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

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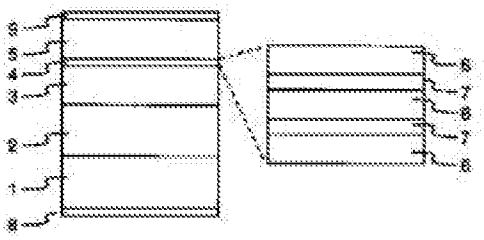
(54) SEMICONDUCTOR LIGHT EMITTING DEVICE

(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.



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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.]

* NOTICES *

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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.]

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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

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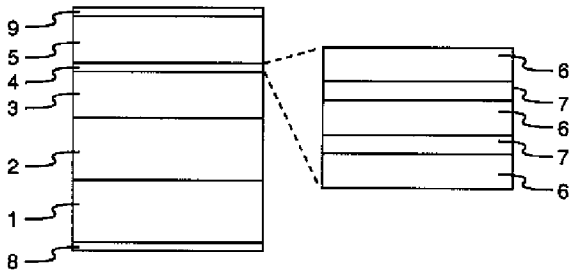
最終頁に続く

(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



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【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ＩｎxＧａyＡｌ1-x-yNzＡｓ1-z（０＜ｘ≦１、０＜ｙ≦１、０＜ｚ≦１）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。

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【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１ｈ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$In_{1-x}GaxN$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…$In_{0.2}G$

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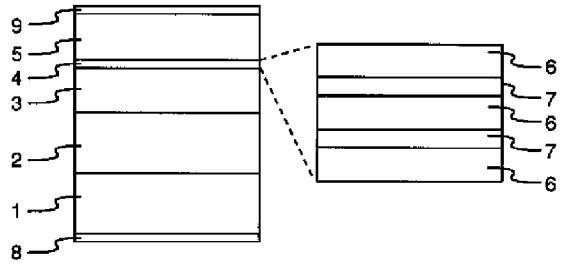
$a_{0.8}$ Ｎ井戸層、２１…アンドープ単一量子井戸活性層、２２…$GaN_{0.95}$ $As_{0.05}$ 井戸層、２３…$In_{0.2}$ ＊Ｇａ$_{0.6}$ Ａｌ$_{0.2}$ Ｎ障壁層、３１…サファイア基板。

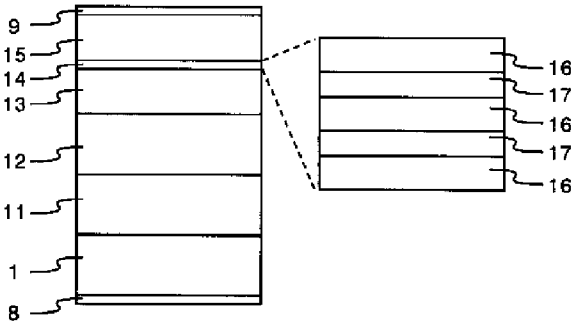
【図１】

図１



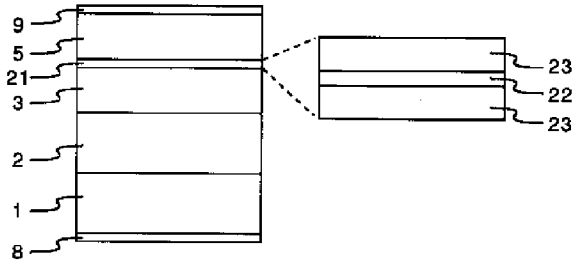
【図２】

図２



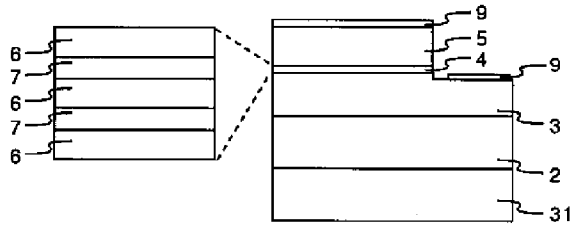
【図３】

図３



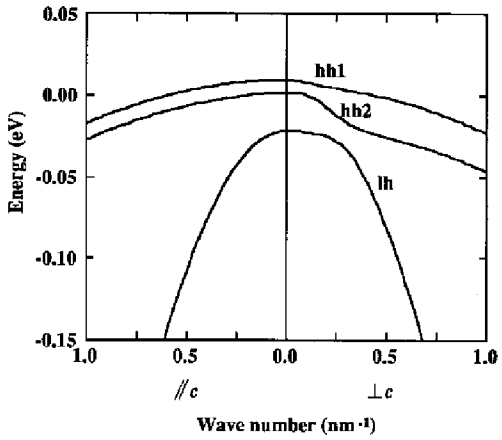
【図４】

図４



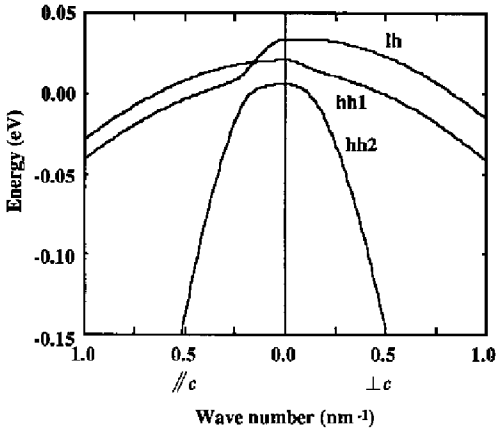
【図５】

図５



【図６】

図６



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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

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:

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

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Attachment(s):

- ☑ PTO/SB/08
- ☑ Document(s)
- ☐ Foreign Patent Office Communication
- ☐ Foreign Search Report
- ☐ Fee
- ☑ Other: **Two (2) U.S. Office Actions**

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.

DRA/CET

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 _____

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Enclosures: Verified English translation of JP 09-081010.

