	
	CL	W.W. HOLLOWAY, Jr. et al., "On The Fluorescence of Cerium - Activated Garnet Crystals", Physics Letters, Vol. 25A, No. 8, 23 October 1967, pp. 614-615.	
	CM	W.J. MINISCALCO et al., "Measurements of Excited-State Absorption in Ce3+:YAGa)", J. Appl. Phys. Vol. 49, No. 12, December 1978, pp. 6109-6111.	
	CN	Takashi MATSUOKA et al., "Growth and Properties of a Wide-Gap Semiconductor InGaN", Optoelectronics-Devices and Technologies, Vol. 5, No. 1, pp.53-64, June 1990.	
	CO	Tadao MIURA, ELECTRONICS ENGINEERING, "High-intensity White Backlighting for LCD of Car Audios", July 1996, Vol. 38, No. 7, pp. 55-58	
	CP	T. NAGATOMO et al., "Ga1-xInxN Blue Light-Emitting Diodes", Proc. Electrochem. Soc., 1993, Vol. 93-10, pp. 136-141.	
	CQ	Shuji NAKAMURA, "Zn-doped InGaN growth and InGaN/AlGaN double-heterostructure blue-light-emitting diodes", Journal of Crystal Growth, 145 (1994), pp. 911-917.	
	CR	Shuji NAKAMURA, "InGaN/AlGaN blue-light-emitting diodes", J. Vac. Sci. Technol. A 13(3), May/Jun 1995, pp.705-710.	
	CS	Shuji NAKAMURA, "High-Power InGaN/AlGaN Double-Heterostructure Blue-Light-Emitting Diodes", IEDM 94 (1994), IEEE, pp. 567-570.	
	CT	Shuji NAKAMURA et al., "Si-Doped InGaN Films Grown on GaN Films", Jpn. J. Appl. Phys. Vol. 32 (1993), pp. L16-L19, Part 2, No. 1A/B, 15 January 1993.	

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Sheet	9	of	12

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	CU	Shuji NAKAMURA et al., "P-GaN/N-InGaN/N-GaN Double-Heterostructure Blue-Light-Emitting Diodes", Jpn. J. Appl. Phys. Vol. 32 (1993), pp. L8-L11, Part 2, No. 1A/B, 15, January 1993.	
	CV	Shigeo SHIONOYA et al. (editors), "Phosphor Handbook", pp. 505-508, CRC Press, 1999.	
	CW	Shigeo SHIONOYA et al. (editors), "Phosphor Handbook", pp. 505-508, CRC Press.	
	CX	Sato et al., Japanese Journal of Applied Physics, Vol. 35, July 1, 1996, pp. L838-L839.	
	CY	S. Nakaura et al., Japanese Journal of Applied Physics Part 2, Vol. 31, No. 10B, 1992, pp. L1457-1459.	
	CZ	R. W. G. Hunt, Color Research & Application, Vol. 16, No. 3, 1991, pp. 146-165.	
	CA1	Proceedings of Illumination National Convention in 1983, page 12.	
	CB1	Phosphor Handbook, 1st Edition, 1987, pp. 233-240 and 275-277.	
	CC1	P. Schlouer et al. "Luminescence Conversion of Blue Light Emitting Diodes", Applied Physics Letter, vol. 46, p. 417-418, February 1997	
	CD1	Nikkei Sangyo Shin-bun of September 13, 1996.	
	CE1	Nakamura, SPIE, Vol. 3002, pp. 26-35 (1997)	
	CF1	Mitsubishi Electric Company Technical Report, Vol. 48, No. 9, 1974, pp. 1121-1124.	
	CG1	M.F. YAN et al., "Preparation of Y3Al5O12-Based Phosphor Powders, J. Electrochem. Soc., Vol. 134, No. 2.	
	CH1	M.F. YAN et al., "Preparation of Y3Al5O12-Based Phosphor Powders, J. Electrochem. Soc., Vol. 134, No. 2, Feb. 1987.	
	CI1	M. Ikeda, Journal of the Illumination Society, Vol. 71, No. 10, 1987, pp. 612-617 and English Abstract.	
	CJ1	M. Ikeda et al., Color Research & Application, Vol. 16, No. 2, April 1991, pp. 72-80.	
	CK1	M. Ikeda et al., Color Research & Application, Vol. 14, No. 4, August 1989, pp. 198-206.	
	CL1	Kozo OSAMURA et al., "Preparation and optical properties of Ga1-xInxN thin films", Journal of Applied Physics, Vol. 46, No. 8, August 1975, pp. 3432-3437.	
	CM1	Journal of the Television Society, Vol. 47, No. 5, 1993, pp. 753-764.	
	CN1	J.M. Robertson, et al., "Colourshift of the Ce3+ Emission in Monocrystalline Epitaxially Grown Garnet Layers", 1981 Philips J. Res. 36, pp. 15-30	

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(Use as many sheets as necessary)	Art Unit	N/A
	Examiner Name	Not Yet Assigned
Sheet 10 of 12	Attorney Docket Number	0020-5147PUS12

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	CI2	Office Action issued February 28, 2006, in U.S. Application No. 10/677,382 (U.S. Patent 7,026,756).	
	CJ2	Notice of Allowance and Examiner's Comments on Allowance issued February 13, 2008, in connection with U.S. Application No. 10/609,402 (U.S. Patent 7,362,048).	
	CK2	Notice of Allowance and Examiner's Comments on Allowance issued February 11, 2009, in U.S. Application No. 11/682,014 (U.S. Patent 7,531,960).	
	CL2	Notice of Allowance and Examiner's Comments on Allowance issued March 10, 2006, in U.S. Application No. 10/864,544 (U.S. Patent 7,126,274).	
	CM2	Notice of Allowance and Examiner's Comments on Allowance issued September 7, 2006, in U.S. Application No. 11/208,729 (U.S. Patent 7,215,074).	
	CN2	Notice of Allowance and Examiner's Comments on Allowance issued May 4, 2005, in U.S. Application No. 10/609,503 (U.S. Patent 7,071,616).	
	CO2	Notice of Allowance and Examiner's Comments on Allowance issued March 25, 2003, in U.S. Application No. 09/736,425 (U.S. Patent 6,608,332).	
	CP2	Notice of Allowance and Examiner's Comments on Allowance issued March 26, 2003, in U.S. Application No. 09/458,024 (U.S. Patent 6,614,179).	
	CQ2	Notice of Allowance and Examiner's Comments on Allowance issued September 25, 2007, in U.S. Application No. 11/653,275 (U.S. Patent 5,998,925).	
	CR2	Notice of Allowance and Examiner's Comments on Allowance issued March 8, 1999, in U.S. Application No. 09/300,315 (U.S. Patent 6,069,440).	

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Sheet	11	of	12

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	CS2	Notice of Allowance and Examiner's Comments on Allowance issued January 28, 1999, in U.S. Application No. 08/902,725 (U.S. Patent 5,998,925).	
	CT2	Office Action issued November 17, 2000, in U.S. Application No. 08/902,725 (U.S. Patent 5,998,925).	
	CU2	Notice of Allowance and Examiner's Comments on Allowance issued September 22, 2005, in U.S. Application No. 10/677,382 (U.S. Patent 7,026,756).	
	CV2	Office Action issed October 20, 2009, in Japanese Patent Application No. 2009-065948 with partial English translation.	
	CW2	Office Action issued April 4, 2007, in U.S. Application 11/653,275 (U.S. Patent 7,329,988 B2).	
	CX2	Notice of Allowance and Examiner's Comments on Allowance issued February 13, 2008, in U.S. Application No. 10/609,402 (U.S. Patent 7,362,048).	
	CY2	Notice of Allowance and Examiner's Comments on Allowance issued September 25, 2007, in U.S. Application No. 11/653,275 (U.S. Patent 7,329,988).	
	CZ2	Notice of Allowance and Examiner's Comments on Allowance issued October 8, 1999, in U.S. Application No. 09/300,315 (U.S. Patent 6,069,440).	
	CA3	Office Action issUed October 20, 2009, in Japanese Patent Application No. 2009-065948 with partial English translation.	
	CB3	Hide et al., "White light from InGaN/conjugated polymer hybrid light-emitting diodes," Appl. Phys. Lett., Vol. 70 (20), May 19, 1997, http://apl.aip.org/apl/copyright.jsp, pp. 2664-2666.	

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	CC3	NAKAMURA et al., "High-Brightness InGaN Blue, Green and Yellow Light-Emitting Diodes with Quantum Well Structures", Japanese Journal of Applied Physics, Vol. 34, No. 7A, Part 2, July 1, 1995, pp. L797-L799 XP000702022	
	CD3	Non-Final Office Action issued August 2, 2010, in co-pending U.S. Application Serial No. 12/559,042.	
	CD4	Hoffman, Journal of Ies, pp. 89-91 (1977).	
	CD5	H. Shinoda et al., Color Research & Application, Vol. 18, No. 5, October 1993, pp. 326-333.	
	CD6	G. BLASSE et al., "Investigation of Some Ce3+-Activated Phosphors", Journal of Chemical Physics, Vol. 47, No. 12, 15 December 1967.	
	CD7	E.F. GIBBONS et al., "Some Factors Influencing the Luminous Decay characteristics of Y3Al5O12:Ce3+", J. Electrochem. Soc., Vol. 120, No. 6, June 1973.	
	CD8	D.J. ROBBINS et al., "Lattice Defects and Energy Transfer Phenomena in Y3Al5O12:Ce3+", pp. 1004-1013, printed June 19, 2001.	
	CD9	Bando et al., Development and applications of highbright white LED lamps, November 29, 1996, The 264th Proceedings of the Institute of Phosphor Society, pages 4-16 of the English translation.	
	CD10	Office Action issued December 13, 2005, in U.S. Application No. 11/208,729 (U.S. Patent No. 7,215,074).	
	CD11	Office Action issued March 13, 2001, in U.S. Application No. 09/458,024 (U.S. Patent No. 6,614,179).	
	CD12	Office Action issued August 14, 2002, in U.S. Application No. 09/736,425 (U.S. Patent No. 6,608,332).	
	CD13	Office Action issued August 19, 2005, in U.S. Application No. 10/609,402 (U.S. Patent No. 7,362,048).	
	CD14	Office Action issued July 27, 2007, in U.S. Application No. 10/609,402 (U.S. Patent No. 7,362,048).	
	CD15	Office Action issued January 2, 2008, in U.S. Application No. 10/609,402 (U.S. Patent No. 7,362,048).	
	CD16	Office Action issued April 8, 2005, in U.S. Application No. 10/677,382 (U.S. Patent No. 7,026,756).	
	CD17	Office Action issued September 7, 2005, in U.S. Application No. 10/864,544 (U.S. Patent No. 7,126,274).	

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Docket No.: 0020-5147PUS12
(Patent)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Patent Application of:
Yoshinori SHIMIZU et al.

Application No.:	NEW	Confirmation No.:	N/A
Filed:	November 9, 2010	Art Unit:	N/A
For:	LIGHT EMITTING DEVICE AND DISPLAY	Examiner:	N/A

LETTER REGARDING COPENDING APPLICATIONS

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Under the provisions of MPEP § 2001.06(b), the Examiner is hereby advised of the following copending U.S. Application(s):

Appl. No.	Filing Date	Group
12/548,614	August 27, 2009	2812
12/548,618	August 27, 2009	2812
12/548,620	August 27, 2009	2811
12/559,042	September 14, 2009	2814
12/548,621	August 27, 2009	2812
12/575,155	October 7, 2009	2811
12/575,162	October 7, 2009	2892
12/689,681	January 19, 2010	2812
12/831,586	July 7, 2010	2812
12/829,182	July 1, 2010	2812

The subject matter contained in the above-listed copending U.S. applications may be deemed to relate to the present application, and thus may be material to the prosecution of this instant application.

The above-listed co-pending applications are not to be construed as prior art. By bringing the above-listed applications to the attention of the Examiner, Applicants do NOT waive any confidentiality concerning the above-listed co-pending applications or this application. See MPEP § 101.

If necessary, the Director is hereby authorized in this, concurrent, and future replies to charge any fees required during the pendency of the above-identified application or credit any overpayment to Deposit Account No. 02-2448.

Dated: November 9, 2010

Respectfully submitted,

By

D. Richard Anderson
Registration No.: 40,439
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road, Suite 100 East
P.O. Box 747
Falls Church, VA 22040-0747
703-205-8000

IN THE U.S. PATENT AND TRADEMARK OFFICE

Applicant(s): SHIMIZU, Yoshinori et al

Serial No.: Group:

COPY

Filed: July 29, 1997 Examiner:

For: LIGHT EMITTING DEVICE AND DISPLAY

L E T T E R

Assistant Commissioner for Patents
Box Patent Application
Washington, D.C. 20231

July 29, 1997
0020-4260P

Sir:

Under the provisions of 35 USC 119 and 37 CFR 1.55(a), the applicant hereby claims the right of priority based on the following application(s):

Country	Application No.	Filed
JAPAN	8-198585	07/29/96
JAPAN	8-244339	09/17/96
JAPAN	8-245381	09/18/96
JAPAN	8-359004	12/27/96
JAPAN	9-081010	03/31/97

A certified copy of the above-noted application(s) is(are) attached hereto.

Please charge any fees under 37 CFR 1.16 - 1.21 (h) or credit any overpayment to Deposit Account No. 02-2448.

Respectfully submitted,

BIRCH, STEWART, KOLASCH & BIRCH, LLP

By: [signature]
ANDREW D. MEIKLE
Reg. No. 32,868
P. O. Box 747
Falls Church, Virginia 22040-0747

\ttachment
703) 205-8000

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LIGHT EMITTING DEVICE AND DISPLAY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a divisional of U.S. Application No. 12/548,614 filed August 27, 2009 which is a divisional of U.S. Application No. 12/028,062 filed February 8, 2008, now U.S. Patent 7,682,848 which is a divisional of U.S. Application No. 10/609,402 filed July 1, 2003, now U.S. Patent 7,362,048, which is a divisional of U.S. Application No. 09/458,024, filed December 10, 1999, now U.S. Patent 6,614,179, which is a divisional of U.S. Application No. 09/300,315, filed on April 28, 1999, now U.S. Patent 6,069,440, which is a divisional of U.S. Application No. 08/902,725, filed on July 29, 1997, now U.S. Patent 5,998,925, which also claims priority on Japanese Patent Application Nos. P 08-198585 filed July 29, 1996; P 08-244339 filed September 17, 1996; P 08-245381 filed September 18, 1996; P 08-359004 filed December 27, 1996; and P 09-081010 filed March 31, 1997. The entire contents of each of these applications are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

(Field of the Invention)

[0002] The present invention relates to a light emitting diode used in LED display, back light source, traffic signal, trailway signal, illuminating switch, indicator, etc. More particularly, it relates to a light emitting device (LED) comprising a phosphor, which converts the wavelength of light emitted by a light emitting component and emits light, and a display device using the light emitting device.

Description of Related Art

[0003] A light emitting diode is compact and emits light of clear color with high efficiency. It is also free from such a trouble as burn-out and has good initial drive characteristic, high vibration resistance and durability to endure repetitive ON/OFF operations, because it is a semiconductor element. Thus it has been used widely in such applications as various indicators and various light sources. Recently light emitting diodes for RGB (red, green and blue) colors having ultra-high luminance and high efficiency have been developed, and large screen LED displays using these light emitting diodes have been put into use. The LED display can be operated with less power and has such good characteristics as light weight and long life, and is therefore expected to be more widely used in the future.

[0004] Recently, various attempts have been made to make white light sources by using light emitting diodes. Because the light emitting diode has a favorable emission spectrum to generate monochromatic light, making a light source for white light requires it to arrange three light emitting components of R, G and B closely to each other while diffusing and mixing the light emitted by them. When generating white light with such an arrangement, there has been such a problem that white light of the desired tone cannot be generated due to variations in the tone, luminance and other factors of the light emitting component. Also when the light emitting components are made of different materials, electric power required for driving differs from one light emitting diode to another, making it necessary to apply different voltages different light emitting components, which leads to complex drive circuit. Moreover, because the light emitting components are semiconductor light emitting components, color tone is subject to variation due to the difference in temperature characteristics, chronological changes and operating environment, or unevenness in color may be caused due to failure in uniformly mixing the light emitted by the light emitting components. Thus light emitting diodes are effective as light emitting devices for generating individual colors, although a satisfactory light source capable of emitting white light by using light emitting components has not been obtained so far.

[0005] In order to solve these problems, the present applicant previously developed light emitting diodes which convert the color of light, which is emitted by light emitting components, by means of a fluorescent material disclosed in Japanese Patent Kokai Nos. 5-152609, 7-99345, 7-176794 and 8-7614. The light emitting diodes disclosed in these publications are such that, by using light emitting components of one kind, are capable of generating light of white and other colors, and are constituted as follows.

[0006] The light emitting diode disclosed in the above gazettes are made by mounting a light emitting component, having a large energy band gap of light emitting layer, in a cup provided at the tip of a lead frame, and having a fluorescent material that absorbs light emitted by the light emitting component and emits light of a wavelength different from that of the absorbed light (wavelength conversion), contained in a resin mold which covers the light emitting component.

[0007] The light emitting diode disclosed as described above capable of emitting white light by mixing the light of a plurality of sources can be made by using a light emitting component capable of emitting blue light and molding the light emitting component with a resin including a fluorescent material that absorbs the light emitted by the blue light emitting diode and emits yellowish light.

[0008] However, conventional light emitting diodes have such problems as deterioration of the fluorescent material leading to color tone deviation and darkening of the fluorescent material resulting in lowered efficiency of extracting light. Darkening here refers to, in the case of using an inorganic fluorescent material such as (Cd, Zn)S fluorescent material, for example, part of metal elements constituting the fluorescent material precipitate or change their properties leading to coloration, or, in the case of using an organic fluorescent material, coloration due to breakage of double bond in the molecule. Especially when a light emitting component made of a semiconductor having a high energy band gap is used to improve the conversion efficiency of the fluorescent material (that is, energy of light emitted by the semiconductor is increased and number of photons having energies above a threshold which can be absorbed by the fluorescent material increases, resulting in more light being absorbed), or the quantity of fluorescent material consumption is decreased (that is, the fluorescent material is irradiated with relatively higher energy), light energy absorbed by the fluorescent material inevitably increases resulting in more significant degradation of the fluorescent material. Use of the light emitting component with higher intensity of light emission for an extended period of time causes further more significant degradation of the fluorescent material.

[0009] Also the fluorescent material provided in the vicinity of the light emitting component may be exposed to a high temperature such as rising temperature of the light emitting component and heat transmitted from the external environment (for example, sunlight in case the device is used outdoors).

[0010] Further, some fluorescent materials are subject to accelerated deterioration due to combination of moisture entered from the outside or introduced during the production process, the light and heat transmitted from the light emitting component.

[0011] When it comes to an organic dye of ionic property, direct current electric field in the vicinity of the chip may cause electrophoresis, resulting in a change in the color tone.

SUMMARY OF THE INVENTION

[0012] Thus, an object of the present invention is to solve the problems described above and provide a light emitting device which experiences only extremely low degrees of deterioration in emission light intensity, light emission efficiency and color shift over a long time of use with high luminance.

[0013] The present applicant completed the present invention through researches based on the assumption that a light emitting device having a light emitting component and a fluorescent material must meet the following requirements to achieve the above-mentioned object.

[0014] The light emitting component must be capable of emitting light of high luminance with light emitting characteristic which is stable over a long time of use.

[0015] The fluorescent material being provided in the vicinity of the high-luminance light emitting component, must show excellent resistance against light and heat so that the properties thereof do not change even when used over an extended period of time while being exposed to light of high intensity emitted by the light emitting component (particularly the fluorescent material provided in the vicinity of the light emitting component is exposed to light of a radiation intensity as high as about 30 to 40 times that of sunlight according to our estimate, and is required to have more durability against light as light emitting component of higher luminance is used).

[0016] With regard to the relationship with the light emitting component, the fluorescent material must be capable of absorbing with high efficiency the light of high monochromaticity emitted by the light emitting component and emitting light of a wavelength different from that of the light emitted by the light emitting component.

[0017] Thus the present invention provides a light emitting device, comprising a light emitting component and a phosphor capable of absorbing a part of light emitted by the light emitting component and emitting light of wavelength different from that of the absorbed light;

[0018] wherein said light emitting component comprises a nitride compound semiconductor represented by the formula: $In_iGa_jAl_kN$ where $0 \leq i$, $0 \leq j$, $0 \leq k$ and $i+j+k=1$) and said phosphor contains a garnet fluorescent material comprising at least one element selected from the group consisting of Y, Lu, Sc, La, Gd and Sm, and at least one element selected from the group consisting of Al, Ga and In, and being activated with cerium.

[0019] The nitride compound semiconductor (generally represented by chemical formula $In_iGa_jAl_kN$ where $0 \leq i$, $0 \leq j$, $0 \leq k$ and $i+j+k=1$) mentioned above contains various materials including InGaN and GaN doped with various impurities.

[0020] The phosphor mentioned above contains various materials defined as described above, including $Y_3Al_5O_{12}$:Ce and $Gd_3In_5O_{12}$:Ce.

[0021] Because the light emitting device of the present invention uses the light emitting component made of a nitride compound semiconductor capable of emitting light with high luminance, the light emitting device is capable of emitting light with high luminance. Also the phosphor used in the light emitting device has excellent resistance against light so that the fluorescent properties thereof experience less change even when used over an extended period of time while being exposed to light of high intensity. This makes it possible to reduce the degradation of characteristics during long period of use and reduce deterioration due to light of high intensity emitted by the light emitting component as well as extraneous light (sunlight including ultraviolet light, etc.) during outdoor use, thereby to provide a light emitting device which experiences extremely less color shift and less luminance decrease. The light emitting device of the present invention can also be used in such applications that require response speeds as high as 120 nsec., for example, because the phosphor used therein allows after glow only for a short period of time.

[0022] The phosphor used in the light emitting diode of the present invention preferably contains an yttrium-aluminum-garnet fluorescent material that contains Y and Al, which enables it to increase the luminance of the light emitting device.

[0023] In the light emitting device of the present invention, the phosphor may be a fluorescent material represented by a general formula $(Re_{1-r}Sm_r)_3(Al_{1-s}Ga_s)_5O_{12}$:Ce, where $0 \leq r < 1$ and $0 \leq s \leq 1$ and Re is at least one selected from Y and Gd, in which case good characteristics can be obtained similarly to the case where the yttrium-aluminum-garnet fluorescent material is used.

[0024] Also in the light emitting device of the present invention, it is preferable, for the purpose of reducing the temperature dependence of light emission characteristics (wavelength of emitted light, intensity of light emission, etc.), to use a fluorescent material represented by a general formula $(Y_{1-p-q-r}Gd_pCe_qSm_r)_3(Al_{1-s}Ga_s)_5O_{12}$ as the phosphor, where $0 \leq p \leq 0.8$, $0.003 \leq q \leq 0.2$, $0.0003 \leq r \leq 0.08$ and $0 \leq s \leq 1$.

