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I, Aurora Landman, hereby certify that the document is a true and accurate translation from Japanese (JP) into English of Japanese Examined Patent Application Publication Number H05-152609.

I declare under penalty of perjury that the foregoing is true and correct. Executed on August 21, 2017.

Aurora Landman

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(22) Date of Application	November 25, Heisei 3 (1991)	(72) Inventor	Yoshiaki Tadatsu C/O Nichia Corporation 491-100 Oka, Kaminaka-cho, Kanan-shi, Tokushima
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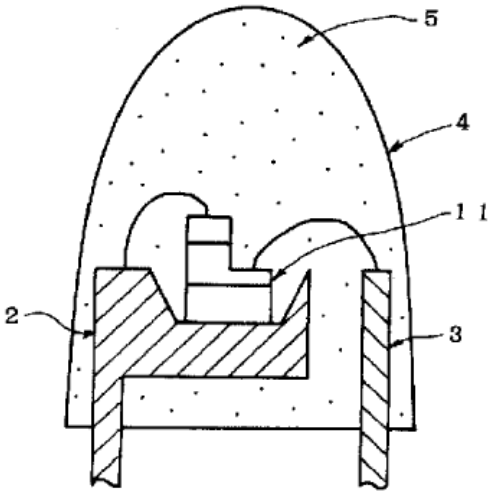
(54) [Title of the Invention] Light-emitting diode

(57) [Abstract]
[Purpose] To improve the luminosity and brightness of the light-emitting diode with the light-emitting elements composed of a gallium nitride based compound material whose light-emitting peaks are located at around 430nm and 370nm
[Constitution] It is a light-emitting diode which has light-emitting elements on its stem, which are surrounded by a resin mold, in which the aforementioned light-emitting elements are composed of a gallium nitride based compound semiconductor generally expressed by the formula, $Ga_XA1_{1-X}N$ (with $0 \leqq X \leqq 1$), and which is made by further adding to the aforementioned resin mold a fluorescent dye or a fluorescent pigment that emits a fluorescent light through excitation by the aforementioned gallium nitride based compound semiconductor's light emission.

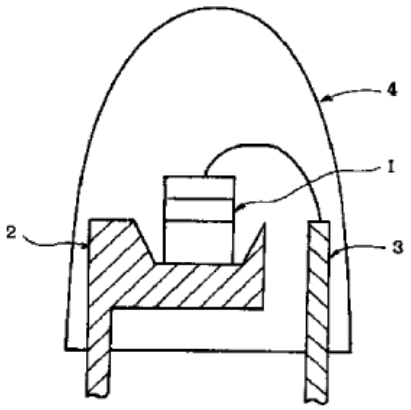


[Scope of Patent Claims]
[Claim 1] It is a light-emitting diode characterized by the fact that it has light-emitting elements on its stem, which is surrounded by a resin mold, in which the aforementioned light-emitting elements are composed of a gallium nitride based compound semiconductor generally expressed by the formula, $Ga_XA1_{1-x}N$ (with $0 \leqq X \leqq 1$), and which is made by further adding in the aforementioned resin mold a fluorescent dye or a fluorescent pigment that emits a fluorescent light through excitation by the aforementioned gallium nitride based compound semiconductor's light emission.
[Detailed description of the invention]
[0001]
[Field of industrial application] This invention is concerning a light-emitting diode made by surrounding the light-emitting elements with a resin mold (hereinafter referred to as light-emitting LED), especially to the wavelength conversion light-emitting diode with greater brightness, which can emit multiple types of lights, through one type of light-emitting element.
[0002]
[Prior Art] Generally an LED has a structure as shown in Figure 1. 1 shows the light-emitting element severed to smaller than 1mm square, for example, composed of GaA1As, and GaP, etc., 2 is the metal stem, 3 is the metal post, and 4 is the resin mold that surrounds the light-emitting element. The electrode on the back of the light emitting element 1 is electrically connected by being adhered to the Metal stem 2 by a silver paste, etc., and the electrode on the surface of the light emitting element 1 is wire bonded on its surface by the metal wire stretched from metal post 3, the other terminal, and furthermore, the light emitting element 1 is molded by the transparent resin mold 4.
[0003] While a resin with a high refractive index and high transparency is usually selected as resin mold 4 for the purpose of efficiently releasing the light-emitting element's light emission into the air, in some cases, an inorganic pigment or organic pigment may be mixed in the resin mold 4, as a coloring agent to convert the light-emitting element's luminance color, or to correct the color, other than that. For example, if a red pigment is added in the green light-emitting element's resin mold with a GaP semiconductor material, you can make the luminance color white.
[0004]
[Problem to be solved by the invention] However, traditionally, the technology to convert the wavelength by adding a coloring agent to the resin mold has rarely been made into practical use, and the technology to correct the color by a coloring agent is barely used. This is because when a coloring agent, which is a non-light-emitting substance strong enough to convert the wavelength, is added to the resin mold, the LED's brightness itself significantly decreases.
[0005] By the way, LEDs that has been put into practical use are infrared, red, yellow and green light-emitting LEDs, but blue or ultraviolet LEDs have not been made into practical use. The light-emitting elements that emit blue and ultraviolet lights have been studied using II-VI group ZnSe, and IV-IV group SiC, and III-V group GaN, etc. semiconductor materials and recently it was announced that a gallium nitride based compound generally expressed by the formula $Ga_XA1_{1-x}N$ (with $0 \leqq X \leqq 1$), shows a relatively excellent light emission at room temperature, which gathered attention. In addition, an LED that realized a pn connection for the first time using a gallium nitride based compound semiconductor was presented (Applied Physics, Volume 60, No.2, p163-p166, 1991). According to this, the light emission wavelength of the LED with a pn connection gallium nitride based compound is mainly located around 430nm, and furthermore, it has a light emission peak in the ultraviolet zone around 370nm as well. Its wavelength is the shortest among the aforementioned semiconductor materials. However, since the LED has a luminance color close to purple, as shown by its light-emission wavelength, its flaw is poor luminosity.
[0006] Such a situation is taken into consideration in this invention, and it aims to improve the luminosity of the LED with the light-emitting elements made of a gallium nitride based compound whose light emission peak is around 430nm and around 370nm, to improve its brightness.
[0007]
[Means for solving the problem] This invention is an LED characterized by having the light-emitting elements on the stem, which is surrounded by a resin mold in which the aforementioned light emitting elements are composed of a gallium nitride based compound semiconductor generally expressed by the formula $Ga_XA1_{1-x}N$ (with $0 \leqq X \leqq 1$), and furthermore, a fluorescent dye or a fluorescent pigment that emits a fluorescent light when excited by the light emission by the aforementioned gallium nitride based compound semiconductor.
[0008] Figure 2 is an example of embodiment that shows the structure of the LED in this invention. 11 shows the blue light emitting element made by laminating GaA1N in an n-type and p-type on a sapphire substrate, 2 and 3 the metal stem, metal post the same as Figure 1, and 4 is the resin mold that surrounds the light emitting elements. The back side of light emitting element 11 is a sapphire insulation substrate, and because the electrode cannot be taken out from the back side, and because the n electrode of the GaA1N layer is electrically connected to Metal stem 2, the method to electrically connect the ohmic electrode by etching the GaA1N layer to expose the n-type layer surface is applied. In addition, other electrodes are wire bonded on the p-type layer surface by the metal wire spread from Metal post 3 in the same manner shown in Figure 1. Furthermore, a fluorescent dye 5 that emits a wavelength that has a light emission peak at 480nm when excited by the wavelength at round 420-440nm, is added to Resin mold 4.
[0009]
[Effect of the Invention] A fluorescent dye and fluorescent pigment is generally excited by a short wavelength light, to emit light with a longer wavelength than the excitation wavelength. While there are fluorescent pigments that emit a short wavelength light when excited by the long wavelength light, on the contrary, they have extremely poor energy efficiency, hence, emit only a faint light. As described before, a gallium nitride based compound semiconductor has its light emission peak at the shortest wavelength side among the semiconductor materials used for LEDs, and in addition, has the light emission peak in the ultraviolet zone as well. Because of this, if it is used as the material for the light emitting element,