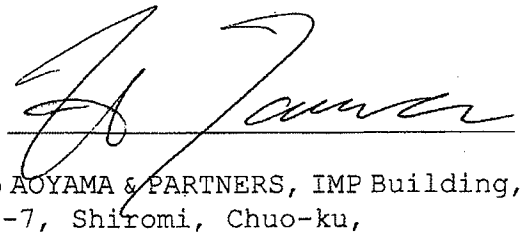
cet

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

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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

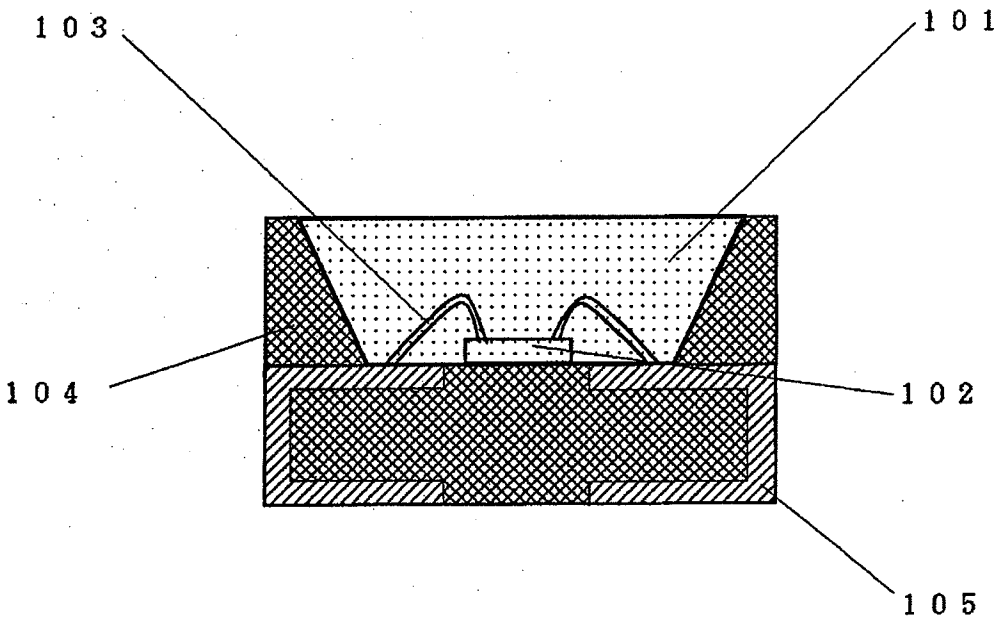
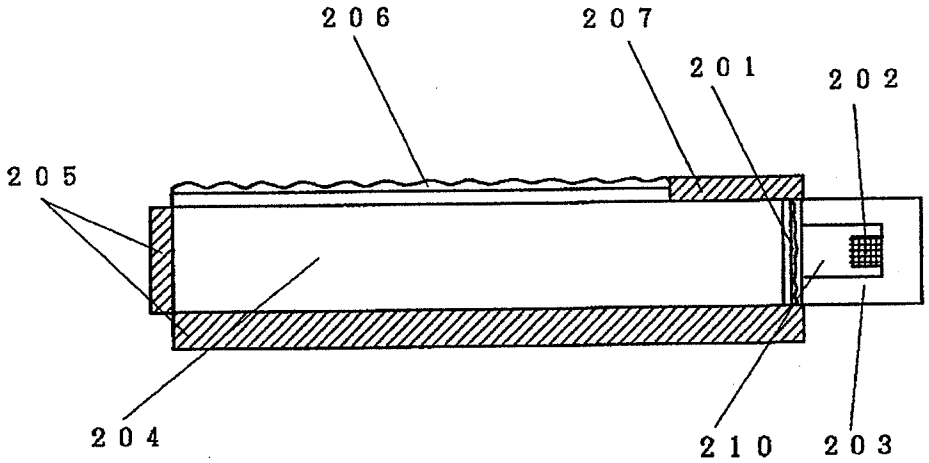
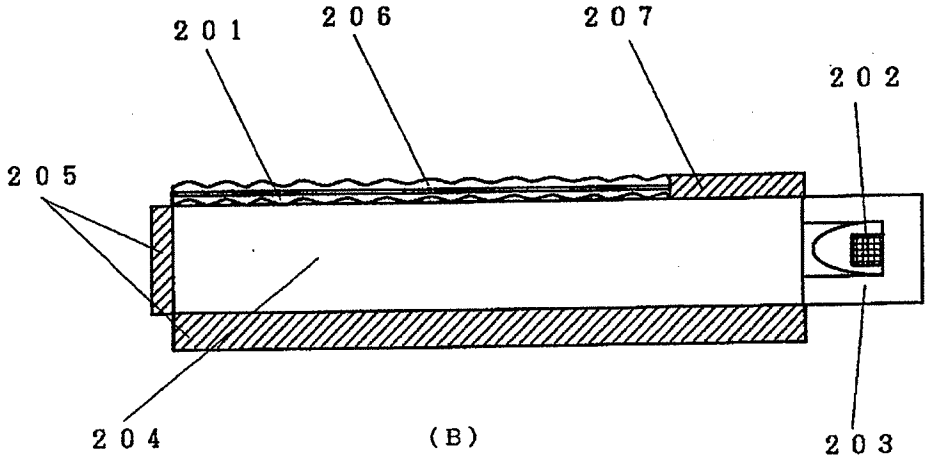


Fig. 2



(A)



(B)