[0025] Also in the light emitting device of the present invention, the phosphor may contain two or more yttrium-aluminum-garnet fluorescent materials, activated with cerium, of different compositions including Y and Al. With this configuration, light of desired color can be emitted by controlling the emission spectrum of the phosphor according to the property (wavelength of emitted light) of the light emitting component.

[0026] Further in the light emitting device of the present invention, in order to have light of a specified wavelength emitted by the light emitting device, it is preferable that the phosphor contains two or more fluorescent materials of different compositions represented by general formula $(Re_{1-r}Sm_r)_3(Al_{1-s}Ga_s)_5O_{12}$:Ce, where $0 \leq r < 1$ and $0 \leq s \leq 1$ and Re is at least one selected from Y and Gd.

[0027] Also in the light emitting device of the present invention, in order to control the wavelength of emitted light, the phosphor may contain a first fluorescent material represented by general formula $Y_3(Al_{1-s}Ga_s)_5O_{12}$:Ce and a second fluorescent material represented by general formula $Re_3Al_5O_{12}$:Ce, where $0 \leq s \leq 1$ and Re is at least one selected from Y, Gd and La.

[0028] Also in the light emitting device of the present invention, in order to control the wavelength of emitted light, the phosphor may be an yttrium-aluminum-garnet fluorescent material containing a first fluorescent material and a second fluorescent material, with different parts of each yttrium being substituted with gadolinium.

[0029] Further in the light emitting device of the present invention, it is preferable that main emission peak of the light emitting component is set within the range from 400 nm to 530 nm and main emission wavelength of the phosphor is set to be longer than the main emission peak of the light emitting component. This makes it possible to efficiently emit white light.

[0030] Further in the light emitting device of the present invention, it is preferable that the light emitting layer of the light emitting component contains a gallium nitride semiconductor which contains In, and the phosphor is an yttrium-aluminum-garnet fluorescent material wherein a part of Al in the yttrium-aluminum-garnet fluorescent is substituted by Ga so that the proportion of Ga:Al is within the range from 1:1 to 4:6 and a part of Y in the yttrium-aluminum-garnet fluorescent is substituted by Gd so that the proportion of Y:Gd is within the range from 4:1 to 2:3. Absorption spectrum of the phosphor which is controlled as described above shows good agreement with that of light emitted by the light emitting component which contains gallium nitride semiconductor including In as the light emitting layer, and is capable of improving the conversion efficiency (light emission efficiency). Also the light, generated by mixing blue light emitted by the light emitting component and fluorescent light of the fluorescent material, is a white light of good color rendering and, in this regard, an excellent light emitting device can be provided.

[0031] The light emitting device according to one embodiment of the present invention comprises a substantially rectangular optical guide plate provided with the light emitting component mounted on one side face thereof via the phosphor and surfaces of which except for one principal surface are substantially covered with a reflective material, wherein a light emitted by the light emitting component is turned into a planar light by the phosphor and the optical guide plate and to be an output from the principal surface of the optical guide plate.

[0032] The light emitting device according to another embodiment of the present invention has a substantially rectangular optical guide plate, which is provided with the light emitting component mounted on one side face thereof and the phosphor installed on one principal surface with surfaces thereof and except for the principal surface being substantially covered with a reflective material, wherein a light emitted by the light emitting component is turned into a planar light by the optical guide plate and the phosphor, to be an output from the principal surface of the optical guide plate.

[0033] The LED display device according to the present invention has an LED display device comprising the light emitting devices of the present invention arranged in a matrix and a drive circuit which drives the LED display device according to display data which is input thereto. This configuration makes it possible to provide a relatively low-priced LED display device which is capable of high-definition display with less color unevenness due to the viewing angle.

[0034] The light emitting diode according to one embodiment of the present invention comprises:

[0035] a mount lead having a cup and a lead;

[0036] an LED chip mounted in the cup of the mount lead with one of electrodes being electrically connected to the mount lead;

[0037] a transparent coating material filling the cup to cover the LED chip; and

[0038] a light emitting diode having a molding material which covers the LED chip covered with the coating material including the cup of the mount lead, the inner lead and another electrode of the LED chip, wherein

[0039] the LED chip is a nitride compound semiconductor and the coating material contains at least one element selected from the group consisting of Y, Lu, Sc, La, Gd and Sm, at least one element selected from the group consisting of Al, Ga and In and a phosphor made of garnet fluorescent material activated with cerium.

[0040] The phosphor used in the light emitting diode of the present invention preferably contains an yttrium-aluminum-garnet fluorescent material that contains Y and Al.

[0041] In the light emitting diode of the present invention, the phosphor may be a fluorescent material represented by a general formula $(Re_{1-r}Sm_r)_3(Al_{1-s}Ga_s)_5O_{12}$:Ce, where $0 \leq r < 1$ and $0 \leq s \leq 1$ and Re is at least one selected from Y and Gd.

[0042] Also in the light emitting diode of the present invention, a fluorescent material represented by a general formula $(Y_{1-p-q-r}Gd_pCe_qSm_r)_3(Al_{1-s}Ga_s)_5O_{12}$ may be used as the phosphor, where $0 \leq p \leq 0.8$, $0.003 \leq q \leq 0.2$, $0.0003 \leq r \leq 0.08$ and $0 \leq s \leq 1$.

[0043] In the light emitting diode of the present invention, the phosphor preferably contain two or more yttrium-aluminum-garnet fluorescent materials, activated with cerium, of different compositions including Y and Al, in order to control the emitted light to a desired wavelength.

[0044] In the light emitting diode of the present invention, similarly, two or more fluorescent materials of different compositions represented by a general formula $(Re_{1-r}Sm_r)_3(Al_{1-s}Ga_s)_5O_{12}:Ce$, where $0 \leq r < 1$ and $0 \leq s \leq 1$ and Re is at least one selected from Y and Gd may be used as the phosphor in order to control the emitted light to a desired wavelength.

[0045] In the light emitting diode of the present invention, similarly, a first fluorescent material represented by a general formula $Y_3(Al_{1-s}Ga_s)_5O_{12}:Ce$ and a second fluorescent material represented by a general formula $Re_3Al_5O_{12}:Ce$, may be used as the phosphor where $0 \leq s \leq 1$ and Re is at least one selected from Y, Gd and La, in order to control the emitted light to a desired wavelength.

[0046] In the light emitting diode of the present invention, similarly, yttrium-aluminum-garnet fluorescent material a first fluorescent material and a second fluorescent material may be used wherein a part of yttrium in the first and second fluorescent materials is substituted with gadolinium to different degrees of substitution as the phosphor, in order to control the emitted light to a desired wavelength.

[0047] Generally, a fluorescent material which absorbs light of a short wavelength and emits light of a long wavelength has higher efficiency than a fluorescent material which absorbs light of a long wavelength and emits light of a short wavelength. It is preferable to use a light emitting component which emits visible light than a light emitting component which emits ultraviolet light that degrades resin (molding material, coating material, etc.). Thus for the light emitting diode of the present invention, for the purpose of improving the light emitting efficiency and ensure long life, it is preferable that main emission peak of the light emitting component be set within a relatively short wavelength range of 400 nm to 530 nm in the visible light region, and main emission wavelength of the phosphor be set to be longer than the main emission peak of the light emitting component. With this arrangement, because light converted by the fluorescent material has longer wavelength than that of light emitted by the light emitting component, it will not be absorbed by the light emitting component even when the light emitting component is irradiated with light which has been reflected and converted by the fluorescent material (since the energy of the converted light is less than the band gap energy). Thus the light which has been reflected by the fluorescent material or the like is reflected by the cup wherein the light emitting component is mounted, making higher efficiency of emission possible.

BRIEF DESCRIPTION OF THE DRAWINGS

[0048] Fig. 1 is a schematic sectional view of a lead type light emitting diode according to the embodiment of the present invention.

[0049] Fig. 2 is a schematic sectional view of a tip type light emitting diode according to the embodiment of the present invention.

[0050] Fig. 3A is a graph showing the excitation spectrum of the garnet fluorescent material activated by cerium used in the first embodiment of the present invention.

[0051] Fig. 3B is a graph showing the emission spectrum of the garnet fluorescent material activated by cerium used in the first embodiment of the present invention.

[0052] Fig. 4 is a graph showing the emission spectrum of the light emitting diode of the first embodiment of the present invention.

[0053] Fig. 5A is a graph showing the excitation spectrum of the yttrium-aluminum-garnet fluorescent material activated by cerium used in the second embodiment of the present invention.

[0054] Fig. 5B is a graph showing the emission spectrum of the yttrium-aluminum-garnet fluorescent material activated by cerium used in the second embodiment of the present invention.

[0055] Fig. 6 shows the chromaticity diagram of light emitted by the light emitting diode of the second embodiment, while

[0056] points A and B indicate the colors of light emitted by the light emitting component and points C and D indicate the colors of light emitted by two kinds of phosphors.

[0057] Fig. 7 is a schematic sectional view of the planar light source according to another embodiment of the present invention.

[0058] Fig. 8 is a schematic sectional view of another planar light source different from that of Fig. 7.

[0059] Fig. 9 is a schematic sectional view of another planar light source different from those of Fig. 7 and Fig. 8.

[0060] Fig. 10 is a block diagram of a display device which is an application of the present invention.

[0061] Fig. 11 is a plan view of the LED display device of the display device of Fig. 10.

[0062] Fig. 12 is a plan view of the LED display device wherein one pixel is constituted from four light emitting diodes including the light emitting diode of the present invention and those emitting RGB colors.

[0063] Fig. 13A shows the results of durable life test of the light emitting diodes of Example 1 and Comparative Example 1, showing the results at 25°C and Fig. 13B shows the results of durable life test of the light emitting diodes of Example 1 and Comparative Example 1, showing the results at 60°C and 90%RH.

[0064] Fig. 14A shows the results of weatherability test of Example 9 and Comparative Example 2 showing the change of luminance retaining ratio with time and Fig. 14B shows the results of weatherability test of Example 9 and Comparative Example 2 showing the color tone before and after the test.

[0065] Fig. 15A shows the results of reliability test of Example 9 and Comparative Example 2 showing the relationship between the luminance retaining ratio and time, and Fig. 15B is a graph showing the relationship between color tone and time.

[0066] Fig. 16 is a chromaticity diagram showing the range of color tone which can be obtained with a light emitting diode which combines the fluorescent materials shown in Table 1 and blue LED having peak wavelength at 465 nm.

[0067] Fig. 17 is a chromaticity diagram showing the change in color tone when the concentration of fluorescent material is changed in the light emitting diode which combines the fluorescent materials shown in Table 1 and blue LED having peak wavelength at 465 nm.

[0068] Fig. 18A shows the emission spectrum of the phosphor $(Y_{0.6}Gd_{0.4})_3Al_5O_{12}$:Ce of Example 18A.

[0069] Fig. 18B shows the emission spectrum of the light emitting component of Example 18B having the emission peak wavelength of 460nm.

[0070] Fig. 18C shows the emission spectrum of the light emitting diode of Example 2.

[0071] Fig. 19A shows the emission spectrum of the phosphor $(Y_{0.2}Gd_{0.8})_3Al_5O_{12}$:Ce of Example 5.

[0072] Fig. 19B shows the emission spectrum of the light emitting component of Example 5 having the emission peak wavelength of 450nm.

[0073] Fig. 19C shows the emission spectrum of the light emitting diode of Example 5.

[0074] Fig. 20A shows the emission spectrum of the phosphor $Y_3Al_5O_{12}$:Ce of Example 6.

[0075] Fig. 20B shows the emission spectrum of the light emitting component of Example 6 having the emission peak wavelength of 450nm.

[0076] Fig. 20C shows the emission spectrum of the light emitting diode of Example 6.

[0077] Fig. 21A shows the emission spectrum of the phosphor $Y_3(Al_{0.5}Ga_{0.5})_5O_{12}$:Ce of the seventh embodiment of the present invention

[0078] Fig. 21B shows the emission spectrum of the light emitting component of Example 7 having the emission peak wavelength of 450nm.

[0079] Fig. 21C shows the emission spectrum of the light emitting diode of Example 7.

[0080] Fig. 22A shows the emission spectrum of the phosphor $(Y_{0.8}Gd_{0.2})_3Al_5O_{12}$:Ce of Example 11.

[0081] Fig. 22B shows the emission spectrum of the phosphor $(Y_{0.4}Gd_{0.6})_3Al_5O_{12}$:Ce of Example 11.

[0082] Fig. 22C shows the emission spectrum of the light emitting component of Example 11 having the emission peak wavelength of 470nm.

[0083] Fig. 23 shows the emission spectrum of the light emitting diode of Example 11.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0084] Now referring to the attached drawings, preferred embodiments of the present invention will be described below.

[0085] A light emitting diode 100 of Fig. 1 is a lead type light emitting diode having a mount lead 105 and an inner lead 106, wherein a light emitting component 102 is installed on a cup 105a of the mount lead 105, and the cup 105a is filled with a coating resin 101 which contains a specified phosphor to cover the light emitting component 102 and is molded in resin. An n electrode and a p electrode of the light emitting component 102 are connected to the mount lead 105 and the inner lead 106, respectively, by means of wires 103.

[0086] In the light emitting diode constituted as described above, part of light emitted by the light emitting component (LED chip) 102 (hereinafter referred to as LED light) excites the phosphor contained in the coating resin 101 to generate fluorescent light having a wavelength different from that of LED light, so that the fluorescent light emitted by the phosphor and LED light which is output without contributing to the excitation of the phosphor are mixed and output. As a result, the light emitting diode 100 also outputs light having a wavelength different from that of LED light emitted by the light emitting component 102.

[0087] Fig. 2 shows a chip type light emitting diode, wherein light emitting diode (LED chip) 202 is installed in a recess of a casing 204 which is filled with a coating material which contains a specified phosphor to form a coating 201. The light emitting component 202 is fixed by using an epoxy resin or the like which contains Ag, for example, and an n electrode and a p electrode of the light emitting component 202 are connected to metal terminals 205 installed on the casing 204 by means of conductive wires 203. In the chip type light emitting diode constituted as described above, similarly to the lead type light emitting diode of Fig. 1, fluorescent light emitted by the phosphor and LED light which is transmitted without being absorbed by the phosphor are mixed and output, so that the light emitting diode 200 also outputs light having a wavelength different from that of LED light emitted by the light emitting component 202.

[0088] The light emitting diode containing the phosphor as described above has the following features.

[0089] Light emitted by a light emitting component (LED) is usually emitted through an electrode which supplies electric power to the light emitting component. Emitted light is partly blocked by the electrode formed on the light emitting component resulting in a particular emission pattern, and is therefore not emitted uniformly in every direction. The light emitting diode which contains the fluorescent material, however, can emit light uniformly over a wide range without forming undesirable emission pattern because the light is emitted after being diffused by the fluorescent material.

[0090] Although light emitted by the light emitting component (LED) has a monochromatic peak, the peak is broad and has high color rendering property. This characteristic makes an indispensable advantage for an application which requires wavelengths of a relatively wide range. Light source for an optical image scanner, for example, is desirable to have a wider emission peak.

[0091] The light emitting diodes of the first and second embodiments to be described below have the configuration shown in Fig. 1 or Fig. 2 wherein a light emitting component which uses nitride compound semiconductor having relatively high energy in the visible region and a particular phosphor are combined, and have such favorable properties as capability to emit light of high luminance and less degradation of light emission efficiency and less color shift over an extended period of use.

[0092] In general, a fluorescent material which absorbs light of a short wavelength and emits light of a long wavelength has higher efficiency than a fluorescent material which absorbs light of a long wavelength and emits light of a short wavelength, and therefore it is preferable to use a nitride compound semiconductor light emitting component which is capable of emitting blue light of short wavelength. It needs not to say that the use of a light emitting component having high luminance is preferable.

[0093] A phosphor to be used in combination with the nitride compound semiconductor light emitting component must have the following requirements:

[0094] 1. Excellent resistance against light to endure light of a high intensity for a long period of time, because the fluorescent material is installed in the vicinity of the light emitting components 102, 202 and is exposed to light of intensity as high as about 30 to 40 times that of sun light.

[0095] 2. Capability to efficiently emit light in blue region for the excitation by means of the light emitting components 102, 202. When mixing of colors is used, should be capable of emitting blue light, not ultraviolet ray, with a high efficiency.

[0096] 3. capability to emit light from green to red regions for the purpose of mixing with blue light to generate white light.

[0097] 4. Good temperature characteristic suitable for location in the vicinity of the light emitting components 102, 202 and the resultant influence of temperature difference due to heat generated by the chip when lighting.

[0098] 5. Capability to continuously change the color tone in terms of the proportion of composition or ratio of mixing a plurality of fluorescent materials.

[0099] 6. Weatherability for the operating environment of the light emitting diode.

Embodiment 1

[0100] The light emitting diode of the first embodiment of the present invention employs a gallium nitride compound semiconductor element which has high-energy band gap in the light emitting layer and is capable of emitting blue light, and a garnet phosphor activated with cerium in combination. With this configuration, the light emitting diode of the first embodiment can emit white light by blending blue light emitted by the light emitting components 102, 202 and yellow light emitted by the phosphor excited by the blue light.

[0101] Because the garnet phosphor activated with cerium which is used in the light emitting diode of the first embodiment has light resistance and weatherability, it can emit light with extremely small degrees of color shift and decrease in the luminance of emitted light even when irradiated by very intense light emitted by the light emitting components 102, 202 located in the vicinity over a long period of time.

[0102] Components of the light emitting diode of the first embodiment will be described in detail below.

<u>(Phosphor)</u>

[0103] The phosphor used in the light emitting diode of the first embodiment is a phosphor which, when excited by visible light or ultraviolet ray emitted by the semiconductor light emitting layer, emits light of a wavelength different from that of the exciting light. The phosphor is specifically garnet fluorescent material activated with cerium which contains at least one element selected from Y, Lu, Sc, La, Gd and Sm and at least one element selected from Al, Ga and In. According to the present invention, the fluorescent material is preferably yttrium-aluminum-garnet fluorescent material (YAG phosphor) activated with cerium, or a fluorescent material represented by general formula $(Re_{1-r}Sm_r)_3(Al_{1-s}Ga_s)_5O_{12}:Ce$, where $0 \leq r < 1$ and $0 \leq s \leq 1$, and Re is at least one selected from Y and Gd. In case the LED light emitted by the light emitting component employing the gallium nitride compound semiconductor and the fluorescent light emitted by the phosphor having yellow body color are in the relation of complementary colors, white color can be output by blending the LED light and the fluorescent light.

[0104] In the first embodiment, because the phosphor is used by blending with a resin which makes the coating resin 101 and the coating material 201 (detailed later), color tone of the light emitting diode can be adjusted including white and incandescent lamp color by controlling the mixing proportion with the resin or the quantity used in filling the cup 105 or the recess of the casing 204 in accordance to the wavelength of light emitted by the gallium nitride light emitting component.

[0105] Distribution of the phosphor concentration has influence also on the color blending and durability. That is, when the concentration of phosphor increases from the surface of the coating or molding where the phosphor is contained toward the light emitting component, it becomes less likely to be affected by extraneous moisture thereby making it easier to suppress the deterioration due to moisture. On the other hand, when the concentration of phosphor increases from the light emitting component toward the surface of the molding, it becomes more likely to be affected by extraneous moisture, but less likely to be affected by the heat and radiation from the light emitting component, thus making it possible to suppress the deterioration of the phosphor. Such distributions of the phosphor concentration can be achieved by selecting or controlling the material which contains the phosphor, forming temperature and viscosity, and the configuration and particle size distribution of the phosphor.

[0106] By using the phosphor of the first embodiment, light emitting diode having excellent emission characteristics can be made, because the fluorescent material has enough light resistance for high-efficient operation even when arranged adjacent to or in the vicinity of the light emitting components 102, 202 with radiation intensity

[0107] (Ee) within the range from 3 Wcm^{-2} to 10 Wcm^{-2}.

[0108] The phosphor used in the first embodiment is, because of garnet structure, resistant to heat, light and moisture, and is therefore capable of absorbing excitation light having a peak at a wavelength near 450 nm as shown in Fig. 3A. It also emits light of broad spectrum having a peak near 580 nm tailing out to 700 nm as shown in Fig. 3B. Moreover, efficiency of excited light emission in a region of wavelengths 460 nm and higher can be increased by including Gd in the crystal of the phosphor of the first embodiment. When the Gd content is increased, emission peak wavelength is shifted toward longer wavelength and the entire emission spectrum is shifted toward longer wavelengths. This means that, when emission of more reddish light is required, it can be achieved by increasing the degree of substitution with Gd. When the Gd content is increased, luminance of light emitted by photoluminescence under blue light tends to decrease.

[0109] Especially when part of Al is substituted with Ga among the composition of YAG fluorescent material having garnet structure, wavelength of emitted light shifts toward shorter wavelength and, when part of Y is substituted with Gd, wavelength of emitted light shifts toward longer wavelength.

[0110] Table 1 shows the composition and light emitting characteristics of YAG fluorescent material represented by general formula $(Y_{1-a}Gd_a)_3(Al_{1-b}Ga_b)_5O_{12}$:Ce.

Table 1

	Gd content a (molar ratio)	Ga content b (molar ratio)	CIE chromaticity coordinates		Luminance Y	Efficiency
			X	y		
	0.0	0.0	0.41	0.56	100	100
	0.0	0.4	0.32	0.56	61	63
	0.0	0.5	0.29	0.54	55	67
	0.2	0.0	0.45	0.53	102	108
	0.4	0.0	0.47	0.52	102	113
	0.6	0.0	0.49	0.51	97	113
	0.8	0.0	0.50	0.50	72	86

[0111] Values shown in Table 1 were measured by exciting the fluorescent material with blue light of 460nm. Luminance and efficiency in Table 1 are given in values relative to those of material No. 1 which are set to 100.

[0112] When substituting Al with Ga, the proportion is preferably within the range from Ga: Al=1:1 to 4:6 in consideration of the emission efficiency and emission wavelength. Similarly, when substituting Y with Gd, the proportion is preferably within the range from Y: Gd=9:1 to 1:9, and more preferably from 4:1 to 2:3. It is because a degree of substitution with Gd below 20% results in a color of greater green component and less red component, and a degree of substitution with Gd above 60% results in increased red component but rapid decrease in luminance. When the ratio Y:Gd of Y and Gd in the YAG fluorescent material is set within the range from 4:1 to 2:3, in particular, a light emitting diode capable of emitting white light substantially along the black body radiation locus can be made by using one kind of yttrium-aluminum-garnet fluorescent material, depending on the emission wavelength of the light emitting component. When the ratio Y:Gd of Y and Gd in the YAG fluorescent material is set within the range from 2:3 to 1:4, a light emitting diode capable of emitting light of incandescent lamp can be made though the luminance is low. When the content (degree of substitution) of Ce is set within the range from 0.003 to 0.2, the relative luminous intensity of light emitting diode of not less than 70% can be achieved. When the content is less than 0.003, luminous intensity decreases because the number of excited emission centers of photoluminescence due to Ce decreases and, when the content is greater than 0.2, density quenching occurs.

