

Description

Title of Invention: LAMP COVER AND LED LAMP USING THE SAME

Technical Field

- [1] The present invention relates to a lamp cover and a light emitting diode (LED) lamp using the lamp cover, and more particularly, to a lamp cover including a phosphor material therein and a LED lamp in which the lamp cover is mounted.

Background Art

- [2] Various types of light emitting diode (LED) devices that emit various colors of light have been currently developed. Also, various methods of manufacturing illuminating lamps providing white light by using the LED devices have been suggested. For example, white light is formed usually by using a luminescent material such as a phosphor material. For example, an example of the phosphor material may be a phosphor material that partially absorbs at least a portion of blue light emitted from a LED device to emit yellow or greenish yellow light.
- [3] A general white LED package based on a phosphor material is formed such that the phosphor material is mixed with a silicone resin encapsulation material, and the mixture is directly coated on a LED chip or is put into a cup and a LED chip is covered with the cup. However, according to the conventional art, a portion of light emitted from the phosphor material proceeds backward to the LED chip to be absorbed by the LED chip, and thus large light loss occurs. Due to this light loss, a white LED lamp based on a phosphor material according to the conventional art has a relatively low correlated color temperature (CCT). Accordingly, the efficiency of the white LED lamp based on a phosphor material may decrease in warm white or neutral white color ranges.
- [4] In order to reduce the high light loss in the white LED lamp based on a phosphor material of the conventional art, it has been suggested to have a distance between a LED chip and a phosphor layer. For example, U.S. Patent No. 5,959,316 and U. S. Patent No. 6,858,456 disclose a method in which a transparent spacer such as a silicone resin is disposed between a LED chip and a phosphor layer to reduce the probability that light emitted from the phosphor layer is absorbed by the LED chip or other substrates nearby. However, this still does not effectively prevent that a portion of light emitted from the phosphor material proceeds backward because refractive indices of the phosphor layer and the transparent spacer are almost the same. That is, light emitted from the phosphor material may not be diffused or refracted on an interface between the phosphor layer and the transparent spacer but proceed to the

LED chip with almost no disturbance.

Disclosure of Invention

Technical Problem

- [5] Embodiments of the present invention seek to provide a lamp cover capable of effectively preventing light loss and a light emitting diode (LED) lamp using the lamp cover.

Solution to Problem

- [6] According to an aspect of the present invention, there is provided a lamp cover comprising: a first lamp cap having a curved surface; a second lamp cap that is fitted to the first lamp cap at a distance from the first lamp cap and has a curved surface; and a wavelength-conversion layer filled between the first lamp cap and the second lamp cap.
- [7] The first lamp cap and the second lamp cap may comprise a transparent material.
- [8] The transparent material may comprise at least one selected from the group consisting of glass, poly(methyl methacrylate) (PMMA), polycarbonate, and silicone resin.
- [9] The first lamp cap and the second lamp cap may have a concave inner surface and a convex outer surface, respectively, and the wavelength-conversion layer is filled between the concave inner surface of the first lamp cap and the convex outer surface of the second lamp cap.
- [10] The first lamp cap and the second lamp cap may have semi-spherical shell shapes.
- [11] A distance between the first lamp cap and the second lamp cap may be uniform so that the wavelength-conversion layer has a uniform thickness.
- [12] The inner surface of the second lamp cap may comprise a plurality of facets having a plurality of different curvatures or a plurality of different normal vector planes.
- [13] The first lamp cap and the second lamp cap may comprise a first support portion and a second support portion, respectively, and the first and second support portions are attached to each other in order to fit the first lamp cap and the second lamp cap to each other.
- [14] The wavelength-conversion layer may comprise a silicone resin material mixed with a luminescent material.
- [15] The luminescent material may be a phosphor material that emits visible light by being excited by UV light, blue light, or green light.
- [16] The phosphor material may comprise at least one phosphor material that emits visible light of various wavelengths by being excited by UV light, blue light, or green light.
- [17] According to another aspect of the present invention, there is provided a LED lamp comprising the above-described lamp cover.
- [18] The LED lamp may further comprise: a substrate; and at least one LED package

mounted on the substrate, wherein the lamp cover is disposed on the substrate to surround the LED package.

