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LIGHT-EMITTING DEVICE PACKAGE AND MANUFACTURING METHOD THEREFOR

Abstract

A light-emitting device package includes a substrate having a mounting region in which a light-emitting device chip is mounted. The light-emitting device package further includes a reflector and a cover enclosing the reflector. The reflector is disposed around the light-emitting device chip and having an opening through which the mounting region of the substrate is exposed. The reflector has elasticity to allow variation of a diameter thereof.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS AND PRIORITY [0001] The present application is a continuation of U.S. patent application Ser. No. 17/113,448, filed Dec. 7, 2020, which is a continuation of International Application No. PCT/KR2019/006930, filed on Jun. 10, 2019, which claims priority to and the benefit of Korean Patent Application No. 10-2018-0065751, filed on Jun. 8, 2018, the disclosures of which are incorporated herein by their entirety.

TECHNICAL FIELD
[0002] Embodiments of the present disclosure relate to a light-emitting device package and a method of manufacturing the same.
BACKGROUND
[0003] A light emitting diode is a semiconductor device that emits light through recombination of electrons and holes in a P-N semiconductor junction structure upon application of electric current thereto. A light emitting apparatus using such a light emitting diode has various advantages, such as cost effectiveness and affordability, low voltage, long lifespan, low price, and the like.
[0004] Conventionally, light emitting diodes are applied to display lamps or for display of simple data, such as numerals and the like. In recent years, with the development of industrial technology, particularly information display technology and semiconductor technology, light emitting diodes have been applied to various fields including displays, lighting, vehicular lamps, projectors, and the like. In addition, light emitting diodes are used for outdoor installations, such as street lamps and traffic lights. Accordingly, there is a need for a light emitting diode having a more durable structure for outdoor installations that can be exposed to more severe environments.
SUMMARY
[0005] Embodiments of the present disclosure provide a light-emitting device package having a highly durable structure obtained through stable and firm assembly of each component.
[0006] In accordance with embodiments of the present disclosure, a light-emitting device package includes: a substrate having a mounting region in which a light-emitting diode chip is mounted; the light-emitting diode chip being mounted in the mounting region on the substrate; a reflector disposed around the light-emitting diode chip and having an opening through which the mounting region of the substrate is exposed, the reflector having elasticity to allow variation of a diameter thereof; and a cover enclosing the reflector.
[0007] In at least one variant, an inner surface of the reflector defining the opening of the reflector may be an inclined surface.
[0008] In another variant, the opening of the reflector may have a width gradually increasing upwards from a surface of the substrate.
[0009] The inner surface of the reflector defining the opening of the reflector may have a parabolic cross-section.
[0010] The light-emitting diode chip may be disposed at a focal point of the parabolic cross-section.
[0011] In further another variant, the reflector may have a ring shape in plan view. The reflector may be provided at one side thereof with a slit formed by removing a portion of the reflector and may be divided by the slit to have both ends facing each other. The slit may be placed on a line passing through a center of the ring or may be slanted with respect to the line. The reflector may

have an outer wall contacting an inner surface of the cover.
[0012] In yet another variant, an outer diameter of the reflector may be the same as an inner diameter of the cover.
[0013] The outer wall of the reflector may be fastened to the inner surface of the cover.
[0014] The outer wall of the reflector and the inner surface of the cover may have threads engaging with each other.
[0015] In at least one variant, the reflector may be formed of a metal. The light-emitting device package may further include a reflective film formed on an inner surface of the reflector. The reflector may be formed of a metal, a ceramic material or an organic polymer. The light-emitting device package may further include a window connected to the cover and allowing light emitted from the light-emitting diode chip to pass therethrough. The window may cover the opening of the reflector. Alternatively, the window may fill the opening of the reflector.
[0016] The light-emitting device package having the above structure may be manufactured by mounting a light-emitting diode chip on a substrate, preparing a cover, mounting the cover on the circumference of the reflector, and connecting the cover to the substrate, with the reflector inserted into the cover.
[0017] In another variant, the reflector may be partially removed to form a slit imparting elasticity to the reflector and an outer diameter of the reflector may be adjusted by the slit. In further another variant, the reflector may be inserted into the cover in a state in which the reflector is adjusted to have an outer diameter that is the same as or smaller than an inner diameter of the cover. In yet another variant, manufacture of the light-emitting device package may further include mounting a window on the cover.
[0018] In at least one variant, the light-emitting device package may be employed by a light irradiation apparatus. The light irradiation apparatus may include at least one light-emitting device package, and a main body on which the at least one light-emitting device package is mounted.
[0019] Embodiments of the present disclosure provide a light-emitting device package having a highly durable structure through stable and firm assembly of each component.

Description

DESCRIPTION OF DRAWINGS
[0020] FIG. **1** is a sectional view of a light-emitting device package according to one embodiment of the present disclosure.
[0021] FIG. **2** is a plan view of the light-emitting device package according to the embodiment of the present disclosure.
[0022] FIG. **3** is a plan view of the light-emitting device package according to the embodiment of the present disclosure.
[0023] FIG. **4**A to FIG. **4**C are sectional view illustrating a method of manufacturing the light-emitting device package according to the embodiment of the present disclosure where:
[0024] FIG. **4**A illustrates assembling a reflector and a cover;
[0025] FIG. **4**B illustrates mounting an assembly of the reflector and the cover on a substrate having a light-emitting diode chip; and
[0026] FIG. **4**C illustrates sealing a gap between the cover and the substrate.
[0027] FIG. **5** is a sectional view of a light-emitting device package having a convex lens shaped window according to another embodiment of the present disclosure.
[0028] FIG. **6** is a sectional view of a light-emitting device package having a curved inner surface of a reflector according to further another embodiment of the present disclosure.
[0029] FIG. **7** is a sectional view of a light-emitting device package having a reflector with a reflective film according to one embodiment of the present disclosure.