[0113] Thus the wavelength of the emitted light can be shifted to a shorter wavelength by substituting part of Al of the composition with Ga, and the wavelength of the emitted light can be shifted to a longer wavelength by substituting part of Y of the composition with Gd. In this way, the light color of emission can be changed continuously by changing the composition. Also the fluorescent material is hardly excited by Hg emission lines which have such wavelengths as 254 nm and 365 nm, but is excited with higher efficiency by LED light emitted by a blue light emitting component having a wavelength around 450 nm. Thus the fluorescent material has ideal characteristics for converting blue light of nitride semiconductor light emitting component into white light, such as the capability of continuously changing the peak wavelength by changing the proportion of Gd.

[0114] According to the first embodiment, the efficiency of light emission of the light emitting diode can be further improved by combining the light emitting component employing gallium nitride semiconductor and the phosphor made by adding rare earth element samarium (Sm) to yttrium-aluminum-garnet fluorescent materials (YAG) activated with cerium.

[0115] Material for making such a phosphor is made by using oxides of Y, Gd, Ce, Sm, Al and Ga or compounds which can be easily converted into these oxides at high temperature, and sufficiently mixing these materials in stoichiometrical proportions. This mixture is mixed with an appropriate quantity of a fluoride such as ammonium fluoride used as a flux, and fired in a crucible at a temperature from 1350 to 1450°C in air for 2 to 5 hours. Then the fired material is ground by a ball mill in water, washed, separated, dried and sieved thereby to obtain the desired material.

[0116] In the producing process described above, the mixture material may also be made by dissolving rare earth elements Y, Gd, Ce and Sm in stoichiometrical proportions in an acid, coprecipitating the solution with oxalic acid and firing the coprecipitate to obtain an oxide of the coprecipitate, and then mixing it with aluminum oxide and gallium oxide.

[0117] The phosphor represented by the general formula $(Y_{1-p-q-r}Gd_pCe_qSm_r)_3Al_5O_{12}$ can emit light of wavelengths 460nm and longer with higher efficiency upon excitation, because Gd is contained in the crystal. When the content of gadolinium is increased, peak wavelength of emission shifts from 530nm to a longer wavelength up to 570nm, while the entire emission spectrum also shifts to longer wavelengths. When light of stronger red shade is needed, it can be achieved by increasing the amount of Gd added for substitution. When the content of Gd is increased, luminance of photoluminescence with blue light gradually decreases. Therefore, value of p is preferably 0.8 or lower, or more preferably 0.7 or lower. Further more preferably it is 0.6 or lower.

[0118] The phosphor represented by the general formula $(Y_{1-p-q-r}Gd_pCe_qSm_r)_3Al_5O_{12}$ including Sm can be made subject to less dependence on temperature regardless of the increased content of Gd. That is, the phosphor, when Sm is contained, has greatly improved emission luminance at higher temperatures. Extent of the improvement increases as the Gd content is increased. Temperature characteristic can be greatly improved particularly by the addition of Sm in the case of fluorescent material of such a composition as red shade is strengthened by increasing the content of Gd, because it has poor temperature characteristics. The temperature characteristic mentioned here is measured in terms of the ratio (%) of emission luminance of the fluorescent material at a high temperature (200°C) relative to the emission luminance of exciting blue light having a wavelength of 450nm at the normal temperature (25°C).

[0119] The proportion of Sm is preferably within the range of $0.0003 \leq r \leq 0.08$ to give temperature characteristic of 60% or higher. The value of r below this range leads to less effect of improving the temperature characteristic. When the value of r is above this range, on the contrary, the temperature characteristic deteriorates. The range of $0.0007 \leq r \leq 0.02$ for the proportion of Sm where temperature characteristic becomes 80% or higher is more desirable.

[0120] The proportion q of Ce is preferably in a range of $0.003 \leq q \leq 0.2$, which makes relative emission luminance of 70% or higher possible. The relative emission luminance refers to the emission luminance in terms of percentage to the emission luminance of a fluorescent material where q=0.03.

[0121] When the proportion q of Ce is 0.003 or lower, luminance decreases because the number of excited emission centers of photoluminescence due to Ce decreases and, when the q is greater than 0.2, density quenching occurs. Density quenching refers to the decrease in emission intensity which occurs when the concentration of an activation agent added to increase the luminance of the fluorescent material is increased beyond an optimum level.

[0122] For the light emitting diode of the present invention, a mixture of two or more kinds of phosphors having compositions of $(Y_{1-p-q-r}Gd_pCe_qSm_r)_3Al_5O_{12}$ having different contents of Al, Ga, Y and Gs or Sm may also be used. This increases the RGB components and enables the application, for example, for a full-color liquid crystal display device by using a color filter.

<u>(Light emitting components 102, 202)</u>

[0123] The light emitting component is preferably embedded in a molding material as shown in Fig. 1 and Fig. 2. The light emitting component used in the light emitting diode of the present invention is a gallium nitride compound semiconductor capable of efficiently exciting the garnet fluorescent materials activated with cerium. The light emitting components 102, 202 employing gallium nitride compound semiconductor are made by forming a light emitting layer of gallium nitride semiconductor such as InGaN on a substrate in the MOCVD process. The structure of the light emitting component may be homostructure, heterostructure or double-heterostructure which have MIS junction, PIN junction or PN junction. Various wavelengths of emission can be selected depending on the material of the semiconductor layer and the crystallinity thereof. It may also be made in a single quantum well structure or multiple quantum well structure where a semiconductor activation layer is formed as thin as quantum effect can occur. According to the present invention, a light emitting diode capable of emitting with higher luminance without deterioration of the phosphor can be made by making the activation layer of the light emitting component in single quantum well structure of InGaN.

[0124] When a gallium nitride compound semiconductor is used, while sapphire, spinnel, SiC, Si, ZnO or the like may be used as the semiconductor substrate, use of sapphire substrate is preferable in order to form gallium nitride of good crystallinity. A gallium nitride semiconductor layer is formed on the sapphire substrate to form a PN junction via a buffer layer of GaN, AlN, etc. The gallium nitride semiconductor has N type conductivity under the condition of not doped with any impurity, although in order to form an N type gallium nitride semiconductor having desired properties (carrier concentration, etc.) such as improved light emission efficiency, it is preferably doped with N type dopant such as Si, Ge, Se, Te, and C. In order to form a P type gallium nitride semiconductor, on the other hand, it is preferably doped with P type dopant such as Zn, Mg, Be, Ca, Sr and Ba. Because it is difficult to turn a gallium nitride compound semiconductor to P type simply by doping a P type dopant, it is preferable to treat the gallium nitride compound semiconductor doped with P type dopant in such process as heating in a furnace, irradiation with low-speed electron beam and plasma irradiation, thereby to turn it to P type. After exposing the surfaces of P type and N type gallium nitride semiconductors by the etching or other process, electrodes of the desired shapes are formed on the semiconductor layers by sputtering or vapor deposition.

[0125] Then the semiconductor wafer which has been formed is cut into pieces by means of a dicing saw, or separated by an external force after cutting grooves (half-cut) which have width greater than the blade edge width. Or otherwise, the wafer is cut into chips by scribing grid pattern of extremely fine lines on the semiconductor wafer by means of a scriber having a diamond stylus which makes straight reciprocal movement. Thus the light emitting component of gallium nitride compound semiconductor can be made.

[0126] In order to emit white light with the light emitting diode of the first embodiment, wavelength of light emitted by the light emitting component is preferably from 400nm to 530nm inclusive in consideration of the complementary color relationship with the phosphor and deterioration of resin, and more preferably from 420nm to 490nm inclusive. It is further more preferable that the wavelength be from 450nm to 475nm, in order to improve the emission efficiency of the light emitting component and the phosphor. Emission spectrum of the white light emitting diode of the first embodiment is shown in Fig. 4. The light emitting component shown here is of lead type shown in Fig. 1, which employs the light emitting component and the phosphor of the first embodiment to be described later. In Fig. 4, emission having a peak around 450 nm is the light emitted by the light emitting component, and emission having a peak around 570 nm is the photoluminescent emission excited by the light emitting component.

[0127] Fig. 16 shows the colors which can be represented by the white light emitting diode made by combining the fluorescent material shown in Table 1 and blue LED (light emitting component) having peak wavelength 465nm. Color of light emitted by this white light emitting diode corresponds to a point on a straight line connecting a point of chromaticity generated by the blue LED and a point of chromaticity generated by the fluorescent material, and therefore the wide white color region (shaded portion in Fig. 16) in the central portion of the chromaticity diagram can be fully covered by using the fluorescent materials 1 to 7 in Table 1. Fig. 17 shows the change in emission color when the contents of fluorescent materials in the white light emitting diode is changed. Contents of fluorescent materials are given in weight percentage to the resin used in the coating material. As will be seen from Fig. 17, color of the light approaches that of the fluorescent materials when the content of fluorescent material is increased and approaches that of blue LED when the content of fluorescent material decreased.

[0128] According to the present invention, a light emitting component which does not excite the fluorescent material may be used together with the light emitting component which emits light that excites the fluorescent material. Specifically, in addition to the fluorescent material which is a nitride compound semiconductor capable of exciting the fluorescent material, a light emitting component having a light emitting layer made of gallium phosphate, gallium aluminum arsenide, gallium arsenic phosphate or indium aluminum phosphate is arranged together. With this configuration, light emitted by the light emitting component which does not excite the fluorescent material is radiated to the outside without being absorbed by the fluorescent material, making a light emitting diode which can emit red/white light.

[0129] Other components of the light emitting diodes of Fig. 1 and Fig. 2 will be described below.

(Conductive wires 103, 203)

[0130] The conductive wires 103, 203 should have good electric conductivity, good thermal conductivity and good mechanical connection with the electrodes of the light emitting components 102, 202. Thermal conductivity is preferably 0.01 cal/(s)(cm^2)(°C/cm) or higher, and more preferably 0.5 cal/(s)(cm^2)(°C/cm) or higher. For workability, diameter of the conductive wire is preferably from 10μm to 45μm inclusive. Even when the same material is used for both the coating including the fluorescent material and the molding, because of the difference in thermal expansion coefficient due to the fluorescent material contained in either of the above two materials, the conductive wire is likely to break at the interface. For this reason, diameter of the conductive wire is preferably not less than 25μm and, for the reason of light emitting area and ease of handling, preferably within 35μm. The conductive wire may be a metal such as gold, copper, platinum and aluminum or an alloy thereof. When a conductive wire of such material and configuration is used, it can be easily connected to the electrodes of the light emitting components, the inner lead and the mount lead by means of a wire bonding device.

(Mount lead 105)

[0131] The mount lead 105 comprises a cup 105a and a lead 105b, and it suffices to have a size enough for mounting the light emitting component 102 with the wire bonding device in the cup 105a. In case a plurality of light emitting components are installed in the cup and the mount lead is used as common electrode for the light emitting component, because different electrode materials may be used, sufficient electrical conductivity and good conductivity with the bonding wire and others are required. When the light emitting component is installed in the cup of the mount lead and the cup is filled with the fluorescent material, light emitted by the fluorescent material is, even if isotropic, reflected by the cup in a desired direction and therefore erroneous illumination due to light from other light emitting diode mounted nearby can be prevented. Erroneous illumination here refers to such a phenomenon as other light emitting diode mounted nearby appearing as though lighting despite not being supplied with power.

[0132] Bonding of the light emitting component 102 and the mount lead 105 with the cup 105a can be achieved by means of a thermoplastic resin such as epoxy resin, acrylic resin and imide resin. When a face-down light emitting component (such a type of light emitting component as emitted light is extracted from the substrate side and is configured for mounting the electrodes to oppose the cup 105a) is used, Ag paste, carbon paste, metallic bump or the like can be used for bonding and electrically connecting the light emitting component and the mount lead at the same time. Further, in order to improve the efficiency of light utilization of the light emitting diode, surface of the cup of the mount lead whereon the light emitting component is mounted may be mirror-polished to give reflecting function to the surface. In this case, the surface roughness is preferably from 0.1S to 0.8 S inclusive. Electric resistance of the mount lead is preferably within 300μΩ·cm and more preferably within 3μΩ·cm. When mounting a plurality of light emitting components on the mount lead, the light emitting components generate significant amount of heat and therefore high thermal conductivity is required.

Specifically, the thermal conductivity is preferably 0.01 cal/(s)(cm^2)(°C/cm) or higher, and more preferably 0.5 cal/(s)(cm^2)(°C/cm) or higher. Materials which satisfy these requirements contain steel, copper, copper-clad steel, copper-clad tin and metallized ceramics.

(Inner lead 106)

[0133] The inner lead 106 is connected to one of electrodes of the light emitting component 102 mounted on the mount lead 105 by means of conductive wire or the like. In the case of a light emitting diode where a plurality of the light emitting components are installed on the mount lead, it is necessary to arrange a plurality of inner leads 106 in such a manner that the conductive wires do not touch each other. For example, contact of the conductive wires with each other can be prevented by increasing the area of the end face where the inner lead is wire-bonded as the distance from the mount lead increases so that the space between the conductive wires is secured. Surface roughness of the inner lead end face connecting with the conductive wire is preferably from 1.6 S to 10 S inclusive in consideration of close contact. In order to form the inner lead in a desired shape, it may be punched by means of a die. Further, it may be made by punching to form the inner lead then pressurizing it on the end face thereby to control the area and height of the end face.

[0134] The inner lead is required to have good connectivity with the bonding wires which are conductive wires and have good electrical conductivity. Specifically, the electric resistance is preferably within 300$\mu\Omega\cdot$cm and more preferably within 3$\mu\Omega\cdot$cm. Materials which satisfy these requirements contain iron, copper, iron-containing copper, tin-containing copper, copper-, gold- or silver-plated aluminum, iron and copper.

<u>(Coating material 101)</u>

[0135] The coating material 101 is provided in the cup of the mount lead apart from the molding material 104 and, in the first embodiment, contains the phosphor which converts the light emitted by the light emitting component. The coating material may be a transparent material having good weatherability such as epoxy resin, urea resin and silicone or glass. A dispersant may be used together with the phosphor. As the dispersant, barium titanate, titanium oxide, aluminum oxide, silicon dioxide and the like are preferably used. When the fluorescent material is formed by sputtering, coating material may be omitted. In this case, a light emitting diode capable of bending colors can be made by controlling the film thickness or providing an aperture in the fluorescent material layer.

<u>(Molding material 104)</u>

[0136] The molding 104 has the function to protect the light emitting component 102, the conductive wire 103 and the coating material 101 which contains phosphor from external disturbance. According to the first embodiment, it is preferable that the molding material 104 further contain a dispersant, which can unsharpen the directivity of light from the light emitting component 102, resulting in increased angle of view. The molding material 104 has the function of lens to focus or diffuse the light emitted by the light emitting component. Therefore, the molding material 104 may be made in a configuration of convex lens or concave lens, and may have an elliptic shape when viewed in the direction of optical axis, or a combination of these. Also the molding material 104 may be made in a structure of multiple layers of different materials being laminated. As the molding material 104, transparent materials having high weatherability such as epoxy resin, urea resin, silicone resin or glass is preferably employed. As the dispersant, barium titanate, titanium oxide, aluminum oxide, silicon dioxide and the like can be used. In addition to the dispersant, phosphor may also be contained in the molding material. Namely, according to the present invention, the phosphor may be contained either in the molding material or in the coating material. When the phosphor is contained in the molding material, angle of view can be further increased. The phosphor may also be contained in both the coating material and the molding material. Further, a resin including the phosphor may be used as the coating material while using glass, different from the coating material, as the molding material. This makes it possible to manufacture a light emitting diode which is less subject to the influence of moisture with good productivity. The molding and the coating may also be made of the same material in order to match the refractive index, depending on the application. According to the present invention, adding the dispersant and/or a coloration agent in the molding material has the effects of masking the color of the fluorescent material obscured and improving the color mixing performance. That is, the fluorescent material absorbs blue component of extraneous light and emits light thereby to give such an appearance as though colored in yellow. However, the dispersant contained in the molding material gives milky white color to the molding material and the coloration agent renders a desired color. Thus the color of the fluorescent material will not be recognized by the observer. In case the light emitting component emits light having main wavelength of 430nm or over, it is more preferable that ultraviolet absorber which serves as light stabilizer be contained.

Embodiment 2

[0137] The light emitting diode of the second embodiment of the present invention is made by using an element provided with gallium nitride compound semiconductor which has high-energy band gap in the light emitting layer as the light emitting component and a fluorescent material including two or more kinds of phosphors of different compositions, or preferably yttrium-aluminum-garnet fluorescent materials activated with cerium as the phosphor. With this configuration, a light emitting diode which allows to give a desired color tone by controlling the contents of the two or more fluorescent materials can be made even when the wavelength of the LED light emitted by the light emitting component deviates from the desired value due to variations in the production process. In this case, emission color of the light emitting diode can be made constantly using a fluorescent material having a relatively short emission wavelength for a light emitting component of a relatively short emission wavelength and using a fluorescent material having a relatively long emission wavelength for a light emitting component of a relatively long emission wavelength.

[0138] As for the fluorescent material, a fluorescent material represented by general formula $(Re_{1-r}Sm_r)_3(Al_{1-s}Ga_s)_5O_{12}$:Ce may also be used as the phosphor. Here $0 \leq r < 1$ and $0 \leq s \leq 1$, and Re is at least one selected from Y, Gd and La. This configuration makes it possible to minimize the denaturing of the fluorescent material even when the fluorescent material is exposed to high-intensity high-energy visible light emitted by the light emitting component for a long period of time or when used under various environmental conditions, and therefore a light emitting diode which is subject to extremely insignificant color shift and emission luminance decrease and has the desired emission component of high luminance can be made.

<u>(Phosphor of the second embodiment)</u>

[0139] Now the phosphor used in the light emitting component of the second embodiment will be described in detail below. The second embodiment is similar to the first embodiment, except that two or more kinds of phosphors of different compositions activated with cerium are used as the phosphor, as described above, and the method of using the fluorescent material is basically the same.

[0140] Similarly to the case of the first embodiment, the light emitting diode can be given high weatherability by controlling the distribution of the phosphor (such as tapering the concentration with the distance from the light emitting component). Such a distribution of the phosphor concentration can be achieved by selecting or controlling the material which contains the phosphor, forming temperature and viscosity, and the configuration and particle size distribution of the phosphor. Thus, according to the second embodiment, distribution of the fluorescent material concentration is determined according to the operating conditions. Also, according to the second embodiment, efficiency of light emission can be increased by designing the arrangement of the two or more kinds of fluorescent materials (for example, arranging in the order of nearness to the light emitting component) according to the light generated by the light emitting component.

[0141] With the configuration of the second embodiment, similarly to the first embodiment, light emitting diode has high efficiency and enough light resistance even when arranged adjacent to or in the vicinity of relatively high-output light emitting component with radiation intensity (Ee) within the range from 3 Wcm^{-2} to 10 Wcm^{-2} can be made.

[0142] The yttrium-aluminum-garnet fluorescent material activated with cerium (YAG fluorescent material) used in the second embodiment has garnet structure similarly to the case of the first embodiment, and is therefore resistant to heat, light and moisture. The peak wavelength of excitation of the yttrium-aluminum-garnet fluorescent material of the second embodiment can be set near 450nm as indicated by the solid line in Fig. 5A, and the peak wavelength of emission can be set near 510nm as indicated by the solid line in Fig. 5B, while making the emission spectrum so broad as to tail out to 700nm. This makes it possible to emit green light. The peak wavelength of excitation of another yttrium-aluminum-garnet fluorescent material activated with cerium of the second embodiment can be set near 450nm as indicated by the dashed line in Fig. 5A, and the peak wavelength of emission can be set near 600nm as indicated by the dashed line in Fig. 5B, while making the emission spectrum so broad as to tail out to 750nm. This makes it possible to emit red light.

[0143] Wavelength of the emitted light is shifted to a shorter wavelength by substituting part of Al, among the constituents of the YAG fluorescent material having garnet structure, with Ga, and the wavelength of the emitted light is shifted to a longer wavelength by substituting part of Y with Gd and/or La. Proportion of substituting Al with Ga is preferably from Ga:Al=1:1 to 4:6 in consideration of the light emitting efficiency and the wavelength of emission. Similarly, proportion of substituting Y with Gd and/or La is preferably from Y:Gd and/or La=9:1 to 1:9, or more preferably from Y:Gd and/or La=4:1 to 2:3. Substitution of less than 20% results in an increase of green component and a decrease of red component. Substitution of 80% or greater part, on the other hand, increases red component but decreases the luminance steeply.

[0144] Material for making such a phosphor is made by using oxides of Y, Gd, Ce, La, Al, Sm and Ga or compounds which can be easily converted into these oxides at high temperature, and sufficiently mixing these materials in stoichiometrical proportions. Or either, mixture material is obtained by dissolving rare earth elements Y, Gd, Ce, La and Sm in stoichiometrical proportions in acid, coprecipitating the solution oxalic acid and firing the coprecipitate to obtain an oxide of the coprecipitate, which is then mixed with aluminum oxide and gallium oxide. This mixture is mixed with an appropriate quantity of a fluoride such as ammonium fluoride used as a flux, and fired in a crucible at a temperature from 1350 to 1450 °C in air for 2 to 5 hours. Then the fired material is ground by a ball mill in water, washed, separated, dried and sieved thereby to obtain the desired material.

[0145] In the second embodiment, the two or more kinds of yttrium-aluminum-garnet fluorescent materials activated with cerium of different compositions may be either used by mixing or arranged independently (laminated, for example). When the two or more kinds of fluorescent materials are mixed, color converting portion can be formed relatively easily and in a manner suitable for mass production. When the two or more kinds of fluorescent materials are arranged independently, color can be adjusted after forming it by laminating the layers until a desired color can be obtained. Also when arranging the two or more kinds of fluorescent materials independently, it is preferable to arrange a fluorescent material that absorbs light from the light emitting component of a shorter wavelength near to the LED element, and a fluorescent material that absorbs light of a longer wavelength away from the LED element. This arrangement enables efficient absorption and emission of light.

[0146] The light emitting diode of the second embodiment is made by using two or more kinds of yttrium-aluminum-garnet fluorescent materials of different compositions as the fluorescent materials, as described above. This makes it possible to make a light emitting diode capable of emitting light of desired color efficiently. That is, when wavelength of light emitted by the semiconductor light emitting component corresponds to a point on the straight line connecting point A and point B in the chromaticity diagram of Fig. 6, light of any color in the shaded region enclosed by points A, B, C and D in Fig. 6 which is the chromaticity points (points C and D) of the two or more kinds of yttrium-aluminum-garnet fluorescent materials of different compositions can be emitted. According to the second embodiment, color can be controlled by changing the compositions or quantities of the LED elements and fluorescent materials. In particular, a light emitting diode of less variation in the emission wavelength can be made by selecting the fluorescent materials according to the emission wavelength of the LED element, thereby compensating for the variation of the emission wavelength of the LED element. Also a light emitting diode including RGB components with high luminance can be made by selecting the emission wavelength of the fluorescent materials.

