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(54) **PACKAGE STRUCTURE AND MANUFACTURING METHOD THEREOF**

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H10H 20/854	(2025.01)
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See application file for complete search history.

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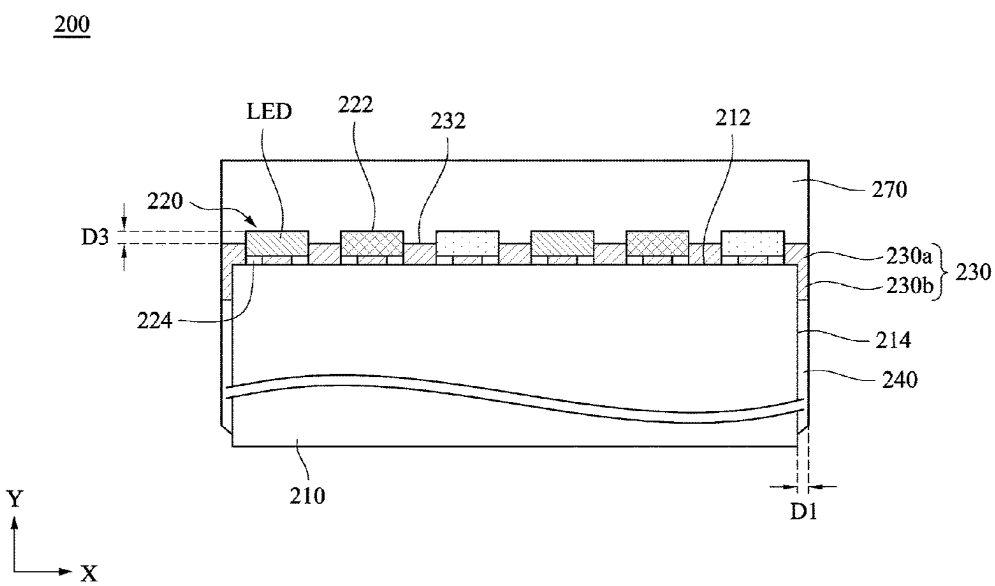
(57) **ABSTRACT**

A package structure includes a circuit substrate, a light emitting diode array, a first encapsulant, and a sealant. The circuit substrate includes a top surface and a side surface of the circuit substrate. The light emitting diode array is disposed on the top surface of the circuit substrate. The first encapsulant is disposed above the circuit substrate. The first encapsulant includes a main portion and an extension portion, in which the main portion of the first encapsulant is disposed parallel to the top surface of the circuit substrate, and the extension portion of the first encapsulant extends to the side surface of the circuit substrate. The sealant is disposed below the extension portion of the first encapsulant, and the sealant contacts the first encapsulant and the circuit substrate. The first encapsulant and the sealant together form a coplanar surface.

20 Claims, 14 Drawing Sheets



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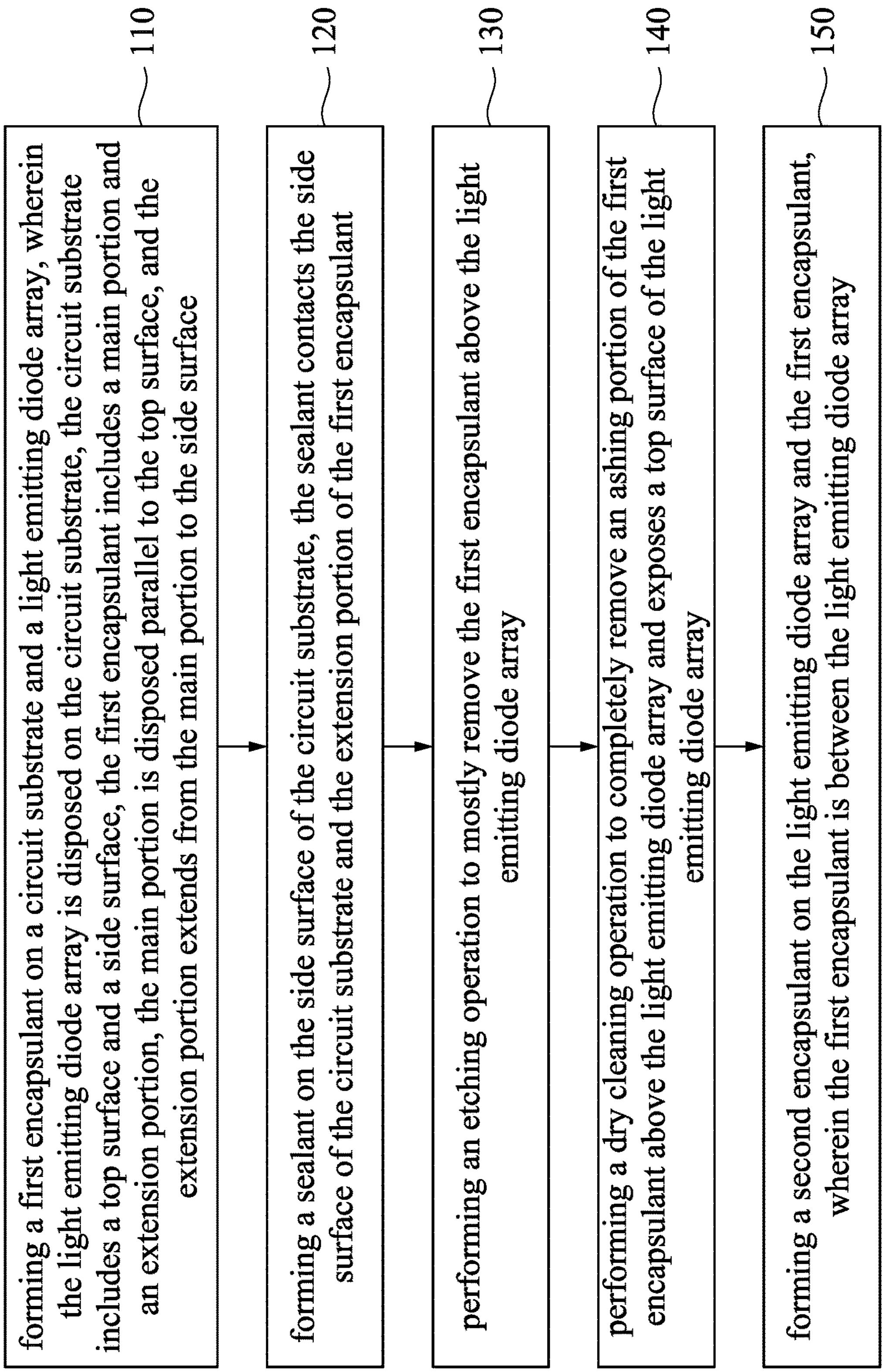
110
forming a first encapsulant on a circuit substrate and a light emitting diode array, wherein the light emitting diode array is disposed on the circuit substrate, the circuit substrate includes a top surface and a side surface, the first encapsulant includes a main portion and an extension portion, the main portion is disposed parallel to the top surface, and the extension portion extends from the main portion to the side surface
120
forming a sealant on the side surface of the circuit substrate, the sealant contacts the side surface of the circuit substrate and the extension portion of the first encapsulant
130
performing an etching operation to mostly remove the first encapsulant above the light emitting diode array
140
performing a dry cleaning operation to completely remove an ashing portion of the first encapsulant above the light emitting diode array and exposes a top surface of the light emitting diode array
150
forming a second encapsulant on the light emitting diode array and the first encapsulant, wherein the first encapsulant is between the light emitting diode array