Fig. 3

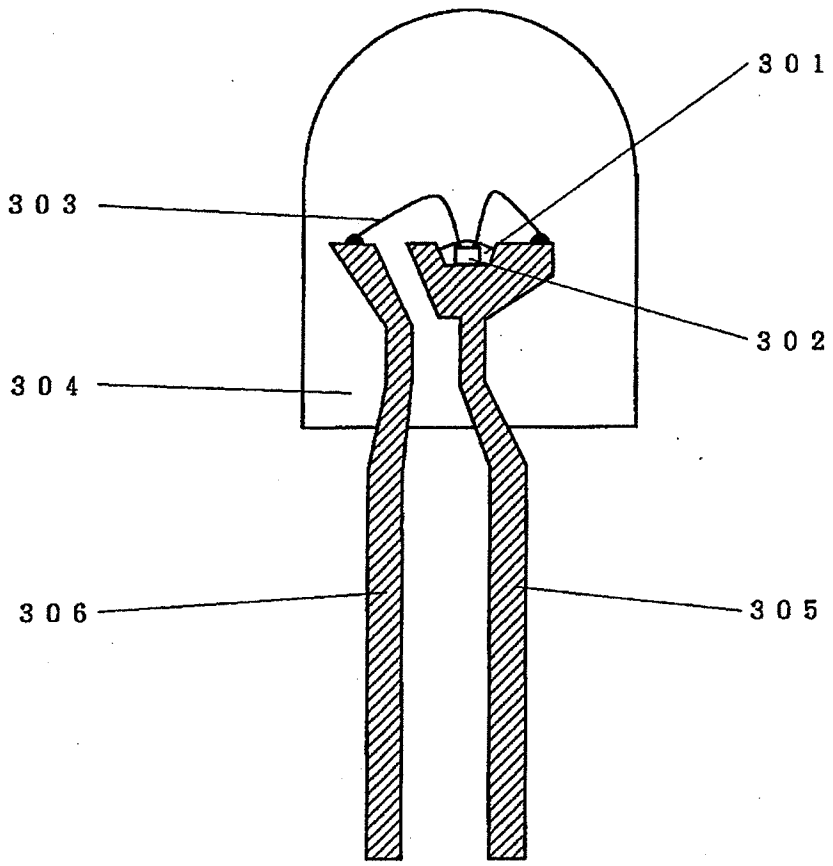
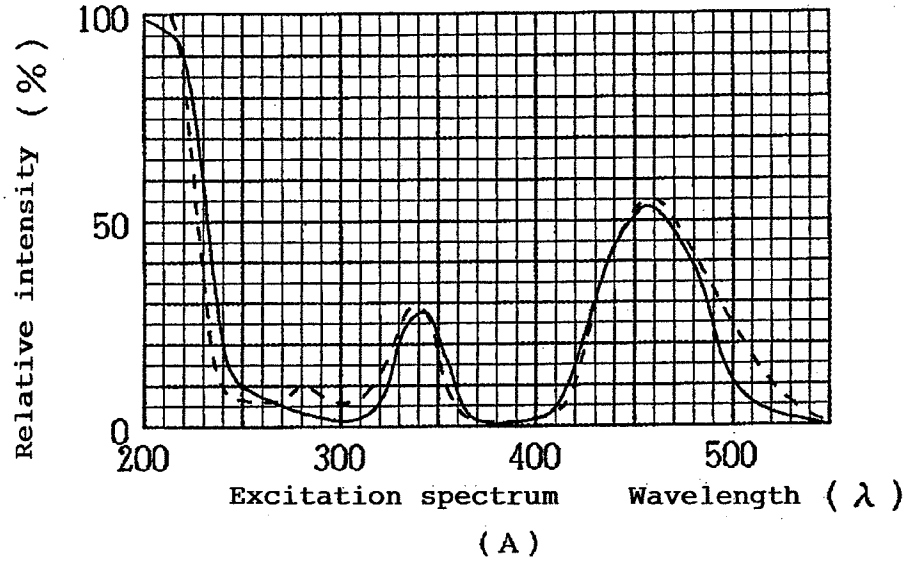
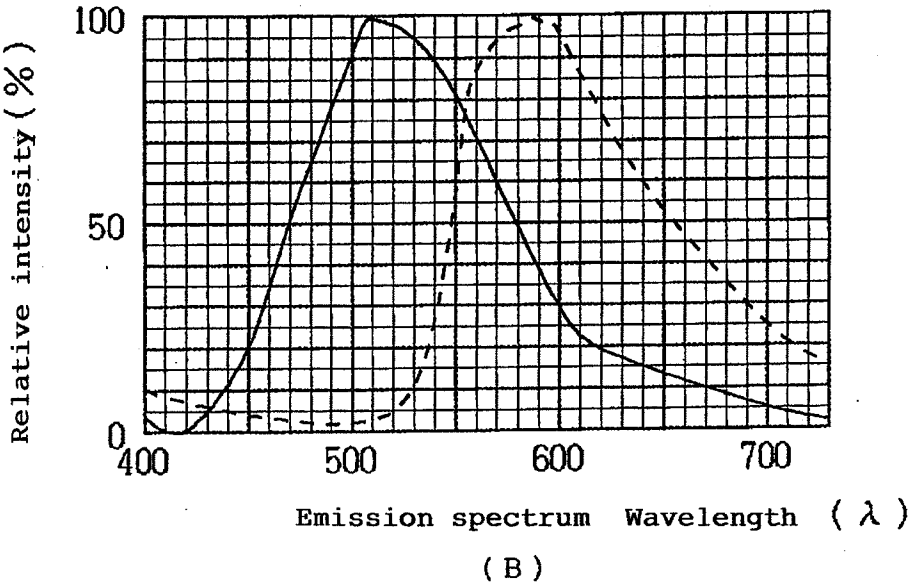


Fig. 4



(A)



(B)

Fig. 5

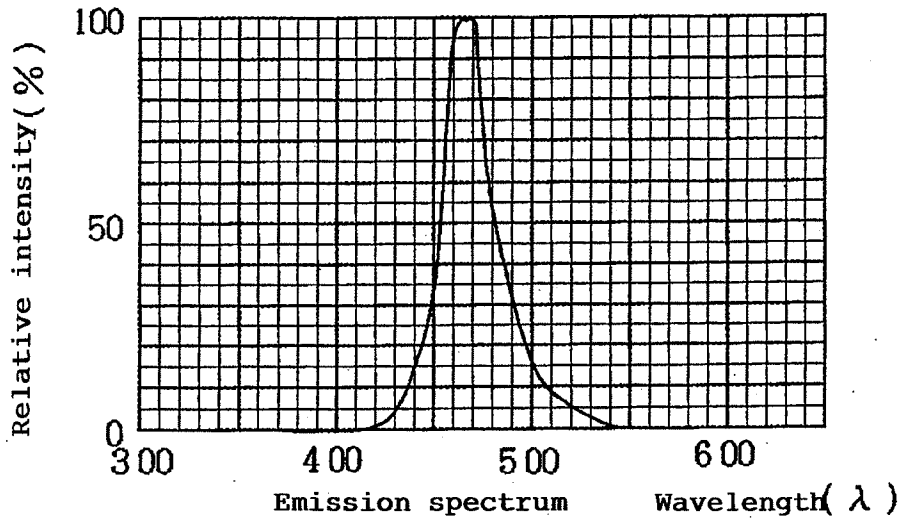
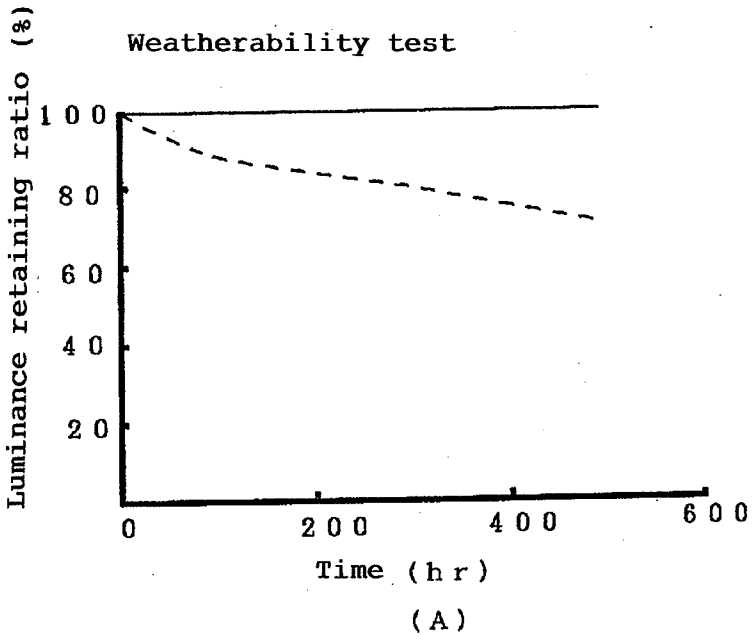