- [19] The substrate may comprise a printed circuit board (PCB).
- [20] The at least one LED package may comprise at least one selected from the group consisting of a UV LED, a blue LED, and a green LED.
- [21] A ratio of a surface area of the inner surface of the second lamp cap to a surface area of the LED package may be greater than 2.
- [22] A distance between the LED package and the inner surface of the second lamp cap may be greater than 3 mm.
- [23] A space may exist between the LED package and the inner surface of the second lamp cap.
- [24] The first lamp cap has an outer surface area of at least 300 mm² per watt of an incident light from the LED package.
- [25] The inner surface of the second lamp cap may comprise a plurality of facets having a plurality of different curvatures or a plurality of different normal vector planes so that light reflected from a point on the concave inner surface of the second lamp is incident to another point on the inner surface of the second lamp cap.
- [26] The plurality of the normal vector planes converge toward the LED package.
- [27] According to another aspect of the present invention, there is provided a method of fabricating the lamp cover comprising preparing the first and second lamp caps by using injection molding; providing a silicone resin material mixed with a luminescent material onto a concave inner surface of the first lamp cap; fitting the first and second lamp caps to each other such that the concave inner surface of the first lamp cap faces a convex outer surface of the second lamp cap; and solidifying the silicone resin material mixed with a luminescent material by heating or UV irradiation to form the wavelength-conversion layer.
- [28] According to still another aspect of the present invention, there is provided a method of fabricating the lamp cover comprising preparing the first and second lamp caps by using injection molding; fitting the first and second lamp caps to each other such that a concave inner surface of the first lamp cap faces a convex outer surface of the second lamp cap; providing a silicone resin material mixed with a luminescent material into a space between the first and second lamp caps until it completely fills the space; and solidifying the silicone resin material mixed with a luminescent material by heating or UV irradiation to form the wavelength-conversion layer.

Brief Description of Drawings

- [29] The above and other features and advantages of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference

to the attached drawings in which:

- [30] FIG. 1 is a cross-sectional view illustrating a lamp cover of a light emitting diode (LED) lamp, according to an embodiment of the present invention;
- [31] FIGS. 2 through 5 are cross-sectional views illustrating a method of assembling the lamp cover of the LED lamp illustrated in FIG. 1, according to an embodiment of the present invention; and
- [32] fig. 6 is a cross-sectional view illustrating a LED lamp using the lamp cover of FIG. 1, according to an embodiment of the present invention.

Best Mode for Carrying out the Invention

- [33] The present invention will now be described more fully with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. Like reference numerals in the drawings denote like elements, and sizes of elements may be exaggerated for convenience and clarity of description.
- [34] FIG. 1 is a cross-sectional view illustrating a lamp cover 10 of a light emitting diode (LED) lamp, according to an embodiment of the present invention. Referring to FIG. 1, the lamp cover 10 includes a first lamp cap 1 having a convex outer surface, a second lamp cap 2 that is fitted to the first lamp cap 1 at a predetermined distance from the first lamp cap 1 and has a convex internal surface, and a wavelength-conversion layer 3 filled between the first lamp cap 1 and the second lamp cap 2.
- [35] The first lamp cap 1 and the second lamp cap 2 have a concave-convex structure as illustrated in FIG. 1. That is, the first lamp cap 1 and the second lamp cap 2 each have a convex outer surface and a concave internal surface. For example, the first lamp cap 1 and the second lamp cap 2 may have semi-spherical shell shapes. However, bottom surfaces of the first lamp cap 1 and the second lamp cap 2 may have other forms. For example, the bottom surfaces of the first lamp cap 1 and the second lamp cap 2 may be rectangular or square, and in this case, the first lamp cap 1 and the second lamp cap 2 may be square shells or cylinders. Also, in order that the wavelength-conversion layer 3 filled between the first lamp cap 1 and the second lamp cap 2 has a predetermined thickness, a distance between the first lamp cap 1 and the second lamp cap 2 may be uniform.
- [36] The first lamp cap 1 and the second lamp cap 2 may be formed of transparent material. The transparent material of the first lamp cap 1 and the second lamp cap 2 may be at least one selected from the group consisting of glass, poly(methyl methacrylate) (PMMA), polycarbonate and a silicone resin. Meanwhile, as illustrated in FIG. 1, the wavelength-conversion layer 3 may be filled between the concave inner surface of the first lamp cap 1 and the convex outer surface of the second lamp cap 2. As the wavelength-conversion layer 3 is filled between the first lamp cap 1 and the

second lamp cap 2, the geometrical form of the wavelength-conversion layer 3 is determined by the forms of the first and second lamp caps 1 and 2.

