US 20140252393A1

(19) **United States**

(12) **Patent Application Publication**

VANLUCHENE

(10) **Pub. No.: US 2014/0252393 A1**

(43) **Pub. Date: Sep. 11, 2014**

(54) **LIGHT-EMITTING STRUCTURE**

(71) Applicant: **LUXO-LED TAIWAN LIMITED**, Taipei City (TW)

(72) Inventor: **Percy VANLUCHENE**, Taipei City (TW)

(73) Assignee: **LUXO-LED TAIWAN LIMITED**, Taipei City (TW)

(21) Appl. No.: **14/205,084**

(22) Filed: **Mar. 11, 2014**

Related U.S. Application Data

(60) Provisional application No. 61/776,640, filed on Mar. 11, 2013.

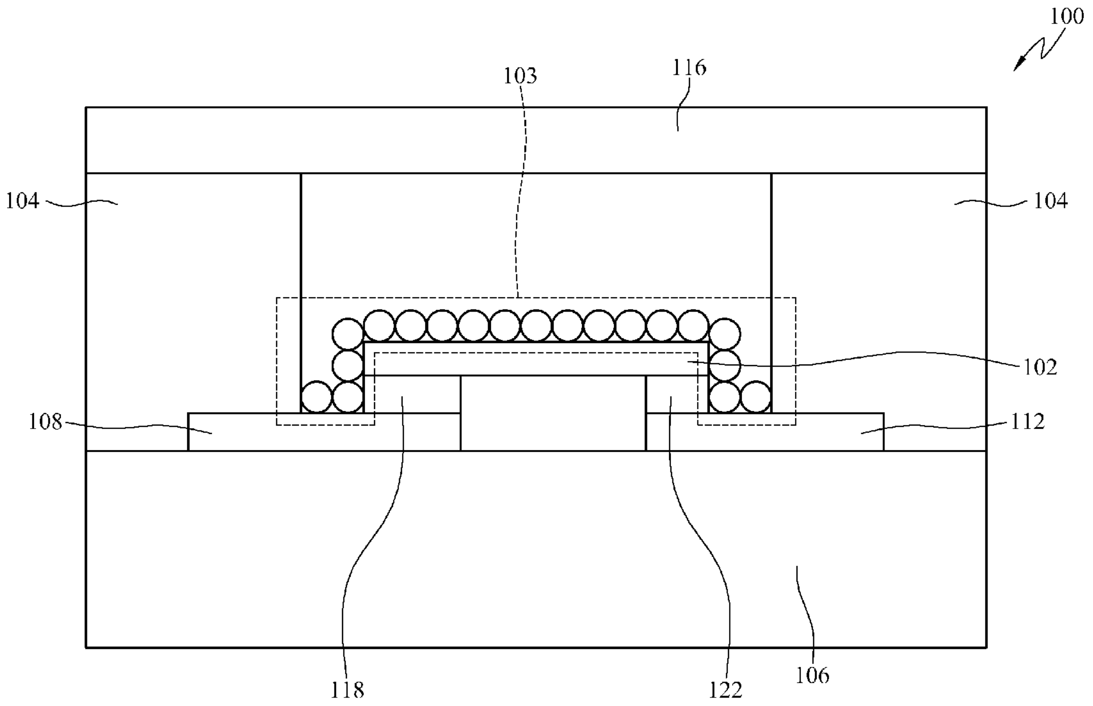
Publication Classification

(51) **Int. Cl.**
H01L 33/50 (2006.01)

(52) **U.S. Cl.**
CPC ***H01L 33/505*** (2013.01)
USPC **257/98**

(57) **ABSTRACT**

A light-emitting structure is provided. The disclosed light-emitting structure may include a light-emitting diode (LED) die, a plurality of light-penetrating microspheres covered a light emitting surface of the LED die, and a light-penetrating structure, disposed over the LED die and the light-penetrating microspheres, for converting light emitting from the LED die. Another light-emitting structure is also provided. The disclosed light-emitting structure may include a light-emitting diode (LED) die, a plurality of light-penetrating microspheres covered a light emitting surface of the LED die, and a light-penetrating structure, disposed between the LED die and the light-penetrating microspheres, for converting light emitting from the LED die.