[0147] Moreover, because the yttrium-aluminum-garnet (YAG) fluorescent material used in the second embodiment has garnet structure, the light emitting diode of the second embodiment can emit light of high luminance for a long period of time. Also the light emitting diodes of the first embodiment and the second embodiment are provided with light emitting component installed via fluorescent material. Also because the converted light has longer wavelength than that of the light emitted by the light emitting component, energy of the converted light is less than the band gap of the nitride semiconductor, and is less likely to be absorbed by the nitride semiconductor layer. Thus, although the light emitted by the fluorescent material is directed also to the LED element because of the isotropy of emission, the light emitted by the fluorescent material is never absorbed by the LED element, and therefore the emission efficiency of the light emitting diode will not be decreased.

(Planar light source)

[0148] A planar light source which is another embodiment of the present invention is shown in Fig. 7.

[0149] In the planar light source shown in the Fig. 7, the phosphor used in the first embodiment or the second embodiment is contained in a coating material 701. With this configuration, blue light emitted by the gallium nitride semiconductor is color-converted and is output in planar state via an optical guide plate 704 and a dispersive sheet 706.

[0150] Specifically, a light emitting component 702 of the planar light source of Fig. 7 is secured in a metal substrate 703 of inverted C shape whereon an insulation layer and a conductive pattern (not shown) are formed. After electrically connecting the electrode of the light emitting component and the conductive pattern, phosphor is mixed with epoxy resin and applied into the inverse C-shaped metal substrate 703 whereon the light emitting component 702 is mounted. The light emitting component thus secured is fixed onto an end face of an acrylic optical guide plate 704 by means of an epoxy resin. A reflector film 707 containing a white diffusion agent is arranged on one of principal planes of the optical guide plate 704 where the dispersive sheet 706 is not formed, for the purpose of preventing fluorescence.

[0151] Similarly, a reflector 705 is provided on the entire surface on the back of the optical guide plate 704 and on one end face where the light emitting component is not provided, in order to improve the light emission efficiency. With this configuration, light emitting diodes for planar light emission which generates enough luminance for the back light of LCD can be made.

[0152] Application of the light emitting diode for planar light emission to a liquid crystal display can be achieved by arranging a polarizer plate on one principal plane of the optical guide plate 704 via liquid crystal injected between glass substrates (not shown) whereon a translucent conductive pattern is formed.

[0153] Now referring to Fig. 8 and Fig. 9, a planar light source according to another embodiment of the present invention will be described below. The light emitting device shown in Fig. 8 is made in such a configuration that blue light emitted by the light emitting diode 702 is converted to white light by a color converter 701 which contains phosphor and is output in planar state via an optical guide plate 704.

[0154] The light emitting device shown in Fig. 9 is made in such a configuration that blue light emitted by the light emitting component 702 is turned to planar state by the optical guide plate 704, then converted to white light by a dispersive sheet 706 which contains phosphor formed on one of the principal plane of the optical guide plate 704, thereby to output white light in planar state. The phosphor may be either contained in the dispersive sheet 706 or formed in a sheet by spreading it together with a binder resin over the dispersive sheet 706. Further, the binder including the phosphor may be formed in dots, not sheet, directly on the optical guide plate 704.

<Application>

(Display device)

[0155] Now a display device according to the present invention will be described below. Fig. 10 is a block diagram showing the configuration of the display device according to the present invention. As shown in Fig. 10, the display device comprises an LED display device 601 and a drive circuit 610 having a driver 602, video data storage means 603 and tone control means 604. The LED display device 601, having white light emitting diodes 501 shown in Fig. 1 or Fig. 2 arranged in matrix configuration in a casing 504 as shown in Fig. 11, is used as monochromatic LED display device. The casing 504 is provided with a light blocking material 505 being formed integrally therewith.

[0156] The drive circuit 610 has the video data storage means (RAM) 603 for temporarily storing display data which is input, the tone control means 604 which computes and outputs tone signals for controlling the individual light emitting diodes of the LED display device 601 to light with the specified brightness according to the data read from RAM 603, and the driver 602 which is switched by signals supplied from the tone control means 604 to drive the light emitting diode to light. The tone control circuit 604 retrieves data from the RAM 603 and computes the duration of lighting the light emitting diodes of the LED display device 601, then outputs pulse signals for turning on and off the light emitting diodes to the LED display device 601. In the display device constituted as described above, the LED display device 601 is capable of displaying images according to the pulse signals which are input from the drive circuit, and has the following advantages.

[0157] The LED display device which displays with white light by using light emitting diodes of three colors, RGB, is required to display while controlling the light emission output of the R, G and B light emitting diodes and accordingly must control the light emitting diodes by taking the emission intensity, temperature characteristics and other factors of the light emitting diodes into account, resulting in complicate configuration of the drive circuit which drives the LED display device. In the display device of the present invention, however, because the LED display device 601 is constituted by using light emitting diodes 501 of the present invention which can emit white light without using light emitting diodes of three kinds, RGB, it is not necessary for the drive circuit to individually control the R, G and B light emitting diodes, making it possible to simplify the configuration of the drive circuit and make the display device at a low cost.

[0158] With an LED display device which displays in white light by using light emitting diodes of three kinds, RGB, the three light emitting diodes must be illuminated at the same time and the light from the light emitting diodes must be mixed in order to display white light by combining the three RGB light emitting diodes for each pixel, resulting in a large display area for each pixel and making it impossible to display with high definition. The LED display device of the display device according to the present invention, in contrast, can display with white light can be done with a single light emitting diode, and is therefore capable of display with white light of higher definition. Further, with the LED display device which displays by mixing the colors of three light emitting diodes, there is such a case as the display color changes due to blocking of some of the RGB light emitting diodes depending on the viewing angle, the LED display device of the present invention has no such problem.

[0159] As described above, the display device provided with the LED display device employing the light emitting diode of the present invention which is capable of emitting white light is capable of displaying stable white light with higher definition and has an advantage of less color unevenness. The LED display device of the present invention which is capable of displaying with white light also imposes less stimulation to the eye compared to the conventional LED display device which employs only red and green colors, and is therefore suited for use over a long period of time.

<u>(Embodiment of another display device employing the light emitting diode of the present invention)</u>

[0160] The light emitting diode of the present invention can be used to constitute an LED display device wherein one pixel is constituted of three RGB light emitting diodes and one light emitting diode of the present invention, as shown in Fig. 12. By connecting the LED display device and a specified drive circuit, a display device capable of displaying various images can be constituted. The drive circuit of this display device has, similarly to a case of monochrome display device, video data storage means (RAM)for temporarily storing the input display data, a tone control circuit which processes the data stored in the RAM to compute tone signals for lighting the light emitting diodes with specified brightness and a driver which is switched by the output signal of the tone control circuit to cause the light emitting diodes to illuminate. The drive circuit is required exclusively for each of the RGB light emitting diodes and the white light emitting diode. The tone control circuit computes the duration of lighting the light emitting diodes from the data stored in the RAM, and outputs pulse signals for turning on and off the light emitting diodes. When displaying with white light, width of the pulse signals for lighting the RGB light emitting diodes is made shorter, or peak value of the pulse signal is made lower or no pulse signal is output at all. On the other hand, a pulse signal is given to the white light emitting diode in compensation thereof. This causes the LED display device to display with white light.

[0161] As described above, brightness of display can be improved by adding the white light emitting diode to the RGB light emitting diodes. When RGB light emitting diodes are combined to display white light, one or two of the RGB colors may be enhanced resulting in a failure to display pure white depending on the viewing angle, such a problem is solved by adding the white light emitting diode as in this display device.

[0162] For the drive circuit of such a display device as described above, it is preferable that a CPU be provided separately as a tone control circuit which computes the pulse signal for lighting the white light emitting diode with specified brightness. The pulse signal which is output from the tone control circuit is given to the white light emitting diode driver thereby to switch the driver. The white light emitting diode illuminates when the driver is turned on, and goes out when the driver is turned off.

(Traffic signal)

[0163] When the light emitting diode of the present invention is used as a traffic signal which is a kind of display device, such advantages can be obtained as stable illumination over a long period of time and no color unevenness even when part of the light emitting diodes go out. The traffic signal employing the light emitting diode of the present invention has such a configuration as white light emitting diodes are arranged on a substrate whereon a conductive pattern is formed. A circuit of light emitting diodes wherein such light emitting diodes are connected in series or parallel is handled as a set of light emitting diodes. Two or more sets of the light emitting diodes are used, each having the light emitting diodes arranged in spiral configuration. When all light emitting diodes are arranged, they are arranged over the entire area in circular configuration. After connecting power lines by soldering for the connection of the light emitting diodes and the substrate with external power supply, it is secured in a chassis of railway signal. The LED display device is placed in an aluminum diecast chassis equipped with a light blocking member and is sealed on the surface with silicone rubber filler. The chassis is provided with a white color lens on the display plane thereof. Electric wiring of the LED display device is passed through a rubber packing on the back of the chassis, for sealing off the inside of the chassis from the outside, with the inside of the chassis closed. Thus a signal of white light is made. A signal of higher reliability can be made by dividing the light emitting diodes of the present invention into a plurality of groups and arranging them in a spiral configuration swirling from a center toward outside, while connecting them in parallel. The configuration of swirling from the center toward outside may be either continuous or intermittent. Therefore, desired number of the light emitting diodes and desired number of the sets of light emitting diodes can be selected depending on the display area of the LED display device. This signal is, even when one of the sets of light emitting diodes or part of the light emitting diodes fail to illuminate due to some trouble, capable of illuminate evenly in a circular configuration without color shift by means of the remaining set of light emitting diodes or remaining light emitting diodes. Because the light emitting diodes are arranged in a spiral configuration, they can be arranged more densely near the center, and driven without any different impression from signals employing incandescent lamps.

<Examples>

[0164] The following Examples further illustrate the present invention in detail but are not to be construed to limit the scope thereof.

(Example 1)

[0165] Example 1 provides a light emitting component having an emission peak at 450nm and a half width of 30nm employing a GaInN semiconductor. The light emitting component of the present invention is made by flowing TMG (trimethyl gallium) gas, TMI (trimethyl indium) gas, nitrogen gas and dopant gas together with a carrier gas on a cleaned sapphire substrate and forming a gallium nitride compound semiconductor layer in MOCVD process. A gallium nitride semiconductor having N type conductivity and a gallium nitride semiconductor having P type conductivity are formed by switching SiH_4 and Cp_2Mg as dopant gas. The LED element of Example 1 has a contact layer which is a gallium nitride semiconductor having N type conductivity, a clad layer which is a gallium nitride aluminum semiconductor having P type conductivity and a contact layer which is a gallium nitride semiconductor having P type conductivity, and formed between the contact layer having N type conductivity and the clad layer having P type conductivity is a non-doped InGaN activation layer of thickness about 3 nm for making a single quantum well structure. The sapphire substrate has a gallium nitride semiconductor layer formed thereon under a low temperature to make a buffer layer. The P type semiconductor is annealed at a temperature of 400°C or above after forming the film.

[0166] After exposing the surfaces of P type and N type semiconductor layers by etching, n and p electrodes are formed by sputtering. After scribing the semiconductor wafer which has been made as described above, light emitting components are made by dividing the wafer with external force.

[0167] The light emitting component made in the above process is mounted in a cup of a mount lead which is made of silver-plated steel by die bonding with epoxy resin. Then electrodes of the light emitting component, the mount lead and the inner lead are electrically connected by wire boding with gold wires 30μm in diameter, to make a light emitting diode of lead type.

[0168] A phosphor is made by dissolving rare earth elements of Y, Gd and Ce in an acid in stoichiometrical proportions, and coprecipitating the solution with oxalic acid. Oxide of the coprecipitate obtained by firing this material is mixed with aluminum oxide, thereby to obtain the mixture material. The mixture was then mixed with ammonium fluoride used as a flux, and fired in a crucible at a temperature of 1400°C in air for 3 hours. Then the fired material is ground by a ball mill in water, washed, separated, dried and sieved thereby to obtained the desired material. Phosphor made as describe above is yttrium-aluminum-garnet fluorescent material represented by general formula $(Y_{0.8}Gd_{0.2})_3Al_5O_{12}$:Ce where about 20% of Y is substituted with Gd and substitution ratio of Ce is 0.03.

[0169] 80 Parts by weight of the fluorescent material having a composition of $(Y_{0.8}Gd_{0.2})_3Al_5O_{12}$:Ce which has been made in the above process and 100 parts by weight of epoxy resin are sufficiently mixed to turn into slurry. The slurry is poured into the cup provided on the mount lead whereon the light emitting component is mounted. After pouring, the slurry is cured at 130°C for one hour. Thus a coating having a thickness of 120μm, which contains the phosphor, is formed on the light emitting component. In Example 1, the coating is formed to contain the phosphor in gradually increasing concentration toward the light emitting component. Irradiation intensity is about

3.5W/cm^2. The light emitting component and the phosphor are molded with translucent epoxy resin for the purpose of protection against extraneous stress, moisture and dust. A lead frame with the coating layer of phosphor formed thereon is placed in a bullet-shaped die and mixed with translucent epoxy resin and then cured at 150 °C for 5 hours.

[0170] Under visual observation of the light emitting diode formed as described above in the direction normal to the light emitting plane, it was found that the central portion was rendered yellowish color due to the body color of the phosphor.

[0171] Measurements of chromaticity point, color temperature and color rendering index of the light emitting diode made as described above and capable of emitting white light gave values of (0.302, 0.280) for chromaticity point (x, y), color temperature of 8080 K and 87.5 for color rendering index (Ra) which are approximate to the characteristics of a 3-waveform fluorescent lamp. Light emitting efficiency was 9.5 lm/W, comparable to that of an incandescent lamp. Further in life tests under conditions of energization with a current of 60mA at 25°C, 20mA at 25°C and 20mA at 60°C with 90% RH, no change due to the fluorescent material was observed, proving that the light emitting diode had no difference in service life from the conventional blue light emitting diode.

<u>(Comparative Example 1)</u>

[0172] Formation of a light emitting diode and life tests thereof were conducted in the same manner as in Example 1 except for changing the phosphor from $(Y_{0.8}Gd_{0.2})_3Al_5O_{12}$:Ce to (ZnCd)S:Cu, Al. The light emitting diode which had been formed showed, immediately after energization, emission of white light but with low luminance. In a life test, the output diminished to zero in about 100 hours. Analysis of the cause of deterioration showed that the fluorescent material was blackened.

[0173] This trouble is supposed to have been caused as the light emitted by the light emitting component and moisture which had caught on the fluorescent material or entered from the outside brought about photolysis to make colloidal zinc to precipitate on the surface of the fluorescent material, resulting in blackened surface. Results of life tests under conditions of energization with a current of 20mA at 25 °C and 20mA at 60 °C with 90% RH are shown in Fig. 13 together with the results of Example 1. Luminance is given in terms of relative value with respect to the initial value as the reference. A solid line indicates Example 1 and a wavy line indicates Comparative Example 1 in Fig. 13.

(Example 2)

[0174] In Example 2, a light emitting component was made in the same manner as in Example 1 except for increasing the content of In in the nitride compound semiconductor of the light emitting component to have the emission peak at 460 nm and increasing the content of Gd in phosphor than that of Example 1 to have a composition of $(Y_{0.6}Gd_{0.4})_3Al_5O_{12}$:Ce.

[0175] Measurements of chromaticity point, color temperature and color rendering index of the light emitting diode, which were made as described above and capable of emitting white light, gave values of (0.375, 0.370) for chromaticity point (x, y), color temperature of 4400 K and 86.0 for color rendering index (Ra). Fig. 18A, Fig. 18B and Fig. 18C show the emission spectra of the phosphor, the light emitting component and the light emitting diode of Example 2, respectively.

[0176] 100 pieces of the light emitting diodes of Example 2 were made and average luminous intensities thereof were taken after lighting for 1000 hours. In terms of percentage of the luminous intensity value before the life test, the average luminous intensity after the life test was 98.8%, proving no difference in the characteristic.

(Example 3)

[0177] 100 light emitting diodes were made in the same manner as in Example 1 except for adding Sm in addition to rare earth elements Y, Gd and Ce in the phosphor to make a fluorescent material with composition of $(Y_{0.39}Gd_{0.57}Ce_{0.03}Sm_{0.01})_3Al_5O_{12}$. When the light emitting diodes were made illuminate at a high temperature of 130 °C, average temperature characteristic about 8% better than that of Example 1 was obtained.

(Example 4)

[0178] LED display device of Example 4 is made of the light emitting diodes of Example 1 being arranged in a 16 x 16 matrix on a ceramics substrate whereon a copper pattern is formed as shown in Fig. 11. In the LED display device of Example 4, the substrate whereon the light emitting diodes are arranged is placed in a chassis 504 which is made of phenol resin and is provided with a light blocking member 505 being formed integrally therewith. The chassis, the light emitting diodes, the substrate and part of the light blocking member, except for the tips of the light emitting diodes, are covered with silicone rubber 506 colored in black with a pigment. The substrate and the light emitting diodes are soldered by means of an automatic soldering machine.

[0179] The LED display device made in the configuration described above, a RAM which temporarily stores the input display data, a tone control circuit which processes the data stored in the RAM to compute tone signals for lighting the light emitting diodes with specified brightness and drive means which is switched by the output signal of the tone control circuit to cause the light emitting diodes to illuminate are electrically connected to make an LED display device. By driving the LED display devices, it was verified that the apparatus can be used as black and white LED display device.

(Example 5)

[0180] The light emitting diode of Example 5 was made in the same manner as in Example 1 except for using phosphor represented by general formula $(Y_{0.2}Gd_{0.8})_3Al_5O_{12}$:Ce. 100 pieces of the light emitting diodes of Example 5 were made and measured for various characteristics.

[0181] Measurement of chromaticity point gave values of (0.450, 0.420) in average for chromaticity point (x, y), and light of incandescent lamp color was emitted. Fig. 19A, Fig. 19B and Fig. 19C show the emission spectra of the phosphor, the light emitting component and the light emitting diode of Example 5, respectively. Although the light emitting diodes of Example 5 showed luminance about 40% lower than that of the light emitting diodes of Example 5, showed good weatherability comparable to that of Example 1 in life test.

(Example 6)

[0182] The light emitting diode of Example 6 was made in the same manner as in Example 1 except for using phosphor represented by general formula $Y_3Al_5O_{12}$:Ce. 100 pieces of the light emitting diodes of Example 6 were made and measured for various characteristics.

[0183] Measurement of chromaticity point slightly yellow-greenish white light compared to Example 1 was emitted. The light emitting diode of Example 6 showed good weatherability similar to that of Example 1 in life test. Fig. 20A, Fig. 20B and Fig. 20C show the emission spectra of the phosphor, the light emitting component and the light emitting diode of Example 6, respectively.

(Example 7)

[0184] The light emitting diode of Example 7 was made in the same manner as in Example 1 except for using phosphor represented by general formula

$Y_3(Al_{0.5}Ga_{0.5})_5O_{12}$:Ce. 100 pieces of the light emitting diodes of Example 7 were made and measured for various characteristics.

[0185] Although the light emitting diodes of Example 7 showed a low luminance, emitted greenish white light and showed good weatherability similar to that of Example 1 in life test. Fig. 21A, Fig. 21B and Fig. 21C show the emission spectra of the phosphor, the light emitting component and the light emitting diode of Example 7, respectively.

(Example 8)

[0186] The light emitting diode of Example 8 was made in the same manner as in Example 1 except for using phosphor represented by general formula $Gd_3(Al_{0.5}Ga_{0.5})_5O_{12}$:Ce which does not contain Y. 100 pieces of the light emitting diodes of Example 8 were made and measured for various characteristics.

[0187] Although the light emitting diodes of Example 8 showed a low luminance, showed good weatherability similar to that of Example 1 in life test.

(Example 9)

[0188] Light emitting diode of Example 9 is planar light emitting device having the configuration shown in Fig. 7.

[0189] In $_{0.05}Ga_{0.95}N$ semiconductor having emission peak at 450nm is used as a light emitting component. Light emitting components are made by flowing TMG (trimethyl gallium) gas, TMI (trimethyl indium) gas, nitrogen gas and dopant gas together with a carrier gas on a cleaned sapphire substrate and forming a gallium nitride compound semiconductor layer in MOCVD process. A gallium nitride semiconductor layer having N type conductivity and a gallium nitride semiconductor layer having P type conductivity are formed by switching SiH_4 and Cp_2Mg as dopant gas, thereby forming a PN junction. For the semiconductor light emitting component, a contact layer which is gallium nitride semiconductor having N type conductivity, a clad layer which is gallium nitride aluminum semiconductor having N type conductivity, a clad layer which is gallium nitride aluminum semiconductor having P type conductivity and a contact layer which is gallium nitride semiconductor having P type conductivity are formed. An activation layer of Zn-doped InGaN which makes a double-hetero junction is formed between the clad layer having N type conductivity and the clad layer having P type conductivity. A buffer layer is provided on the sapphire substrate by forming gallium nitride semiconductor layer at a low temperature. The P type nitride semiconductor layer is annealed at a temperature of 400°C or above after forming the film.

[0190] After forming the semiconductor layers and exposing the surfaces of P type and N type semiconductor layers by etching, electrodes are formed by sputtering. After scribing the semiconductor wafer which has been made as described above, light emitting components are made as light emitting components by dividing the wafer with external force.

[0191] The light emitting component is mounted on a mount lead which has a cup at the tip of a silver-plated copper lead frame, by die bonding with epoxy resin. Electrodes of the light emitting component, the mount lead and the inner lead are electrically connected by wire boding with gold wires having a diameter of 30μm.

[0192] The lead frame with the light emitting component attached thereon is placed in a bullet-shaped die and sealed with translucent epoxy resin for molding, which is then cured at 150°C for 5 hours, thereby to form a blue light emitting diode. The blue light emitting diode is connected to one end face of an acrylic optical guide plate which is polished on all end faces. On one surface and side face of the acrylic plate, screen printing is applied by using barium titanate dispersed in an acrylic binder as white color reflector, which is then cured.

[0193] Phosphor of green and red colors are made by dissolving rare earth elements of Y, Gd, Ce and La in acid in stoichiometrical proportions, and coprecipitating the solution with oxalic acid. Oxide of the coprecipitate obtained by firing this material is mixed with aluminum oxide and gallium oxide, thereby to obtain respective mixture materials. The mixture is then mixed with ammonium fluoride used as a flux, and fired in a crucible at a temperature of 1400 °C in air for 3 hours. Then the fired material is ground by a ball mill in water, washed, separated, dried and sieved thereby to obtained the desired material.