[37] The wavelength-conversion layer 3 may be formed of a luminescent material for converting a wavelength. For example, the wavelength-conversion layer 3 may be formed of a mixture material that is formed by mixing a luminescent material for converting a wavelength and a silicone resin material. In particular, the luminescent material may be a phosphor material that emits visible light by being excited by UV light, blue light, or green light. For example, the luminescent material in the wavelength-conversion layer 3 may be one selected from the group consisting of various phosphor materials that respectively emit visible light of various wavelengths, such as blue, green, yellow, and red. The green, yellow, orange, and red phosphor materials may emit light spectrums having peak wavelengths in green, yellow, orange, and red color ranges by at least partially absorbing blue light or green light or completely absorbing UV light. Also, the blue phosphor material may emit a light spectrum having a peak wavelength in a blue range by completely absorbing UV light.

[38] When the lamp cover 10 is used to cover a LED device that emits light having an excitation wavelength with respect to a luminescent material, fluorescent light emitted by the luminescent material may be mixed with residual excitation light emitted from the LED device to thereby form white light. For example, when the LED device emits blue light in a wavelength range of 450 nm to 480 nm, the luminescent material may emit light having a yellow peak wavelength by being excited by blue light. Then as yellow light and residual blue light are mixed, white light is formed. The luminescent material may include various phosphor materials emitting light of various wavelengths by being excited by light having an excitation wavelength emitted from the LED device. In this case, the light of various wavelengths may be mixed, thereby forming white light. For example, when the LED device emits near-UV rays in a range of 380 nm to 450 nm, the luminescent material may include blue, green, and red phosphor materials that emit light having blue, green, and red peak wavelengths by being excited by the near-UV rays. Then, as the blue, green, and red lights are mixed, white light may be formed.

[39] FIGS. 2 through 5 are cross-sectional views illustrating a method of assembling the lamp cover 10 illustrated in FIG. 1, according to an embodiment of the present invention. First, referring to fig. 2, the first lamp cap 1 having a concave inner surface and a convex outer surface is provided. As described above, the first lamp cap 1 is formed of a transparent material and may have various geometric shapes according to embodiments of the present invention. Referring to fig. 2, a first support portion 1a for fitting the first lamp cap 1 to the second lamp cap 2 is formed at a portion of ends of the first lamp cap 1.

[40] Next, referring to fig. 3, for example, a mixture material 3' of a liquid luminescent

material and a silicone resin is dispensed into a concave inner portion of the first lamp cap 1. An amount of the mixture material 3' is approximately the same as a volume of a space between the first and second lamp caps 1 and 2 when the first and second lamp caps 1 and 2 are fitted to each other.

[41] Next, referring to fig. 4, the second lamp cap 2 is disposed above the concave inner portion the first lamp cap 1 containing the mixture material 3'. As illustrated in fig. 4, a second support portion 2a for fitting the second lamp cap 2 to the first lamp cap 1 is also formed at ends of the second lamp cap 2. Accordingly, as the first support portion 1a of the first lamp cap 1 and the second support portion 2a of the second lamp cap 2 are fitted to each other, the first and second lamp caps 1 and 2 may be fitted with each other. An adhesive may be further interposed between the first and second support portions 1a and 2a. After fitting the second lamp cap 2 to the first lamp cap 1, the mixture material 3' may be solidified by using heat or UV irradiation as illustrated in fig. 5, thereby forming the wavelength-conversion layer 3 between the first and second lamp caps 1 and 2.

[42] Alternatively, after fitting the second lamp cap 2 to the first lamp cap 1, the mixture material 3' may be filled in the space between the first and second lamp caps 1 and 2 and then solidified by using heat or UV irradiation.

[43] In the lamp cover 10 for a LED lamp, as described above, a distance between the first lamp cap 1 and the second lamp cap 2 may be uniform, and thus the thickness of the wavelength-conversion layer 3 filled therebetween is also uniform. Also, the thickness and shape of the wavelength-conversion layer 3 may be adjusted as desired by providing the first lamp cap 1 and the second lamp cap 2 having desired forms. As a result, the LED lamp using the lamp cover 10 may maintain a uniform color correlated temperature (CCT), thereby achieving a high manufacture yield. Also, as the phosphor material is disposed between the first lamp cap 1 and the second lamp cap 2, physical or chemical change to the phosphor material may be prevented. Accordingly, the life span of the LED lamp may be increased.

[44] fig. 6 is a cross-sectional view illustrating a LED lamp 20 including the lamp cover 10 of FIG. 1, according to an embodiment of the present invention. Referring to fig. 6, the LED lamp 20 may include a substrate 11, a LED package 12 mounted on the substrate 11, and the lamp cover 10 disposed on the substrate 11 to surround the LED package 12. In fig. 6, the LED lamp 20 includes one LED package 12; however the present invention is not limited thereto, and the LED package 12 may include more than one LED package 12. A space 15 exists between the LED package 12 and the lamp cover 10, that is, between the LED package 12 and an inner surface 2i of the second lamp cap 2.