100

Fig. 1

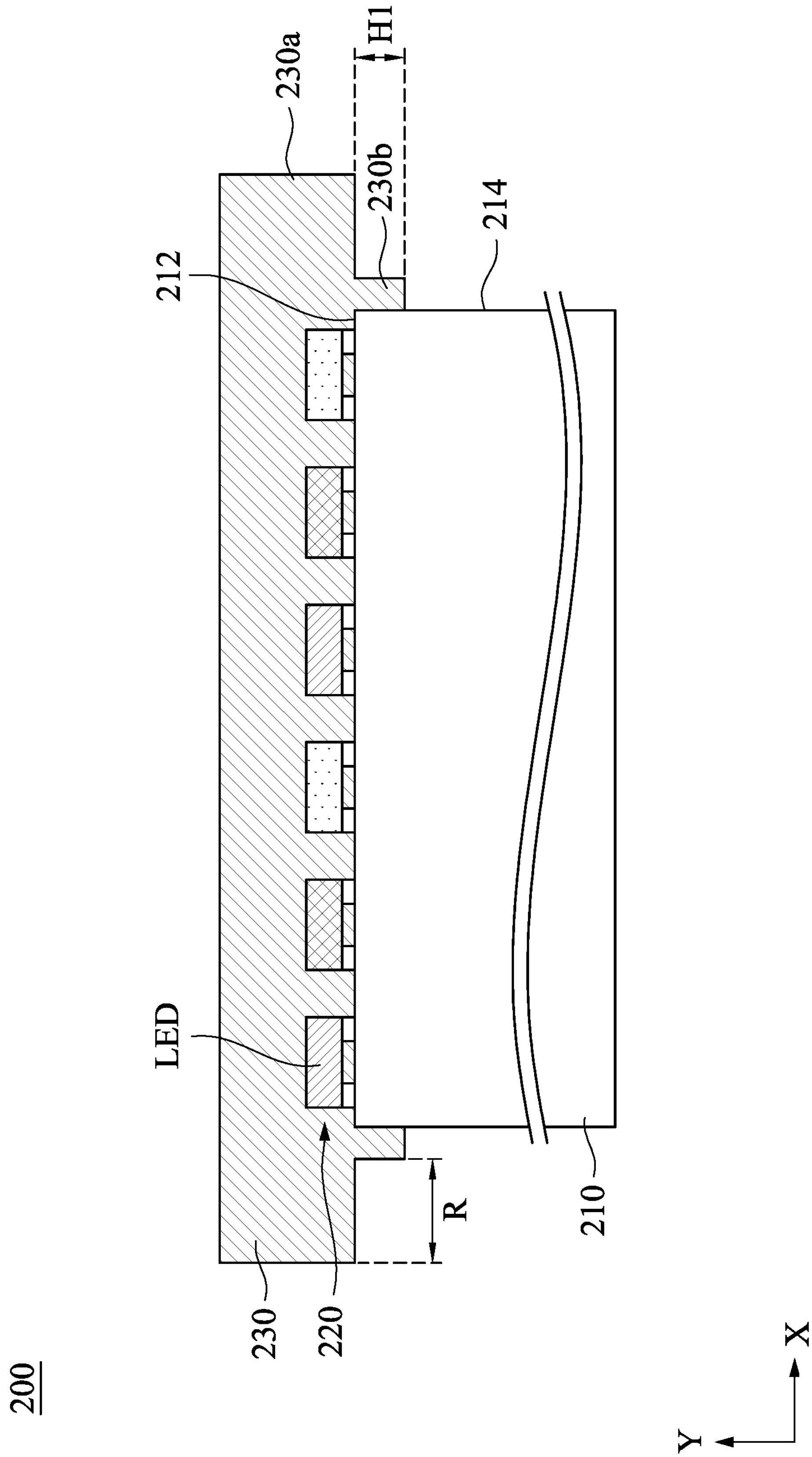

Fig. 2A

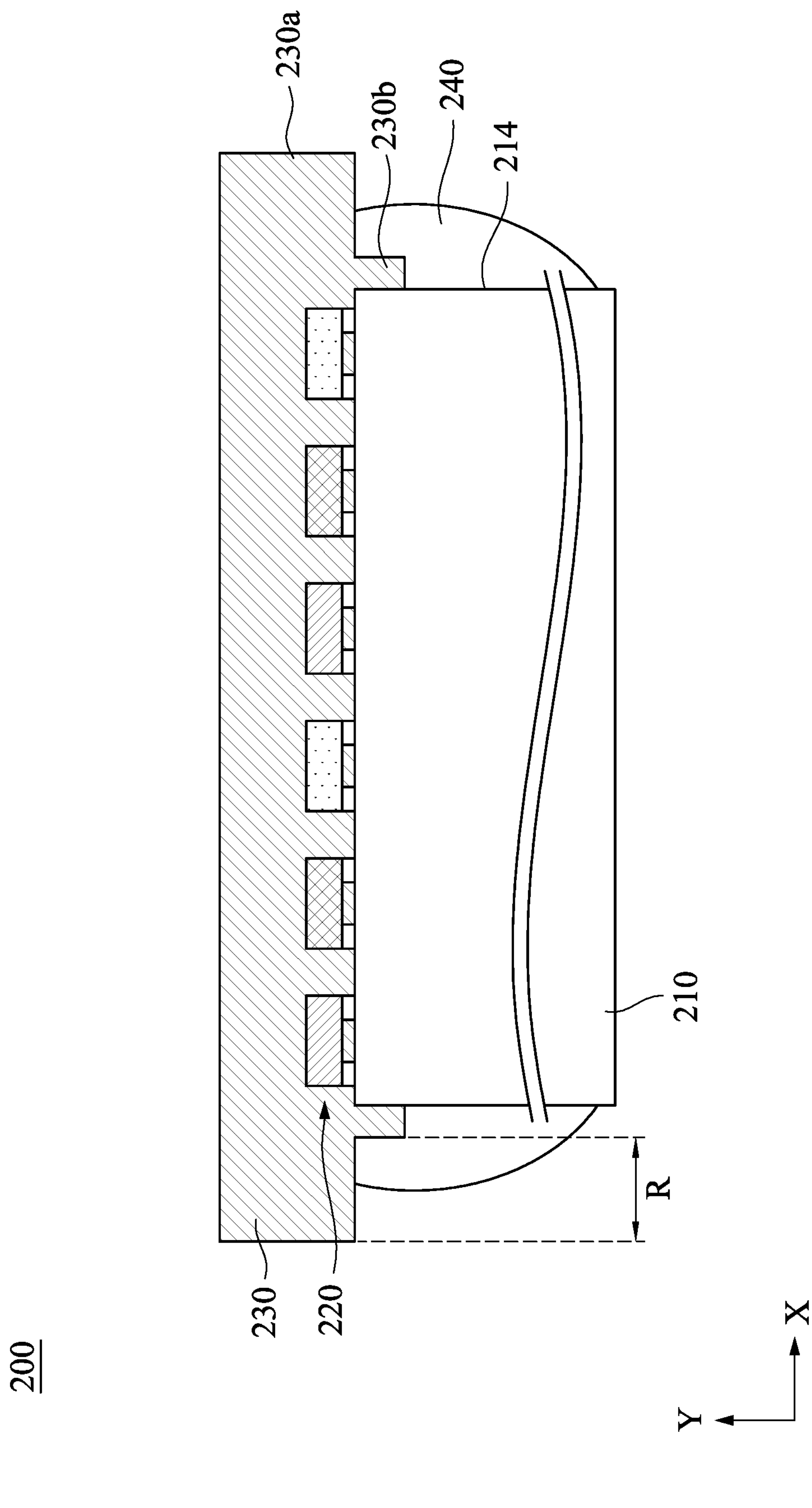

Fig. 2B

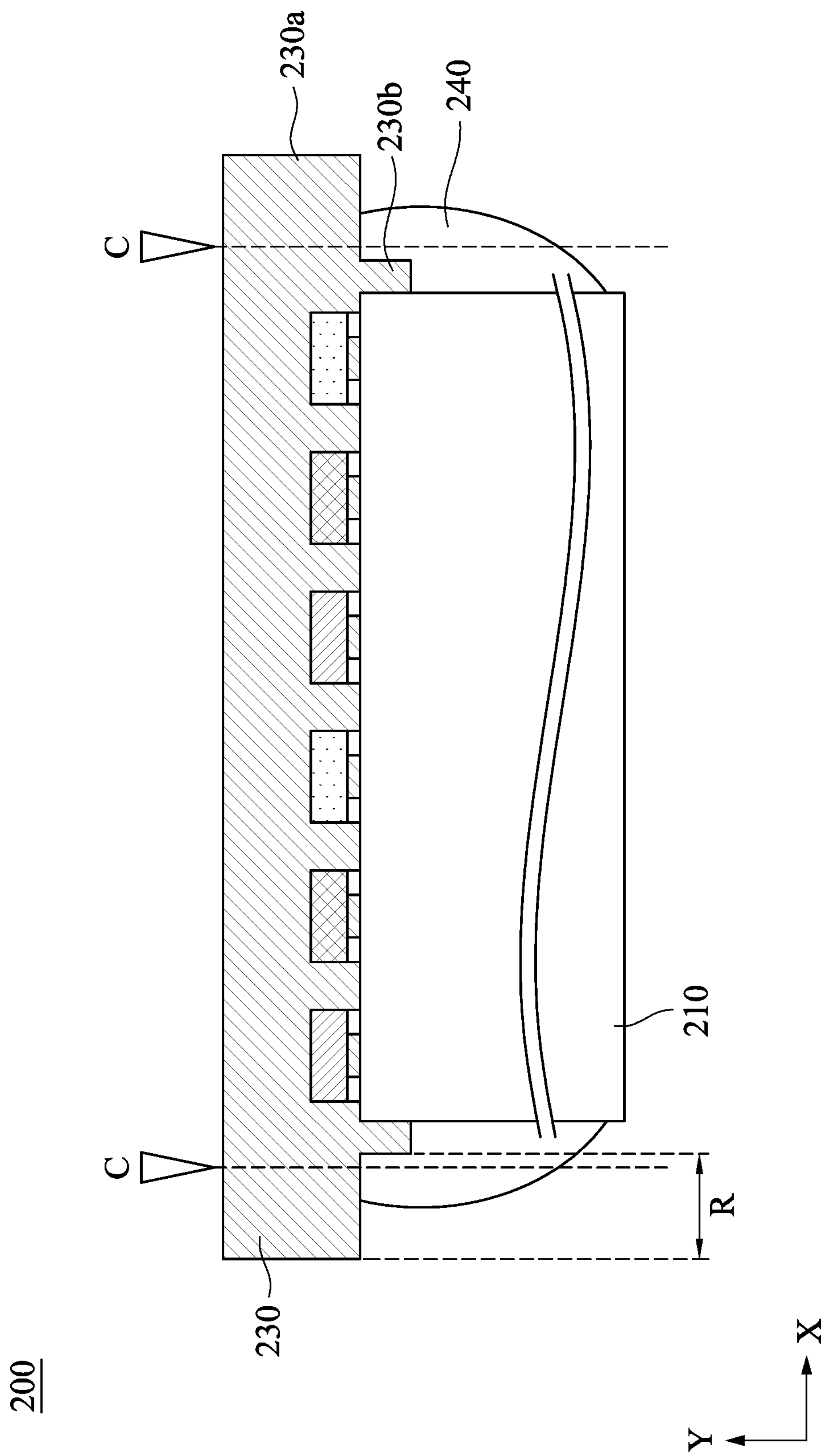