[0194] 120 parts by weight of the first fluorescent material having a composition of $Y_3(Al_{0.6}Ga_{0.4})_5O_{12}$:Ce and capable of emitting green light prepared as described above and 100 parts by weight of the second fluorescent material having a composition of $(Y_{0.4}Gd_{0.6})_3Al_5O_{12}$:Ce and capable of emitting red light prepared in a process similar to that for the first fluorescent material, are sufficiently mixed with 100 parts by weight of epoxy resin, to form a slurry. The slurry is applied uniformly onto an acrylic layer having a thickness of 0.5 mm by means of a multi-coater, and dried to form a fluorescent material layer to be used as a color converting material having a thickness of about 30μm. The fluorescent material layer is cut into the same size as that of the principal light emitting plane of the optical guide plate, and arranged on the optical guide plate thereby to form the planar light emitting device. Measurements of chromaticity point and color rendering index of the light emitting device gave values of (0.29, 0.34) for chromaticity point (x, y) and 92.0 for color rendering index (Ra) which are approximate to the properties of 3-waveform fluorescent lamp. Light emitting efficiency of 12 lm/W comparable to that of an incandescent lamp was obtained. Further in weatherability tests under conditions of energization with a current of 60mA at room temperature, 20mA at room temperature and 20mA at 60°C with 90% RH, no change due to the fluorescent material was observed.

<u>(Comparative Example 2)</u>

[0195] Forming of light emitting diode and weatherability tests thereof were conducted in the same manner as in Example 9 except for mixing the same quantities of a green organic fluorescent pigment (FA-001 of Synleuch Chemisch) and a red organic fluorescent pigment (FA-005 of Synleuch Chemisch) which are perylene-derivatives, instead of the first fluorescent material represented by general formula $Y_3(Al_{0.6}Ga_{0.4})_5O_{12}$:Ce capable of emitting green light and the second fluorescent material represented by general formula $(Y_{0.4}Gd_{0.6})_3Al_5O_{12}$:Ce capable of emitting red light of Example 9. Chromaticity coordinates of the light emitting diode of Comparative Example 1 thus formed were (x, y) = (0.34, 0.35). Weatherability test was conducted by irradiating with ultraviolet ray generated by carbon arc for 200 hours, representing equivalent irradiation of sun light over a period of one year, while measuring the luminance retaining ratio and color tone at various times during the test period. In a reliability test, the light emitting component was energized to emit light at a constant temperature of 70°C while measuring the luminance and color tone at different times. The results are shown in Fig. 14 and Fig. 15, together with Example 9. As will be clear from Fig. 14 and Fig. 15, the light emitting component of Example 9 experiences less deterioration than Comparative Example 2.

(Example 10)

[0196] The light emitting diode of Example 10 is a lead type light emitting diode.

[0197] In the light emitting diode of Example 10, the light emitting component having a light emitting layer of $In_{0.05}Ga_{0.95}N$ with emission peak at 450nm which is made in the same manner as in Example 9 is used. The light emitting component is mounted in the cup provided at the tip of a silver-plated copper mount lead, by die bonding with epoxy resin. Electrodes of the light emitting component, the mount lead and the inner lead were electrically connected by wire boding with gold wires.

[0198] Phosphor is made by mixing a first fluorescent material represented by general formula $Y_3(Al_{0.5}Ga_{0.5})_5O_{12}$:Ce capable of emitting green light and a second fluorescent material represented by general formula $(Y_{0.2}Gd_{0.8})_3Al_5O_{12}$:Ce capable of emitting red light prepared as follows. Namely, rare earth elements of Y, Gd and Ce are solved in acid in stoichiometrical proportions, and coprecipitating the solution with oxalic acid. Oxide of the coprecipitation obtained by firing it is mixed with aluminum oxide and gallium oxide, thereby to obtain respective mixture materials. The mixture is mixed with ammonium fluoride used as a flux, and fired in a crucible at a temperature of 1400°C in air for 3 hours. Then, the fired material is ground by a ball mill in water, washed, separated, dried and sieved thereby to obtained the first and second fluorescent materials of the specified particle size distribution.

[0199] 40 parts by weight of the first fluorescent material, 40 parts by weight of the second fluorescent material and 100 parts by weight of epoxy resin are sufficiently mixed to form a slurry. The slurry is poured into the cup which is provided on the mount lead wherein the light emitting component is placed. Then the resin including the phosphor is cured at 130°C for 1 hour. Thus a coating layer including the phosphor in thickness of 120μm is formed on the light emitting component. Concentration of the phosphor in the coating layer is increased gradually toward the light emitting component. Further, the light emitting component and the phosphor are sealed by molding with translucent epoxy resin for the purpose of protection against extraneous stress, moisture and dust. A lead frame with the coating layer of phosphor formed thereon is placed in a bullet-shaped die and mixed with translucent epoxy resin and then cured at 150°C for 5 hours. Under visual observation of the light emitting diode formed as described above in the direction normal to the light emitting plane, it was found that the central portion was rendered yellowish color due to the body color of the phosphor.

[0200] Measurements of chromaticity point, color temperature and color rendering index of the light emitting diode of Example 10 which was made as described above gave values of (0.32, 0.34) for chromaticity point (x, y), 89.0 for color rendering index (Ra) and light emitting efficiency of 10 lm/W. Further in weatherability tests under conditions of energization with a current of 60mA at room temperature, 20mA at room temperature and 20mA at 60°C with 90% RH, no change due to the phosphor was observed, showing no difference from an ordinary blue light emitting diode in the service life characteristic.

<u>(Example 11)</u>

[0201] $In_{0.4}Ga_{0.6}N$ semiconductor having an emission peak at 470nm is used as an LED element. Light emitting components are made by flowing TMG (trimethyl gallium) gas, TMI (trimethyl indium) gas, nitrogen gas and dopant gas together with a carrier gas on a cleaned sapphire substrate thereby to form a gallium nitride compound semiconductor layer in the MOCVD process. A gallium nitride semiconductor layer having N type conductivity and a gallium nitride semiconductor layer having P type conductivity were formed by switching SiH_4 and Cp_2Mg used as the dopant gas, thereby forming a PN junction. For the LED element, a contact layer which is gallium nitride semiconductor having N type conductivity, a clad layer which is gallium nitride aluminum semiconductor having P type conductivity and a contact layer which is gallium nitride semiconductor having P type conductivity are formed. An activation layer of non-doped InGaN with thickness of about 3nm is formed between the contact layer having N type conductivity and the clad layer having P type conductivity, thereby to make single quantum well structure. A buffer layer is provided on the sapphire substrate by forming a gallium nitride semiconductor layer at a low temperature.

[0202] After forming the layers and exposing the surfaces of P type and N type semiconductor layers by etching, electrodes are formed by sputtering. After scribing the semiconductor wafer which is made as described above, light emitting components are made by dividing the wafer with an external force.

[0203] The light emitting component is mounted in a cup at the tip of a silver-plated copper mount lead by die bonding with epoxy resin. Electrodes of the light emitting component, the mount lead and the inner lead are electrically connected by wire boding with gold wires having a diameter of 30μm.

[0204] The lead frame with the light emitting component attached thereon is placed in a bullet-shaped die and sealed with translucent epoxy resin for molding, which is then cured at 150°C for 5 hours, thereby to form a blue light emitting diode. The blue light emitting diode is connected to one end face of an acrylic optical guide plate which is polished on all end faces. On one surface and side face of the acrylic plate, screen printing is applied by using barium titanate dispersed in an acrylic binder as white color reflector, which is then cured.

[0205] Phosphor is made by mixing a fluorescent material represented by general formula $(Y_{0.8}Gd_{0.2})_3Al_5O_{12}$:Ce capable of emitting yellow light of relatively short wavelength and a fluorescent material represented by general formula $(Y_{0.4}Gd_{0.6})_3Al_5O_{12}$:Ce capable of emitting yellow light of relatively long wavelength prepared as follows. Namely, rare earth elements of Y, Gd and Ce are solved in acid in stoichiometrical proportions, and coprecipitating the solution with oxalic acid. Oxide of the coprecipitation obtained by firing it is mixed with aluminum oxide, thereby to obtain respective mixture material. The mixture is mixed with ammonium fluoride used as a flux, and fired in a crucible at a temperature of 1400°C in air for 3 hours. Then the fired material is ground by a ball mill in water, washed, separated, dried and sieved.

[0206] 100 parts by weight of yellow fluorescent material of relatively short wavelength and 100 parts by weight of yellow fluorescent material of relatively long wavelength which are made as described above are sufficiently mixed with 1000 parts by weight of acrylic resin and extruded, thereby to form a fluorescent material film to be used as color converting material of about 180μm in thickness. The fluorescent material film is cut into the same size as the principal emission plane of the optical guide plate and arranged on the optical guide plate, thereby to make a light emitting device. Measurements of chromaticity point and color rendering index of the light emitting device of Example 3 which is made as described above gave values of (0.33, 0.34) for chromaticity point (x, y), 88.0 for color rendering index (Ra) and light emitting efficiency of 101 m/W. Fig. 22A, Fig. 22B and Fig. 22C show emission spectra of the fluorescent material represented by $(Y_{0.8}Gd_{0.2})_3Al_5O_{12}$:Ce and a fluorescent material represented by general formula $(Y_{0.4}Gd_{0.6})_3Al_5O_{12}$:Ce used in Example 11. Fig. 23 shows emission spectrum of the light emitting diode of Example 11. Further in life tests under conditions of energization with a current of 60mA at room temperature, 20mA at room temperature and 20mA at 60°C with 90% RH, no change due to the fluorescent material was observed. Similarly, desired chromaticity can be maintained even when the wavelength of the light emtting component is changed by changing the content of the fluorescent material.

<u>(Example 12)</u>

[0207] The light emitting diode of Example 12 was made in the same manner as in Example 1 except for using phosphor represented by general formula $Y_3In_5O_{12}$:Ce. 100 pieces of the light emitting diode of Example 12 were made. Although the light emitting diode of Example 12 showed luminance lower than that of the light emitting diodes of Example 1, showed good weatherability comparable to that of Example 1 in life test.

[0208] As described above, the light emitting diode of the present invention can emit light of a desired color and is subject to less deterioration of emission efficiency and good weatherability even when used with high luminance for a long period of time. Therefore, application of the light emitting diode is not limited to electronic appliances but can open new applications including display for automobile, aircraft and buoys for harbors and ports, as well as outdoor use such as sign and illumination for expressways.

WHAT IS CLAIMED IS:

1. A method for manufacturing a light emitting device comprising:

preparing a light emitting component having an active layer of a semiconductor, said active layer comprising a gallium nitride based semiconductor containing indium and being capable of emitting a blue color light having a spectrum with a peak wavelength within the range from 420 to 490 nm;

preparing a phosphor capable of absorbing a part of the blue color light emitted from said light emitting component and emitting a yellow color light having a broad emission spectrum comprising a peak wavelength existing around the range from 510 to 600 nm and a tail continuing beyond 700 nm, wherein selection of said phosphor is controlled based on an emission wavelength of said light emitting component; and

combining said light emitting component and said phosphor so that the blue color light from said light emitting component and the yellow color light from said phosphor are mixed to make a white color light, wherein a chromaticity point of the white color light is on a straight line connecting a point of chromaticity of the blue color light and a point of chromaticity of the yellow color light, and

wherein a content of said phosphor in said light emitting device is selected to obtain a desired chromaticity of the white color light.

2. The method for manufacturing a light emitting device according to claim 1, wherein said phosphor comprises a garnet fluorescent material activated with cerium.

3. The method for manufacturing a light emitting device according to claim 1, wherein said phosphor comprises two or more kinds of fluorescent materials.

4. The method for manufacturing a light emitting device according to claim 1, wherein

the emission spectrum of said phosphor comprises a peak wavelength existing around the range from 530 to 570 nm and a tail continuing beyond 700 nm.

5. The method for manufacturing a light emitting device according to claim 1, wherein said phosphor comprises an yttrium-aluminum-garnet fluorescent material containing Y and Al.

6. The method for manufacturing a light emitting device according to claim 1, wherein said phosphor has a crystal structure.

7. The method for manufacturing a light emitting device according to claim 1, wherein the active layer of said light emitting component has a single quantum well or multi quantum well structure.

8. The method for manufacturing a light emitting device according to claim 1, wherein the active layer of said light emitting component comprises InGaN.

9. The method for manufacturing a light emitting device according to claim 1, wherein said light emitting device is capable of emitting white light substantially along the black body radiation locus.

10. The method for manufacturing a light emitting device according to claim 1, further comprising:

controlling emission color of said light emitting device by changing a content of said phosphor with respect to a content of a resin in a coating material.

11. The method for manufacturing a light emitting device according to claim 1, wherein

said step of controlling selection of said phosphor is used to reduce variation in the emission wavelength of said light emitting device, by compensating for a variation of the emission wavelength of said light emitting component.

12. The method for manufacturing a light emitting device according to claim 3, further comprising:

controlling compositions or quantities of light emitting components and fluorescent materials included in said light emitting device, to control color emitted by said light emitting device.

13. The method for manufacturing a light emitting device according to claim 3, wherein the emission wavelength of the fluorescent materials are selected so that said light emitting device produces RGB components with high luminance.

14. The method for manufacturing a light emitting device according to claim 13, wherein

the emission spectrum of one fluorescent material comprises a peak wavelength around 510 nm, and the emission spectrum tails out to around 700 nm, and

the emission spectrum of a second fluorescent material comprises a peak wavelength around 600 nm, and the emission spectrum tails out to around 750 nm,

so that said light emitting device produces RGB components with high luminance.

15. The method for manufacturing a light emitting device according to claim 3, further comprising mixing said two or more kinds of fluorescent materials.

16. The method for manufacturing a light emitting device according to claim 3, wherein said two or more kinds of fluorescent materials are arranged independently to adjust color by laminating the layers of fluorescent materials.

17. The method for manufacturing a light emitting device according to claim 3, wherein one of said fluorescent materials absorbs light of a shorter wavelength and another of said fluorescent materials absorbs light of a longer wavelength, and said fluorescent material that absorbs light of a longer wavelength is arranged away from said light emitting component, while said fluorescent material that absorbs light of a shorter wavelength is arranged near said light emitting component.

18. The method for manufacturing a light emitting device according to claim 1, wherein said phosphor is a fluorescent material represented by formula $(Re_{1-r}Sm_r)_3\ (Al_{1-s}Ga_s)_5O_{12}$:Ce where $0 \leq r < 1$, $0 \leq s \leq 1$ and Re is at least one element selected from Y, Gd and La.

19. The method for manufacturing a light emitting device according to claim 1, further comprising:

controlling compositions or quantities of light emitting components included in said light emitting device and controlling composition of said phosphor, to control color emitted by said light emitting device.

ABSTRACT OF THE DISCLOSURE

A method for manufacturing a light emitting device comprises: preparing a light emitting component having an active layer of a semiconductor, the active layer comprising a gallium nitride based semiconductor containing indium and being capable of emitting a blue color light; preparing a phosphor capable of absorbing a part of the blue color light emitted from the light emitting component and emitting a yellow color light, wherein selection of the phosphor is controlled based on an emission wavelength of the light emitting component; and combining the light emitting component and the phosphor so that the blue color light from the light emitting component and the yellow color light from the phosphor are mixed to make a white color light.

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FOR PATENT AND DESIGN APPLICATIONS

ATTORNEY DOCKET NO. 20-4260P

PLEASE NOTE: YOU MUST COMPLETE THE FOLLOWING:

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated next to my name; that I verily believe that I am the original, first and sole inventor (if only one inventor is named below) or an original, first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:*

Insert Title: LIGHT EMITTING DEVICE AND DISPLAY

Check Box If Appropriate - For Use Without Specification Attached

the specification of which is attached hereto unless the following box is checked:

☐ was filed on ______ as United States Application Number ______ or PCT International Application Number ______ and was amended on ______ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I do not know and do not believe the same was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof, or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (six months for designs) prior to this application, and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States of America prior to this application by me or my legal representatives or assigns, except as follows.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 (a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

Insert Priority Information (If appropriate)

(Number)	(Country)	(Month/Day/Year Filed)	Priority Claimed Yes	No
P 08-198585	Japan	07/29/1996	☒	☐
P 08-244339 .	Japan	09/17/1996	☒	☐
P 08-245381	Japan	09/18/1996	☒	☐
P 08-359004	Japan	12/27/1996	☒	☐
P 09-081010	Japan	03/31/1997	☒	☐

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

(Application Number) (Filing Date)

(Application Number) (Filing Date)

All Foreign Applications, if any, for any Patent or Inventor's Certificate Filed More Than 12 Months (6 Months for Designs) Prior To The Filing Date of This Application:

Country | Application No. | Date of Filing (Month/Day/Year)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Number) (Filing Date) (Status — patented, pending, abandoned)

*NOTE: Must be completed.

I hereby a[p]... t the following attorneys to prosecute ... application and/or an international application based [on] this application and to transact all busi[ness] in the Patent and Trademark Office connected therewith and in connection with the resulting paten[t] [b]ased on instructions received from the entity who first sent the application papers to the attorneys identified below, unless the inventor(s) or assignee provides said attorneys with a written notice to the contrary:

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JOSEPH A. KOLASCH (Reg. No. 22,463)
JAMES M. SLATTERY (Reg. No. 28,380)
[redacted]
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JOE McKINNEY MUNCY (Reg. No. 32,334)
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ANDREW D. MEIKLE (Reg. No. 32,868)
ANDREW F. REISH (Reg. No. 33,443)

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Send Correspondence to: **BIRCH, STEWART, KOLASCH AND BIRCH, LLP**

P.O. Box 747
Falls Church, Virginia 22040-0747
Telephone: (703) 205-8000
Facsimile: (703) 205-8050

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of First or Sole Inventor: Insert Name of Inventor Insert Date This Document Is Signed
Insert Residence Insert Citizenship
Insert Post Office Address

GIVEN NAME FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
Yoshinori SHIMIZU	Yoshinori Shimizu	07/22/1997
Residence (City, State & Country): Naka-gun, Tokushima, Japan	CITIZENSHIP: Japan	
POST OFFICE ADDRESS (Complete Street Address including City, State & Country): c/o Nichia Kagaku Kogyo Kabushiki Kaisha, 491-100, Oka, Kaminakacho, Anan-shi, TOKUSHIMA 774 JAPAN		

Full Name of Second Inventor, if any: see above

GIVEN NAME FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
Kensho SAKANO	Kensho Sakano	07/22/1997
Residence (City, State & Country): Anan-shi, Tokushima, Japan	CITIZENSHIP: Japan	
POST OFFICE ADDRESS (Complete Street Address including City, State & Country): c/o Nichia Kagaku Kogyo Kabushiki Kaisha, 491-100, Oka, Kaminakacho, Anan-shi, TOKUSHIMA 774 JAPAN		

Full Name of Third Inventor, if any: see above

GIVEN NAME FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
Yasunobu NOGUCHI	Yasunobu Noguchi	07/22/1997
Residence (City, State & Country): Naka-gun, Tokushima, Japan	CITIZENSHIP: Japan	
POST OFFICE ADDRESS (Complete Street Address including City, State & Country): c/o Nichia Kagaku Kogyo Kabushiki Kaisha, 491-100, Oka, Kaminakacho, Anan-shi, TOKUSHIMA 774 JAPAN		

Full Name of Fourth Inventor, if any: see above

GIVEN NAME FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
Toshio MORIGUCHI	Toshio Moriguchi	07/22/1997
Residence (City, State & Country): Anan-shi, Tokushima, Japan	CITIZENSHIP: Japan	
POST OFFICE ADDRESS (Complete Street Address including City, State & Country): c/o Nichia Kagaku Kogyo Kabushiki Kaisha, 491-100, Oka, Kaminakacho, Anan-shi, TOKUSHIMA 774 JAPAN		

Full Name of Fifth Inventor, if any: see above

GIVEN NAME FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
Residence (City, State & Country):	CITIZENSHIP:	
POST OFFICE ADDRESS (Complete Street Address including City, State & Country):		

*Note: Must be completed — date this document is signed.