Fig. 6



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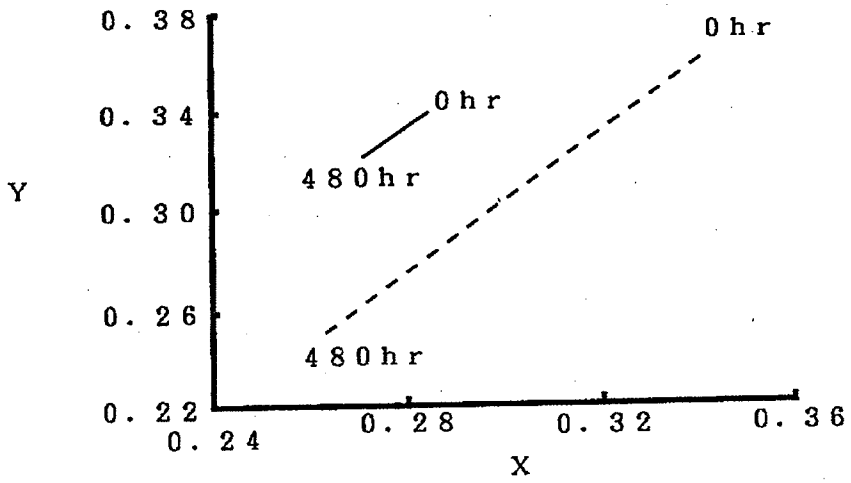


(B)

Fig. 7

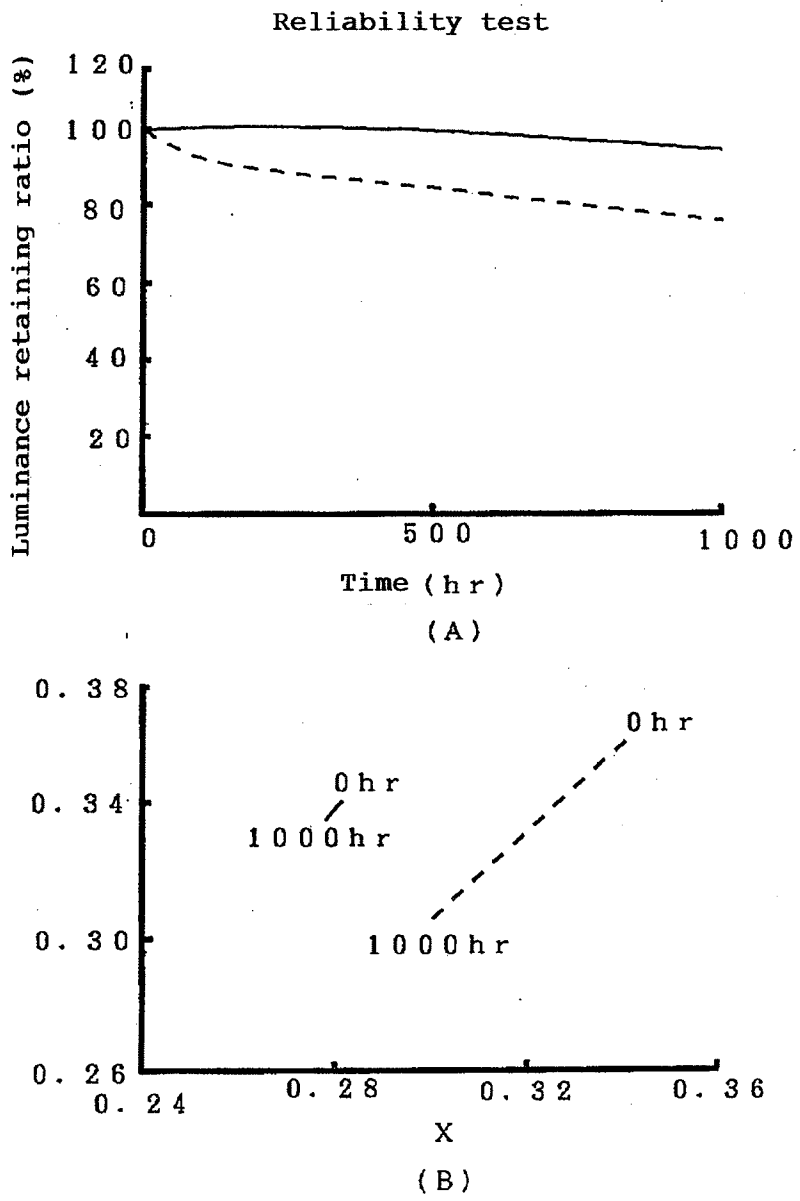
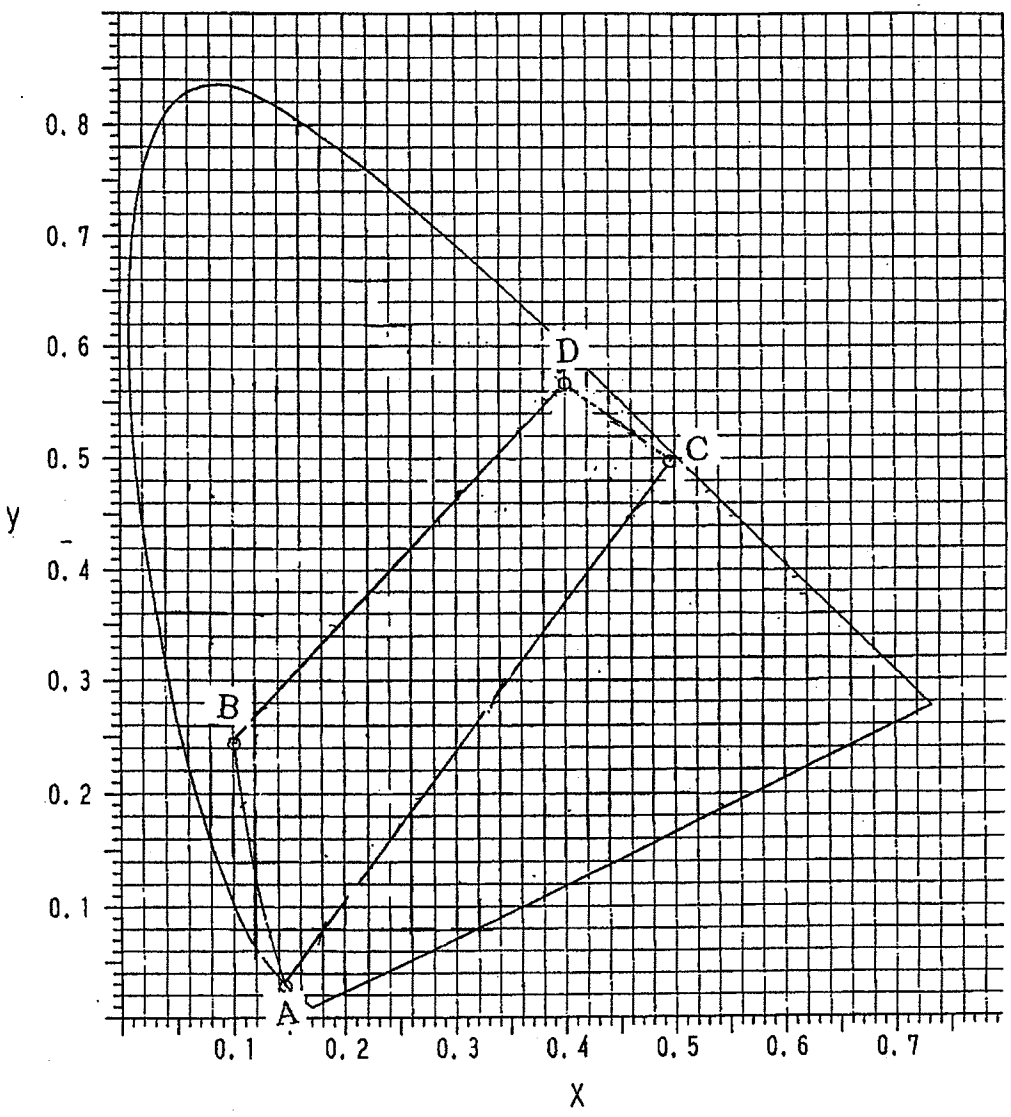