[0030] FIG. **8** is a sectional view of a light-emitting device package having a reflector with fastening members according to further another embodiment of the present disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS

[0031] The present disclosure may be implemented in various ways and certain embodiments will be described in detail with reference to the accompanying drawings. However, it should be understood that the present disclosure is not limited to the following embodiments and includes all modifications, variations, alterations, and equivalents within the spirit and scope of the present disclosure.

[0032] Hereinafter, embodiments of the present disclosure will be described in detail with reference to the accompanying drawings.

[0033] FIG. **1** is a sectional view of a light-emitting device package according to one embodiment of the present disclosure and FIG. **2** is a plan view of the light-emitting device package according to the embodiment of the present disclosure.

[0034] Referring to FIG. **1** and FIG. **2**, a light-emitting device package **100** according to one embodiment of the present disclosure is a light source employed by various apparatuses through surface mounting and includes a light-emitting diode chip **21** adapted to emit light. More specifically, the light-emitting device package **100** according to the embodiment includes a substrate **10** on which the light-emitting diode chip **21** is mounted, a reflector **30** and a cover **43**. The light-emitting diode chip **21** is mounted on the substrate **10**. The reflector **30** reflects light emitted from the light-emitting diode chip **21**, and the cover **43** is fastened to the reflector **30** while surrounding the circumference of the reflector **30**.

[0035] The substrate **10** has a mounting region and allows at least one light-emitting diode chip **21** to be mounted thereon.

[0036] The substrate **10** may have various shapes to allow the light-emitting diode chip **21** to be mounted thereon. By way of example, the substrate **10** may be provided in a plate shape having a substantially circular shape in plan view and a predetermined height. However, the substrate **10** is not limited thereto and may have an elliptical shape or a rectangular shape.

[0037] The substrate **10** may be at least partially formed of a material having high thermal conductivity. The substrate **10** may be formed of, for example, a metal selected from among copper, iron, nickel, chromium, aluminum, silver, gold, titanium, or an alloy thereof. However, it should be understood that the substrate **10** is not limited thereto and may be formed of a non-conductive material. For the substrate **10** formed of the non-conductive material, a conductor may be disposed on an upper surface of the substrate **10**. The non-conductive material may include ceramic materials, resins, glass, and composites thereof (for example, a composite resin or a mixture of a composite resin and a conductive material).

[0038] In the embodiment, the substrate **10** may be provided as a monolithic structure, without being limited thereto. Alternatively, the substrate **10** may be provided in the form of a combination of multiple sub-substrates **10**.

[0039] The substrate **10** is provided with a terminal unit for supplying electric power to the light-emitting diode chip **21**. The terminal unit may include a first terminal **51** and a second terminal **53** connected to a cathode and an anode of the light-emitting diode chip **21**, respectively.

[0040] In the embodiment, the first and second terminals **51**, **53** may be provided in the form of pins penetrating the upper and lower surfaces of the substrate **10**. The first and second terminals **51**, **53** may have a longer length than a thickness of the substrate **10** and may extend to a lower end of the substrate **10**. Each of the first and second terminals **51**, **53** may be formed of a conductive material, for example, a metal. Although an upper end of each of the first and second terminals **51**, **53** is flush with an upper end of the substrate **10** in this embodiment, it should be understood that this structure is provided for convenience of description and the first and second terminals may be arranged in a different way. For example, the upper ends of the first and second terminals **51**, **53** may protrude from the upper surface of the substrate **10**. Although not shown in the drawings, each of the first and second terminals **51**, **53** may be provided at an upper portion thereof with a pad having a relatively large area to facilitate connection to the light-emitting diode chip **21**. In addition, although each of the first and second terminals **51**, **53** extends to the lower surface of the substrate **10** in this embodiment, it should be understood that other implementations are possible. Alternatively, the first and second terminals **51**, **53** may extend towards a side surface of the substrate **10**.

[0041] In the embodiment, an insulator **55** may be disposed between the terminal unit and the substrate **10**. That is, the insulator **55** may be disposed between the substrate **10** and the first terminal **51** and between the substrate **10** and the second terminal **53** to surround the first terminal **51** and the second terminal **53**. The insulator **55** insulates the first and second terminals **51**, **53** from the substrate **10**.

[0042] In the embodiment, since the substrate **10** formed of a non-conductive material, for example, a ceramic material, is an insulator, the insulator **55** may be omitted and the substrate **10** may contact the first terminal **51** and the second terminal **53**.

[0043] The light-emitting diode chip **21** is mounted in the mounting region on the substrate **10**. The light-emitting diode chip **21** may be directly mounted on the substrate **10** or may be disposed on the substrate **10** via a sub-mount **27** as shown in FIG. **1**. In one embodiment, with the light-emitting diode chip **21** disposed on the sub-mount **27**, the sub-mount **27** is mounted on the substrate **10**.

[0044] Although one light-emitting diode chip **21** is mounted on the substrate **10** in this embodiment, it should be understood that other implementations are possible. Two or more light-emitting diode chip **21** may be disposed thereon, as needed.