Fig.1

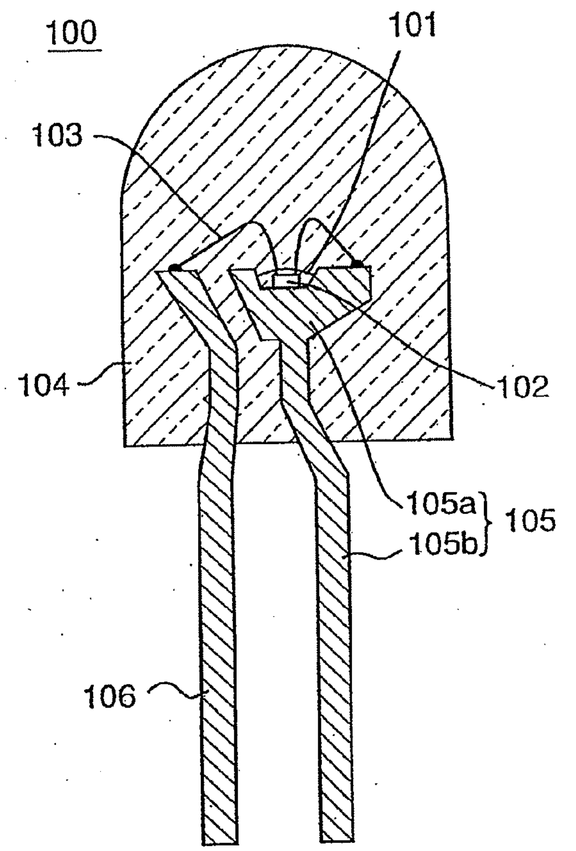


Fig.2

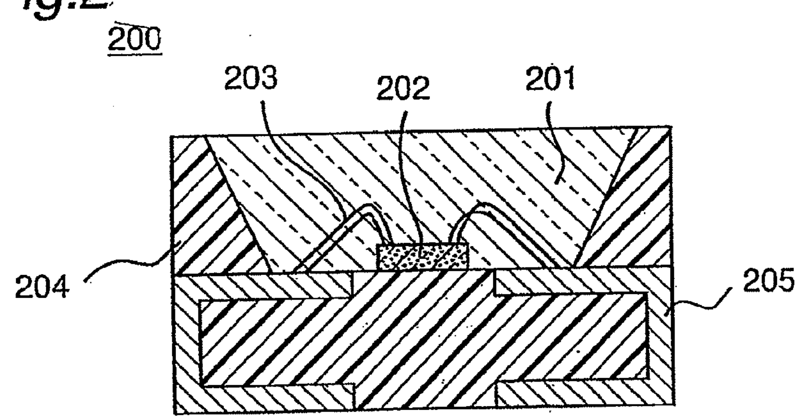


Fig.3A

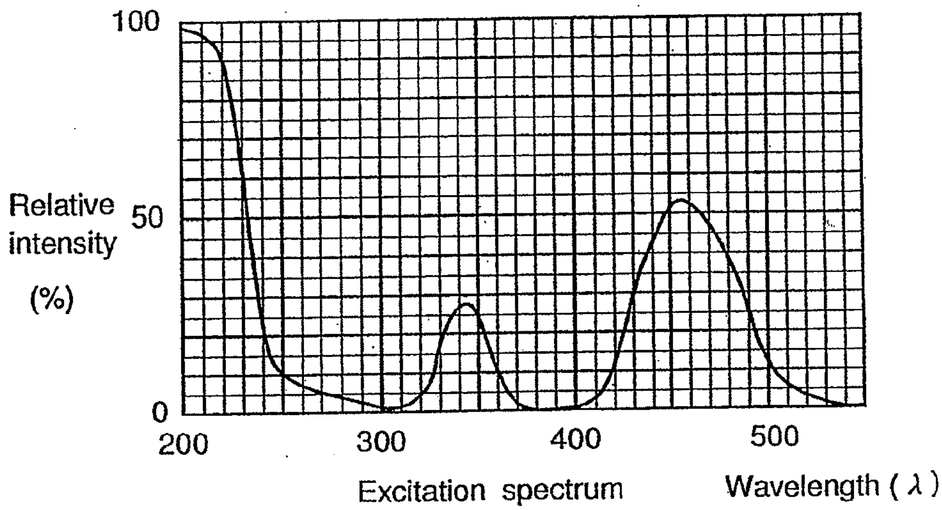

100
Relative intensity (%)
50
0
200
300
400
500
Excitation spectrum
Wavelength (λ)

Fig.3B

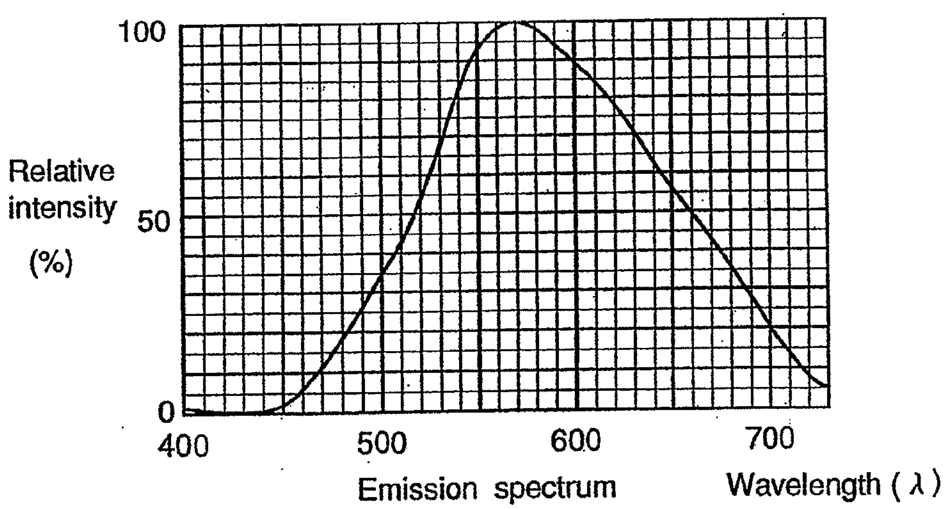

100
Relative intensity (%)
50
0
400
500
600
700
Emission spectrum
Wavelength (λ)

Fig.4

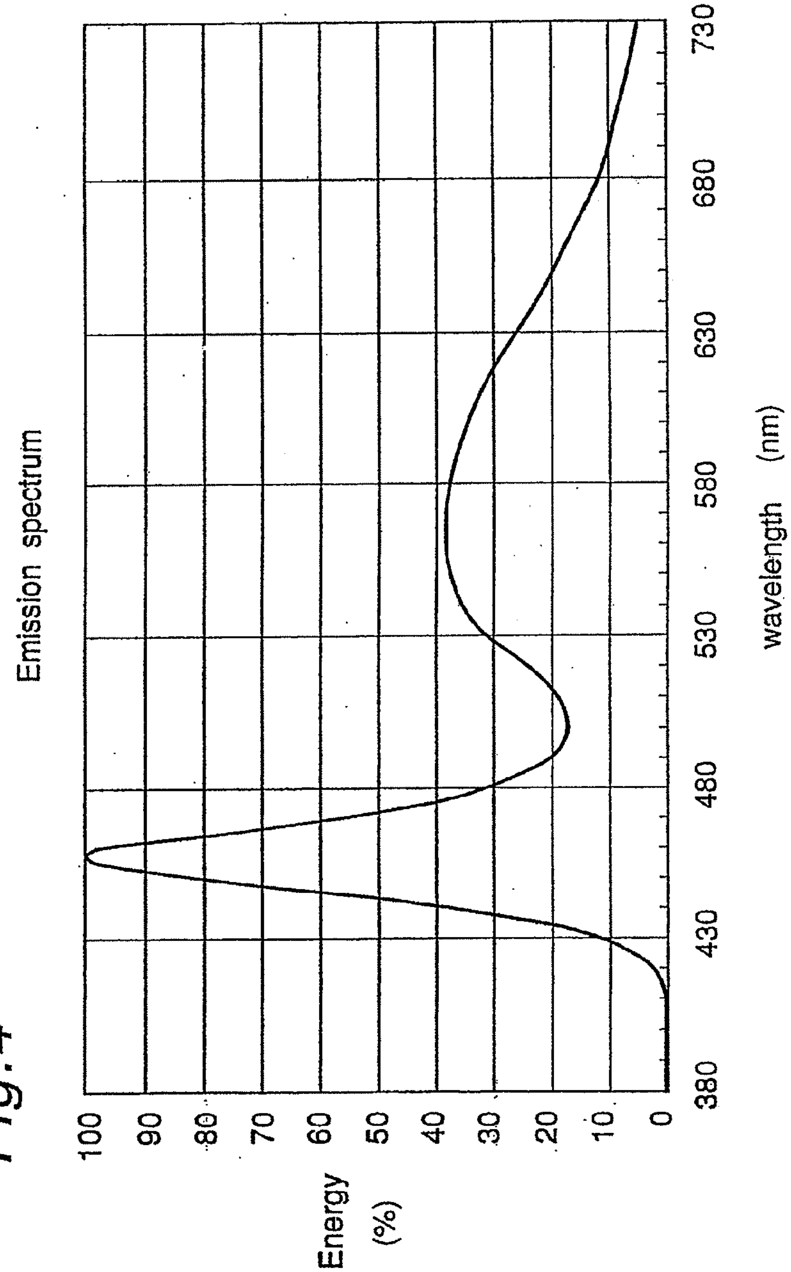

Emission spectrum
Energy (%)
100
90
80
70
60
50
40
30
20
10
0
380
430
480
530
580
630
680
730
wavelength (nm)

Fig.5A

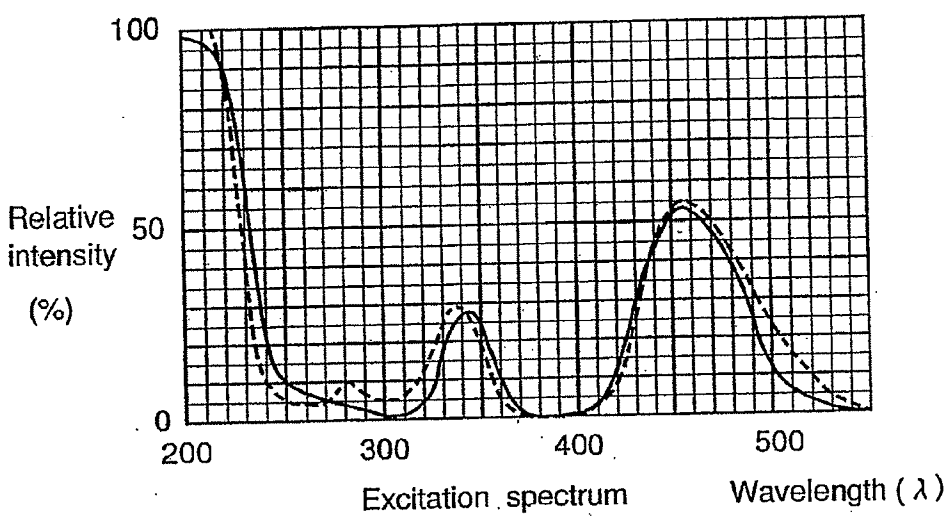

100
Relative intensity (%)
50
0
200
300
400
500
Excitation spectrum
Wavelength (λ)

Fig.5B

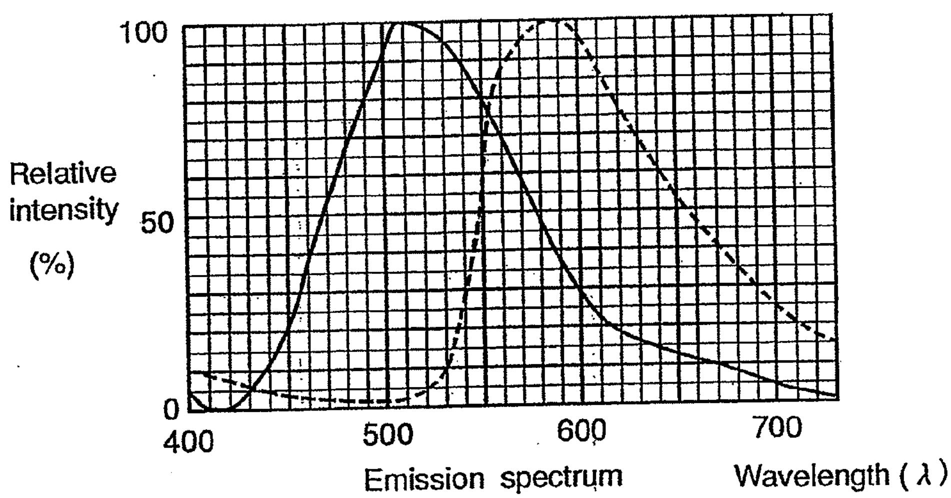

100
Relative intensity (%)
50
0
400
500
600
700
Emission spectrum
Wavelength (λ)

Fig.6

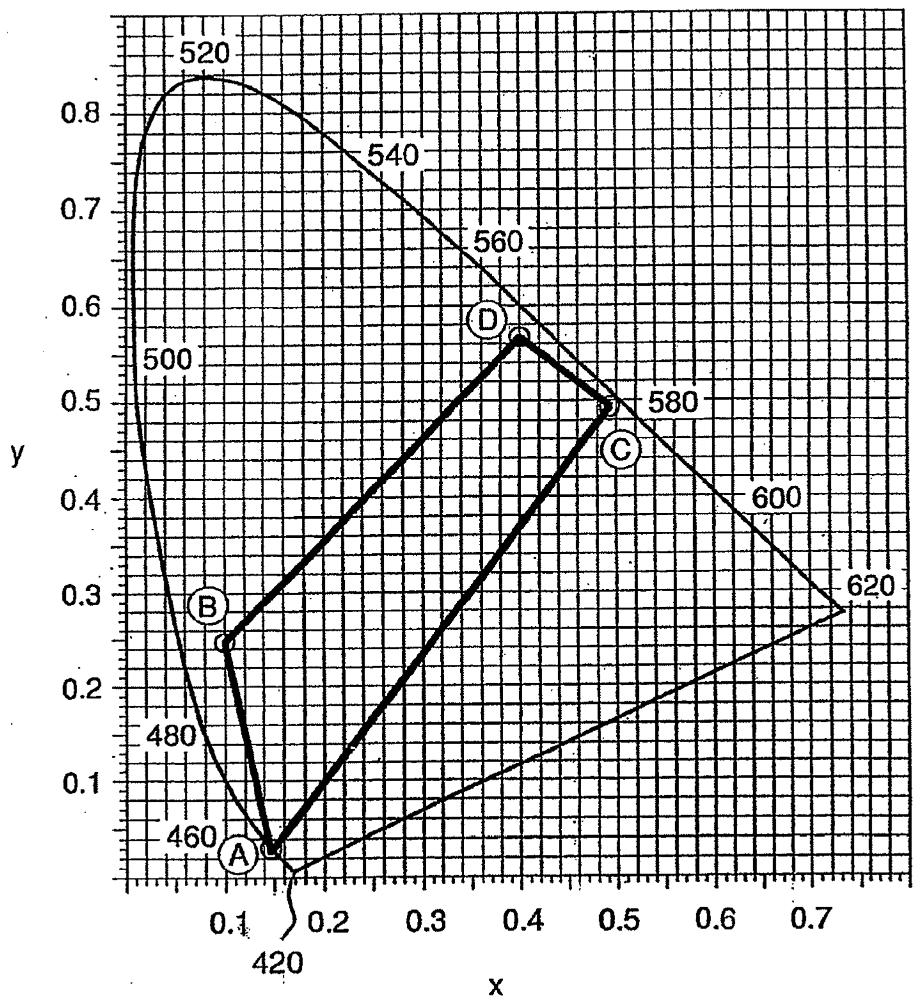

520
540
560
580
600
620
500
480
460
420
D
C
B
A
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
y
0.1
0.2
0.3
0.4
0.5
0.6
0.7
x