[45] The substrate 11 may be, for example, a printed circuit board (PCB). The LED

package 12 may include at least one selected from the group consisting of a UV LED, a blue LED, and a green LED in order to excite a luminescent material in the lamp cover 10. Also, the luminescent material in the wavelength-conversion layer 3 of the lamp cover 10 may include at least one phosphor material that emits light of various wavelengths by being excited by UV light, blue light, or green light. For example, as described above, the phosphor material may be at least one phosphor selected from the group consisting of blue, green, yellow, orange, and red phosphors.

[46] According to the current embodiment of the present invention, it is essential to prevent light emitted from the wavelength-conversion layer 3 of the lamp cover 10 from being incident to the LED package 12, in order to improve light output and efficiency of the LED lamp 20. To this end, the lamp cover 10 may be formed such that light emitted from a point on the inner surface 2i of the second lamp cap 2 is incident to another point on the inner surface 2i of the second lamp cap 2 of the lamp cover 10 immediately after the light is emitted. That is, the lamp cover 10 may be formed such that light that is refracted on an interface between the second lamp cap 2 and the space 15 proceeds to the inner surface 2i of the second lamp cap 2 again.

[47] One of the parameters for achieving this goal is a distance D between the LED package 12 and the lamp cover 10. The greater the distance D, the higher a ratio of a surface area of the inner surface 2i of the second lamp cap 2 to a surface area of the LED package 12. The increase in the ratio of the surface areas reduces a solid angle at a point on the inner surface 2i with respect to the LED package 12, and thus a probability that light emitted from the lamp cover 10 is incident to the LED package 12 is reduced. This concept may be easily understood by one of ordinary skill in the art in that an object looks smaller as an observation point becomes farther from the object.

[48] Also, the greater the distance D, a probability that light emitted from a point on the inner surface 2i of the second lamp cap 2 is incident to another point on the inner surface 2i of the second lamp cap 2 is increased. In order to further increase the probability, the inner surface 2i of the second lamp cap 2 may have a plurality of different curvatures or a plurality of different normal vector planes. That is, although not shown in fig. 6, the inner surface 2i may have a plurality of facets having different curvatures or different normal vector planes. The normal vector planes of the inner surface 2i may be disposed to converge toward the LED package 12. Then, as illustrated in fig. 6, light reflected from a point E on the inner surface 2i proceeds along various light paths P1 and P2 and is directly incident to other points C1 and C2 on the inner surface 2i instead of being incident to the LED package 12. Then without loss, the light may be emitted to the outside the LED lamp 20. Accordingly, according to the present embodiment of the present invention, light absorption loss due to the LED package 12 may be reduced, and consequently, light output of the LED lamp 20 may

be increased.

[49] According to an embodiment of the present invention, in order to effectively reduce light that is emitted from the wavelength-conversion layer 3 and incident to the LED package 12, the distance D between the LED package 12 and the lamp cover 10 may be selected such that a ratio of a surface area of the inner surface 2i of the second lamp cap 2 to a surface area of the LED package 12 is greater than about 2. For example, the distance D between the LED package 12 and the inner surface 2i of the second lamp cap 2 may be greater than at least about 3 mm. A value of the distance D indicates a minimum lower limit, and a value larger than the minimum lower limit may be selected according to embodiments of the present invention within the scope of the present invention.

[50] When the distance D is increased, a reliability and life span of the LED lamp 20 may also be increased. The reliability and lifespan of the LED lamp 20 is determined by a ratio of a surface area of the lamp cover 10 to a light output intensity of the LED package 12. The greater the distance D, the larger the surface area of the lamp cover 10. Also, the larger the surface area of the lamp cover 10, the faster the thermal transfer from the lamp cover 10. In order to overcome severe test conditions or environments such as high temperature and high humidity environments, an outer surface area of the lamp cover 10 with respect to the light output intensity of the LED package 12 may preferably be as large as possible. For example, a ratio of an outer surface area of the lamp cover 10, that is, an outer surface area of the first lamp cap 1 of the lamp cover 10, with respect to the light output intensity of the LED package 12 may be greater than 300 mm²/watt. A value of the ratio of the outer surface area of the lamp cover 10 with respect to the light output intensity of the LED package 12 indicates a minimum lower limit, and thus an outer surface of the first lamp cap 1 having a larger value than the minimum lower limit may be selected according to embodiments of the present invention within the scope of the present invention.

[51] The LED lamp 20 according to the current embodiment of the present invention may maintain a uniform efficiency regardless of a CCT. That is, in the case of the LED lamp 20 according to the current embodiment of the present invention, efficiency in warm white or neutral white color ranges is nearly the same as that in a cool white color range.