[0045] In this embodiment, the light-emitting diode chip **21** may be a flip-chip type. However, it should be understood that the light-emitting diode chip **21** is not limited thereto and various types of light-emitting diode chips including a lateral type and a vertical type may be provided as the light-emitting diode chip **21**.

[0046] Although not shown in the drawings, the light-emitting diode chip **21** may include a light emitting structure and electrodes formed on a base substrate.

[0047] The base substrate may be, for example, a sapphire substrate, particularly a patterned sapphire substrate. Preferably, the base substrate is an insulating substrate, without being limited thereto.

[0048] The light emitting structure may include a first semiconductor layer, an active layer, and a second semiconductor layer.

[0049] The first semiconductor layer may be a semiconductor layer doped with a first conductivity type dopant. The first conductivity type dopant may be an n-type dopant. The first conductivity type dopant may be Si, Ge, Se, Te, or C. In one embodiment, the first semiconductor layer may include a nitride-based semiconductor material. For example, the first semiconductor layer may be formed of a semiconductor material having a composition represented by In.sub.xAl.sub.yGa.sub.1-x-yN (0≤x≤1, 0≤y≤1, 0≤x+y≤1). In some embodiments, the semiconductor material having this composition may include GaN, AlN, AlGaN, InGaN, InN, InAlGaN, AllnN, and the like. The first semiconductor layer may be formed by growing the semiconductor material so as to contain the n-type dopant, such as Si, Ge, Sn, Se, Te, and the like.

[0050] The active layer is formed on the first semiconductor layer and corresponds to a light emitting layer. The active layer refers to a layer in which electrons (or holes) injected through the first semiconductor layer recombine with holes (or electrons) injected through the second semiconductor layer to emit layer generated by an energy band gap depending upon materials of the active layer. The active layer may emit light having at least one peak wavelength selected from UV light, blue light, green light and red light.

[0051] The active layer may be realized by compound semiconductors. The active layer may be realized by, for example, at least one of group III-V or II-VI compound semiconductors, and may have a composition represented by In.sub.xAl.sub.yGa.sub.1-x-yN (0≤x≤1, 0≤y≤1, 0≤x+y≤1).

[0052] The second semiconductor layer is formed on the active layer. The second semiconductor layer is a semiconductor layer having a second conductivity type dopant having an opposite polarity to the first conductivity type dopant. The second conductivity type dopant may be a p-type dopant. The conductivity type dopant may include, for example, Mg, Zn, Ca, Sr, Ba, and the like. In one embodiment, the second semiconductor layer may include a nitride-based semiconductor material. For example, the second semiconductor layer may be formed of a semiconductor material having a composition represented by In.sub.xAlyGa.sub.1-x-yN (0≤x≤1, 0≤y≤1, 0≤x+y≤1). In some embodiments, the semiconductor material having this composition may include GaN, AlN, AlGaN, InGaN, InN, InAlGaN, AllnN, and the like. The second semiconductor layer may be formed by growing the semiconductor material so as to contain the p-type dopant, such as Mg, Zn, Ca, Sr, Ba, and the like.
[0053] In this embodiment, an insulating layer is formed on each of the first semiconductor layer and the second semiconductor layer, and a cathode and an anode are formed on the insulating layers to be connected to the first semiconductor layer and the second semiconductor layer through the insulating layers disposed therebetween, respectively.
[0054] In some embodiments, the sub-mount **27** may be disposed between the substrate **10** and the light-emitting diode chip **21** to be placed under the light-emitting diode chip **21** such that the light-emitting diode chip **21** can be electrically connected to the terminal unit of the substrate **10** by the sub-mount **27**.
[0055] The sub-mount **27** may be formed of a material having high thermal conductivity to allow heat generated from the light-emitting diode chip **21** to be effectively discharged therethrough. For example, the sub-mount **27** may be formed of a ceramic material, such as AIIN.
[0056] First and second pads **25***a*, **25***b* may be disposed on an upper surface of the sub-mount **27** to be electrically connected to the light-emitting diode chip **21**. The first and second pads **25***a*, **25***b* may be connected to the cathode and the anode of the light-emitting diode chip **21** through a conductive bonding member **23**, respectively. The first and second pads **25***a*, **25***b* may be connected to the first and second terminals **51**, **53** by wire bonding, respectively, whereby the cathode of the light-emitting diode chip **21** is connected to the first pad **25***a* through the conductive bonding member **23** and the first pad **25***a* is connected to the first terminal **51** through a wire W1, as shown in FIG. **1**. The anode of the light-emitting diode chip **21** is connected to the second pad **25***b* through the conductive bonding member **23** and the second pad **25***b* is connected to the second terminal **53** through a wire W2. Accordingly, electric power can be applied to the light-emitting diode chip **21** through the terminal unit.
[0057] Here, the conductive bonding member **23** may be realized by conductive pastes, such as solder pastes, silver pastes, and the like, or by a conductive resin. Alternatively, the conductive bonding member **23** may be realized by an anisotropic conductive film.
[0058] The shape of the sub-mount **27** may be modified in various ways so long as the sub-mount **27** can electrically connect the light-emitting diode chip **21** to the terminal unit of the substrate **10** as needed. Alternatively, the sub-mount **27** may be omitted. In a structure where the sub-mount **27** is omitted, the light-emitting diode chip **21** may have a chip-on-board structure in which the light-emitting diode chip **21** is directly mounted on the substrate **10**.
[0059] The reflector **30** is disposed along the circumference of the mounting region on the substrate **10**. The reflector **30** reflects light emitted from the light-emitting diode chip **21** such that the light travels in an upward direction.
[0060] The reflector **30** is disposed around the light-emitting diode chip **21** and has an opening OPN through which the mounting region of the substrate **10** is exposed. That is, the reflector **30** is provided in a ring shape open at upper and lower portions thereof on the substrate **10**. The reflector **30** may have a shape corresponding to the shape of the substrate **10** and may have a circular ring shape in plan view. However, it should be understood that the reflector **30** is not limited thereto and may be provided in an elliptical shape, a rectangular shape, or the like, and may have a different

shape than that of the substrate **10**.