Fig.7

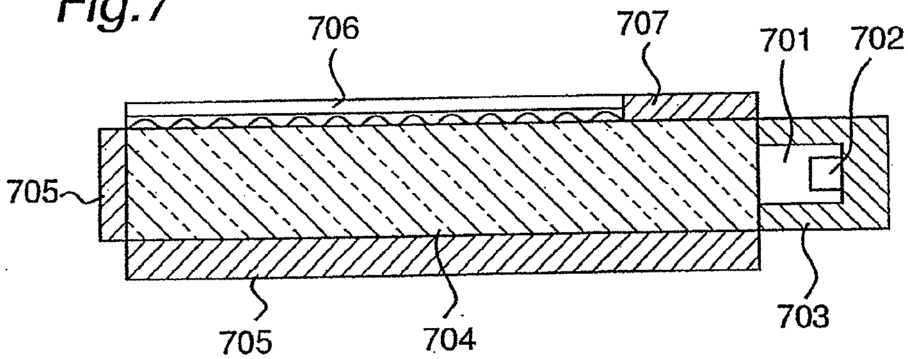


Fig.8

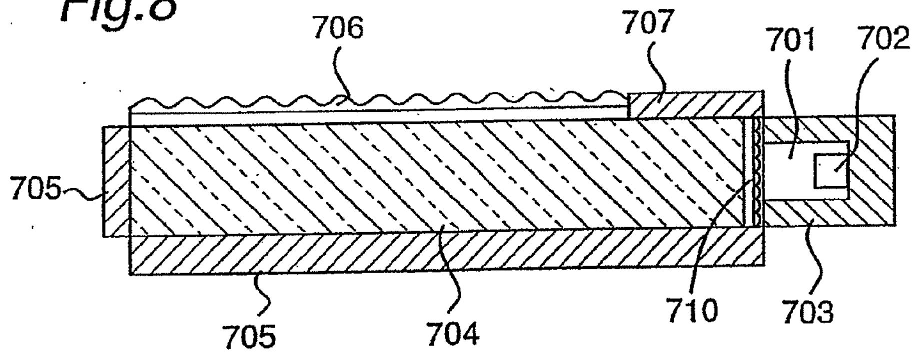


Fig.9

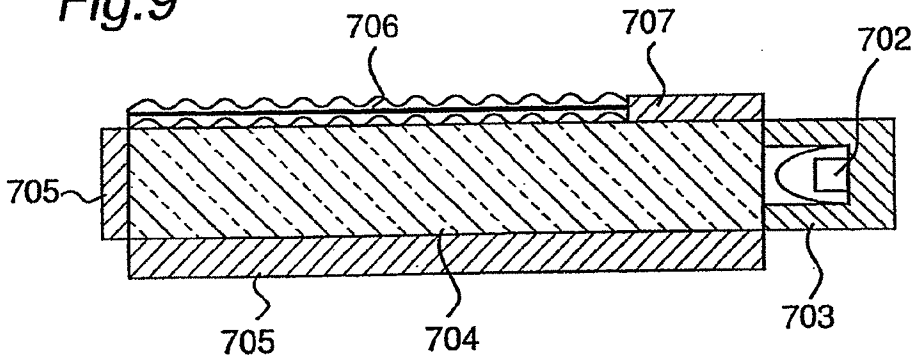


Fig.10

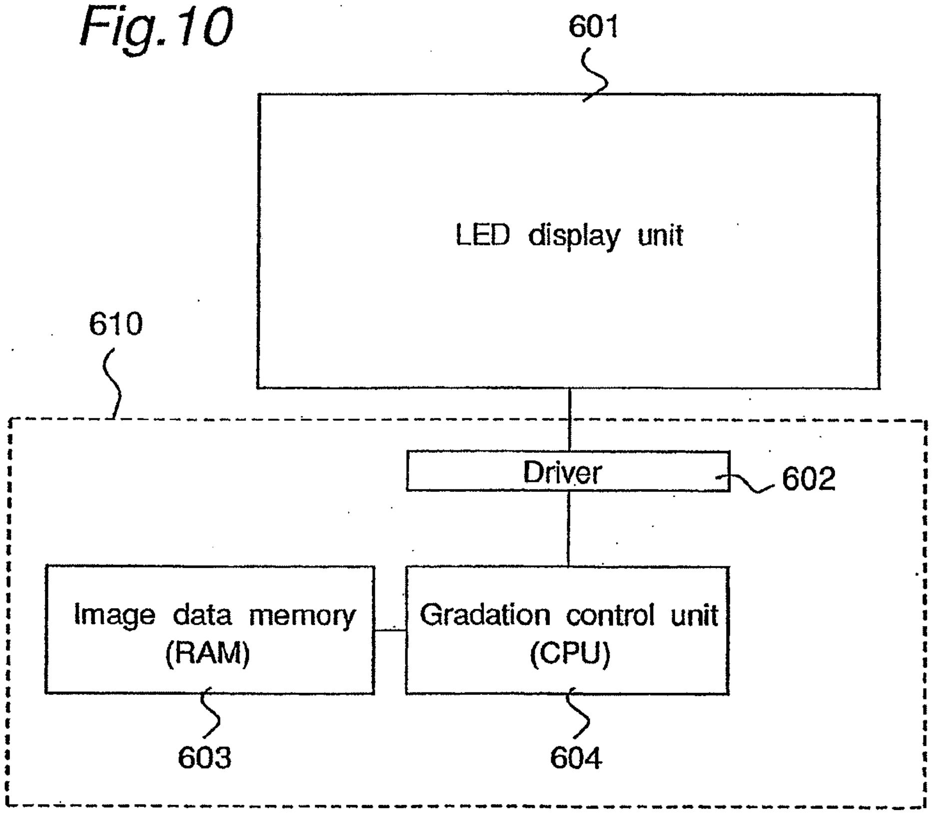

601
LED display unit
610
Driver
602
Image data memory (RAM)
Gradation control unit (CPU)
603
604

Fig.11

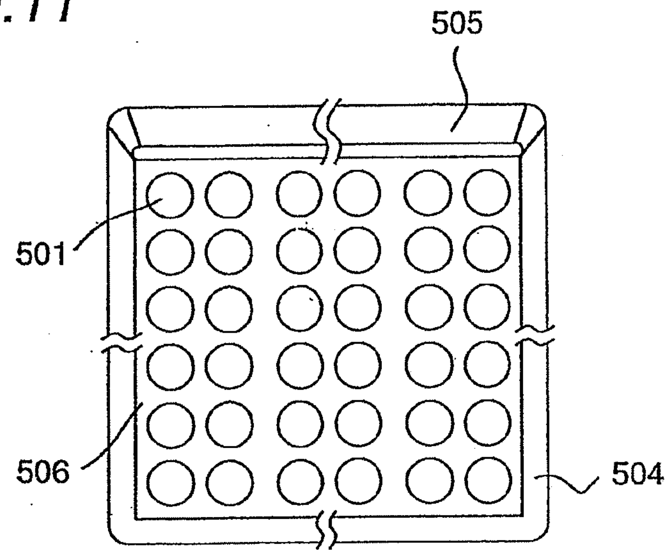


Fig.12

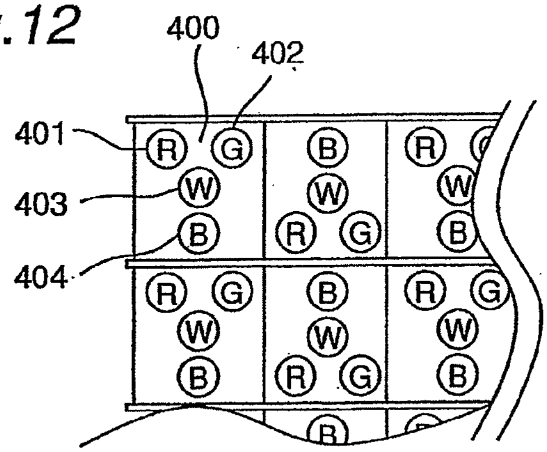


Fig. 13A

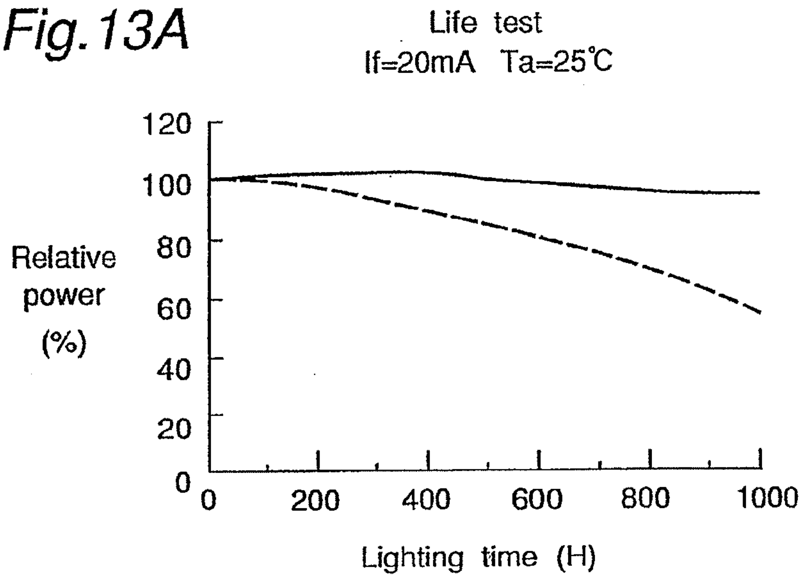


Fig. 13B

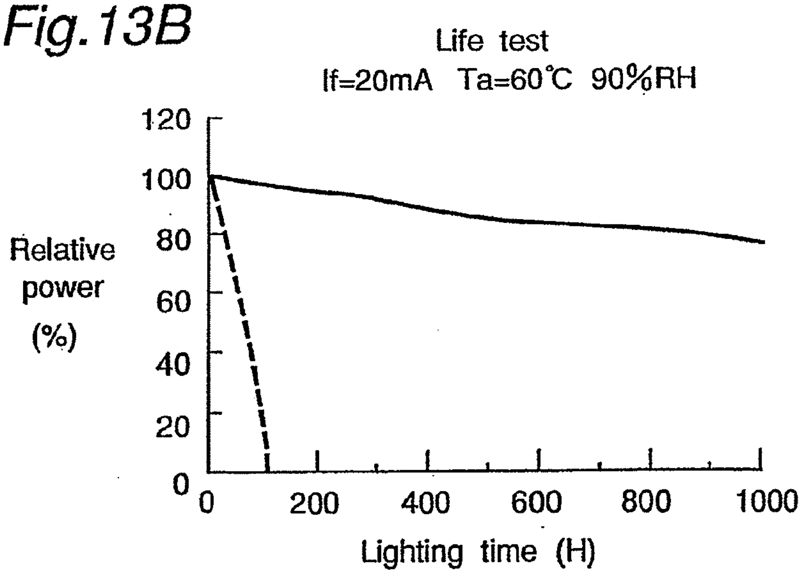


Fig.14A

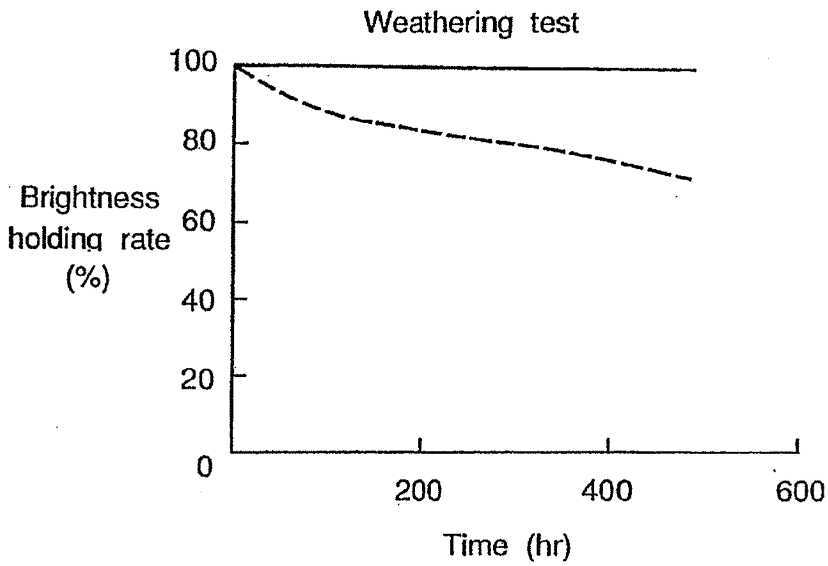


Fig.14B

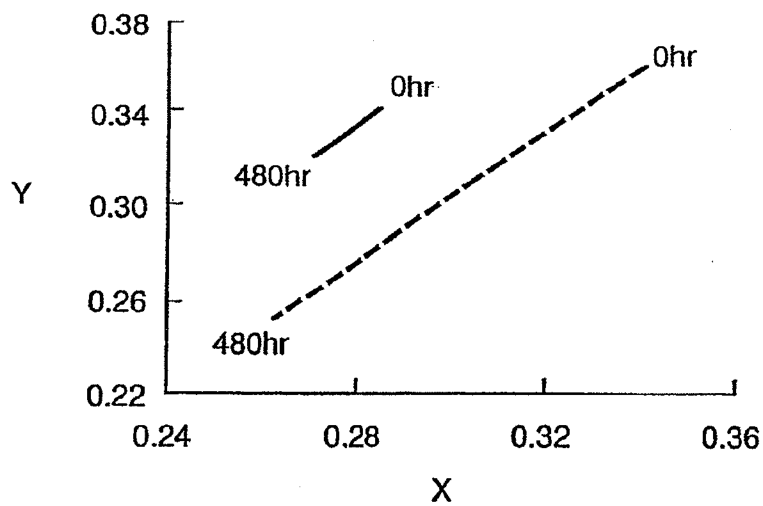


Fig.15A

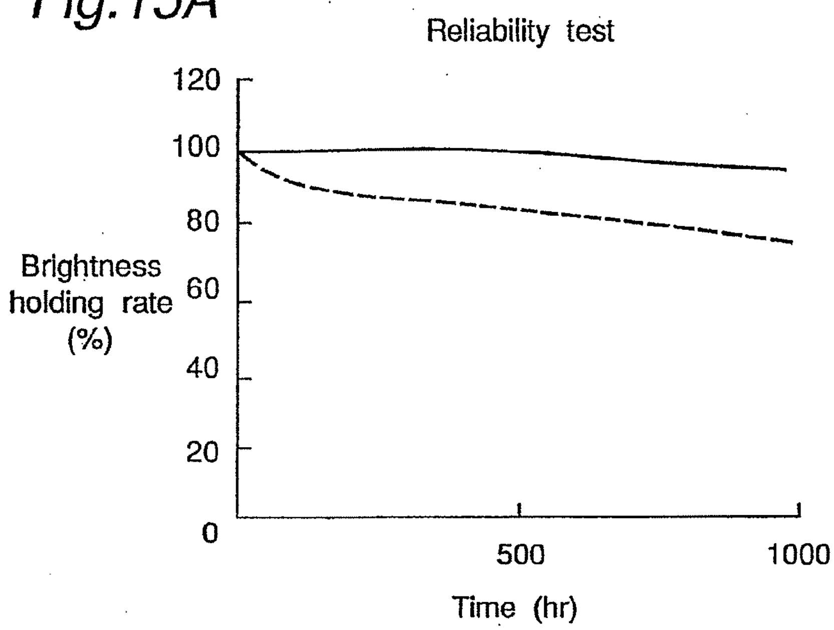


Fig.15B

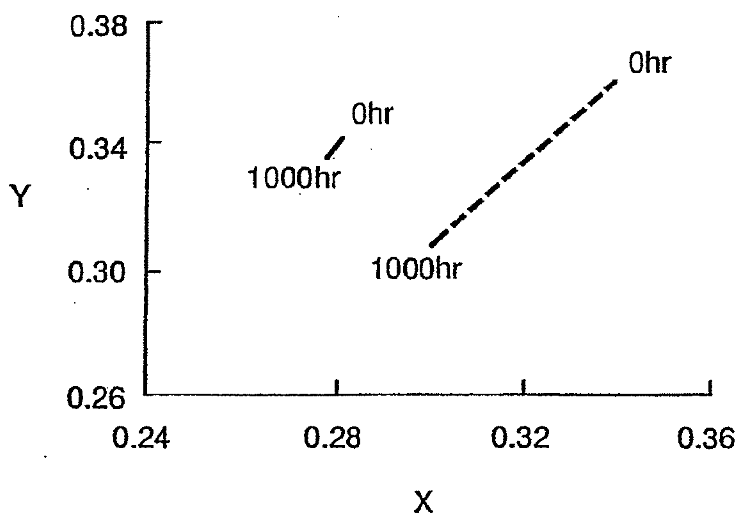


Fig.16

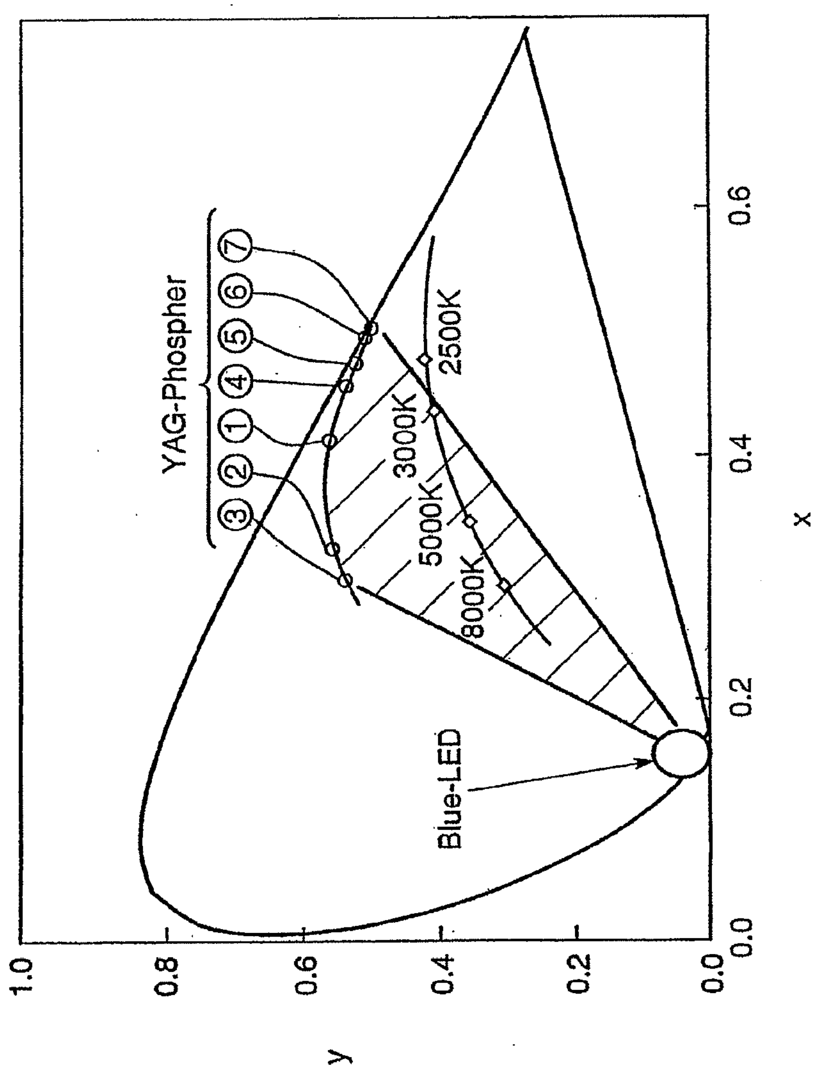

YAG-Phospher
③ ② ① ④ ⑤ ⑥ ⑦
2500K
3000K
5000K
8000K
Blue-LED
0.0
0.2
0.4
0.6
x
1.0
0.8
0.6
0.4
0.2
0.0
y

Fig.17

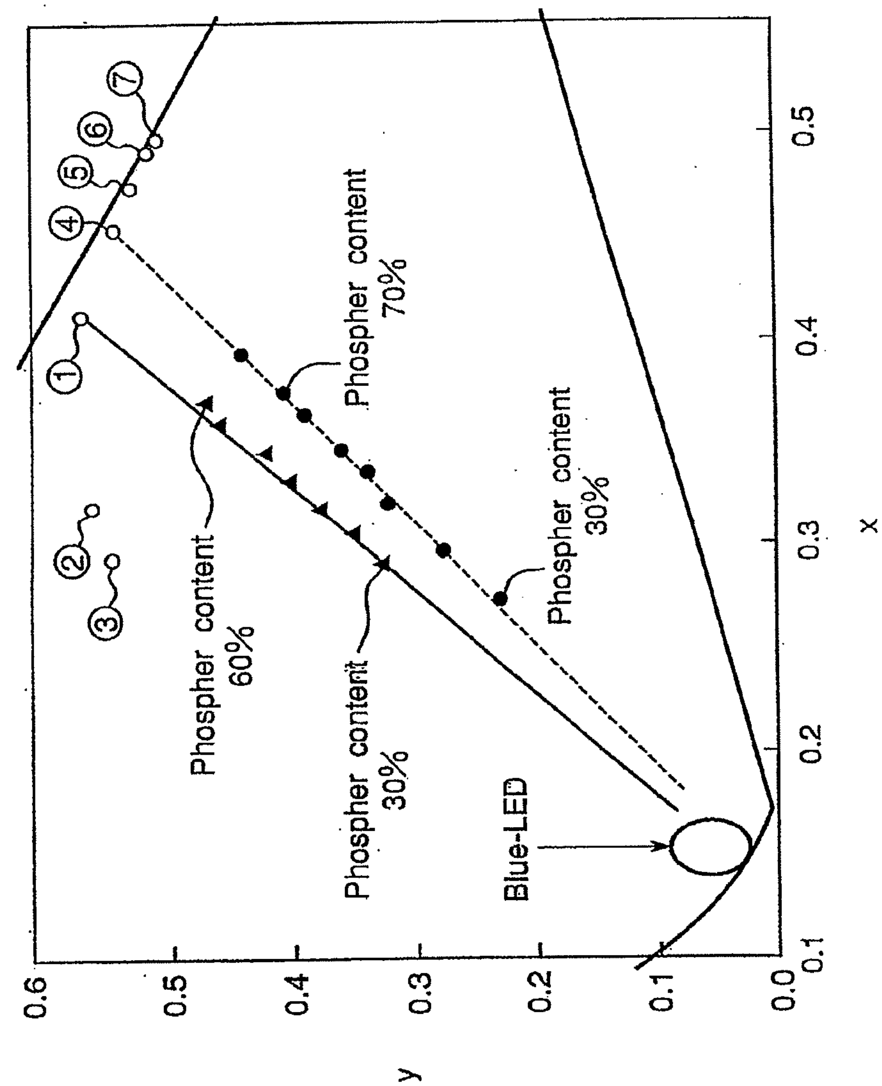

Phospher content 70%
Phospher content 30%
Phospher content 60%
Phospher content 30%
Blue-LED
1
2
3
4
5
6
7
y
x
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1
0.2
0.3
0.4
0.5