[52] While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims.

Claims

- [Claim 1] A lamp cover comprising:
a first lamp cap having a curved surface;
a second lamp cap that is fitted to the first lamp cap at a distance from the first lamp cap and has a curved surface; and
a wavelength-conversion layer filled between the first lamp cap and the second lamp cap.
- [Claim 2] The lamp cover of claim 1, wherein the first lamp cap and the second lamp cap comprise a transparent material.
- [Claim 3] The lamp cover of claim 2, wherein the transparent material comprises at least one selected from the group consisting of glass, poly(methyl methacrylate) (PMMA), polycarbonate, and silicone resin.
- [Claim 4] The lamp cover of claim 1, wherein the first lamp cap and the second lamp cap have a concave inner surface and a convex outer surface, respectively, and the wavelength-conversion layer is filled between the concave inner surface of the first lamp cap and the convex outer surface of the second lamp cap.
- [Claim 5] The lamp cover of claim 4, wherein the first lamp cap and the second lamp cap have semi-spherical shell shapes.
- [Claim 6] The lamp cover of claim 4, wherein a distance between the first lamp cap and the second lamp cap is uniform so that the wavelength-conversion layer has a uniform thickness.
- [Claim 7] The lamp cover of claim 6, wherein the inner surface of the second lamp cap comprises a plurality of facets having a plurality of different curvatures or a plurality of different normal vector planes.
- [Claim 8] The lamp cover of claim 1, wherein the first lamp cap and the second lamp cap comprise a first support portion and a second support portion, respectively, and the first and second support portions are attached to each other in order to fit the first lamp cap and the second lamp cap to each other.
- [Claim 9] The lamp cover of claim 1, wherein the wavelength-conversion layer comprises a silicone resin material mixed with a luminescent material.
- [Claim 10] The lamp cover of claim 9, wherein the luminescent material is a phosphor material that emits visible light by being excited by UV light, blue light, or green light.
- [Claim 11] The lamp cover of claim 10, wherein the phosphor material comprises at least one phosphor material that emits visible light of various

- wavelengths by being excited by UV light, blue light, or green light.
- [Claim 12] A LED lamp comprising a lamp cover of one of claims 1 through 11.
- [Claim 13] The LED lamp of claim 12, further comprising:
a substrate; and
at least one LED package mounted on the substrate,
wherein the lamp cover is disposed on the substrate to surround the LED package.
- [Claim 14] The LED lamp of claim 13, wherein the substrate comprises a printed circuit board (PCB).
- [Claim 15] The LED lamp of claim 13, wherein the at least one LED package comprises at least one selected from the group consisting of a UV LED, a blue LED, and a green LED.
- [Claim 16] The LED lamp of claim 13, wherein a ratio of a surface area of the inner surface of the second lamp cap to a surface area of the LED package is greater than 2.
- [Claim 17] The LED lamp of claim 13, wherein a distance between the LED package and the inner surface of the second lamp cap is greater than 3 mm.
- [Claim 18] The LED lamp of claim 17, wherein a space exists between the LED package and the inner surface of the second lamp cap.
- [Claim 19] The LED lamp of claim 13, wherein the first lamp cap has an outer surface area of at least 300 mm² per watt of an incident light from the LED package.
- [Claim 20] The LED lamp of claim 13, wherein the inner surface of the second lamp cap comprises a plurality of facets having a plurality of different curvatures or a plurality of different normal vector planes so that light reflected from a point on the inner surface of the second lamp is incident on another point on the inner surface of the second lamp cap.
- [Claim 21] The LED lamp of claim 20, wherein the plurality of the normal vector planes converge toward the LED package.
- [Claim 22] A method of fabricating the lamp cover of claim 1 comprising:
preparing the first and second lamp caps by using injection molding;
providing a silicone resin material mixed with a luminescent material onto a concave inner surface of the first lamp cap;
fitting the first and second lamp caps to each other such that the concave inner surface of the first lamp cap faces a convex outer surface of the second lamp cap; and
solidifying the silicone resin material mixed with a luminescent

material by heating or UV irradiation to form the wavelength-conversion layer.

[Claim 23]

A method of fabricating the lamp cover of claim 1 comprising:
preparing the first and second lamp caps by using injection molding;
fitting the first and second lamp caps to each other such that a concave inner surface of the first lamp cap faces a convex outer surface of the second lamp cap;
providing a silicone resin material mixed with a luminescent material into a space between the first and second lamp caps until it completely fills the space; and
solidifying the silicone resin material mixed with a luminescent material by heating or UV irradiation to form the wavelength-conversion layer.