Fig. 8

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:

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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:					
2	Miscellaneous Incoming Letter	20120530VerifiedEnglishTranslationofJP09081010.pdf	1877581 01aa2aafa02b5f3d543e9cf39d23cf15e97079ba	no	59
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30135 e957083f64f421c1e3931ed7787a8f281180b22c	no	2
Warnings:					
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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/17 (09-11)
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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		
		Small Entity		Small Entity		Small Entity	
Application Type	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fee ($)	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 ($)		Fee Paid ($)
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 ($)	Fee Paid ($)

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): 1251 - 1 mo. EOT	150.00

SUBMITTED BY

Signature		Registration No. (Attorney/Agent) 40,439	Telephone 703-205-8000
Name (Print/Type)	D. Richard Anderson		Date May 30, 2012

This collection of information is required by 37 CFR 1.136. 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 30 minutes to complete, including gathering, preparing, and submitting the completed application form to 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, U.S. Department of Commerce, 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.**

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PTO/SB/22 (09-11)
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U.S. Patent and Trademark Office; U.S. DEPARMENT OF COMMERCE

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.

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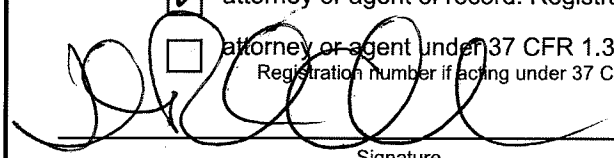
I am the

☐ 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.

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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

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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. _____

This collection of information is required by 37 CFR 1.311. 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 12 minutes to complete, including gathering, preparing, and submitting the completed application form to 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, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

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.	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.	Applicant(s)	
	12/942,792	SHIMIZU ET AL.	
	Examiner	Art Unit	
	ABDULFATTAH MUSTAPHA	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
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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.

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
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 2 of 12

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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

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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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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Sheet 3 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./	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.	
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/A.M./	AE2*	US-20100001258	01-07-2010	Shimizu et al.	

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/A.M./	BM	EP-0 500 937-A1	09-02-1992			
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/A.M./	BR	EP-0 383 215-A	08-22-1990			

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

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	AF2*	US-20090315015	12-24-2009	SHIMIZU et al.	
	AG2*	US-5,221,984	06-22-1993	Furuyama et al.	
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/A.M./	BS	DE-9013615-U	01-24-1991			
	BT	JP-59-30107-U	02-24-1984			
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	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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	BZ	JP-06-160635-A	06-07-1994			
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	BC1	JP-07-114904-A	05-02-1995			
	BD1	JP-07-235207-A	09-05-1995			
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	BI1	JP-60-185457	09-20-1985			
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	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			
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	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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Sheet 6 of 12

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Application Number	~~NEW~~ 12/942792
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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

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	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			
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	BH3	JP-06268257	09-22-1994			
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	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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Sheet	7	of	12

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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

NON PATENT LITERATURE DOCUMENTS

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

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Sheet 8 of 12

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First Named Inventor	Yoshinori SHIMIZU
Art Unit	~~N/A~~ 2812
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Examiner Signature	/Abdulfattah Mustapha/	Date Considered	07/02/2012

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Sheet 9 of 12

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Application Number	NEW 12/942792
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First Named Inventor	Yoshinori SHIMIZU
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	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.	
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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

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

*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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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 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

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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.	