Fig. 2C

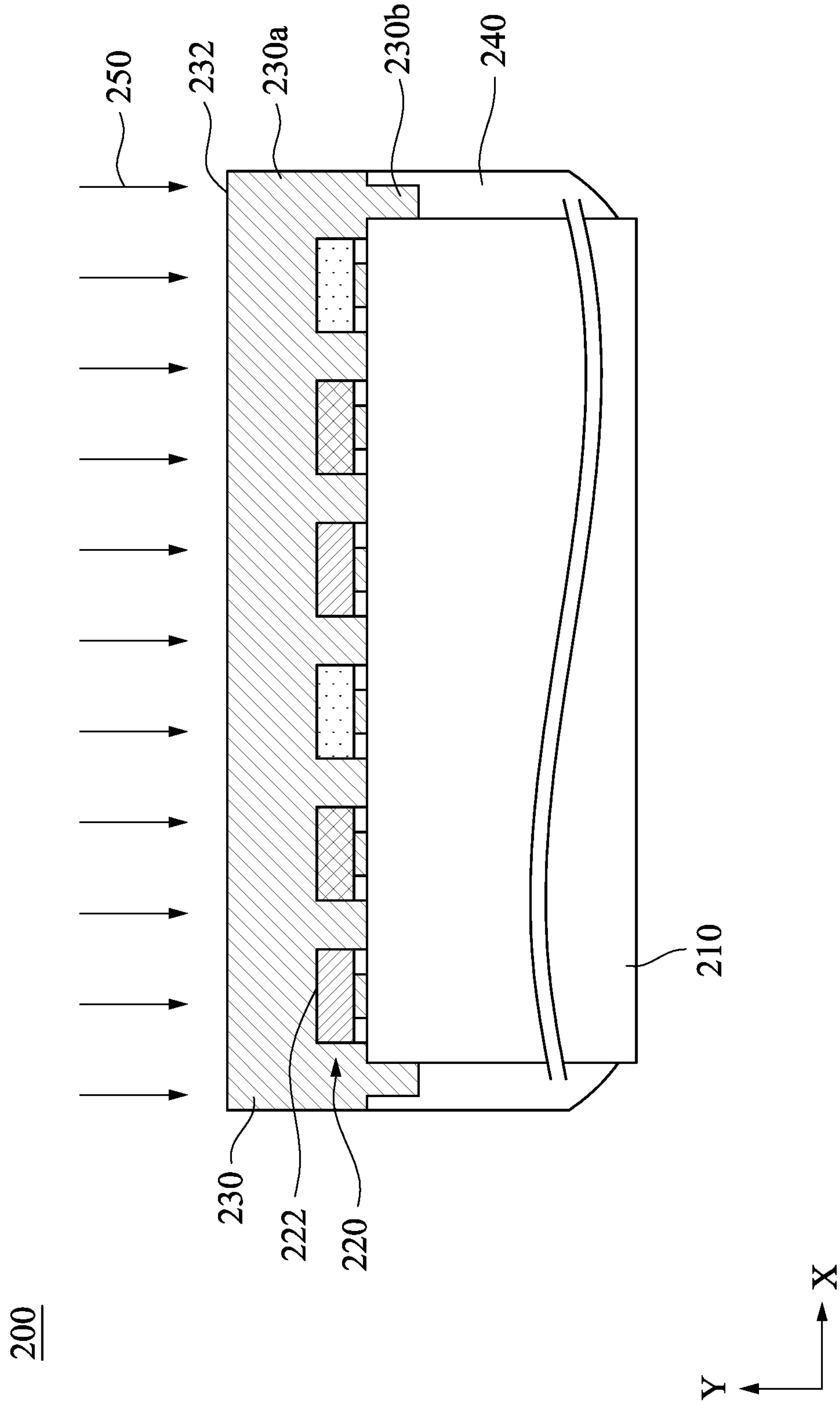

Fig. 2D

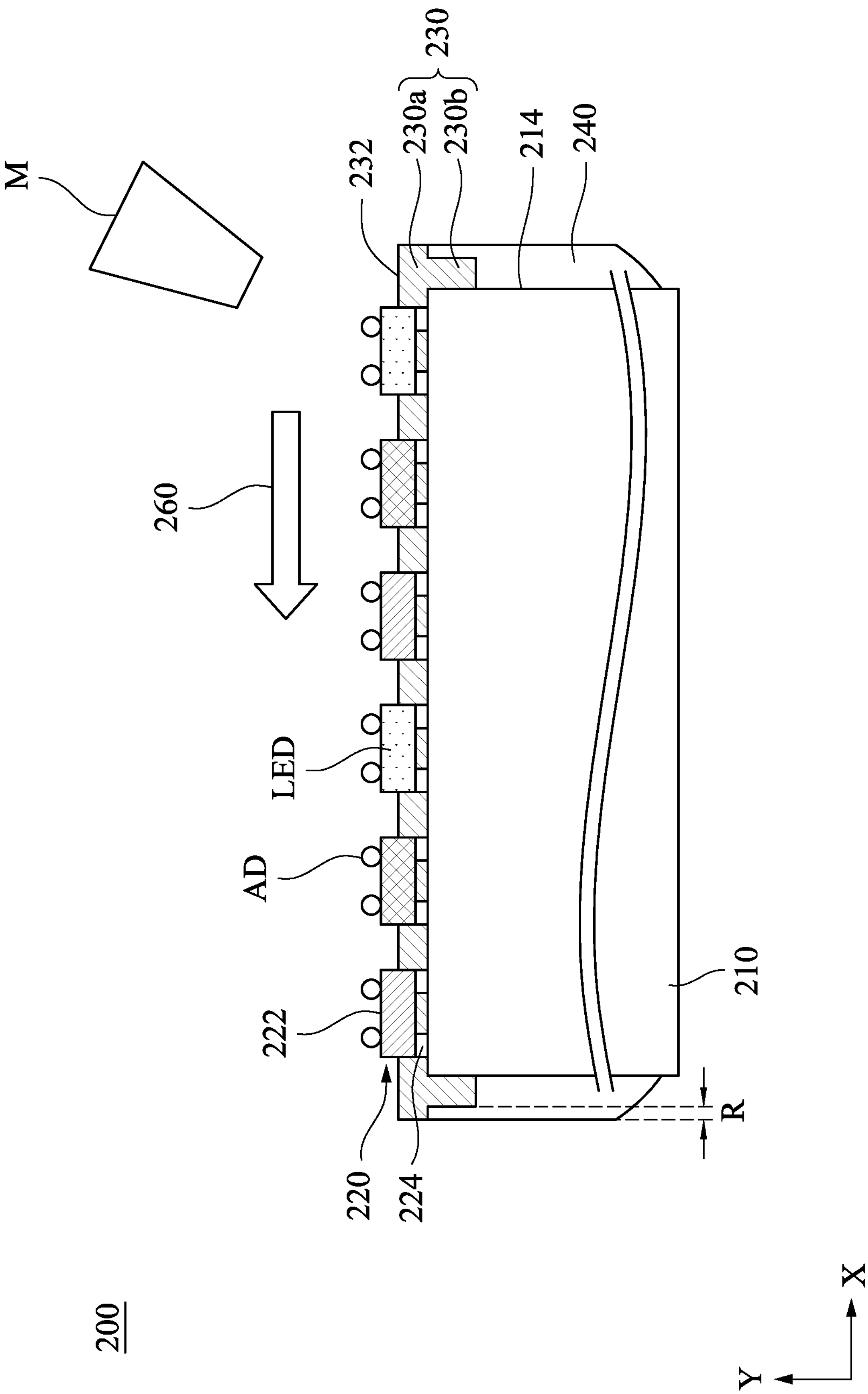

Fig. 2E

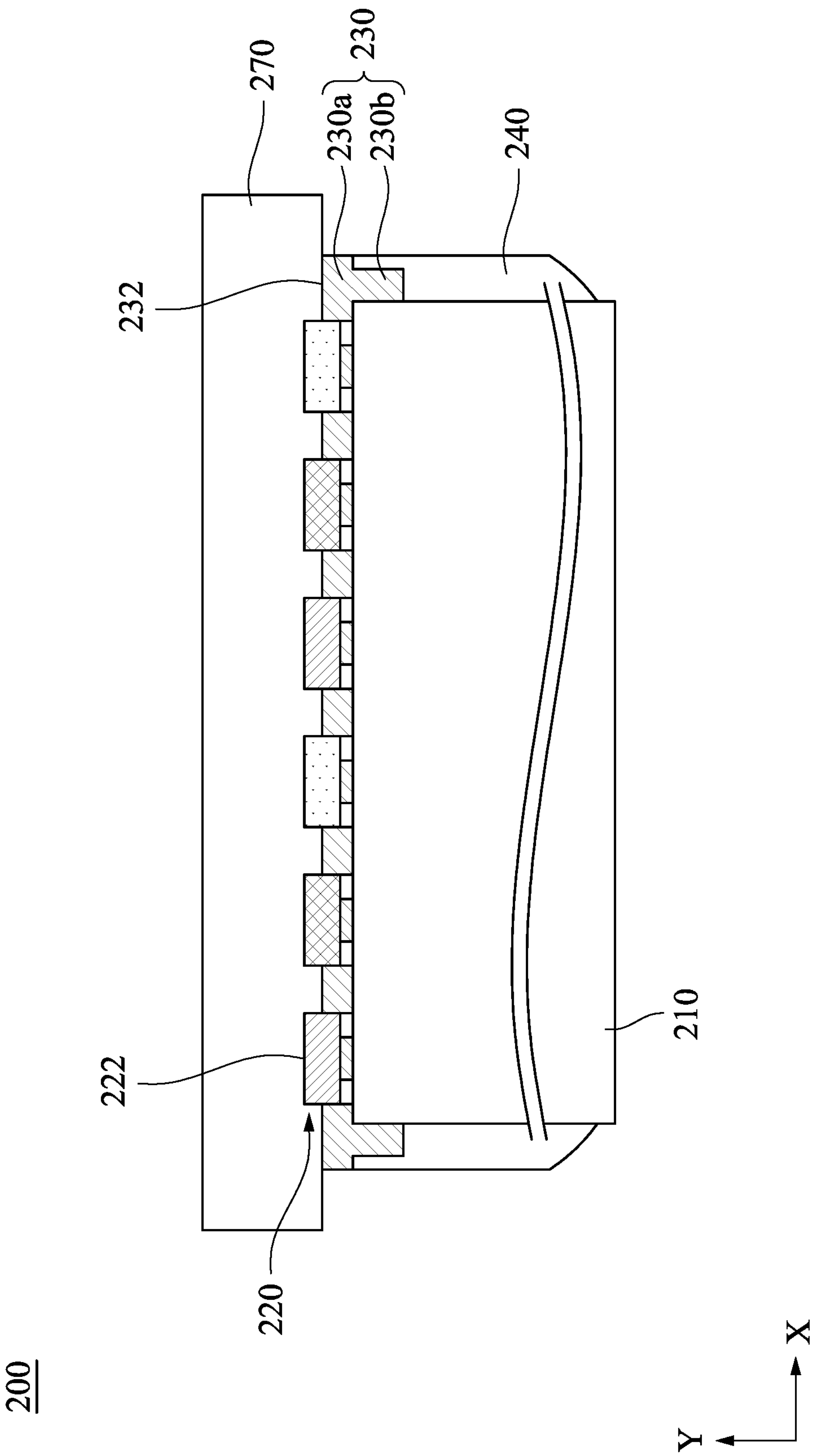

Fig. 2F