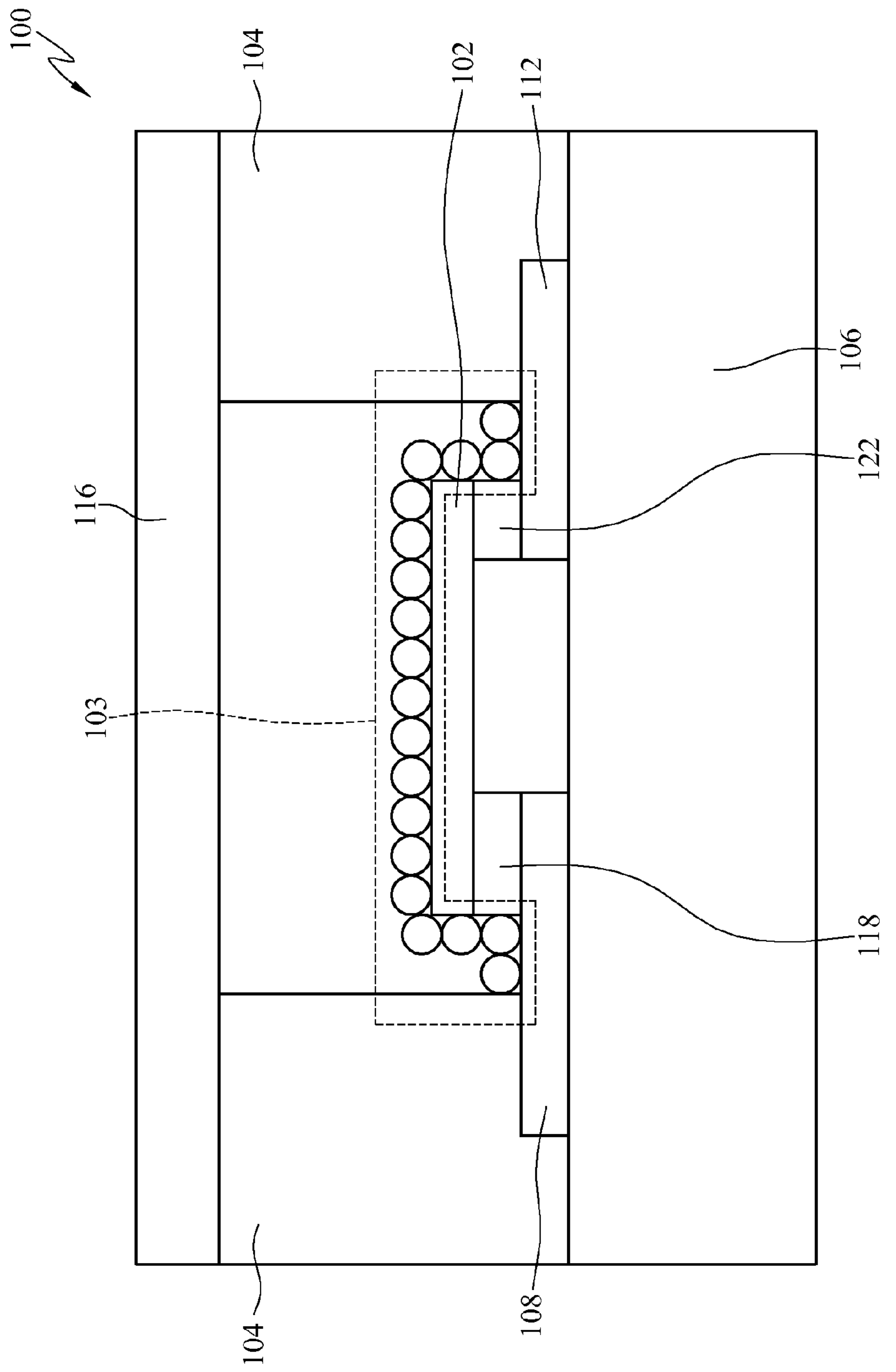


FIG.1

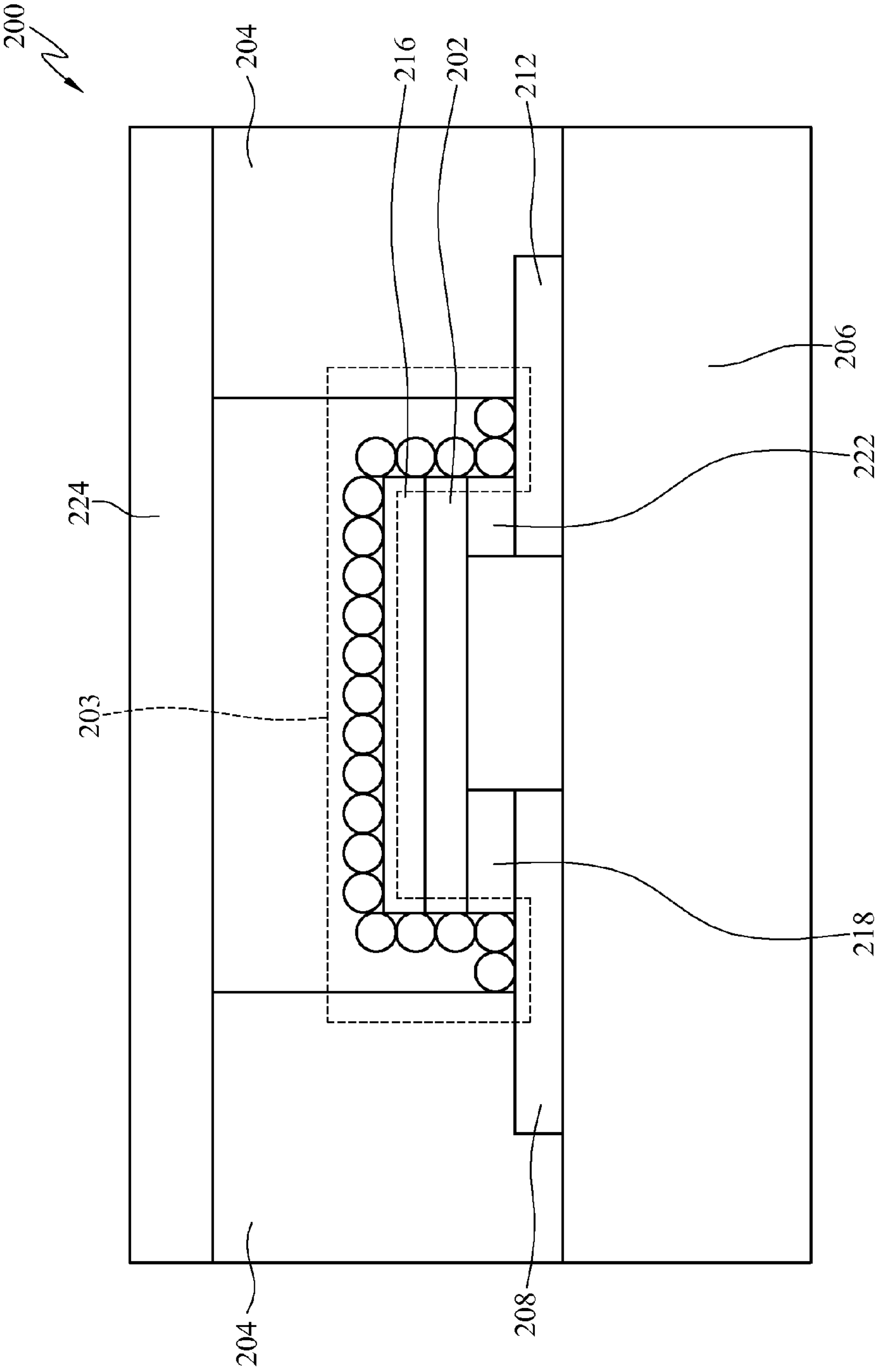


FIG.2

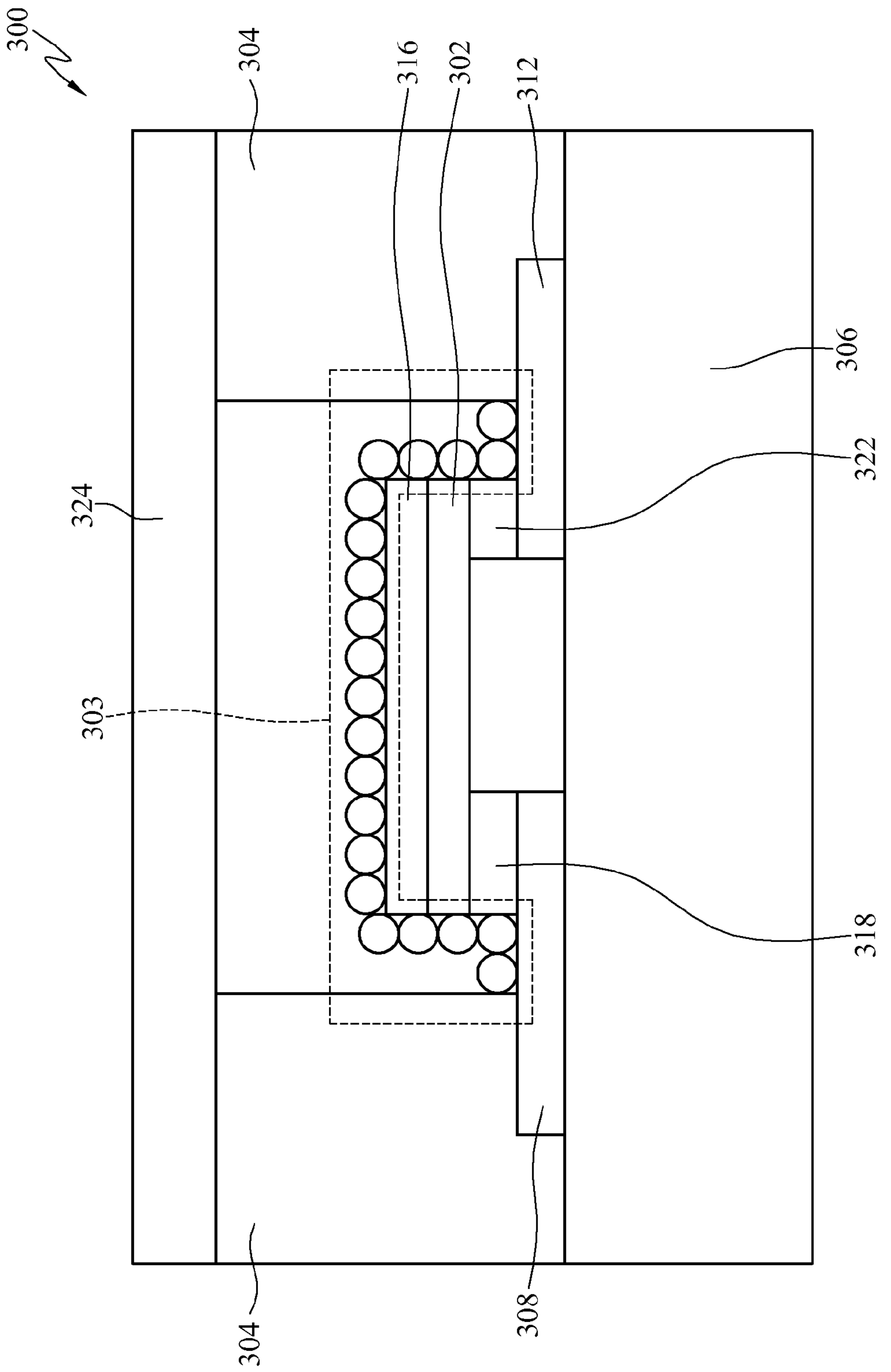


FIG.3

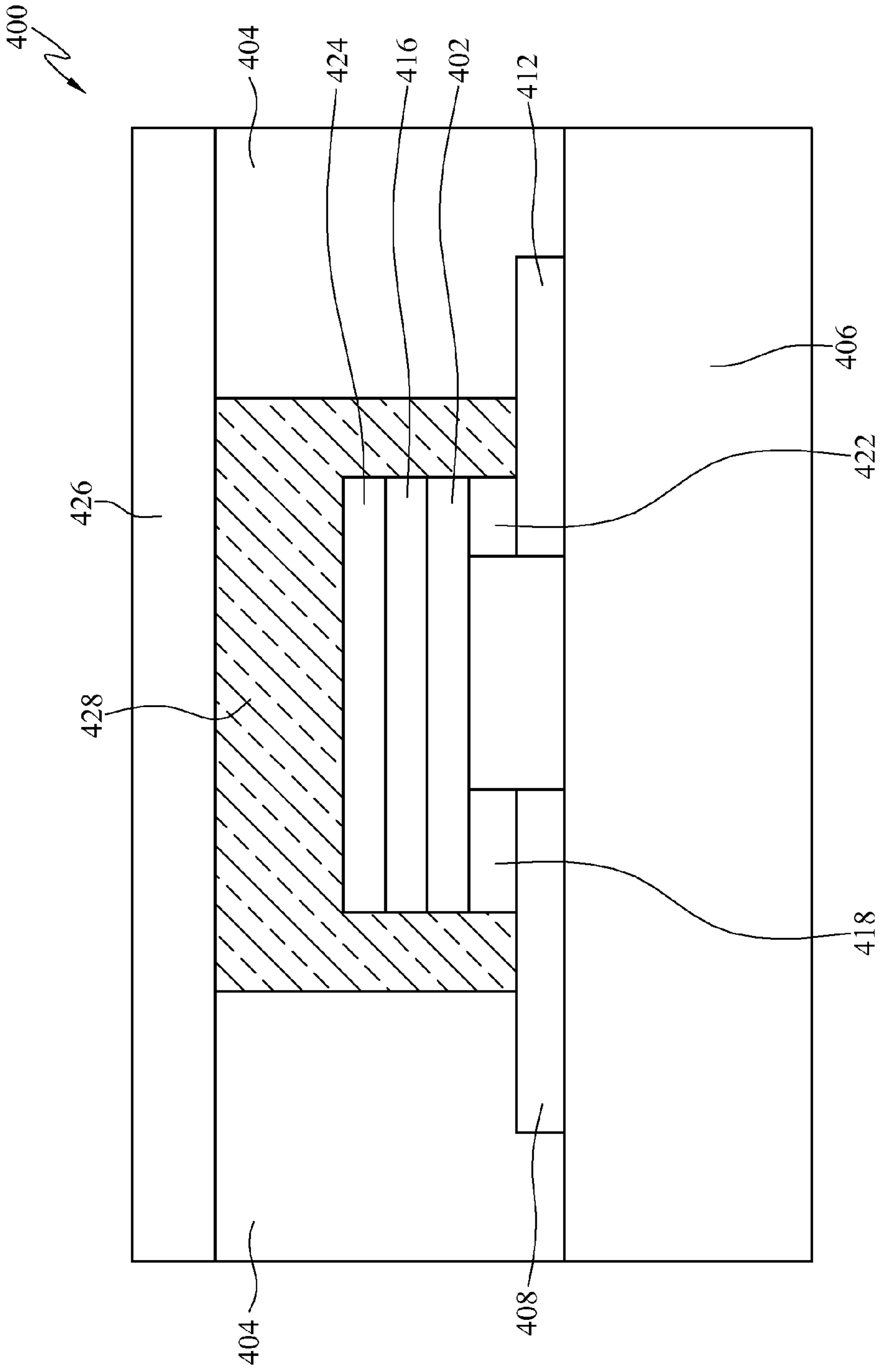


FIG.4A

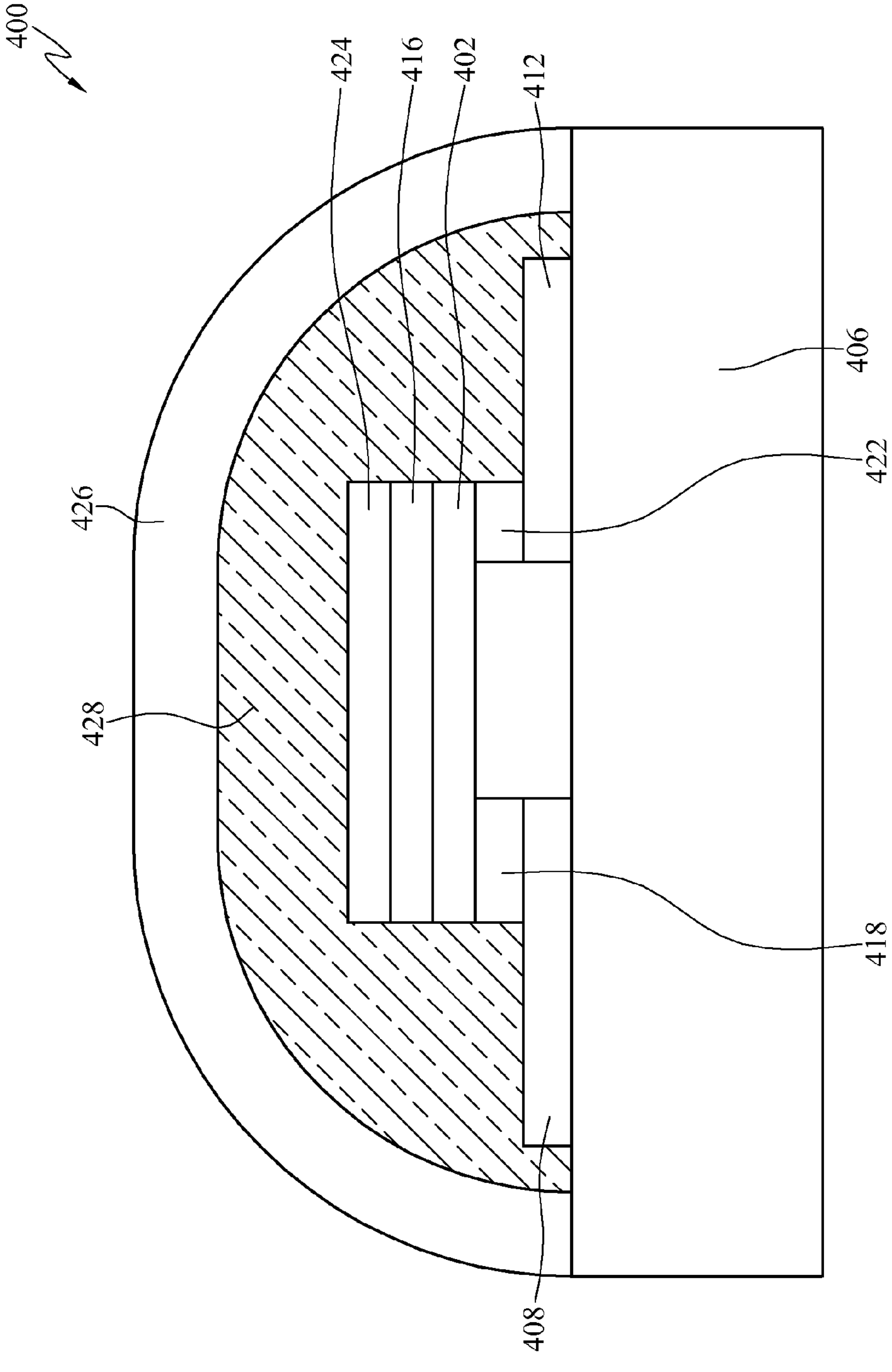


FIG.4B

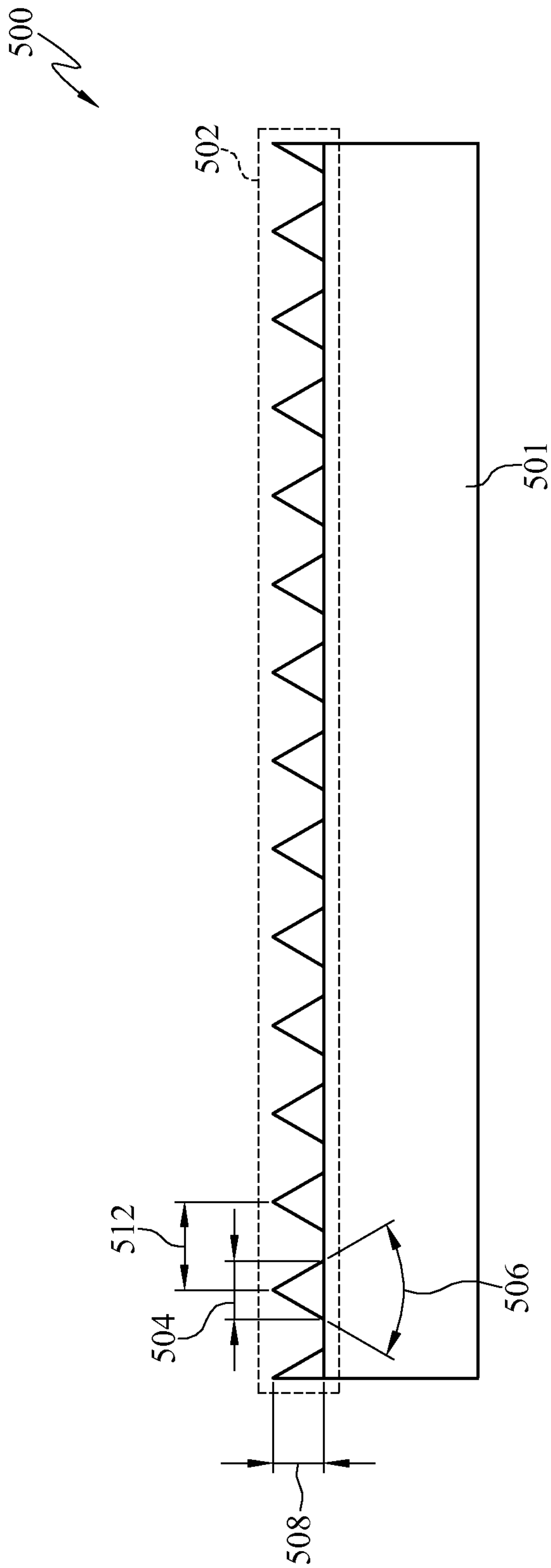


FIG.5

LIGHT-EMITTING STRUCTURE

CROSS REFERENCE TO RELATED APPLICATION

[0001] The application claims priority based on U.S. provisional application, Ser. No. 61/776,640, filed 2013 Mar. 11, entitled LIGHT-EMITTING STRUCTURE, which is hereby incorporated by reference in its entirely.

BACKGROUND

Technical Field

[0002] The present disclosure relates to a light-emitting structure, and more particularly, to a light-emitting structure capable of enabling the light emitted from the light-emitting structure to substantially travel in a predetermined direction.

SUMMARY