[0061] The mounting region of the substrate **10** is exposed through the opening OPN of the reflector **30**. The light-emitting diode chip **21** may be disposed at a location on the substrate **10** at which the opening OPN of the reflector **30** is disposed. When the reflector **30** has a circular ring shape, the light-emitting diode chip **21** may be placed in a region corresponding to the center of the circle defined by the reflector **30** so as to maximize reflectivity of light.

[0062] In this embodiment, the reflector **30** includes an inner surface **31** facing the opening OPN, an outer surface **33** facing outwards, and a lower surface adjoining the upper surface of the substrate **10**. In one embodiment, the reflector **30** may have a substantially right-angled triangular cross-section and the inner surface **31** of the reflector **30** may correspond to an oblique side of the right-angled triangular cross-section. However, it should be understood that the reflector **30** is not limited thereto and may have an inner surface **31**, an outer surface **33**, a lower surface, and an upper surface opposite to the lower surface and having a narrower area than the lower surface. In this case, the reflector **30** may have a substantially trapezoidal cross-section and the inner surface **31** of the reflector **30** may correspond to an oblique side of the trapezoidal cross-section, as shown in FIG. **1**.

[0063] In the embodiment, the inner surface **31** is at least partially slanted with respect to the upper surface of the substrate **10**. Accordingly, the opening OPN of the reflector **30** has a width gradually increasing upwards from the upper surface of the substrate **10**. In other words, an inner diameter D1 of the reflector **30** gradually increases upwards from the upper surface of the substrate **10**. The outer surface **33** of the reflector **30** may be disposed at a right angle with respect to the upper surface of the substrate **10**, whereby an outer diameter D2 of the reflector **30** mounted on the cover **43** can be kept substantially constant without increasing or decreasing upwards from the upper surface of the substrate **10**. However, it should be understood that the outer diameter D2 of the reflector **30** is not limited thereto and may be changed to allow easy fastening of the reflector **30** to the cover **43**.

[0064] A bonding agent may be disposed between the substrate **10** and the reflector **30** to bond the substrate **10** to the reflector **30**. Alternatively, the substrate **10** may be connected to the reflector **30** by a separate fastening member, such as a hook. However, it should be understood that other implementations are possible and the bonding agent between the substrate **10** and the reflector **30** may be omitted.

[0065] The reflector **30** may be formed of a highly reflective material in order to maximize efficiency in extracting light from the light-emitting diode chip **21**.

[0066] For example, the reflector **30** may be formed of aluminum and/or an aluminum alloy. Alternatively, the reflector **30** may be formed of other materials having high reflectivity, for example, various metals, such as silver, gold, tin, copper, chromium, nickel, molybdenum, titanium, and the like, and alloys thereof. Further, the reflector **30** may be formed of a material having high reflectivity depending upon the wavelength of light emitted from the light-emitting diode chip **21**. For example, silver (Ag) has low light reflectivity in a certain UV wavelength band, and silver may not be used as the material for the reflector **30** for the light-emitting diode chip **21** adapted to emit UV light.

[0067] In other embodiments, the reflector **30** may be formed of a reflective material excluding metals. For example, the reflector **30** may be formed of an organic polymer material having reflectivity. In order for the organic polymer to exhibit reflectivity, the organic polymer may be composed of a single layer or multiple layers, and at least one of the single layer or multiple layers can be drawn, pulled, stretched and expanded. Further, the organic polymer may have polymer nodes linked to each other by fibrils that form fine porous vacancies. There are various organic polymer materials having such a structure and reflectivity and, for example, Teflon® may be used. By way of example, the reflector **30** may be formed of a polytetrafluoroethylene resin that can be drawn and expanded.

[0068] In one embodiment, the reflector **30** has a slit **37** formed by removing a portion of the reflector **30** to impart elasticity to the reflector **30**, as shown in FIGS. **2-3**. The slit **37** is disposed at one side of the reflector **30** to divide the reflector **30**. With this structure, the reflector **30** has a continuous ring shape other than the slit **37** and has both ends divided by the slit **37** and facing each other via the slit **37**. In some embodiments, both ends of the reflector **30** may contact each other. In other embodiments, both ends may be separated by a predetermined distance from each other. The reflector **30** has elasticity imparted by the slit **37** and is manufactured, with both ends of the reflector **30** separated from each other, such that the outer diameter of the reflector **30** can be changed by force applied inwards from both ends of the reflector **40**. This structure will be described below.

[0069] In some embodiments, the slit **37** may be disposed on a line passing through the center of the shape defined by the reflector **30**. For example, for the reflector **30** having a circular shape, the slit **37** may be disposed on a line extending outwards from the center of the circular shape. However, it should be understood that the shape of the slit **37** is not limited thereto and may be changed in various ways so long as the slit can stably impart certain elasticity to the reflector **30** while maximizing reflectivity of the reflector **30**.

