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

Aurora Landman

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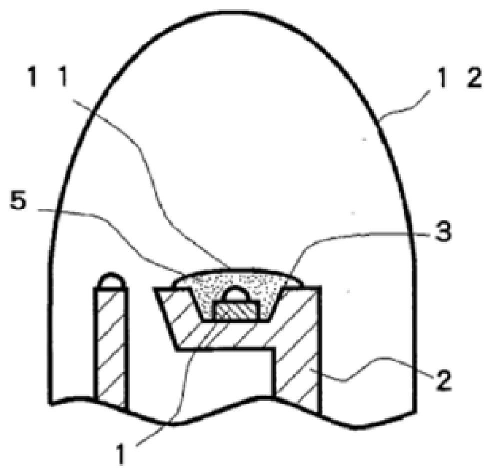
(54) [Title of the Invention] Light-emitting diode

(57) [Abstract]

[Purpose] To increase an LED's luminance by improving the capability to condense light emission when converting the light-emitting chip's wavelength by including a wave length conversion substance in an LED resin, and to provide an LED that does not have mixed color, even when an LED with a different wave length is installed in close proximity, when a fluorescent pigment is used.

[Constitution] The LED's sealing resins are composed of the first resin, 11, which fills the inside of Cup 3, and the 2nd resin, 12, which surrounds the 1st resin, and since the 1st resin, 11, contains a fluorescent substance which converts the light-emitting chip's emission wavelength to a different wavelength, or the wavelength conversion material 5, such as a filter material, etc. which absorbs some of the emission wavelengths, the resulting wavelength conversion light is reflected to Cup 3, so the luminance and condensing efficiency.