[0003] A light-emitting structure is provided. The disclosed light-emitting structure may include a light-emitting diode (LED) die, a plurality of light-penetrating microspheres covered a light emitting surface of the LED die, and a light-penetrating structure, disposed over the LED die and the light-penetrating microspheres, for converting light emitting from the LED die. Another light-emitting structure is also provided. The disclosed light-emitting structure may include a light-emitting diode (LED) die, a plurality of light-penetrating microspheres covered a light emitting surface of the LED die, and a light-penetrating structure, disposed between the LED die and the light-penetrating microspheres, for converting light emitting from the LED die.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] The present disclosure will become more fully understood from the detailed description given herein below for illustration only, and thus are not limitative of the present disclosure, and wherein:

[0005] FIG. **1** is a schematic diagram of a light-emitting structure according to one embodiment of the present disclosure;

[0006] FIG. **2** is a schematic diagram of another light-emitting structure according to one embodiment of the present disclosure;

[0007] FIG. **3** is a schematic diagram of another light-emitting structure according to one embodiment of the present disclosure;

[0008] FIG. **4**A illustrates another light-emitting structure according to one embodiment of the present disclosure;

[0009] FIG. **4**B illustrates the other light-emitting structure according to one embodiment of the present disclosure; and

[0010] FIG. **5** shows an example light guiding lens assembly used by the light-emitting structure according to one embodiment of the present disclosure.

DETAILED DESCRIPTION

[0011] Please refer to FIG. **1** of a schematic diagram of a light-emitting structure **100** according to one embodiment of the present disclosure. The light-emitting structure **100** may include a light-emitting diode (LED) die **102**, a plurality of light-penetrating microspheres **103**, a lateral light blocking wall **104** enclosing the LED die **102** and the light-penetrating microspheres **103**, a substrate **106**, metal contacts **108** and **112**, and a light-penetrating structure **116** over the LED die **102** and the light-penetrating microspheres **103** and in contact with the lateral light blocking wall **104**. In addition, a heat dissipation layer may also be disposed beneath the substrate **106**. The light-penetrating structure **116** may have a various 3D shape, and/or microstructured surface and also can have various optical and photonic characteristics (e.g. CFQ, color changing properties, CRI enhancing properties) The light blocking wall **104** might be omitted and the light-penetrating structure **116** may immediately connected to the substrate **106**. The light-emitting structure **100** may further include bonding pads **118** and **122** electrically contacting the metal contacts **108** and **112**, respectively.