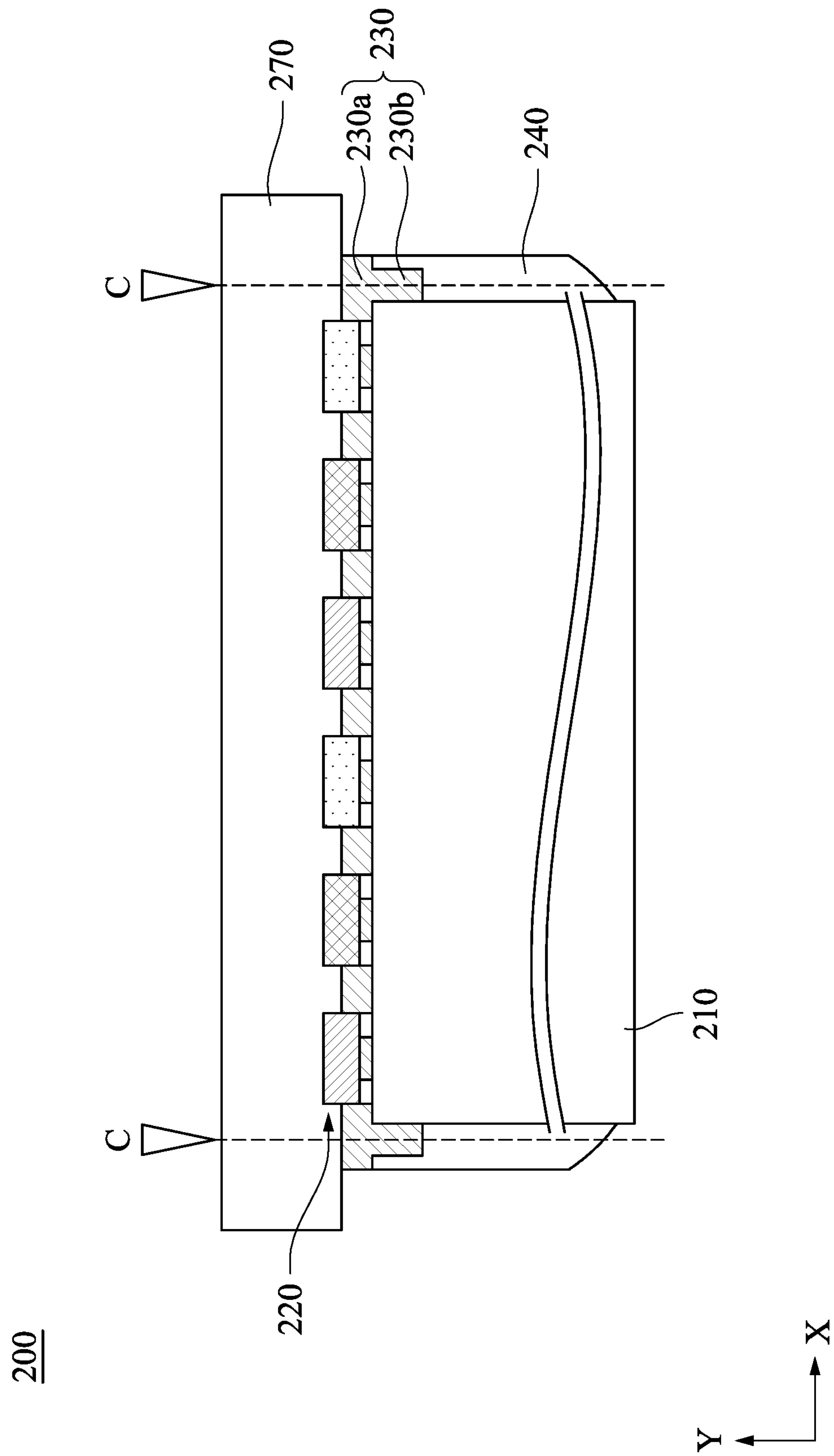

Fig. 2G

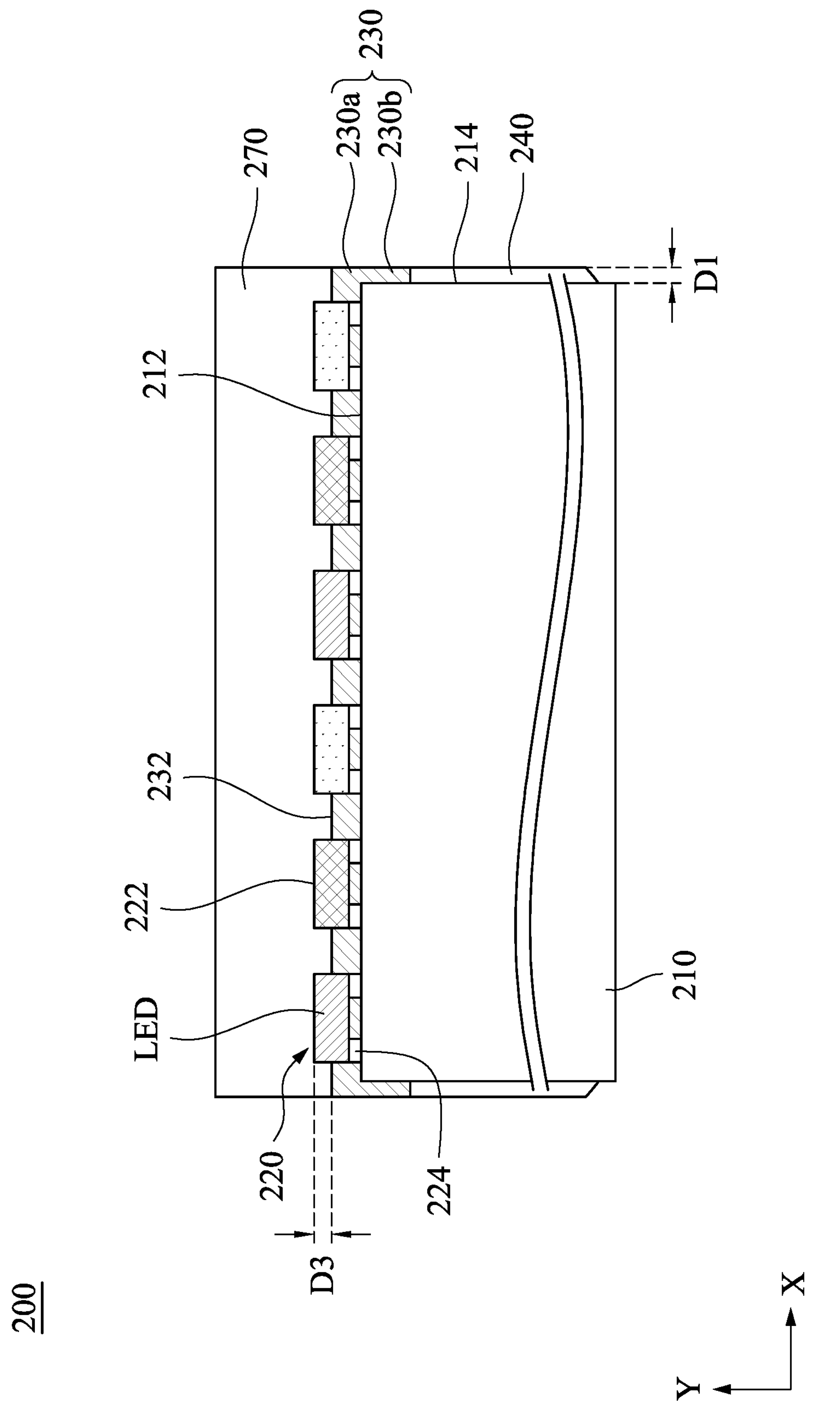
230
230a
230b
270
214
240
D1
212
232
222
LED
220
224
210
D3
200
X
Y