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

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Approved for use through 07/31/2012. OMB 0651-0031
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet	12	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

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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	07/02/2012

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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.	Applicant(s)/Patent Under Reexamination
	12942792	SHIMIZU ET AL.
	Examiner	**Art Unit**
	ABDULFATTAH MUSTAPHA	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	06/14/2012	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	19	
/CHARLES GARBER/ Supervisory Patent Examiner.Art Unit 2812	06/18/2012	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	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
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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 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

* 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.

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 (1-800-786.9199) and select option 2.

VIZIO 1003

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)

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.

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.

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

PTO/SB/08b (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
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Substitute for form 1449B/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

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

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

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

BIB DATA SHEET

CONFIRMATION NO. 2357

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
12/942,792	11/09/2010	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
☑ Yes ☐ No	☑ Yes ☐ No	/ABDULFATTAH B MUSTAPHA/ Examiner's Signature	☐ 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

FILING FEE RECEIVED	FEES: Authority has been given in Paper	
1090	No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

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	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-3,560,849	02-02-1971	Anderson	

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.

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	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]
	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.

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:

2	Non Patent Literature	20120510NonfinalRejection.pdf	483853 e217f267002443e0a31af9c851620f4a54329d78	no	11

Warnings:

Information:

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.

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/17 (08-11)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

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

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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 ($)	Multiple Dependent Claims Fee Paid ($)
.....	.....

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 /D. Richard Anderson/	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,

Reg. No. 64042

By Corina Tanasa

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:

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

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Application Number	12/942,792
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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-5,247,533	09-21-1993	Okazaki et al.	
	2	US-5,408,120	04-18-1995	Manabe 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 7-335942	12-22-1995	Nichia Chem Ind Ltd.		☑
						☐
						☐
						☐
						☐
						☐

Examiner Signature		Date Considered	

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(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	Singaporean Examination and Search Report issued on July 2, 2012 in counterpart Singapore Patent Application No. 201007151-2.	☑
	5	Singaporean Examination and Search Report issued on July 5, 2012 in counterpart Singapore Patent Application No. 201007150-4.	☑
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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**

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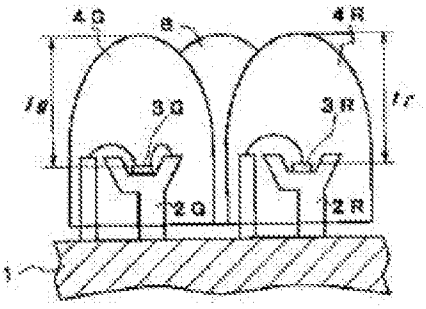
(54) FULL-COLOR LED DISPLAY

(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 100 μm thick and 350 μm 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.



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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.

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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.]

* NOTICES *

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

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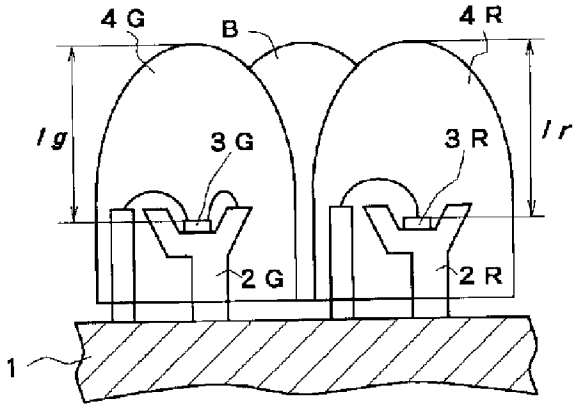
(54)【発明の名称】　フルカラーＬＥＤディスプレイ

(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

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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。

【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、ＧａＡＩＡｓ、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（ＩｎXAｌYGａ1-X-YN、0≦X、0≦Y、X+Y≦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ＧａＡＩＮ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ＧａＡＩＡｓ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ＧａＡＩＡｓ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は透明な工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、ＧａＡＩＮ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、同じく透明な工ポキシ樹脂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（Ｉｒ）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（Ｉｇ）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。

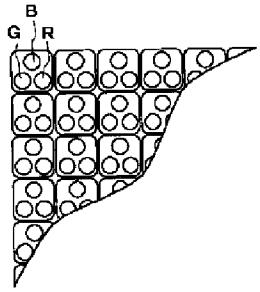
【図２】　図１のディスプレイの一画素の構造を示す模式断面図。

【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。

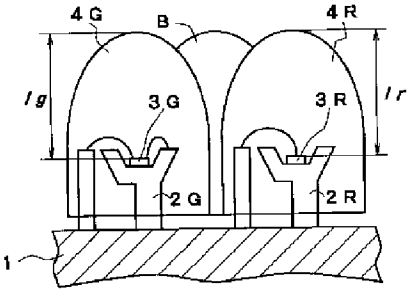
【符号の説明】

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

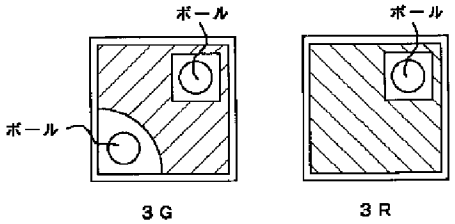
【図１】



【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

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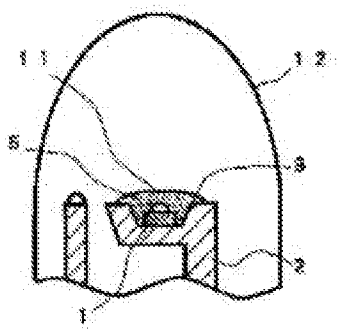
(54) LIGHT EMITTING DIODE

(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.



* NOTICES *

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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.]