Fig.18A

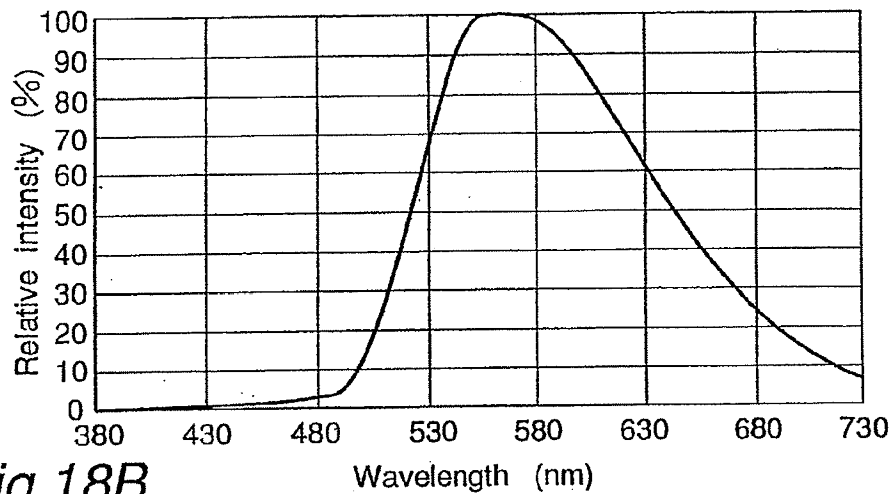


Fig.18B

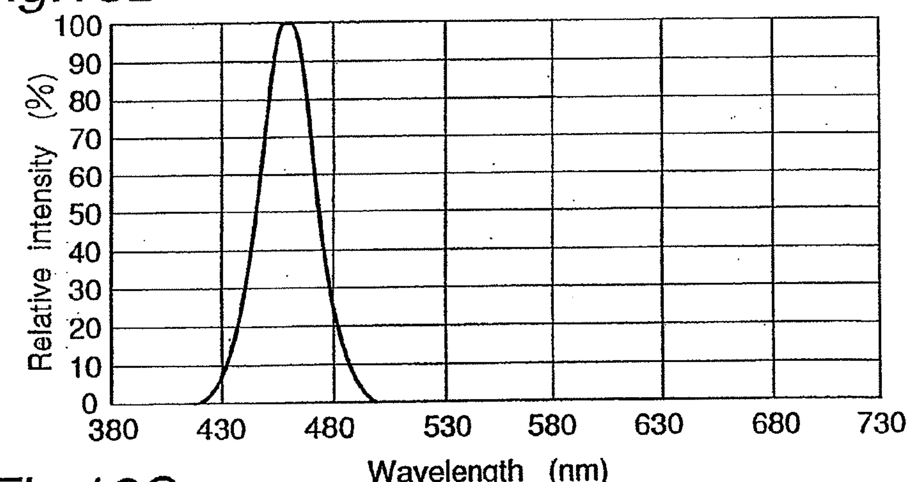


Fig.18C

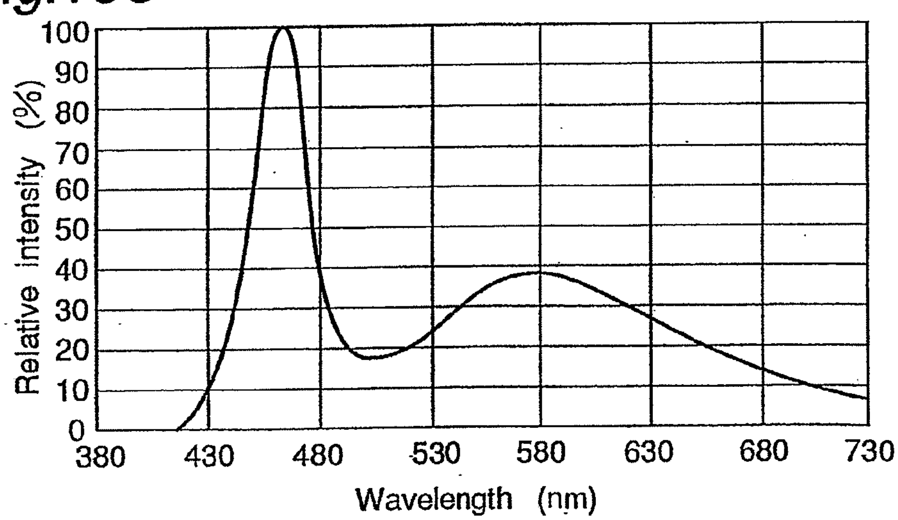


Fig.19A

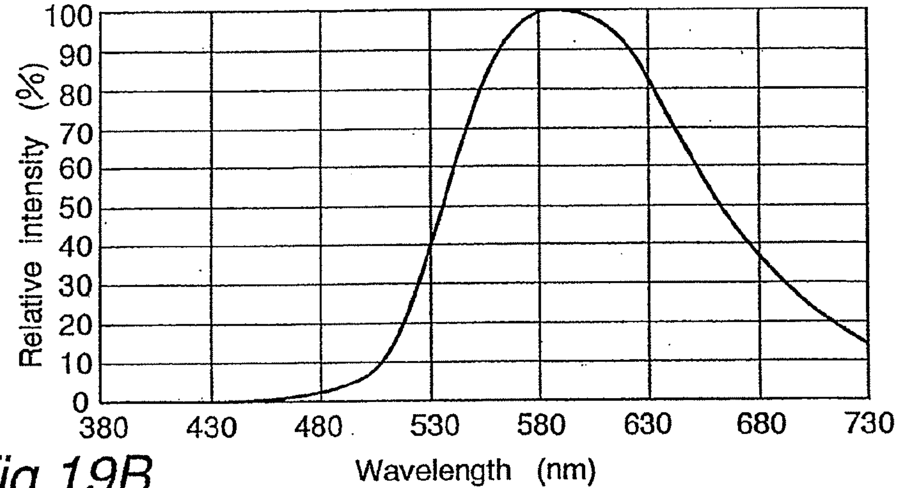


Fig.19B

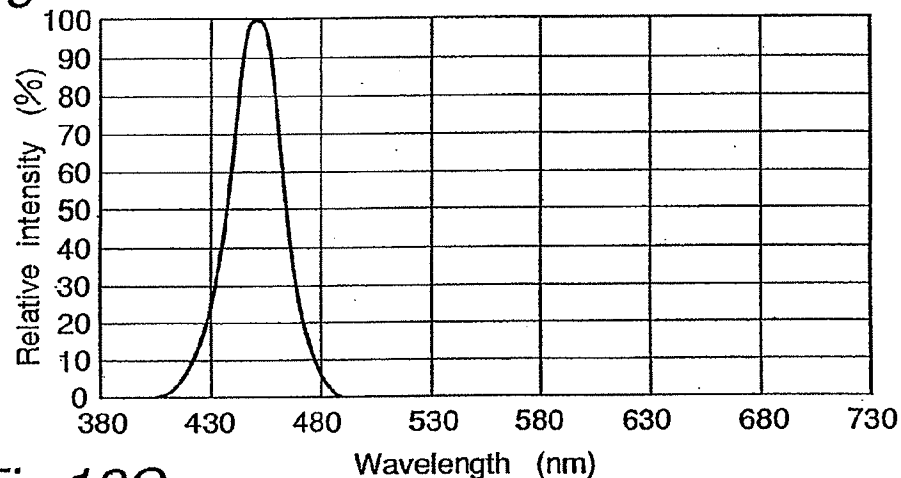


Fig.19C

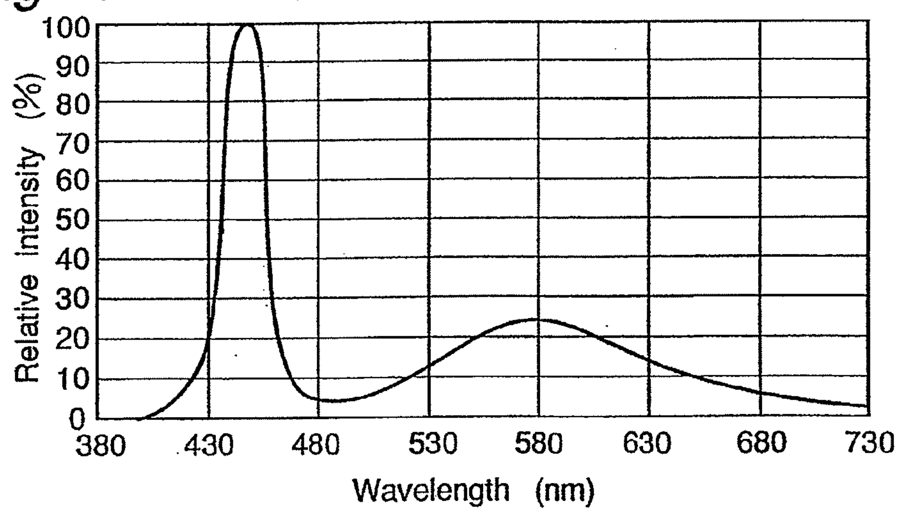


Fig.20A

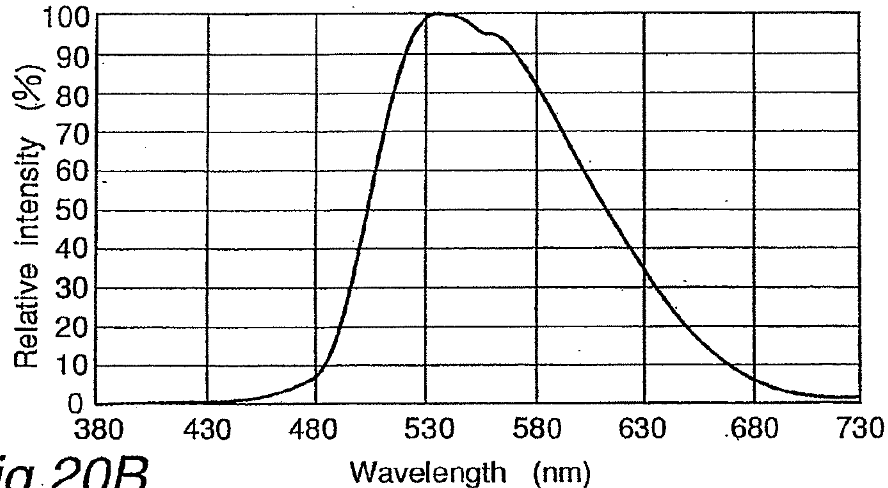


Fig.20B

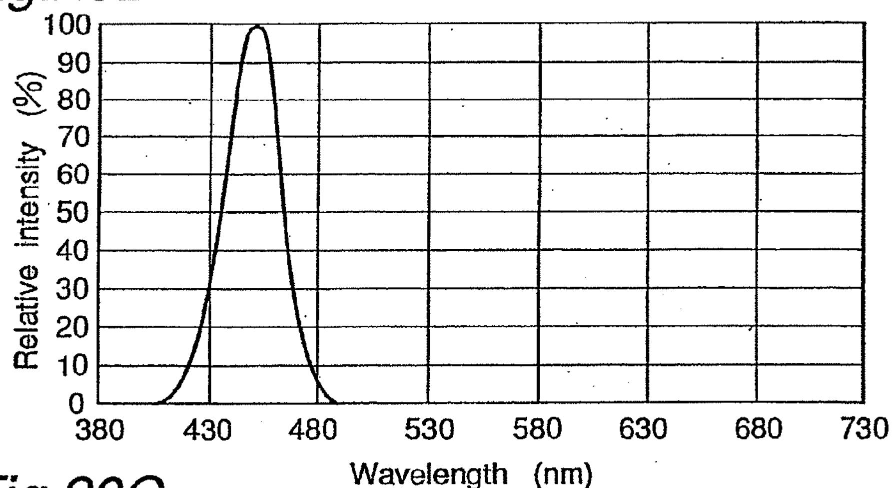


Fig.20C

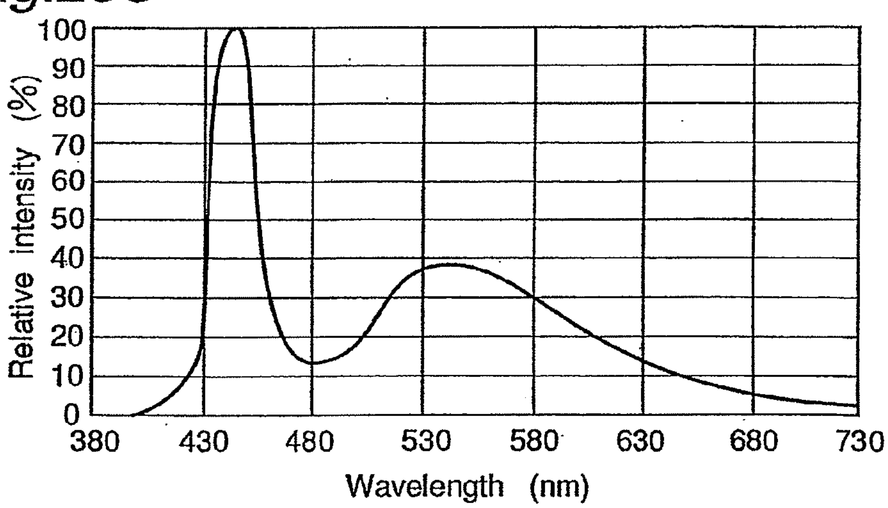


Fig.21A

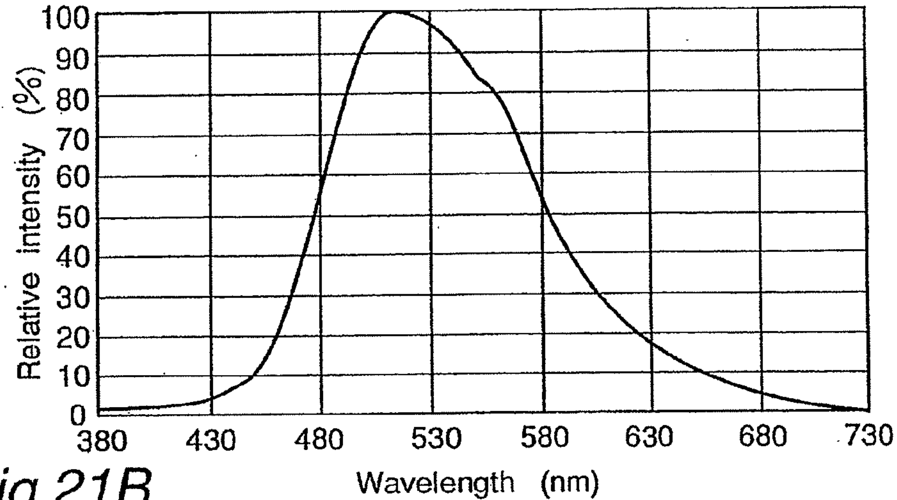


Fig.21B

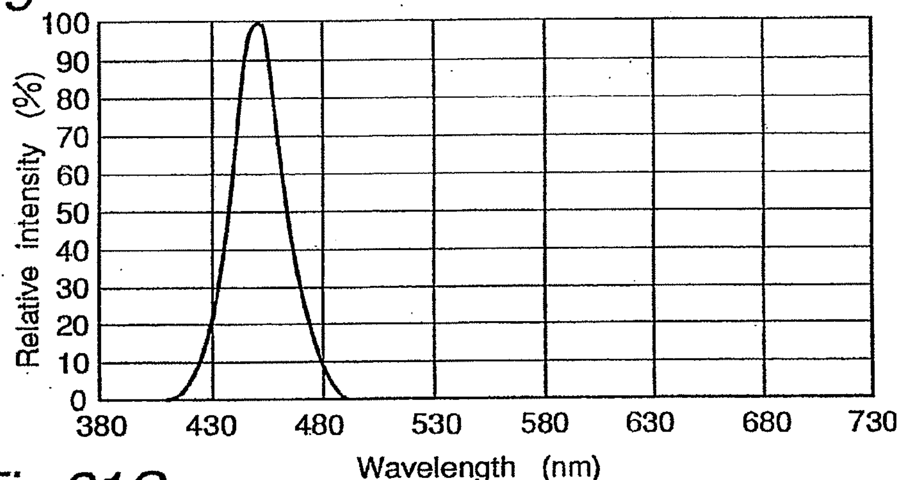


Fig.21C

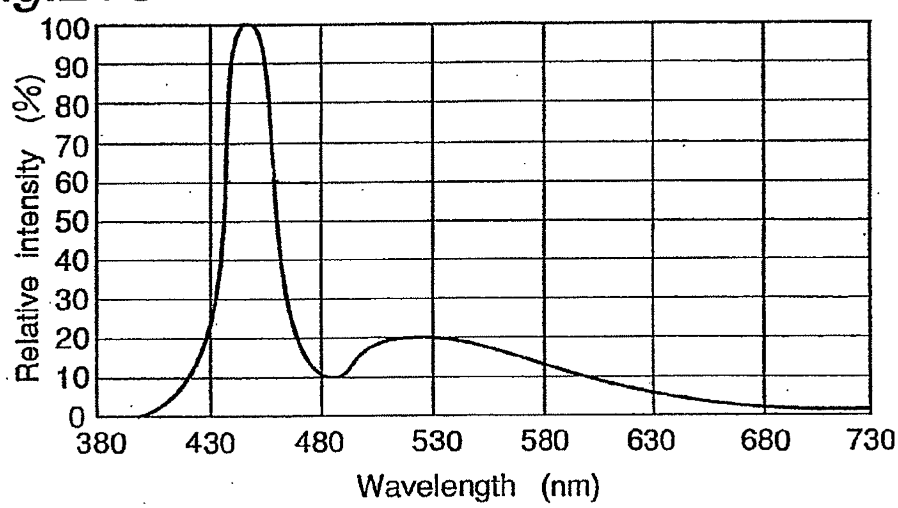


Fig.22A

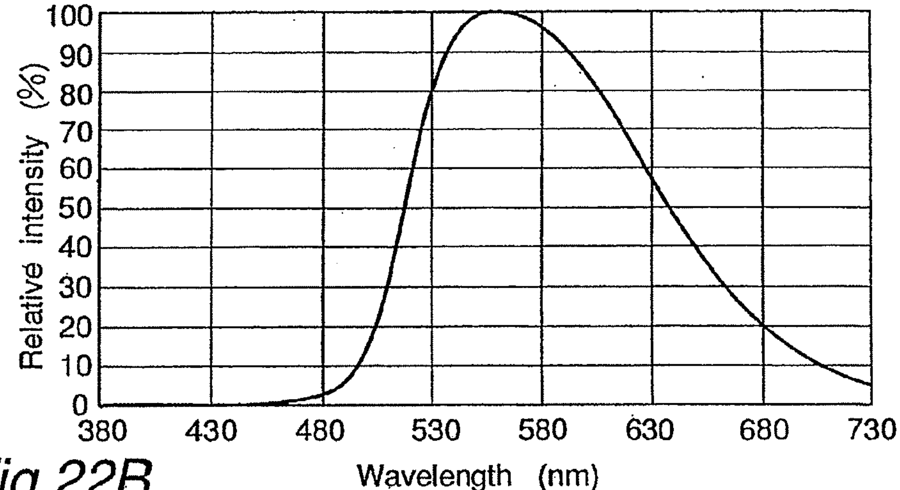


Fig.22B

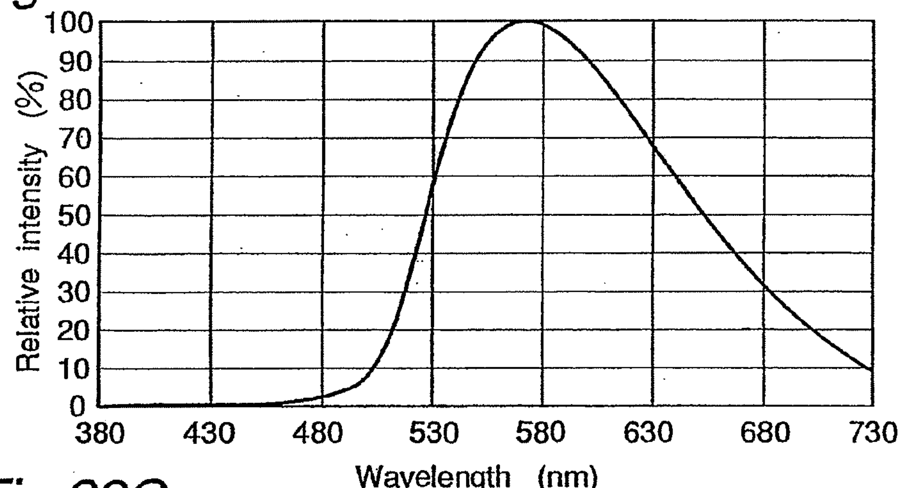


Fig.22C

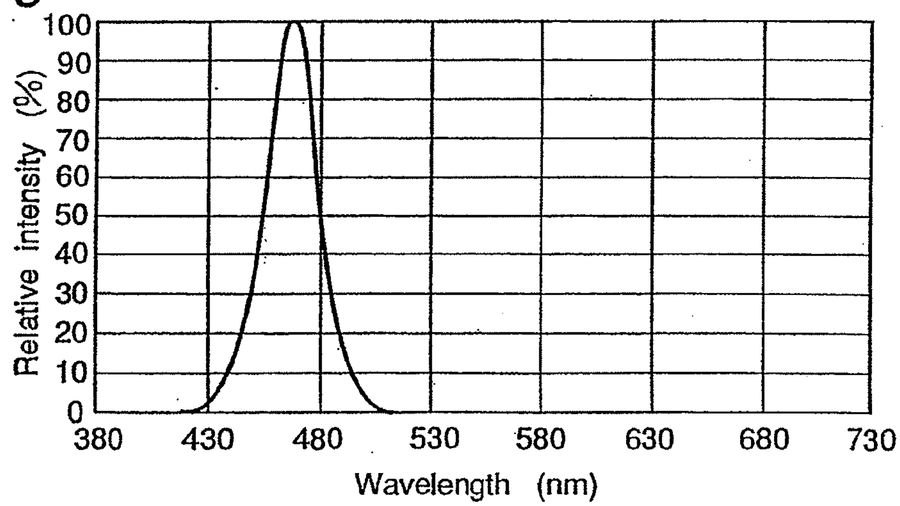
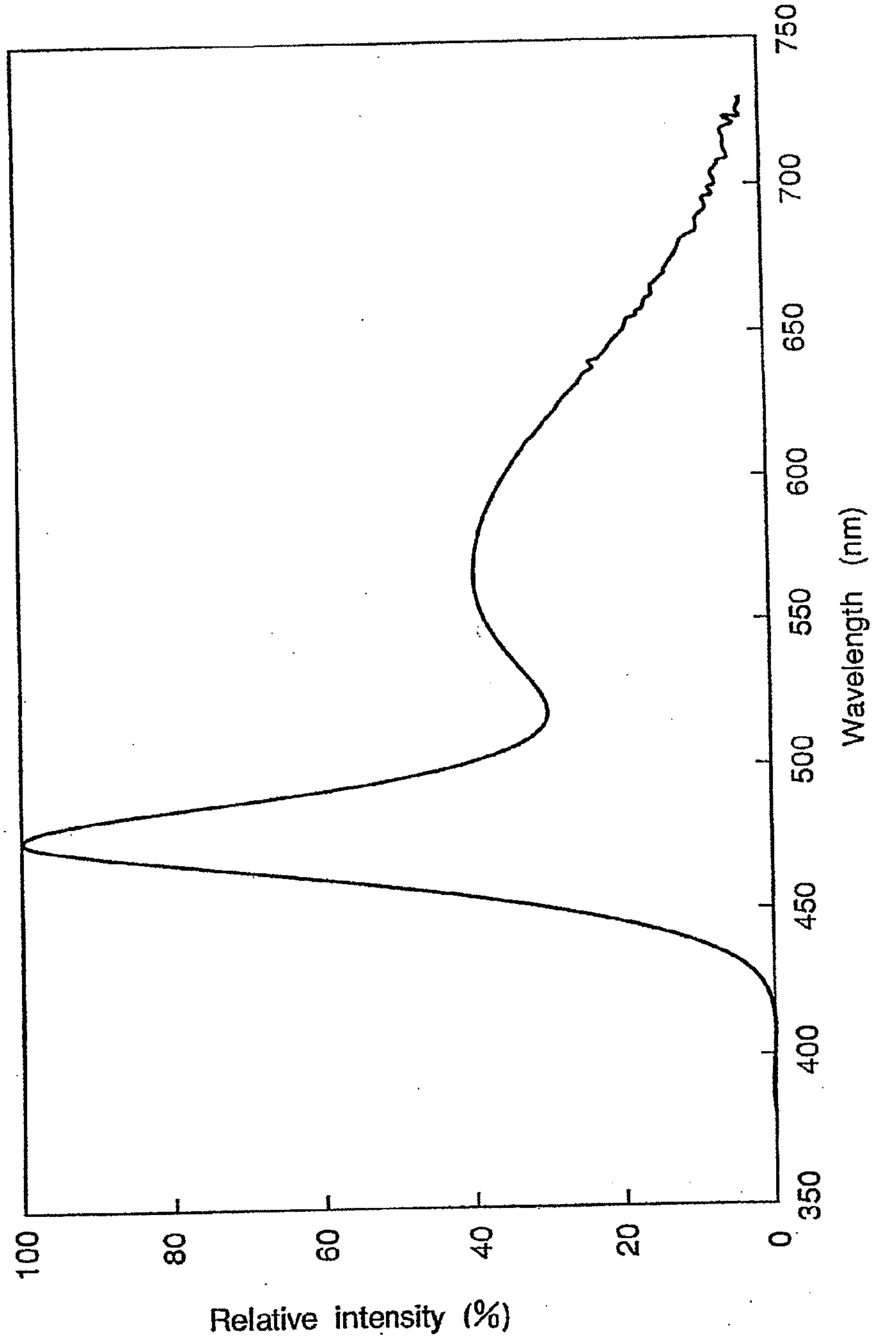


Fig.23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40
60
80
100
Wavelength (nm)
350
400
450
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550
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700
750

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori SHIMIZU
Filer:	David Richard Anderson/Patti Young
Attorney Docket Number:	0020-5147PUS12

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

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Utility Search Fee	1111	1	540	540
Utility Examination Fee	1311	1	220	220
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
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Miscellaneous:				
		Total in USD ($)		**1090**

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EFS ID:	8803171
Application Number:	12942792
International Application Number:	
Confirmation Number:	2357
Title of Invention:	LIGHT EMITTING DEVICE AND DISPLAY
First Named Inventor/Applicant Name:	Yoshinori SHIMIZU
Customer Number:	02292
Filer:	David Richard Anderson/Patti Young
Filer Authorized By:	David Richard Anderson
Attorney Docket Number:	0020-5147PUS12
Receipt Date:	09-NOV-2010
Filing Date:	
Time Stamp:	17:47:10
Application Type:	Utility under 35 USC 111(a)

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Payment was successfully received in RAM	$1090
RAM confirmation Number	4395
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Multipart Description/PDF files in .zip description

Document Description	Start	End
Miscellaneous Incoming Letter	1	1
Transmittal of New Application	2	2

Warnings:

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
2		20101109IDS.pdf	817889 fd85c5b202ec95a3ba461768b3cab9438e8385ec	yes	17

Multipart Description/PDF files in .zip description

Document Description	Start	End
Transmittal Letter	1	5
Information Disclosure Statement (IDS) Filed (SB/08)	6	17

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Information:

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6	Claims	20101109CLAIMS.pdf	144202 61cb64eb3234aa5815b372d00634c10d26e06c82	no	4
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7	Abstract	20101109ABSTRACT.pdf	21490 5143177e0120e9af1fd51d209b5b2ac02d2ff810	no	1
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Information:					
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PTO/SB/17 (10-08)
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Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL
For FY 2009

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT	($)	1,090.00

Complete if Known	
Application Number	NEW Conf. No.: N/A
Filing Date	November 9, 2010
First Named Inventor	Yoshinori SHIMIZU
Examiner Name	N/A
Art Unit	N/A
Attorney Docket No.	0020-5147PUS12

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify):

☑ Deposit Account Deposit Account Number: 02-2448 Deposit Account Name:

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☑ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☑ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☑ Credit any overpayments

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

Application Type	FILING FEES Fee ($)	Small Entity Fee ($)	SEARCH FEES Fee ($)	Small Entity Fee ($)	EXAMINATION FEES Fee ($)	Small Entity Fee ($)	Fees Paid ($)
Utility	330	165	540	270	220	110	1,090.00
Design	220	110	100	50	140	70	
Plant	220	110	330	165	170	85	
Reissue	330	165	540	270	650	325	
Provisional	220	110	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	Fee ($)	Small Entity Fee ($)
Each claim over 20 (including Reissues)	52	26
Each independent claim over 3 (including Reissues)	220	110
Multiple dependent claims	390	195

Total Claims		Extra Claims		Fee ($)		Fee Paid ($)
19	- 20 or HP =	0	x		=	0.00

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims		Extra Claims		Fee ($)		Fee Paid ($)
1	- 3 or HP =	0	x		=	0.00

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims

Fee ($)	Fee Paid ($)
	0.00

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $270 ($135 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		Extra Sheets		Number of each additional 50 or fraction thereof		Fee ($)		Fee Paid ($)
80	- 100 =	0	/ 50 =	0 (round **up** to a whole number)	x		=	0.00

4. OTHER FEE(S)

	Fees Paid ($)
Non-English Specification, $130 fee (no small entity discount)	0.00
Other (e.g., late filing surcharge):	

SUBMITTED BY

Signature		Registration No. (Attorney/Agent) 40,439	Telephone 703-205-8000
Name (Print/Type)	D. Richard Anderson		Date November 9, 2010

Effective on 12/08/2004.
Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).

FEE TRANSMITTAL
For FY 2009

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 1,090.00

Complete if Known	
Application Number	NEW Conf. No.: N/A
Filing Date	November 9, 2010
First Named Inventor	Yoshinori SHIMIZU
Examiner Name	N/A
Art Unit	N/A
Attorney Docket No.	0020-5147PUS12

METHOD OF PAYMENT (check all that apply)

☐ Check ☐ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): ____________

☑ Deposit Account Deposit Account Number: 02-2448 Deposit Account Name: ____________

For the above-identified deposit account, the Director is hereby authorized to: (check all that apply)

☑ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

☑ Charge any additional fee(s) or underpayments of fee(s) under 37 CFR 1.16 and 1.17 ☑ Credit any overpayments

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FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
Application Type	**Fee ($)**	**Small Entity Fee ($)**	**Fee ($)**	**Small Entity Fee ($)**	**Fee ($)**	**Small Entity Fee ($)**	**Fees Paid ($)**
Utility	330	165	540	270	220	110	1,090.00
Design	220	110	100	50	140	70	
Plant	220	110	330	165	170	85	
Reissue	330	165	540	270	650	325	
Provisional	220	110	0	0	0	0	

2. EXCESS CLAIM FEES

Fee Description	**Fee ($)**	**Small Entity Fee ($)**
Each claim over 20 (including Reissues)	52	26
Each independent claim over 3 (including Reissues)	220	110
Multiple dependent claims	390	195

Total Claims		**Extra Claims**		**Fee ($)**		**Fee Paid ($)**
19	- 20 or HP =	0	x		=	0.00

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims		**Extra Claims**		**Fee ($)**		**Fee Paid ($)**
1	- 3 or HP =	0	x		=	0.00

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims

Fee ($)	**Fee Paid ($)**
	0.00

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $270 ($135 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		**Extra Sheets**		**Number of each additional 50 or fraction thereof**		**Fee ($)**		**Fee Paid ($)**
80	- 100 =	0	/ 50 =	0 (round **up** to a whole number)	x		=	0.00

4. OTHER FEE(S) **Fees Paid ($)**

Non-English Specification, $130 fee (no small entity discount) 0.00

Other (e.g., late filing surcharge): ____________ ____________

SUBMITTED BY

Signature		Registration No. (Attorney/Agent) 40,439	Telephone 703-205-8000
Name (Print/Type)	D. Richard Anderson		Date November 9, 2010

Date: 11/09/10

PTO/SB/06 (12-04)
Approved for use through 7/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PATENT APPLICATION FEE DETERMINATION RECORD
Substitute for Form PTO-875

Application or Docket Number: 12/942,792

APPLICATION AS FILED – PART I

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	SMALL ENTITY RATE ($)	SMALL ENTITY FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	330
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	540
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	220
TOTAL CLAIMS (37 CFR 1.16(i))	19 minus 20 =		x$26		OR	x$52	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =	*	x$110			x$220	
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $270 ($135 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR						
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))			195			390	
			TOTAL			TOTAL	1090

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED – PART II

AMENDMENT A

	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
					TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

OR

AMENDMENT B

	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
					TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.