[0012] The light-penetrating microspheres **103** may be adapted to position in a predetermined fashion in order to cover or surround the entire LED die **102**. In one implementation, the light-penetrating microspheres **103** may be in the form of the plastic powder and may cover or surround the LED die **102** by coating. In another implementation, the light-penetrating microspheres **103** may cover or surround the LED die **102** through a bonding agent such as glue. In another implementation, the light-penetrating microspheres **103** may be in the form of glass balls. The microspheres can be mixed at randomly in an agent (e.g. silicone) to create a floating effect of the microsphere.

[0013] The lateral light blocking wall **104** may be used to eliminate the possibility of the light emitted from the LED die **102** of laterally travelling out of the light-emitting structure. The lateral light blocking wall **104** may be formed out of material of copper (Cu) or epoxy, or silicone, or any other material which is stable enough to form a solid structure. In the case of the copper forming the lateral light blocking wall **104**, an isolation layer might be applied onto the base of the lateral light blocking wall **104** to prevent the base from being electrically connected to the top of the same lateral light blocking wall **104**. Further, a reflective layer formed in silver (Ag) may be placed on the top of the lateral light blocking wall **104** for enhancing the reflection. With the lateral light blocking wall **104**, the light emitted from the LED die **102** may be guided upwardly. In one implementation, the light-penetrating structure **116** may be implemented in form of a color converting crystal, or a lamination of several layers (one of them can be a color converting crystal) with different properties to enhance the desired output, which may not just allow for the light from the LED die **102** to penetrate but also convert the color of such light. In other words, the light-penetrating structure **116** may serve several purposes, such as adjusting correlated color temperature (CCT), color rendering index (CRI), optical diffusing, and/or optical focusing. The substrate **106**, which is now a physical part, might become the integral part of a housing onto which the die will be bonded in the future.

[0014] The bonding pads **118** and **122**, which are electrically coupled to the metal contacts **108** and **112**, may be used as negative and positive electrodes for the LED die **102**. And the heat arising out of the operation of the LED die **102** may be transmitted out of the light-emitting structure **100** through the metal contacts **108** and **112**, the substrate **106**, and the heat dissipation layer. It is worth noting that in one implementation the substrate **106** may be a ceramic substrate and 125-500 micrometers in thickness. To be noted, the thickness is not a limiting factor.

[0015] The LED die **102** may be flipped in order to be in contact with the metal contacts **108** and **112** through the bonding pads **118** and **122** using the flip-chip technology.

[0016] Please refer to FIG. **2** illustrating another light-emitting structure **200** according to one embodiment of the present disclosure. The light-emitting structure **200** may include a light-emitting diode (LED) die **202**, a plurality of light-penetrating microspheres **203**, a lateral light blocking wall **204** enclosing the LED die **202** and the light-penetrating microspheres **203**, a substrate **206**, metal contacts **208** and **212**, and a light-penetrating structure **216**. In addition, a heat dissipation layer may also be disposed beneath the substrate **206**. The light-emitting structure **200** may further include bonding pads **218** and **222** electrically contacting the metal contacts **208** and **212**, respectively. The light-emitting structure **200** also includes a protective film **224** (could also be considered as another light-penetrating structure mentioned before) contacting the lateral light blocking wall **204**. The protective film **224** may have a various 3D shape, and/or microstructured surface and also can have various optical and photonic characteristics (e.g. CFQ, color changing properties, CRI enhancing properties) The light blocking wall **204** might be omitted and the protective film **224** may immediately connected to the substrate **206**.

[0017] Instead of being placed above both the LED die **202** and the light-penetrating microspheres **203** as illustrated in FIG. **1**, the light-penetrating structure **216** (or a lamination of different layers with optical and photonic characteristics) may be placed between the LED die **202** and the light-penetrating microspheres **203**. Under this arrangement, the intended functions of the light-penetrating structure **216**, which may include allowing for the light emitted from the LED die **202** to penetrate and converting the color of the same light emitted from the LED die **202**, may not be compromised.

[0018] The light-penetrating microspheres **203** may be adapted to position in a predetermined fashion in order to cover or surround both the entire LED die **202** and the light-penetrating structure **216**. Similar to the way the light-penetrating microspheres **103** covers or surrounds the LED die **102**, the light-penetrating microspheres **203** may be in the form of the plastic powder covering or surrounding the light-penetrating structure **216** and the LED die **202** by coating. Alternatively, the light-penetrating microspheres **203** may cover or surround the LED die **102** and the light-penetrating structure **216** through gluing.

[0019] The lateral light blocking wall **204** meanwhile may be used to prevent the light emitted from the LED die **202** from laterally travelling out of the light-emitting structure **200**, which may ensure the light emitted from the LED die **202** may be guided upwardly.

[0020] The bonding pads **218** and **222**, which are electrically coupled to the metal contacts **208** and **212**, may be used as negative and positive electrodes for the LED die **202**. And the heat arising out of the operation of the LED die **202** may be transmitted out of the light-emitting structure **200** through the metal contacts **208** and **212**, the substrate **206**, and the heat dissipation layer. Additionally, the LED die **202** may be flipped in order to be in contact with the metal contacts **208** and **212** through the bonding pads **218** and **222** using the flip-chip technology. Plus, it is worth noting that the protective film **224** may be used to prevent foreign particles (for example, dust) and the moisture from invading into the light-emitting structure **200**. Also, the protective film **224** may serve as a color converting layer. The protective film **224** layer can have various shapes and surface structures with different optical and photonic properties.

[0021] Please refer to FIG. **3** illustrating another light-transmitting structure **300** according to one embodiment of the present disclosure. The light-emitting structure **300** may include a light-emitting diode (LED) die **302**, a plurality of light-penetrating microspheres **303**, a lateral light blocking wall **304** enclosing the LED die **302** and the light-penetrating microspheres **303**, a substrate **306**, metal contacts **308** and **312**, and a light-penetrating structure **316** placed between the light-penetrating microspheres **303** and the LED die **302**. In addition, a heat dissipation layer may also be disposed beneath the substrate **306**. The light-emitting structure **300** may further include bonding pads **318** and **322** electrically contacting the metal contacts **308** and **312**, respectively.