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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.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

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

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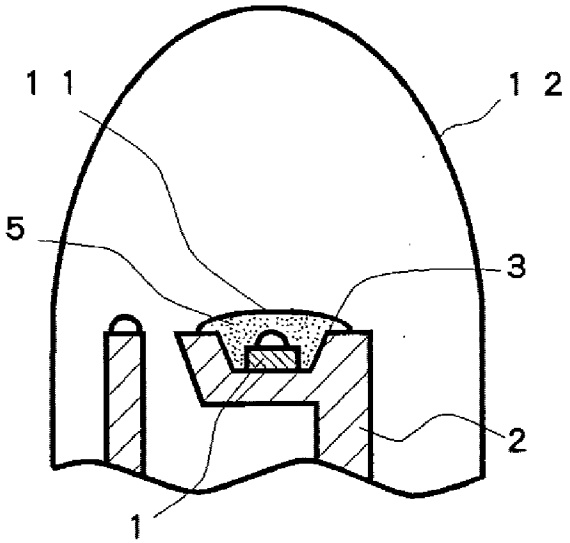
(54)【発明の名称】　発光ダイオード

(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。



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【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

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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、例えば両方とも工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。

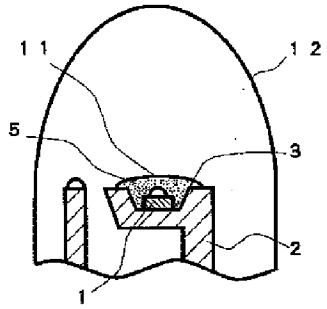
【図３】　本発明の他の実施例に係るＬＥＤのカップ３の部分を拡大して示す模式断面図。

【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。

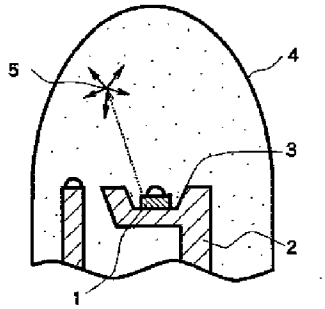
【符号の説明】

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

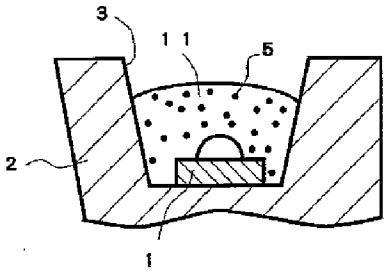
【図１】



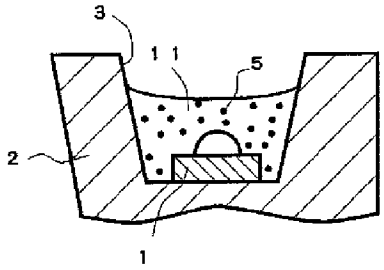
【図２】



【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	ＦＩ	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

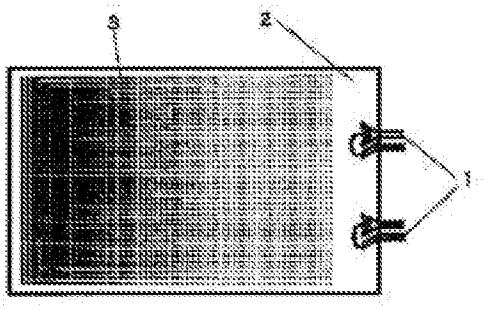
(51)Int.Cl. H01L 33/00
G09F 9/00

(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.



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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.]

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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.

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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

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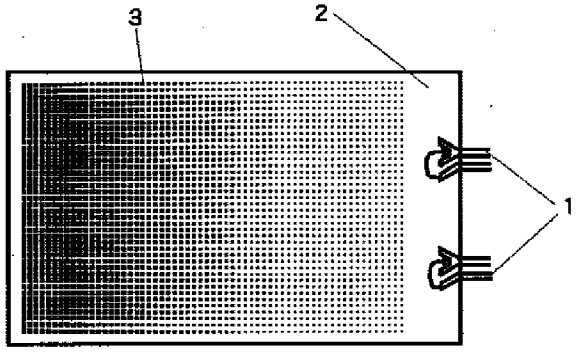
(54)【発明の名称】　面状光源

(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

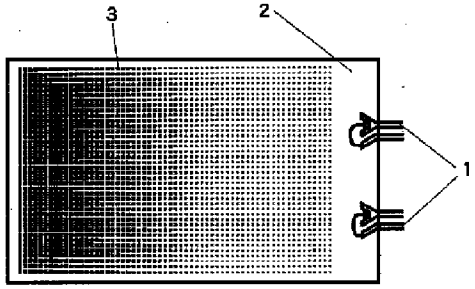
5

2・・・・・導光板
3・・・・・蛍光散乱層
4・・・・・反射層

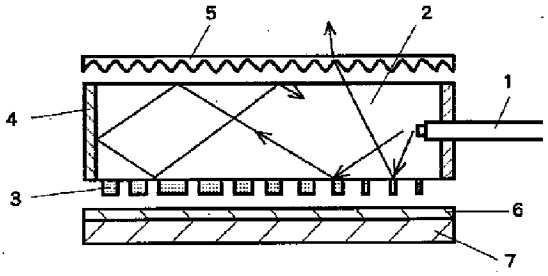
6

＊ 5・・・・・光拡散板
6・・・・・散乱反射層
＊ 7・・・・・ＡＩ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:				
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:	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
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)

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		20120808IDS.pdf	443359 81afc2ed7e15cc63aafc686e85af27558a013ed4	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:					
2	Foreign Reference	JP7335942.pdf	4167280 e6b0a788aceb9be939b6589012ea841896187e0a	no	11
Warnings:					
Information:					
3	Foreign Reference	JP7099345.pdf	3183622 a1bd8e4710ca48a4a2dfee2a92c61483d31b69bf	no	10
Warnings:					
Information:					
4	Foreign Reference	JP7176794.pdf	3820053 25b29adbd35b45886617abbc214cfac31a1af7b4	no	11
Warnings:					
Information:					
5	Non Patent Literature	SGSearchReportdated20120702.pdf	911518 1b085df251ebb0508859934ad038a61d0437b63d	no	13
Warnings:					
Information:					
6	Non Patent Literature	SGSearchReportdated20120705.pdf	714004 ad0e5dded079562712536b7360a5584242b40021	no	9
Warnings:					
Information:					

7	Fee Worksheet (SB06)	fee-info.pdf	30215 f6ede363d9c6eb93800a77ada3e7f1f225358015	no	2

Warnings:	
Information:	
Total Files Size (in bytes):	13270051

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/17 (09-11)
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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

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FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES

	FILING FEES		SEARCH FEES		EXAMINATION FEES		
		Small Entity		Small Entity		Small Entity	
Application Type	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fee ($)	Fee ($)	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 August 8, 2012

This collection of information is required by 37 CFR 1.136. 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 30 minutes to complete, including gathering, preparing, and submitting the completed application form to 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, U.S. Department of Commerce, 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.