[0070] FIG. **3** is a plan view of the light-emitting device package **100** according to the embodiment of the present disclosure, in which the slit **37** has a different shape. Referring to FIG. **3**, the slit **37** may be obliquely disposed with respect to the line passing through the center of the circular shape defined by the reflector **30**. Since both ends of the slit **37** facing each other are obliquely disposed and have a larger area than a slit formed along a straight line, distortion of both ends of the slit **37** can be suppressed, thereby providing a stable ring shape.

[0071] Referring again to FIG. **1** and FIG. **2**, the cover **43** is disposed along a side of the reflector **30**, that is, along the circumference of the reflector **30**. The cover **43** surrounds the outer surface of the reflector **30** and is open at upper and lower sides thereof.

[0072] The cover **43** is disposed along the circumference of the reflector **30** and is attached to the substrate **10** while supporting a window **41**. The cover **43** may be formed of various materials, for example, a metal. In addition to aluminum and/or an aluminum alloy, the cover **43** may be formed of a material having high reflectivity, for example, various metals including silver, gold, tin, copper, chromium, nickel, molybdenum, titanium, and the like, and/or alloys thereof. Alternatively, the cover **43** may be formed of other materials, for example, an organic polymer, which is coated with a metal or a metal alloy.

[0073] An upper end of the cover **43** may partially extend in a direction parallel to the surface of the substrate **10** and may be provided at an extended portion thereof with a step (not shown) for mounting the window **41**. The step of the cover **43** may be provided corresponding to a thickness of the window **41**. A bonding agent may be disposed between the step of the cover **43** and the window **41** to attach the window **41** thereto.

[0074] A lower end of the cover **43** is provided to the surface of the substrate **10** and is connected to the substrate **10** via a coupling member **47** to seal an interior space. Here, the coupling member **47** may be realized in various ways so long as the coupling member **47** can connect the lower end of the cover **43** to the substrate **10** to seal the interior space. For example, in some embodiments, the cover **43** may be formed of a metal and the coupling member **47** may be a welding portion at which the cover **43** is welded to the substrate **10**. In this embodiment, the lower end of the cover **43** may be sealed by welding.

[0075] In one embodiment, an inner diameter C1 of the cover **43** is substantially the same as the outer diameter D2 of the reflector **30**. As a result, the entirety of the inner surface of the cover **43** contacts the outer surface **33** of the reflector **30**, as shown in FIG. **1**.

[0076] The cover **43** may be provided at an upper side thereof with the window **41** in a region thereof corresponding to an upper portion of the light-emitting diode chip **21** to allow light emitted from the light-emitting diode chip **21** to pass therethrough.

[0077] The window **41** is disposed in the region of the cover **43** corresponding to the upper portion of the light-emitting diode chip **21** to allow light emitted from the light-emitting diode chip **21** to pass therethrough.
[0078] The window **41** may protect the light-emitting diode chip **21** inside the opening OPN. The window **41** may have various shapes so as to allow light emitted from the light-emitting diode chip **21** to pass therethrough or so as to change a path of the light emitted from the light-emitting diode chip **21**. Collection or dispersion of light may be required depending upon the purpose of the light-emitting device package **100** according to the embodiment of the present disclosure and the window **41** may be applied, structured and/or configured as needed according to such a purpose.
[0079] The window **41** is formed of a transparent insulating material to allow the light emitted from the light-emitting diode chip **21** to pass therethrough and protects the light-emitting diode chip **21** while allowing the light emitted from the light-emitting diode chip **21** to pass therethrough. The window **41** may be formed of a material that can prevent deformation or discoloration due to the light emitted from the light-emitting diode chip **21**. For example, when the light emitted from the light-emitting diode chip **21** is UV light, the window **41** may be formed of a material that can prevent deformation or discoloration due to UV light. The window **41** may be formed of various materials without being limited to a particular material so long as the window can satisfy the above functions. For example, the window **41** may be formed of quartz or an organic polymer material. Here, since the wavelength of light absorbed by or transmitted through the organic polymer material differs depending upon the kinds of monomers and molding methods and conditions, the organic polymer material may be selected in consideration of the wavelength of light emitted from the light-emitting diode chip **21**. For example, organic polymer materials such as poly (methyl methacrylate) (PMMA), polyvinyl alcohol (PVA), polypropylene (PP), and low density polyethylene (PE) absorb substantially no UV light, whereas an organic polymer such as polyesters can absorb UV light.
[0080] Although the window **41** is illustrated as disposed above the light-emitting diode chip **21** to be separated from the light-emitting diode chip **21** in this embodiment, it should be understood that other implementations are possible and the window **41** can be modified in various ways so long as the window **41** allows efficient transmission of the light emitted from the light-emitting diode chip **21** therethrough. For example, the window **41** may be provided so as to fill the opening OPN of the reflector **30**.
[0081] A method for manufacturing the light-emitting device package **100** having the above structure is described according to FIGS. **4**A through **4**C. FIG. **4**A to FIG. **4**C are sectional views illustrating the method of manufacturing the light-emitting device package according to embodiments of the present disclosure.
[0082] Referring to FIG. **4**A, a cover **43** and a reflector **30** are prepared and assembled to each other.
[0083] The reflector **30** has a slit **37** (see FIG. **2**) formed by partially removing a portion of the reflector **30**. Both ends of the reflector **30** divided by the slit **37** are separated a predetermined distance from each other. Since both ends of the reflector **30** are separated by a predetermined distance from each other via the slit **37**, an outer diameter of the reflector **30** can be reduced through the decrease in distance between both ends of the reflector **30** when force is applied inwardly to the reflector **30** at both sides thereof. If the force applied inwardly to the reflector **30** at both sides thereof is released, the reflector **30** returns to an initial diameter due to elasticity of the reflector **30**. As shown in FIG. **4**A, when the initial diameter of the reflector **30**, i.e., not exposed to external force, is referred to as a first diameter DO and the diameter of the reflector **30** exposed to external force P1 applied inwardly at both sides thereof is referred to as a second diameter D2, the second diameter D2 is smaller than the first diameter DO. The decrease in diameter may differ depending upon the magnitude of the external force P1 and the width of the slit **37**.
[0084] The reflector **30** is inserted into the cover **43** by applying external force P1 to the reflector