[0022] The light-emitting structure **300** may also include a light guiding lens assembly **324** placed above the LED die **302**, the light-penetrating microspheres **303**, and the light-penetrating structure **316**. In one implementation, the light guiding lens assembly **324** may be an array of silicon-based micro prisms. In another implementation, the light guiding lens assembly **324** may be in the form of Fresnel lens. In another implementation, the light guiding lens assembly **324** may be having silicon-based domes.

[0023] The light-penetrating microspheres **303** may be adapted to position in a predetermined fashion, in order to cover or surround both the entire LED die **302** and the light-penetrating structure **316**. Similar to the way the light-penetrating microspheres **103** covers or surrounds the LED die **302**, the light-penetrating microspheres **303** may be in the form of the plastic powder covering or surrounding the light-penetrating structure **316** and the LED die **302** by coating. Alternatively, the light-penetrating microspheres **303** may cover or surround the LED die **302** and the light-penetrating structure **316** through gluing.

[0024] Similar to its counterparts in FIGS. **1** and **2**, the lateral light blocking wall **304** may be used to prevent the light emitted from the LED die **302** from laterally travelling out of the light-emitting structure **300**. Such light may be further guided along a predetermined direction present the light guiding lens assembly **324**.

[0025] The bonding pads **318** and **322**, which are electrically coupled to the metal contacts **308** and **312**, may be used as negative and positive electrodes for the LED die **302**, respectively. And the heat arising out of the operation of the LED die **302** may be transmitted out of the light-emitting structure **300** through the metal contacts **308** and **312**, the substrate **306**, and the heat dissipation layer. Additionally, the LED die **302** may be flipped in order to be in contact with the metal contacts **308** and **312** through the bonding pads **318** and **322** using the flip-chip technology.

[0026] FIG. 4A, meanwhile, illustrates another light-emitting structure **400** according to one embodiment of the present disclosure. The light-emitting structure **400** may include a light-emitting diode (LED) die **402**, a lateral light blocking wall **404** enclosing the LED die **402**, a substrate **406**, metal contacts **408** and **412**, and a light-penetrating structure **416** placed above the LED die **402**. In addition, a heat dissipation layer may also be disposed beneath the substrate **406**. The light-emitting structure **400** may further include bonding pads **418** and **422** electrically contacting the metal contacts **408** and **412**, respectively.

[0027] Above the light-penetrating structure **416** may be a primary light guiding lens assembly **424**. Additionally, the light-emitting structure **400** may further include a secondary light guiding lens assembly **426** contacting the lateral light blocking wall **404**. The light-emitting structure **400** may also include a silicon-based filler **428** that may partially or totally fill up the space at least defined by the lateral blocking wall **404**, the stacked structure consisting of the LED die **402**, the light-penetrating structure **416**, and the primary light guiding lens assembly **424**, and the secondary light guiding lens assembly **426**.

[0028] In one implementation, both the primary light guiding lens assembly **424** and the secondary light guiding lens assembly **426** may be an array of silicon-based micro prisms. In another implementation, both the primary light guiding lens assembly **424** and the secondary light guiding lens assembly **426** may be in the form of Fresnel lens. Similar to the light guiding lens assembly **324**, both the primary light guiding lens assembly **424** and the secondary light guiding lens assembly **426** may be having the silicon-based domes as well.

[0029] The silicon-based filler **428** may replace the light-penetrating microspheres **303** shown in FIG. **3** and may at least serve to allow for the light emitted from the LED die **402** to penetrate. The lateral light blocking wall **404** may be used to prevent the light emitted from the LED die **402** from laterally travelling out of the light-emitting structure **400**. And with the primary light guiding lens assembly **424**, the silicon-based filler **428**, and the secondary light guiding lens assembly **426** the light emitted from the LED die **402** may be further guided along a predetermined direction.

[0030] It is worth noting that the silicon-based filler **428** may be replaced by another filler with particles capable of scattering, diffusing, and/or reflecting. Therefore, such filler, which may not be silicon-based and thus could be of another compound, could be the transparent filler, the milky type, or the colored filler.

[0031] The bonding pads **418** and **422**, which are electrically coupled to the metal contacts **408** and **412**, may be used as negative and positive electrodes for the LED die **402**, respectively. The light-penetrating structure **416** may perform the color converting function especially when the secondary light guiding lens assembly **426** is in the form of a transparent medium. Plus, in another implementation the color converting may not be performed by the light-penetrating structure **416**. Rather, the function of the color converting may be realized by the secondary light guiding lens assembly **426**. In this particular example, the primary light guiding lens assembly **416** may be in the form of a sapphire transparent material. The heat arising out of the operation of the LED die **402** may be transmitted out of the light-emitting structure **400** through the metal contacts **408** and **412**, the substrate **406**, and the heat dissipation layer. Additionally, the LED die **402** may be flipped in order to be in contact with the metal contacts **408** and **412** through the bonding pads **418** and **422** using the flip-chip technology. The light-penetrating structure **416** may also function to convert the color of the light emitted from the LED die **402**.

[0032] The lateral light blocking wall **404** might be omitted and the secondary light guiding lens assembly **426** may immediately connected to the substrate **406**. As shown in FIG. 4B, the difference between FIG. 4A and 4B is that the secondary light guiding lens assembly **426** is disposed directly on the substrate **406**, and the secondary light guiding lens assembly **426** has a curved shape. The silicon-based filler **428**, also shown in FIG. 4A, that may partially or totally fill up the space at least defined by the stacked structure consisting of the LED die **402**, the light-penetrating structure **416**, and the primary light guiding lens assembly **424**, and the secondary light guiding lens assembly **426**.