Fig. 2H

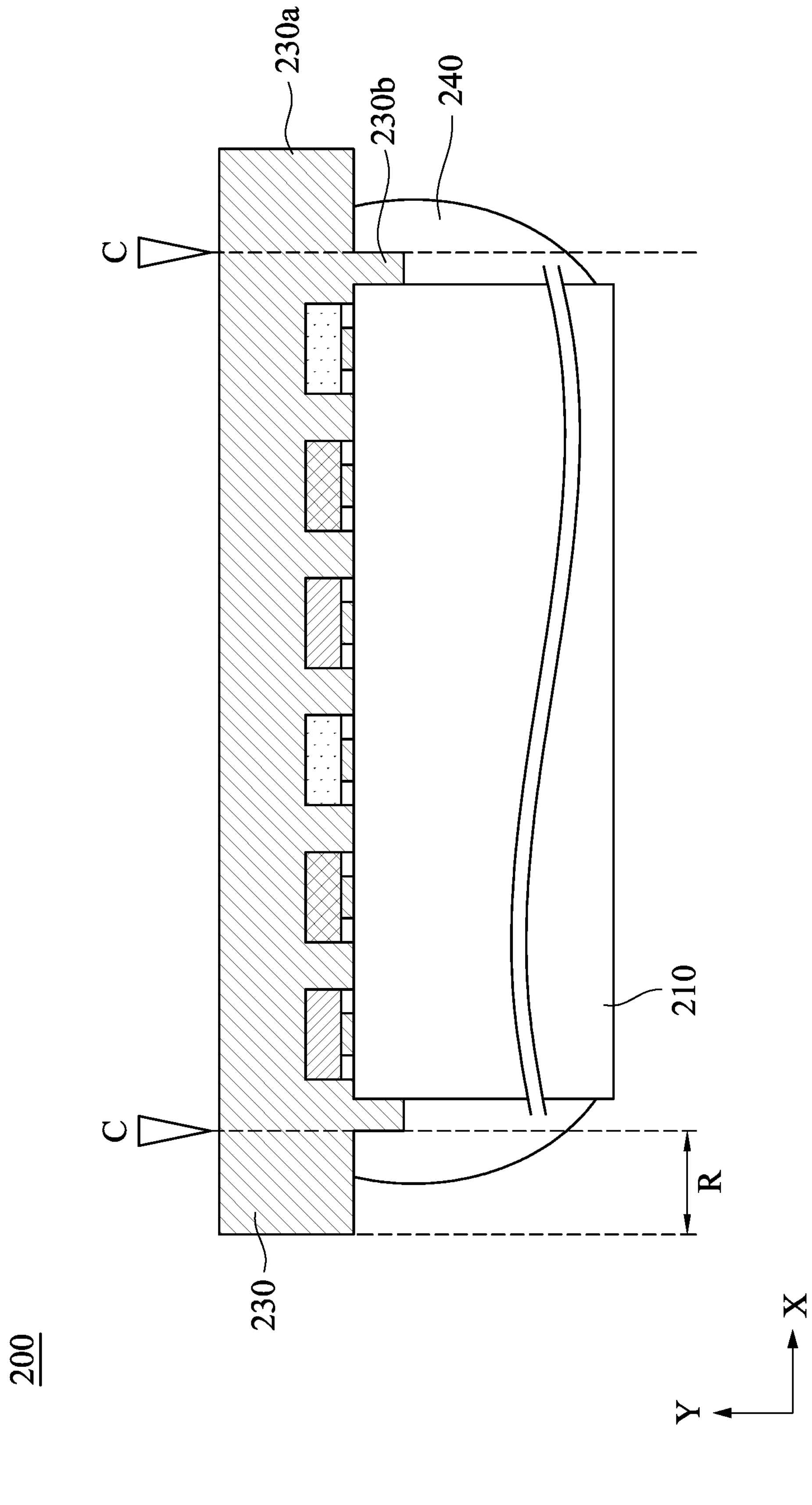

Fig. 3

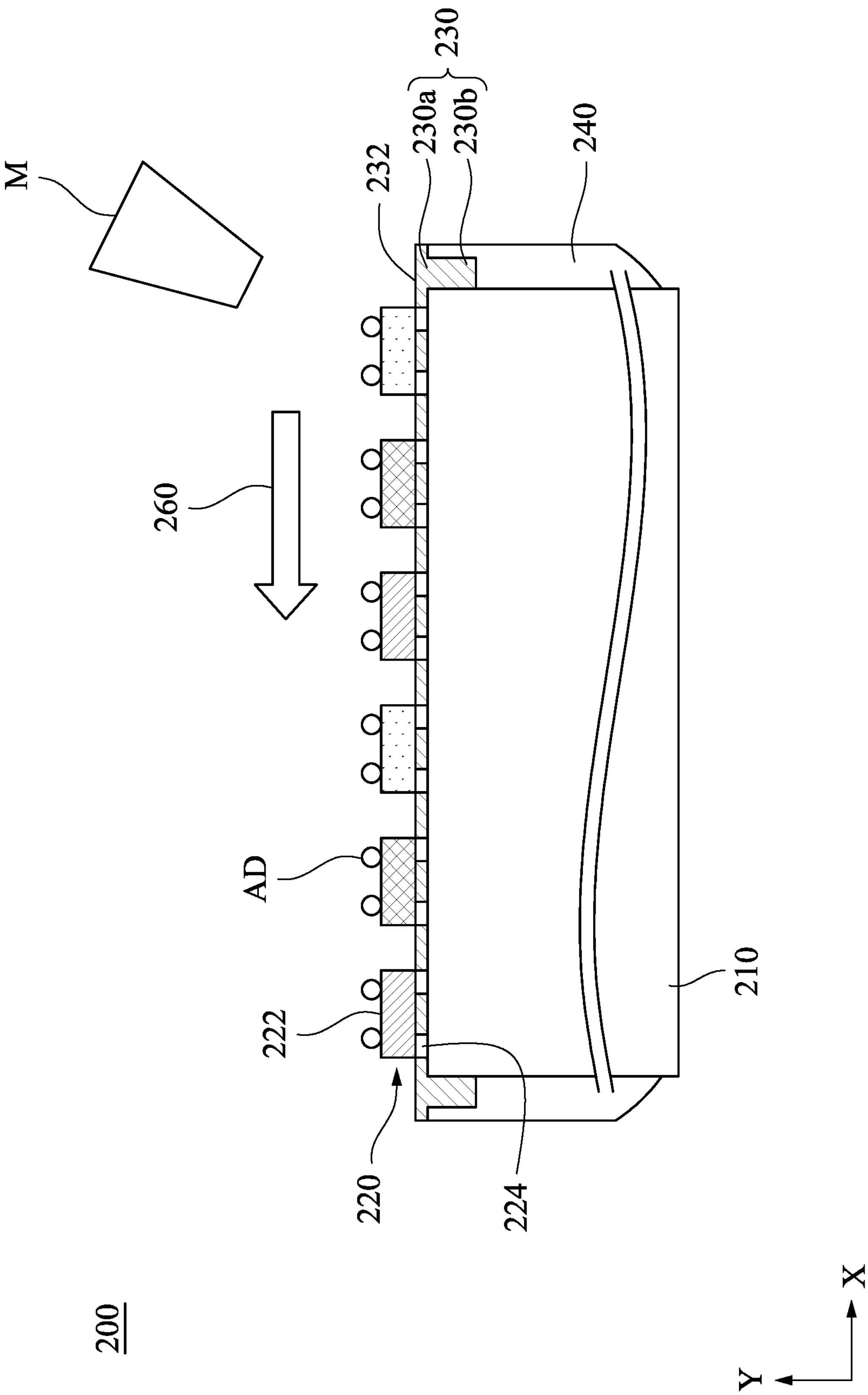

Fig. 4

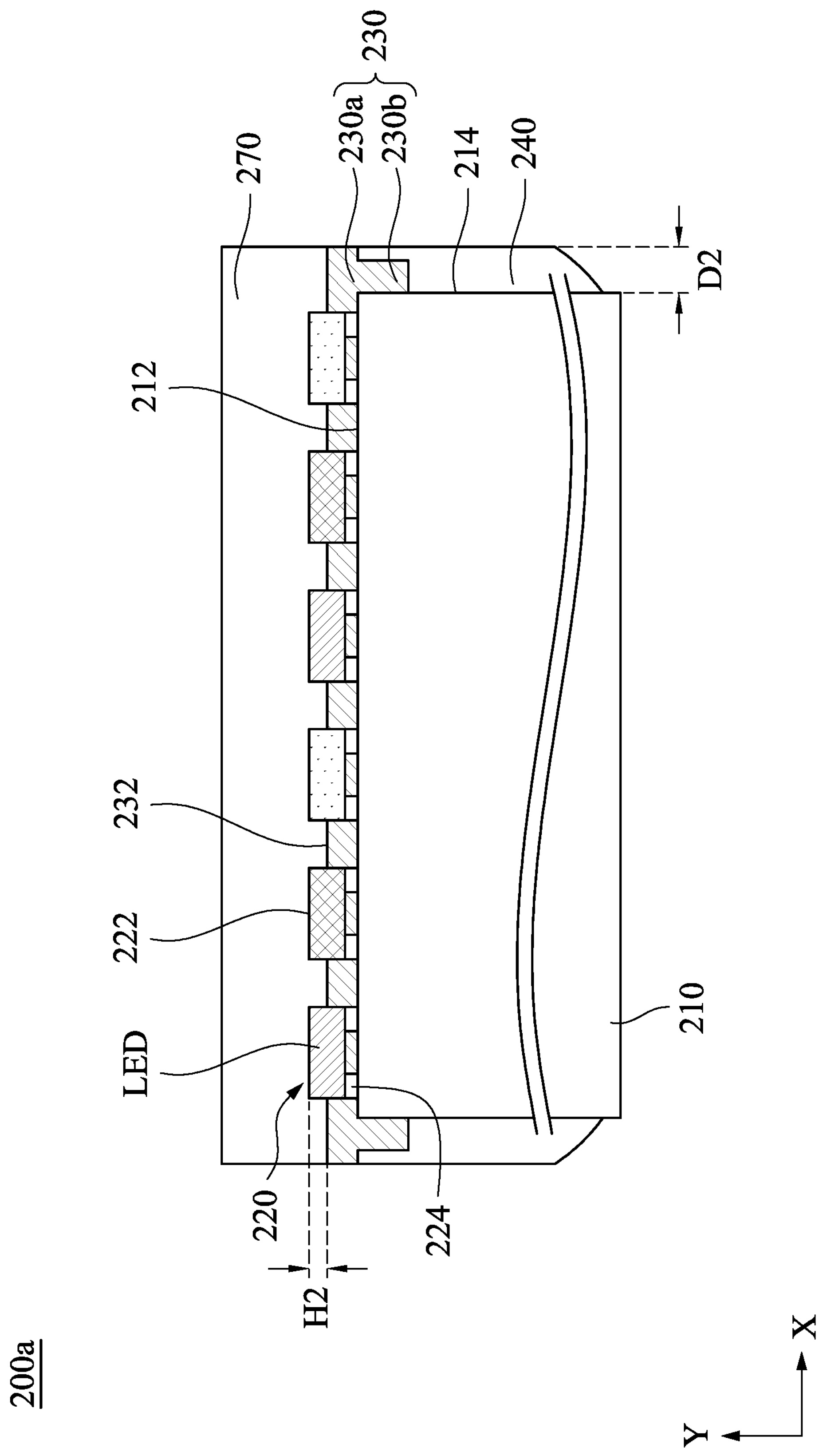
230
230a
230b
270
214
240
D2
212
232
222
LED
210
220
224
H2
200a
X
Y

Fig. 5

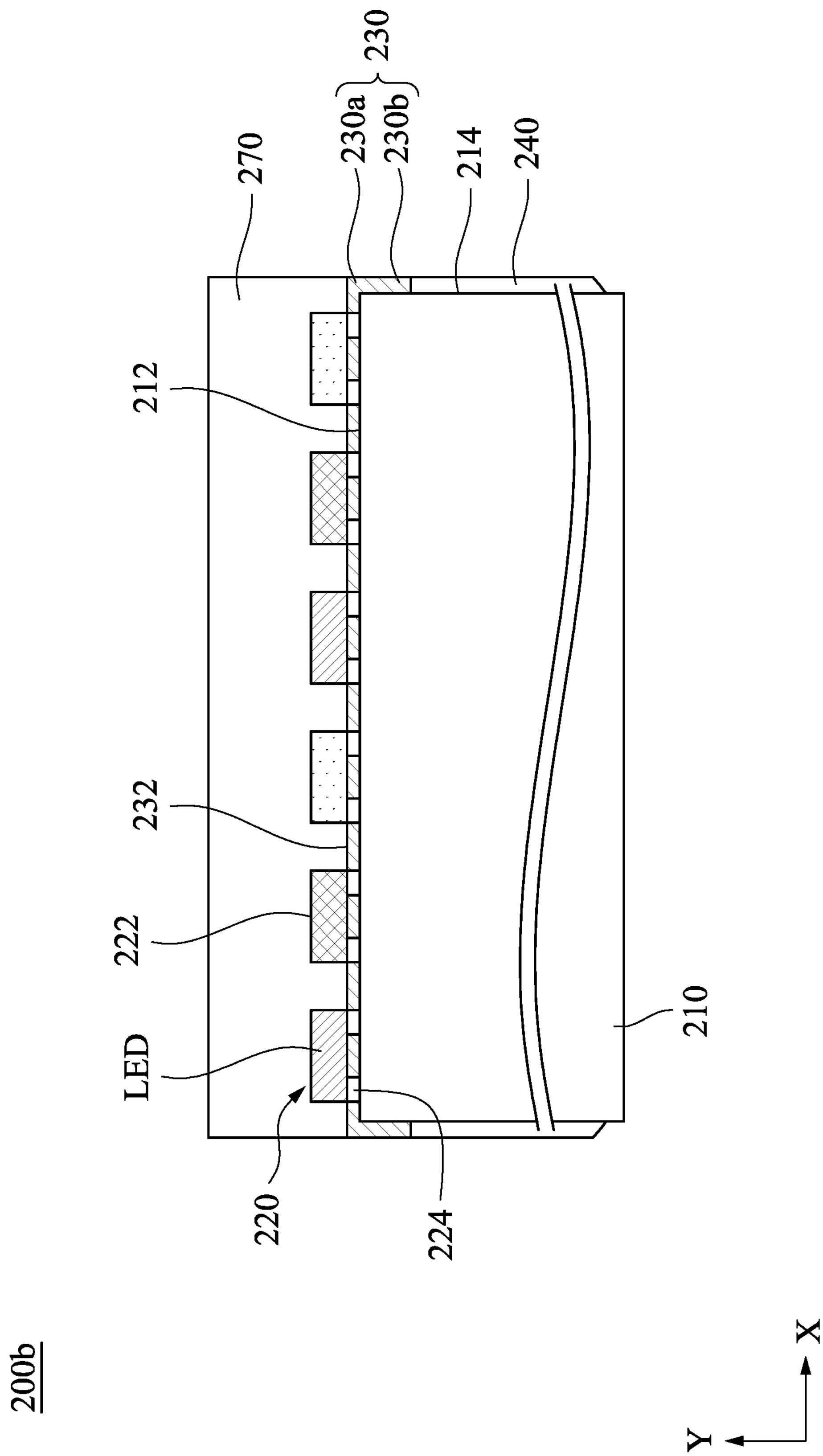