[Scope of Patent Claims]
[Claim 1] It is a light-emitting diode made by sealing the entire light-emitting element where the light-emitting chip is installed at the bottom of a cup with resins which reflect the luminance from the light-emitting chip on the light emission observing plane, and it is the light-emitting diode, characterized by the fact that the aforementioned resins are composed of the 1st resin that fills the aforementioned cup and the 2nd resin that surrounds the 1st resin, and that the aforementioned 1st resin contains a fluorescent substance that converts the light-emitting chip's emission wavelength to a different wave length, or employs a filter substance that absorbs some of the light-emitting chip's luminance wavelengths.
[Claim 2] It is the light-emitting diode described in Claim 1 which is characterized by the fact that the substance contained in the aforementioned 1st resin is a fluorescent substance, and that the aforementioned 1st resin is filled so that it will be lower than the level of the aforementioned cup's edge.
[Detailed Description of the Invention]
[0001]
[Field of Industrial Application] This invention concerns a light-emitting diode (hereinafter referred to as an LED), especially an LED that converts the light-emitting chip's emission wavelength or absorbs some of the light-emitting chip's emissions.
[0002]
[Prior Art] Figure 2 is a schematic cross-section view that shows the structure of a traditional LED. Number 1 indicates the light -emitting chip made of a chemical semiconductor, Number 2 is the lead frame, Number 3 is the cup installed to reflect the light-emitting chip's luminance on the light emission observing plate, and 4 is the resin that seals the entire light-emitting element. Usually, a resin with high transparency that efficiently releases the light-emitting chip's emissions into the air is selected for Resin 4, however, a fluorescent substance that converts the light-emitting chip's emission to a different wavelength, or a filter substance 5 that absorbs some of the emission wavelengths (hereinafter referred to as Wavelength Conversion Material 5) is mixed with the Resin 4 to convert the light-emitting chip's luminance color, or to correct the color. In such a case, the Wavelength Conversion Material 5 is usually mixed so that it is evenly dispersed in Resin 4.
[0003]
[Problem to Be Solved by the Invention] However, when the Wavelength Conversion Material 5 is evenly dispersed in Resin 4 for the aforementioned purpose, as shown in this diagram, there is a problem in that the light, whose wavelength is converted, or whose unnecessary wavelength is cut, is scattered in all directions, which deteriorates light condensation. The arrows in Figure 2 schematically show light from the light-emitting chip hitting the Wavelength Conversion Material 5 and wavelength-converted light being scattered. In other words, the quantity of light at the luminescence observation surface is reduced by the scattering of wavelength-converted light, thereby reducing brightness.
[0004] Moreover, if the Wavelength Conversion Material 5 is limited to the fluorescent substance, there is a new problem in that when a different luminance color LED is installed in close proximity, there is an unnecessary fluorescent substance light emission by another LED light emission. For example, if green luminance is obtained using a blue color light emitting chip, and a simple blue LED made of only a blue light-emitting chip are aligned in close proximity at the same
Horizontal level plane when the green LED is turned off and the blue LED is turned on, the green LED's fluorescent substance is excited by the light leaked from the blue LED, in short, by the scattered light, which leads to a condition as if the green LED were turned on, causing both LED color to mix.
[0005] Therefore, the purpose of this invention is to increase the LED brightness by first improving the converted light emission condensing when converting the light-emitting chip's wavelength by having the LED resin contain a wavelength conversion material, and the other purpose is to provide an LED that does not cause color mixing even if an LED with a different wavelength is installed in a close proximity, when using a fluorescent pigment.
[0006]
[Means for Solving the Problem] The LED in this invention is made by sealing the LED element with the resins, the entire light-emitting element wherein the light-emitting chip is installed at the bottom of a cup that reflects the light-emitting chip's emission onto a light-emission observing plane, characterized by the fact that the aforementioned resins are composed of the 1st resin that fills the aforementioned cup, and the 2nd resin that surrounds the 1st resin, and that the aforementioned 1st resin contains a fluorescent substance that converts the light-emitting chip's emission wavelength to a different wave length, or a filter substance that absorbs some of the light-emitting chip's luminance wavelengths.
[0007]
[Operation] The LED in this invention converts the light-emitting chip's emission, or absorbs some of the unnecessary wavelengths inside the 1st resin, to obtain the desired wavelength. The lights, whose wavelengths are converted as such scatter in all directions, however, most of the scattered light is reflected by the cup and condensed on the light emission observing plane. In short, because the cup in this application can reflect and condense the lights whose wavelengths are converted by the wavelength conversion material inside the 1st resin, the converted lights' condensing efficiency improves significantly.
[0008] Furthermore, when selecting a fluorescent substance as the wavelength conversion material, if the 1st resin containing a fluorescent substance is filled to a level that is lower than the level of the cup's edge, the lights entering from outside are blocked by the cup's edge and do not reach the fluorescent substance, hence the color mixing between LEDs can be prevented. Simply stated, by increasing the cup depth so that the 1st resin containing the fluorescent substance will not protrude from the cup, we control the fluorescent substance's excitation source by the light-emitting chip's emission length alone.
[0009]
[Examples of Embodiment] Figure 1 is a schematic cross-section drawing that indicates the structure of the LED in an example of embodiment of this application, in which the entire light-emitting element equipped with a light-emitting chip 1 composed of a chemical semiconductor on a Lead frame 2 with Cup 3 is sealed with resins in the same manner as in Figure 2. However, the difference from Figure 2 is that the sealing resins are composed of the 1st resin 11 that fills inside Cup 3, and the 2nd resin 12 that surrounds the 1st resin, and that the 1st resin 11 contains a

absorbs some of them.

[0010] In this LED invention, the material for the 1st resin 11 and the 2nd resin can be the same. For example, we can compose both of epoxy resin, and make only the 1st resin contain a florescent substance 5. Moreover, it is sufficient to say that the material for the 2nd resin 12 can be the same as Resin 4 in Figure 2. In addition, as long as it is a fluorescent substance, any material that can convert the light-emitting chip's emission wavelength to a different wavelength, such as a fluorescent dye, a fluorescent pigment or a phosphorous element, etc. can be used as wavelength conversion material 5, and if it is a filter material, a material that absorbs the unnecessary wavelengths of the light-emitting chip's emission to improve the color purity is selected, hence, an inorganic or organic filter pigment which has the same color as the light-emitting chip's emission color is usually used.