30. Upon insertion of the reflector **30** into the cover **43**, the reflector **30** may be inserted downwardly into the cover **43** from an upper portion of the cover **43**, with the cover **43** disposed to be vertically penetrated, as shown in FIG. **4**A. Here, a lower surface of the reflector **30** is disposed at the upper side of the cover as shown in FIG. **4**A.
[0085] However, it should be understood that this insertion method is described by way of example. Alternatively, with the cover **43** disposed to have the opening (OPN), the reflector **30** is inserted into the cover **43** through the opening by upwardly applying force to the reflector **30** at a lower side of the cover **43**. The cover **43** may be assembled to the reflector **30** by fitting the cover **43** to the reflector **30** in a secured state.
[0086] Here, the second diameter D2 of the reflector **30** is smaller than or equal to the inner diameter C1 of the cover **43** in order to allow the reflector **30** to be easily inserted into the cover **43**. The reflector **30** can be easily inserted into the cover **43** when the second diameter D2 of the reflector **30** is smaller than the inner diameter C1 of the cover **43**.
[0087] When the reflector **30** is completely inserted into the cover, the external force P1 applied to the reflector **30** is released. When the force applied to the reflector **30** is released, restoration force acts on the reflector **30**. As a result, the reflector **30** is secured to the cover **43** in a stable and tight manner. Next, referring to FIG. **4**B, a substrate **10** having a light-emitting diode chip **21** mounted thereon is provided and an assembly of the reflector **30** and the cover **43** is disposed on the substrate **10**.
[0088] The light-emitting diode chip **21** may be first mounted on a sub-mount **27**. The light-emitting diode chip **21** mounted on the sub-mount **27** may be disposed on the substrate **10** having first and second terminal **51**, **53** through wire bonding using W1 and W2, as shown in FIG. **4**B. Although not shown in the drawings, a bonding agent may be disposed between the sub-mount **27** and the substrate **10**.
[0089] After assembly of the reflector **30** and the cover **43** is rotated in a direction in which the opening of the reflector **30** is gradually widened, the assembly of the reflector **30** and the cover **43** may be disposed on the substrate **10** as shown in FIG. **4**B. Here, the reflector **30** surrounds the circumference of the light-emitting diode chip **21** and is disposed such that the light-emitting diode chip **21** is placed in the opening OPN of the reflector **30**. According to this embodiment, since the reflector **30** is tightly secured to the cover **43** and can be stably disposed on the substrate **10**, a bonding agent may be omitted between the reflector **30** and the substrate **10**. However, it should be noted that the bonding agent may be disposed to more tightly secure the reflector **30** to the substrate **10** in other embodiments.
[0090] Next, as shown in FIG. **4**C, a gap between the cover **43** and the substrate **10** is sealed. A lower end of the cover **43** is coupled to the substrate **10** by welding to seal the gap therebetween, thereby completing the light-emitting device package **100** according to the embodiment of the present disclosure.
[0091] In one embodiment, the step of preparing the cover **43**, the step of preparing the reflector **30**, and the step of preparing the substrate **10** or a light emitting device is not performed according to a particular sequence, and the light-emitting device package **100** may be manufactured by individually preparing the cover **43**, the reflector **30**, the substrate **10** and the light emitting device, followed by mounting or assembling these components.
[0092] Although the cover **43** is first coupled to the window **41** and the reflector **30** is then mounted on the cover **43** in this embodiment, it should be understood that other implementations are possible. The sequence of coupling the cover **43** and the window **41** may be changed in various ways. For example, after the cover **43** is assembled to the reflector **30**, the window **41** may be connected to the cover **43** before assembly of the cover **43** and the reflector **30** is mounted on the substrate **10**. Alternatively, the cover **43** may be first assembled to the reflector **30** and the assembly of the cover **43** and the reflector **30** may be mounted on the substrate **10**, followed by connecting the window **41** to the cover **43**.

[0093] Although the method of manufacturing one light-emitting device package **100** is illustrated in FIG. **4**A to FIG. **4**C, it should be understood that other implementations are possible. According to some embodiments, multiple light-emitting device packages **100** can be simultaneously manufactured through batch production.

[0094] For example, assemblies of the reflectors **30** and the covers **43** may be formed by arranging multiple covers **43** in a matrix, followed by simultaneously or sequentially inserting the reflectors **30** into the covers **43**. In addition, multiple substrates **10** each having the light-emitting diode chip **21** mounted thereon may be prepared and arranged in a matrix, and the assemblies of the reflectors **30** and the covers **43** may be assembled and welded to the substrates **10** to cover the light-emitting diode chips **21**, thereby manufacturing multiple light-emitting device packages **100**. Alternatively, a cover **43** or a substrate **10** not divided and having a broad area is prepared for individual light-emitting device packages **100**, and the reflector **30** is inserted into each cover, followed by cutting, thereby manufacturing multiple light-emitting device packages **100**.