[0033] Please refer to FIG. **5** illustrating an example light guiding lens assembly **500** used in the light-emitting structure according to one embodiment of the present disclosure. The light guiding lens assembly **500** may be utilized as the light guiding lens assembly **324**, the primary light guiding lens assembly **424**, and the secondary light guiding lens assembly **426**

[0034] The light guiding lens assembly **500** may include a transparent substrate **501** along with a lens array **502** having multiple lens structures placed on the transparent substrate **501**. The lens array **502** may be made of acrylic resin, silicone resin and in form of such layer coated on the transparent substrate **501**. In one implementation, the transparent substrate **501** may be a polyester PET substrate, sapphire, glass or any substrate to resist temperature and light.

[0035] The parameters of the lens array **502** may include the width (pitch) **504**, the angle **506**, the height **508** of the lens structure, and the distance between the neighboring lens structures. Each lens structure may be different from others in terms of the aforementioned parameters. With the light guiding lens assembly **500**, the light emitted from the LED die, may be guided in desired directions.

[0036] The foregoing description of the exemplary embodiments of the present disclosure has been presented only for the purposes of illustration and description and is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations are possible in light of the above teaching.

[0037] The embodiments were chosen and described in order to explain the principles of the present disclosure and their practical application so as to activate others skilled in the art to utilize the present disclosure and various embodiments and with various modifications as are suited to the particular use contemplated. Alternative embodiments will become apparent to those skilled in the art to which the present disclosure pertains without departing from its spirit and scope. Accordingly, the scope of the present disclosure is defined by the appended claims rather than the foregoing description and the exemplary embodiments described therein.

What is claimed is:

1. A light-emitting structure, comprising:

a LED die;

a plurality of light-penetrating microspheres, disposed above the LED die, covered a light emitting surface of the LED die; and

a light-penetrating structure, disposed over the LED die and the light-penetrating microspheres, for converting the color of the light.

2. The light-emitting structure according to claim **1**, wherein the light-penetrating microspheres are adapted to position in a predetermined fashion in order to cover or surround the entire LED die.

3. The light-emitting structure according to claim **2**, wherein the light-penetrating microspheres are directly disposed on the light emitting surface of the LED die.

4. The light-emitting structure according to claim **3**, wherein the light-penetrating microspheres are in the form of the plastic powder and cover the LED die by coating.

5. The light-emitting structure according to claim **3**, wherein the light-penetrating microspheres cover the LED die through a bonding agent.

6. The light-emitting structure according to claim **3**, further comprising:

a lateral light blocking wall, enclosing the LED die and the light-penetrating microspheres, configured to eliminate the possibility of the light emitted from the LED die of laterally travelling out of the light-emitting structure;

wherein the light-penetrating structure is disposed over the LED die and the light-penetrating microspheres and in contact with a top portion of the lateral light blocking wall.

7. The light-emitting structure according to claim **6**, further comprising:

a reflective layer, disposed on a top portion of the lateral light blocking wall, for enhancing the reflection of the light emitted from the LED die.

8. The light-emitting structure according to claim **3**, further comprising:

a substrate disposed under the LED die;

a plurality of metal contacts connected to the substrate and electrically connected to the LED die;

wherein at least a part of the metal contacts disposed between the substrate and the LED die.

9. The light-emitting structure according to claim **8**, further comprising:

a plurality of pads directly connected to the LED die;

wherein each of the pads connected to one of the metal contacts, at least one of the pads is configured to be a negative electrode of the LED die, and at least another one of the pads is configured to be a positive electrode of the LED die.

10. The light-emitting structure according to claim **9**, further comprising:

a heat dissipation layer directly connected to the substrate.

11. A light-emitting structure, comprising:

a LED die;

a plurality of light-penetrating microspheres, disposed above the LED die, covered a light emitting surface of the LED die; and

a light-penetrating structure, disposed between the LED die and the light-penetrating microspheres, for converting the color of the light.

12. The light-emitting structure according to claim **11**, wherein the light-penetrating microspheres are directly disposed on the light-penetrating structure, and the light-penetrating structure is directly disposed on the substrate.

13. The light-emitting structure according to claim **11**, further comprising:

a lateral light blocking wall, enclosing the LED die and the light-penetrating microspheres, configured to eliminate the possibility of the light emitted from the LED die of laterally travelling out of the light-emitting structure.

14. The light-emitting structure according to claim **13**, further comprising:

a reflective layer, disposed on a top portion of the lateral light blocking wall, for enhancing the reflection of the light emitted from the LED die.

15. The light-emitting structure according to claim **13**, further comprising:

a protective film, disposed over the light-penetrating microspheres and in contact with a top portion of the lateral light blocking wall, for preventing foreign particles and the moisture from invading into the light-emitting structure.

16. The light-emitting structure according to claim **15**, further comprising:

a secondary light guiding lens assembly disposed over the light-penetrating microspheres and in contact with a top portion of the lateral light blocking wall.

17. The light-emitting structure according to claim **16**, wherein the light-penetrating microspheres are configured to be served as a primary light guiding lens assembly directly disposed on the light-penetrating structure.

18. The light-emitting structure according to claim **17**, further comprising:

a silicon-based filler partially or totally fill up the space at least defined by the lateral blocking wall, the secondary light guiding lens assembly, and the stacked structure consisting of the LED die, the light-penetrating structure, and the primary light guiding lens assembly.

19. The light-emitting structure according to claim **11**, further comprising:

a substrate disposed under the LED die;

a plurality of metal contacts connected to the substrate and electrically connected to the LED die;

wherein at least a part of the metal contacts disposed between the substrate and the LED die.

20. The light-emitting structure according to claim **19**, further comprising:

a plurality of pads directly connected to the LED die;

wherein each of the pads connected to one of the metal contacts, at least one of the pads is configured to be a negative electrode of the LED die, and at least another one of the pads is configured to be a positive electrode of the LED die.

* * * * *