[0011] In order to obtain an LED with such a structure, for example, we pre-dip the inside of the cup equipped with the light-emitting chip 1 with a resin in advance, during the LED manufacturing process. When pre-dipping, if the 1st resin 11 contains wavelength conversion material 5, we can obtain the LED by sealing with the 2nd resin 12, when the 1st resin 11 containing wavelength conversion material 5 is hardened. In addition, we can also inject the 1st resin 11 containing wavelength conversion material 5 inside Cup 3 in advance. The LED's light condensing significantly improves by filling the 1st resin containing wavelength conversion material 5 inside Cup 3, hence causing most of the light, whose wavelengths are converted by the 1st resin 11, to return inside the reflecting mirror of Cup 3, and be reflected on the light emission observing plane.

[0012] In addition, by making the 1st resin 11 and the 2nd resin 12 with different materials, and by setting the refractive indexes of 1st resin 11 and 2nd resin 12 successively smaller so that it will be closer to the refractive index of the air, the external quantum efficiency of the lights whose wavelengths are converted increases. Needless to say, in such case, a material with a smaller refraction index than the light-emitting chip 1 is selected for the 1st resin 11 material.

[0013] Figure 3 and Figure 4 are schematic cross-section diagrams which indicate the enlarged Cup 3 of the LED concerning other examples of embodiment of this invention. Figure 3 shows the condition wherein the 1st resin 11's surface is convex and hardened and filled inside Cup 3, and Figure 4 shows it in a concave condition, hardened and filled. In any condition, if a fluorescent substance is used as wavelength conversion material 5, the 1st resin 11 containing that fluorescent substance is filled so that it will be lower than the level of the edge of Cup 3, hence it does not protrude from Cup 3, therefore, the external light that excites the fluorescent substance can be blocked by the edge of Cup 3, thus the LED color mixing can be prevented.

[0014]

[Effect of the Invention] As explained above, the LED in this invention has the cup filled inside with 1st resin containing a wavelength conversion material, hence the converted lights are reflected inside the cup and are condensed, thus improving the brightness by more than double. In addition, when containing a fluorescent pigment in the 1st resin to convert the wavelength, by increasing the cup depth so that the 1st resin will not protrude from the cup, we can prevent color mixing between LEDs, and when we can realize a flat display by LED, for example, we will be able to obtain images with extremely good resolution.

[Brief Description of the Drawings]

[Figure 1] Schematic cross-section drawing that shows a LED structure in this invention

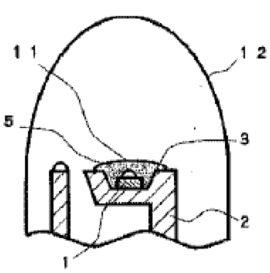
[Figure 2] Schematic cross-section drawing that shows a traditional LED structure

[Figure 3] Schematic cross-section drawing that shows the enlarged Cup 3 area of the LED concerning other examples of embodiment of this invention

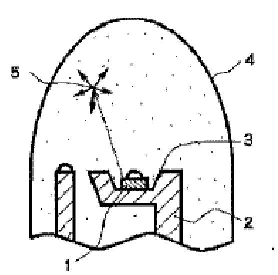
[Explanation of References]

1 … Light-emitting chip	2 … Lead frame
3 …Cup	5 … Wavelength conversion material
11 … 1st resin	12 … 2nd resin

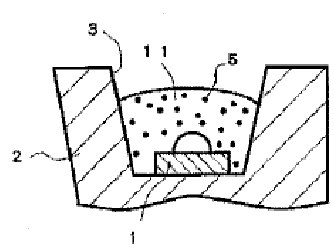
[Figure 1]



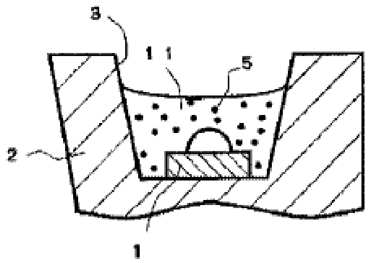
[Figure 2]



[Figure 3]



[Figure 4]



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