[0095] The light-emitting device package **100** according to the embodiments described above has high durability through stable and tight assembly between components thereof.

[0096] According to the embodiments described above, the reflector **30** is tightly fastened to the cover **43**, thereby suppressing separation of the reflector **30** inside the light-emitting device package **100**. In particular, when there is a difference in diameter between the cover **43** and the reflector **30**, a space is formed between the cover **43** and the reflector **30**. If the reflector **30** may not be firmly secured to the cover **43**, the reflector **30** may move into the space between the cover **43** and the reflector **30**. In addition, when the reflector **30** is not firmly secured to the substrate **10**, the reflector **30** can be separated from the substrate **10** and unexpectedly moved into the space, potentially causing rattling of the reflector **30** inside the light-emitting device package **100**. The reflector **30**, if moving inside the cover **43**, may damage other components, for example, the light-emitting diode chip **21** or the wires W1 and W2. In the related art, in order to address possible movement of the reflector **30**, a separate bonding agent is required to secure the reflector **30** and the cover **43** and a separate process of securing the reflector **30** to the cover **43** using the bonding agent is further added. Nevertheless, in use, the bonding agent can wear off and fall out due to external impact or curing of the bonding agent over time, thereby causing separation of the reflector **30** from the cover **43** again.

[0097] However, according to the embodiments of the present disclosure, the reflector **30** is stably provided to the cover **43** through simple insertion without a separate process, thereby preventing the aforementioned problem. In particular, the reflector **30** is formed to have elasticity and stably secured to the cover **43** using elasticity thereof. As a result, the light-emitting device package according to the embodiment may not use a separate bonding agent between the reflector **30** and the cover **43**, and the assembly of the reflector **30** and the cover **43** is completed simply by inserting the reflector **30** into the cover **43**. In the embodiments of the present disclosure, the step of bonding the reflector **30** to the cover **43** using the bonding agent and the step of curing the bonding agent are omitted. As a result, the process of fastening the reflector **30** to the cover **43** becomes very easy and simple, and assembly of the light-emitting device package can achieve reduction in a defect rate while improving a manufacturing yield.

[0098] The light-emitting device package having the above structure may be modified in various shapes in order to improve light extraction efficiency or workability.

[0099] FIG. **5** to FIG. **8** are sectional views of light-emitting device packages according to embodiments of the present disclosure. In order to avoid repetition, the following description will focus on different features from the above embodiments and, for details of components not described herein, reference to the description of the above embodiments can be made.

[0100] Referring to FIG. **5**, the window **41** may have a simple plate shape instead of a lens shape, as described above, or may have a convex lens shape or a concave lens shape. For example, the window **41** may have various shapes, such as a spherical shape, an elliptical shape, a hemispherical shape, a semi-elliptical shape, a bifocal shape, and the like. Referring to FIG. **5**, the window **41** having a convex lens shape with a flat lower surface is shown by way of example. According to the embodiment of the present disclosure, the shape of the window **41** may be modified to adjust the path of light emitted from the light-emitting diode chip **21** to achieve, for example, collection or dispersion of the light.

[0101] Referring to FIG. **6**, the reflector **30** may include an inner surface **31** facing the opening OPN, an outer surface **33** facing outwards, and a lower surface adjoining the upper surface of the substrate **10**, in which the inner surface **31** of the reflector **30** according to the embodiment may be a curved surface. The curved surface may have various curvatures depending upon a profile of light emitted from the light-emitting diode chip **21**. For example, when the light-emitting diode chip **21** is configured to emit a larger quantity of light in an upward direction or in a lateral direction, the inner surface **31** may have different curvatures depending upon locations thereof.

[0102] In one embodiment, the inner surface **31** of the reflector **30** may be a parabolic surface and the light emitting diode may be disposed at a focal point of the elliptical surface. In other words, in a cross-sectional view of the reflector **30**, a side of the reflector **30** corresponding to the inner surface **31** may define a parabolic shape and the light emitting diode may be disposed at the focal point of the parabolic shape. In this embodiment, among light emitted from the light emitting diode, light reflected by the inner surface **31** of the reflector **30** may travel upwards.

[0103] Although the inner surface **31** has a curved surface in this embodiment, the shape of the inner surface **31** is not limited thereto. The inner surface **31** may be a combination of at least one curved surface and at least one flat surface, in which an inclination of the flat surface or the curvature of the curved surface may be set in various ways.

[0104] Referring to FIG. **7**, the reflector **30** may include a reflective film **39** in order to improve reflectivity. The reflective film **39** may be plated or coated with a material having high reflectivity with respect to light emitted from the light-emitting diode chip **21**. Although the reflector **30** may have the reflective film **39** over the entire surface thereof, the reflective film **39** may be provided to the inner surface **31** of the reflector **30**, by which light is substantially reflected.

[0105] In the structure wherein the reflector **30** includes the reflective film **39**, a portion of the reflector **30** other than the reflective film **39** may be formed of a metal, a ceramic material, or an organic polymer. For example, organic polymers, such as polycarbonate (PC), polyether sulfone, triacetylcellulose (TAC), poly (methyl methacrylate) (PMMA), polyvinyl alcohol (PVA), polyimide (PI), cyclic olefin copolymer (COC), Teflon®, polytetrafluoroethylene (ePTFE), and the like, may be used. Here, among materials for the reflector **30**, a material capable of enduring heat or UV light emitted from the light-emitting diode chip **21** may be selected.