Fig. 6

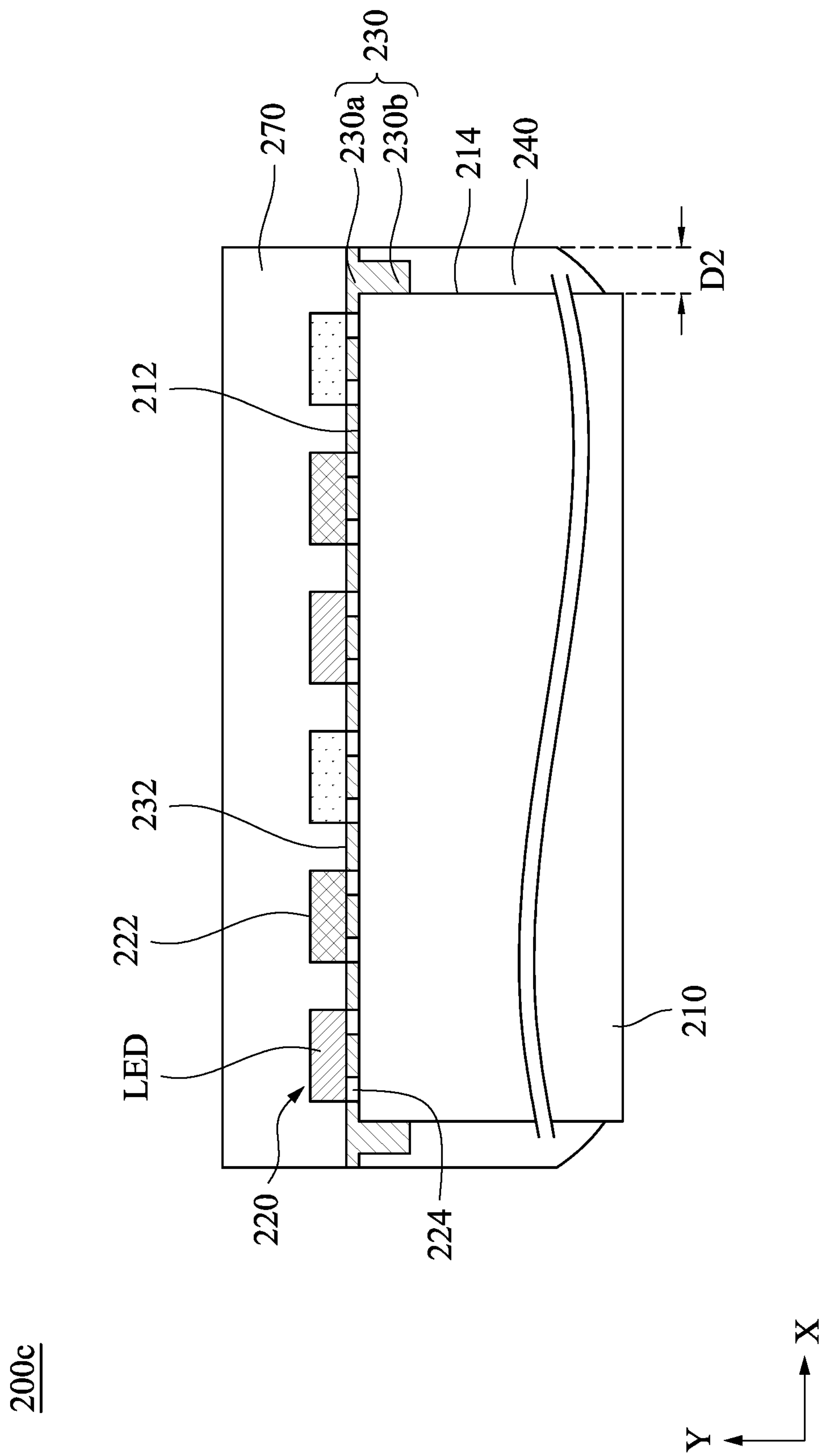

Fig. 7

PACKAGE STRUCTURE AND MANUFACTURING METHOD THEREOF

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to Taiwan Application Serial Number 111104141, filed Jan. 28, 2022, which is herein incorporated by reference.