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

12/548,614 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 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: August 8, 2012

Respectfully submitted,

Reg. No. 64042

By Corina Tanasa

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.

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.	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
08/09/2012	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

UNITED STATES DEPARTMENT OF COMMERCE
U.S. Patent and Trademark Office
Address : COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450

APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR / PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.
12/942,792	09 November, 2010	SHIMIZU ET AL.	0020-5147PUS12

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

EXAMINER	
ABDULFATTAH MUSTAPHA	
ART UNIT	PAPER
2812	20120801

DATE MAILED:

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner for Patents

The IDS of 07/23/2012 is considered.

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

PTO-90C (Rev.04-03)

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	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-3,560,849	02-02-1971	Anderson	

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	08/01/2012

* 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.

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
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Substitute for form 1449B/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

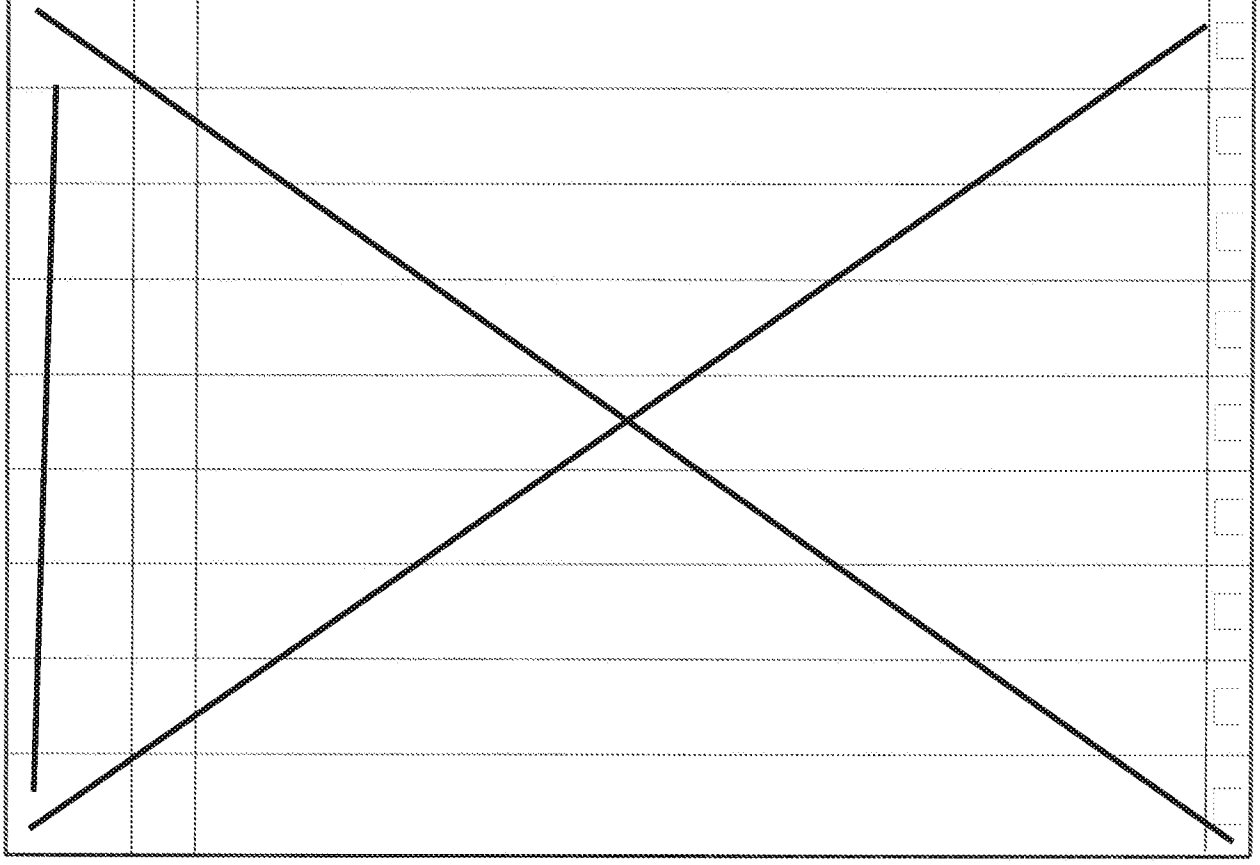
(Use as many sheets as necessary)

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

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	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-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

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

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

* 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.

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
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Attorney Docket Number	0020-5147PUS12

NON PATENT LITERATURE DOCUMENTS

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/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.	☑
			☐
			☐
			☐
			☐
			☐
			☐
			☐
			☐

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

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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.

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 assisstance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/SB/17 (09-11)
Approved for use through 01/31/2014. OMB 0651-0032
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 displays a valid OMB control number

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

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 ($)	Multiple Dependent Claims Fee Paid ($)

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

VIZIO 1003

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.

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

PTO/SB/08a (07-09)
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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 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

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
						☐
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						☐
						☐
						☐
						☐

Examiner Signature		Date Considered	

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U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Substitute for form 1449B/PTO

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(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]
	3	U.S. Office Action in co-pending application no. 12/689,681 dated September 7, 2012.	☐
			☐
			☐
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			☐

Examiner Signature		Date Considered	

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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.

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
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		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:

2	Non Patent Literature	20120907FinalRejection.pdf	651775 b850e066ac202b2cef5d9f6338f9bc44f65c94d1	no	12

Warnings:

Information:

3	Fee Worksheet (SB06)	fee-info.pdf	30282 3351edc7655c85b1d26762d18a31c60f7817eabb	no	2

Warnings:

Information:

Total Files Size (in bytes):	1113873

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

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/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.

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

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

This collection of information is required by 37 CFR 1.311. 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 12 minutes to complete, including gathering, preparing, and submitting the completed application form to 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, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

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		

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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.

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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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;

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**

AO 120 (Rev. 08/10)

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

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