[0106] In addition to aluminum and/or aluminum alloys, the reflective film **39** may be formed of other materials having high reflectivity, for example, various metals, such as silver, gold, tin, copper, chromium, nickel, molybdenum, titanium, and the like, and alloys thereof, or reflective organic polymers.

[0107] In one embodiment, the reflector **30** and/or the reflective film **39** may have roughness to improve light emission efficiency through improvement in scattering of light emitted from the light-emitting diode chip **21**. In particular, roughness may be provided to an inclined inner surface of the reflector **30** and/or the reflective film **39** and may be further added to the upper surface of the substrate **10**, as needed.

[0108] Referring to FIG. **8**, the cover **43** and the reflector **30** may be provided with fastening members for enhancement of assembly. For example, the cover **43** and the reflector **30** may be provided with threads formed on surfaces thereof facing each other to engage each other. The threads **35** of the cover **43** may be engaged with the threads **35** of the reflector **30**.

[0109] As a result, the cover **43** can be more firmly fastened to the reflector **30**. In some embodiments, the light-emitting device package may be applied to various light irradiation apparatuses, for example, a UV curing machine, a sterilizer, and the like. In this case, the light

irradiation apparatus includes at least one light-emitting device package and a main body on which the at least one light-emitting device package is mounted. The main body may be further provided with a power supply for supplying electric power, a controller for controlling the quantity of light emitted from the light-emitting device package, and the like.
[0110] Although some exemplary embodiments have been described herein, it should be understood by those skilled in the art that these embodiments are given by way of example only, and that various modifications, variations, and alterations can be made without departing from the spirit and scope of the present disclosure.
[0111] Therefore, the scope of the present disclosure should be interpreted according to the following appended claims and equivalents thereto.

Claims

1-10. (canceled)
11. A light emitting apparatus comprising: a substrate; a light emitting device disposed on the substrate; a reflector disposed on the substrate to a side of the light emitting device, the reflector including an opening region exposing a mounting region of the substrate; and a cover disposed on an outer region of the reflector, wherein the reflector includes a slit disposed on a side of the reflector, wherein the slit is configured to impart elasticity to the reflector, and wherein the slit is disposed on a line extending between the opening region and the outer region.
12. The light emitting apparatus according to claim 11, wherein the opening region has a loop shape on the substrate.
13. The light emitting apparatus according to claim 11, wherein the slit is defined by at least two ends of the reflector facing each other.
14. The light emitting apparatus according to claim 11, wherein the light emitting device is disposed on the mounting region of the substrate.
15. The light emitting apparatus according to claim 11, wherein the line further extends through a center of the reflector.
16. The light emitting apparatus according to claim 11, wherein the slit is obliquely oriented with respect to a line passing through a center of the reflector and an end of the slit.
17. The light emitting apparatus according to claim 11, wherein the opening region has a substantially trapezoidal vertical cross-section and an inner surface of the reflector corresponds to an oblique side of the trapezoidal vertical cross-section.
18. A light emitting apparatus comprising: a substrate; a light emitting device disposed on a mounting region of the substrate; a reflector disposed on the substrate to a side of the light emitting device, the reflector including an opening region exposing the mounting region of the substrate; and a cover disposed on an outer region of the reflector, wherein the reflector includes a slit disposed on a side of the reflector, wherein the slit is configured to impart elasticity to the reflector, and wherein an inner diameter of the cover and an outer diameter of the reflector at the outer region of the reflector are substantially the same.
19. The light emitting apparatus according to claim 18, wherein the opening region has a loop shape on the substrate.
20. The light emitting apparatus according to claim 18, wherein the slit is defined by at least two ends of the reflector facing each other.
21. The light emitting apparatus according to claim 18, further comprising a window attached to the cover, the window enclosing the opening region.
22. The light emitting apparatus according to claim 18, wherein the slit is disposed on a line extending between the opening region of the reflector and the outer region of the reflector.
23. The light emitting apparatus according to claim 22, wherein the slit is obliquely oriented with respect to a line passing through a center of the reflector and an end of the slit.

24. The light emitting apparatus according to claim 18, wherein the opening region has a substantially trapezoidal vertical cross-section and an inner surface of the reflector corresponds to an oblique side of the trapezoidal vertical cross-section.
25. A light emitting apparatus comprising: a substrate; a light emitting device disposed on a mounting region of the substrate; a cover disposed on the substrate to a side of the light emitting device; and a reflector disposed between the cover and the light emitting device, the reflector including an opening region exposing the mounting region of the substrate, wherein the reflector includes a slit disposed on a side of the reflector, and wherein the slit is obliquely oriented with respect to a line passing through a center of the reflector and an end of the slit.
26. The light emitting apparatus according to claim 25, wherein the opening region has a loop shape on the substrate.
27. The light emitting apparatus according to claim 25, wherein the cover is formed of a material having reflectivity.
28. The light emitting apparatus according to claim 25, wherein the slit is defined by two ends of the reflector facing each other.
29. The light emitting apparatus according to claim 28, wherein both ends of the reflector facing each other are obliquely oriented and have a larger area than a cross-sectional area of the side of the reflector formed along a line passing through a center of the reflector.
30. The light emitting apparatus according to claim 25, wherein the reflector has a substantially trapezoidal vertical cross-section and an inner surface of the reflector corresponds to an oblique side of the trapezoidal vertical cross-section.