BACKGROUND

Field of Invention

The present disclosure is relates to a package structure and a manufacturing method for the package structure.

Description of Related Art

With the technological development of electronic products, the quality requirements for display panels are getting higher and higher. The processes of the display panel include sealing, cutting, etching, cleaning operations, and so on. If each process could not be appropriately treated, the luminous efficiency of light emitting diodes (LEDs) may be affected, thereby affecting the quality of the display panel

For example, if the black encapsulant covering LEDs could not be effectively removed, the luminous efficiency of the LEDs would be reduced. If the side edge of the encapsulant is pulled during the cleaning process, the side edge would be peeled (degumming), which causes damage to the display area (effective area) of the display panel.

SUMMARY

In order to solve the above-mentioned problems and overcome the deficiencies of the prior art, the purpose of the present disclosure is to provide a packaging structure and a manufacturing method of the packaging structure. The present disclosure could improve the above-mentioned problems and prevent the display panel from being damaged due to incomplete cleaning or degumming.

The present disclosure provides a package structure including a circuit substrate, a light emitting diode array, a first encapsulant, and a sealant. The circuit substrate includes a top surface and a side surface of the circuit substrate. The light emitting diode array is disposed on the top surface of the circuit substrate. The first encapsulant is disposed above the circuit substrate, the first encapsulant includes a main portion and an extension portion, in which the main portion is disposed parallel to the top surface, and the extension portion extends from the main portion to the side surface of the circuit substrate. The sealant is disposed below the extension portion of the first encapsulant, and the sealant contacts the first encapsulant and the circuit substrate. The first encapsulant forms a coplanar surface in community with the sealant.

In some embodiments, the first encapsulant includes 5~20 wt % of black particles.

In some embodiments, a cutting profile of the first encapsulant and a cutting profile of the sealant form a continuous structure on the coplanar surface.

In some embodiments, a material of the sealant includes acrylic resin.

In some embodiments, an optical density of the sealant is greater than 3.

In some embodiments, the main portion of the first encapsulant forms the coplanar surface in community with the extension portion of the first encapsulant and the sealant.

In some embodiments, the main portion of the first encapsulant forms the coplanar surface in community with the sealant, and the extension portion of the first encapsulant is between the coplanar surface and the side surface of the circuit substrate.

In some embodiments, the package structure further includes a second encapsulant covering the light emitting diode array and the first encapsulant.

In some embodiments, the first encapsulant forms the coplanar surface in community with the sealant and the second encapsulant.

In some embodiments, a distance between the coplanar surface and the side surface of the circuit substrate is in a range from 5 μm to 15 μm.

In some embodiments, a distance between the coplanar surface and the side surface of the circuit substrate is in a range from 45 μm to 55 μm.

In some embodiments, the light emitting diode array includes a light emitting diode, and a distance between a top surface of the main portion of the first encapsulant and a top surface of the light emitting diode is in a range from 5 μm to 10 μm.

In some embodiments, the light emitting diode array includes a light emitting diode. The light emitting diode includes a bonding pad between the light emitting diode and the circuit substrate, and a height position of the main portion of the first encapsulant is substantially the same as a height position of the bonding pad.

The present disclosure provides a manufacturing method for a package structure. The manufacturing method includes the following operations. A first encapsulant is formed on a circuit substrate and a light emitting diode array, the light emitting diode array is disposed on the circuit substrate, the circuit substrate includes a top surface and a side surface, the first encapsulant includes a main portion and an extension portion, the main portion is disposed parallel to the top surface, and the extension portion extends from the main portion to the side surface. A sealant is formed on the side surface of the circuit substrate, the sealant contacts the side surface of the circuit substrate and the extension portion of the first encapsulant. An etching operation is performed to mostly remove the first encapsulant light above the emitting diode array. A dry cleaning operation is performed to completely remove an ashing portion of the first encapsulant above the light emitting diode array and expose a top surface of the light emitting diode array. A second encapsulant is formed on the light emitting diode array and the first encapsulant, in which the first encapsulant is between the light emitting diode array.

In some embodiments, the manufacturing method for the package structure further including: performing a cutting operation after forming the sealant on the side surface of the circuit substrate, and thereby the main portion of the first encapsulant forms a coplanar surface in community with the sealant.

In some embodiments, the manufacturing method for the package structure further including: performing a cutting operation after forming the sealant on the side surface of the circuit substrate, and thereby the main portion of the first encapsulant forms a coplanar surface in community with the extension portion of the first encapsulant, and the sealant.

In some embodiments, the manufacturing method for the package structure further including: performing a cutting operation after forming the second encapsulant on the light emitting diode array and on the first encapsulant between the light emitting diode array, and thereby the main portion of the first encapsulant forms a coplanar surface in community with the second encapsulant, the extension portion of the first encapsulant, and the sealant.

In some embodiments, the manufacturing method for the package structure further including: performing a cutting operation after forming the second encapsulant on the light emitting diode array and on the first encapsulant between the light emitting diode array, and thereby the main portion of the first encapsulant forms a coplanar surface in community with the second encapsulant, and the sealant.

In some embodiments, the first encapsulant includes 5~20 wt % of black particles.

In some embodiments, an optical density of the sealant is greater than 3.

BRIEF DESCRIPTION OF THE DRAWINGS

Aspects of the present disclosure are best understood from the following detailed description when read with the accompanying figures. It is noted that, in accordance with the standard practice in the industry, various features are not drawn to scale. In fact, the dimensions of the various features may be arbitrarily increased or reduced for clarity of discussion.

FIG. **1** is a flowchart of a manufacturing method for a package structure in accordance with some embodiments of the present disclosure.

FIG. **2**A to FIG. **2**H are cross-sectional views of various forming stages of a package structure in accordance with some embodiments of the present disclosure.

FIG. **3** is a cross-sectional view of an alternative embodiment in FIG. **2**B to FIG. **2**C.

FIG. **4** is a cross-sectional view of an alternative embodiment in FIG. **2**D to FIG. **2**E.

FIG. **5** is a cross-sectional view of an alternative embodiment in FIG. **2**G to FIG. **2**H.

FIG. **6** to FIG. **7** are cross-sectional views of package structures in accordance with some alternative embodiments of the present disclosure.

DETAILED DESCRIPTION

The following disclosure provides many different embodiments, or examples, for implementing different features of the provided subject matter. Specific examples of components and arrangements are described below to simplify the present disclosure. These are, of course, merely examples and are not intended to be limiting. For example, the formation of a first feature over or on a second feature in the description that follows may include embodiments in which the first and second features are formed in direct contact, and may also include embodiments in which additional features may be formed between the first and second features, such that the first and second features may not be in direct contact. In addition, the present disclosure may repeat reference numerals and/or letters in the various examples. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various embodiments and/or configurations discussed.

Further, spatially relative terms, such as "beneath," "below," "lower," "above," "upper" and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. The spatially relative terms are intended to encompass different orientations of the device in use or operation in addition to the orientation depicted in the figures. The apparatus may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein may likewise be interpreted accordingly.

Although a series of operations or steps are used below to illustrate the methods disclosed herein, the order of these operations or steps should not be construed a limitation of the present disclosure. For example, some operations or steps could be may be performed in a different order and/or concurrently with other steps. Furthermore, not all operations, steps, and/or features must be performed in order to implement embodiments of the present disclosure. Each operation or step herein could include several sub-operations or sub-steps.

The present disclosure provides a manufacturing method for a package structure, please refer to FIG. **1** and FIG. **2**A to FIG. **2**H. FIG. **1** is a flowchart of a manufacturing method **100** for a package structure in accordance with some embodiments of the present disclosure. The method **100** includes an operation **110** to an operation **150**. FIG. **2**A to FIG. **2**H are cross-sectional views of various forming stages of a package structure **200** in accordance with some embodiments of the present disclosure.

Please refer to the operation **110** in FIG. **1** and FIG. **2**A. A first encapsulant **230** is formed on a circuit substrate **210** and a light emitting diode array **220**. The light emitting diode array **220** is disposed on the circuit substrate **210**. The circuit substrate **210** includes a top surface **212** and a side surface **214**, the first encapsulant **230** includes a main portion **230***a* and an extension portion **230***b*, the main portion **230***a* of the first encapsulant **230** is disposed parallel to the top surface **212** of the circuit substrate **210**, the extension portion **230***b* of the first encapsulant **230** extends from the main portion **230***a* to the side surface **214** of the circuit substrate **210**. The sides of the first encapsulant **230** have T-shaped structures. Specifically, the main portion **230***a* of the first encapsulant **230** extends along a direction X, the extension portion **230***b* of the first encapsulant **230** extends along a direction Y and contacts the side surface **214** of the circuit substrate **210**. It is noticed that the main portion **230***a* of the first encapsulant **230** in the direction X protrudes from the extension portion **230***b* of the first encapsulant **230**. Therefore, the protruding portion could be referred to as a wing region R. The extension portion **230***b* of the first encapsulant **230** extends downward an amount of a height H**1**. In some embodiments, the height H**1** is in a range from 0 to 200 μm.