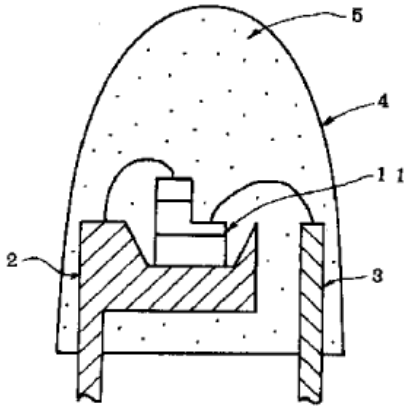
by adding a fluorescent dye or fluorescent pigment in the resin mold that surrounds the light emitting elements, these fluorescent substances can be excited in the most desirable manner. Therefore, various wavelength lights can be converted by the types of the fluorescent dye or fluorescent pigment, correcting the color of the blue LED. Furthermore, since the energy efficiency is good as the short wavelength light is converted to one with a long wavelength, and it is very convenient from the loss of brightness point of view, since it requires only a small amount of fluorescent dye or fluorescent pigment to be added.

[Brief Description of the Drawings]
[Figure 1] Schematic cross-section drawing that shows a traditional LED structure
[Figure 2] Schematic cross-section drawing that shows an example of embodiment of the LED in this invention
[Explanation of References]
11 … Light emitting element
2 … Metal stem
3 … Metal post
4 … Resin mold
5 … Fluorescent pigment

[Figure 1]



[Figure 2]



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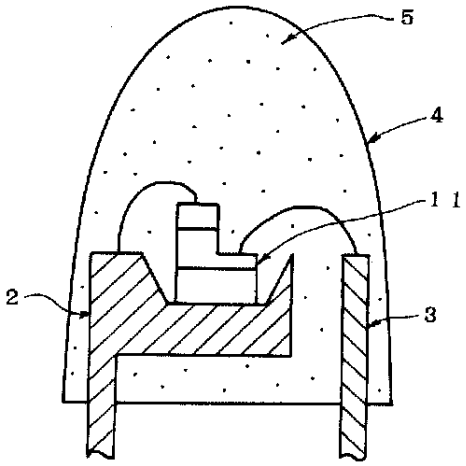
(54)【発明の名称】　発光ダイオード

(57)【要約】

【目的】　発光ピークが４３０ｎｍ付近、および３７０ｎｍ付近にある窒化ガリウム系化合物半導体材料よりなる発光素子を有する発光ダイオードの視感度を良くし、またその輝度を向上させる。

【構成】　ステム上に発光素子を有し、それを樹脂モールドで包囲してなる発光ダイオードにおいて、前記発光素子が、一般式$Ga_XAl_{1-X}N$（但し０≦Ｘ≦１である）で表される窒化ガリウム系化合物半導体よりなり、さらに前記樹脂モールド中に、前記窒化ガリウム系化合物半導体の発光により励起されて蛍光を発する蛍光染料、または蛍光顔料が添加されてなる発光ダイオード。



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