In some embodiments, the circuit substrate **210** could be a thin film transistor (TFT) substrate, a microchip (driver chip) substrate, a glass substrate, a polyimide (PI) substrate, or a printed circuit board (PCB). In some embodiments, the light emitting diode array **220** includes a plurality of light emitting diodes (LEDs), micro light emitting diodes (micro LEDs), mini light emitting diodes (mini LEDs), or organic light emitting diodes (organic LEDs, OLEDs).

As shown in FIG. **2**A, the first encapsulant **230** is configured to as a light-shielding layer and has a function of absorbing light. Therefore, the first encapsulant **230** also could be referred to as a black encapsulant. In some embodiments, a material of the first encapsulant **230** may include an organic compound, an inorganic compound, other suitable material, or combinations thereof. The organic compound could be, for example, polyacrylic resin, epoxy resin, allyl resin, phenolic resin, polytetrafluoroethylene, polymethyl methacrylate (acrylic), or combinations thereof. The inorganic compound could be, for example, alumina, silicon oxide (silicone), boron oxide, aluminosilicate, borosilicate, or combinations thereof. In some embodiments, the first encapsulant **230** includes 5~20 wt % of the black particles, for example, 8, 10, 12, 15, or 18 wt %. If the proportion of black particles is too low, the first encapsulant **230** may not have the function of absorbing (or shading) light. If the proportion of black particles is too high, after performing the etching operation and the dry cleaning operation of the light emitting diode LED (it will be discussed in FIG. **2**D and FIG. **2**E below), the first encapsulant **230** may not have positive effect on the luminous efficiency of the light emitting diode LED. In some embodiments, the first encapsulant **230** may be disposed on the circuit substrate **210** and the light emitting diode array **220** by using a lamination process.

Please refer to the operation **120** in FIG. **1** and FIG. **2**B. The sealant **240** is formed on the side surface **214** of the circuit substrate **210**. Specifically, the sealant **240** contacts the side surface **214** of the circuit substrate **210** and the extension portion **230***b* of the first encapsulant **230**. More specifically, the sealant **240** further contacts a portion of the wing region R. The sealant **240** surrounds the side surface **214** of the circuit substrate **210**. Therefore, the disclosed sealant **240** also could be referred to as a side sealant. In some embodiments, the sealant **240** is formed by using a piezoelectric jet method. The sealant **240** is configured to provide good adhesion such that the circuit substrate **210** and the first encapsulant **230** are tightly bonded without degumming. Since the sealant **240** is disposed below the sealant **240** and the first encapsulant **230** has the function of shading light, the sealant **240** may not be doped with black particles. In some embodiments, an optical density of the sealant **240** is greater than 3. In some embodiments, a material of the sealant **240** may include acrylic resin, such as UV-curing resin.

Still refer to FIG. **2**B and FIG. **2**C. After performing the operation **120** in FIG. **1**, performing a cutting operation C such that the main portion **230***a* of the first encapsulant **230** forms a coplanar surface in community with the sealant **240**, as shown in FIG. **2**D. Specifically, the coplanar surface is formed by the side surface of the main portion **230***a* of the first encapsulant **230** and the side surface of the sealant **240**. In some embodiments, a cutting profile of the first encapsulant and a cutting profile of the sealant form a continuous structure on the coplanar surface. In some embodiments, the continuous structure may include an undulating structure. In some embodiments, the undulating structure may include an undulating surface and a recess. In some embodiments, an extension direction of the recess is parallel to a cutting direction of the cutting operation C. After the cutting operation C, the sides of the first encapsulant **230** remain T-shaped structures (please refer to FIG. **2**D). More specifically, the inverted triangle signs (V) in FIG. **2**C represent the cutting positions, and the cutting positions are at the wing region R of the protruding portion of the main portion **230***a* of the first encapsulant **230**, such that the relatively small-sized wing regions R are remained in the package structure **200**. On the one hand, since the main portion **230***a* of the first encapsulant **230** contacts the sealant **240** and form the coplanar surface together, the sealant **240** could provide good adhesion for the first encapsulant **230**. On the other hand, the reduced sizes of the wing regions R could prevent the sealant **240** and the first encapsulant **230** from peeling or degumming at the following dry cleaning operation (it will be discussed in FIG. **2**E below), thereby avoiding the damage to the display area (or may be referred to as the effective area) of the display panel. The cutting operation C may be, for example, a laser cutting operation.

Please refer to FIG. **3**. FIG. **3** is a cross-sectional view of an alternative embodiment in FIG. **2**B to FIG. **2**C. The differences between FIG. **3** and FIG. **2**C are the cutting positions (triangle signs V). The cutting positions in FIG. **3** show that the wing region R of the protruding portion of the main portion **230***a* of the first encapsulant **230** are cut, such that the main portion **230***a* of the first encapsulant **230** forms a coplanar surface in community with the extension portion **230***b* of the first encapsulant **230** and the sealant **240**. Specifically, the coplanar surface is formed by the side surface of the main portion **230***a* of the first encapsulant **230**, the side surface of the extension portion **230***b* of the first encapsulant **230**, and the side surface of the sealant **240**. After the cutting operation C, the sides of the first encapsulant **230** have n-shaped structures. On the one hand, since the main portion **230***a* and the extension portion **230***b* of the first encapsulant **230** contact the sealant **240** and form the coplanar surface together, the sealant **240** could provide good adhesion for the first encapsulant **230**. On the other hand, removing the wing region R could prevent the sealant **240** and the first encapsulant **230** from peeling or degumming at the following dry cleaning operation (it will be discussed in FIG. **2**E below).

Please refer to the operation **130** in FIG. **1** and FIG. **2**D. An etching operation **250** is performed to mostly remove the first encapsulant **230** above the light emitting diode array **220**. Specifically, most of the main portion **230***a* of the first encapsulant **230** are removed and a top surface **222** of the light emitting diode array **220** is mostly exposed (please refer to FIG. **2**E), such that a height position of a top surface **232** of the main portion **230***a* of the first encapsulant **230** is lowered. In some embodiments, the etching operation **250** may be a dry etching operation, for example, a plasma etching.

Please refer to the operation **140** in FIG. **1** and FIG. **2**E. A dry cleaning operation **260** is performed to completely remove an ashing portion AD of the first encapsulant **230** above the light emitting diode array **220** and expose the top surface **222** of the light emitting diode array **220**. Specifically, after performing the etching operation **250** in FIG. **2**D, the top surface **232** of the first encapsulant **230** is lowered to below the top surface **222** of the light emitting diode LED of the light emitting diode array **220**, and a height position of the top surface **232** of the first encapsulant **230** is higher than a height position of a bonding pad **224** of the light emitting diode LED, as shown in FIG. **2**E.

Please refer to FIG. **4**. FIG. **4** is a cross-sectional view of an alternative embodiment in FIG. **2**D to FIG. **2**E. After performing the etching operation **250** in FIG. **2**D, the top surface **232** of the first encapsulant **230** is lowered to below the top surface **222** of the light emitting diode LED of the light emitting diode array **220**, and the height position of the top surface **232** of the first encapsulant **230** is at the same level as the height position of the bonding pad **224** of the light emitting diode LED, as shown in FIG. **4**. In some embodiments, the height position of the top surface **232** of the first encapsulant **230** may not lower than the height position of the bonding pad **224** of the light emitting diode LED.

Please refer to FIG. **2**E again. The dry cleaning operation **260** is performed by a dry ice blasting assembly M. The dry ice blasting assembly M is configured to apply pressurized particles of dry ice (CO_2 snow) over the light emitting diode array **220** to clean and remove the ashing portion AD of the first encapsulant **230**. Since the sealant **240** could provide good adhesion for the circuit substrate **210** and the first encapsulant **230**, the degumming possibility in the wing region R would be reduced during performing the dry cleaning operation **260**. In addition, the extension portion **230***b* of the first encapsulant **230** extends to the side surface **214** of the circuit substrate **210**. Therefore, even though the wing region R may occur degumming to a small extent, the adhesive bonding among the circuit substrate **210**, the light emitting diode array **220**, and the first encapsulant **230** may not be affected. As a result, it could avoid damage to the display area (such as the light emitting diode array **220** region) of the package structure **200** because of the degumming between the circuit substrate **210** and the first encapsulant **230**.

Please refer to the operation **150** in FIG. **1** and FIG. **2**F. A second encapsulant **270** is formed on the light emitting diode array **220** and the first encapsulant **230** between the light emitting diode array **220**. Specifically, the second encapsulant **270** covers the top surface **222** of the light emitting diode array **220** and the top surface **232** of the first encapsulant **230**. In some embodiments, the second encapsulant **270** is a transparent encapsulant or an optical film, such as anti-reflection film. In some embodiments, the second encapsulant **270** may be disposed on the light emitting diode array **220** and the first encapsulant **230** by using a lamination process. In some embodiments, a material of the second encapsulant **270** may be the same or similar to that of the first encapsulant **230**, in which the difference is that the second encapsulant **270** does not include black particles.

Still refer to FIG. **2**F and FIG. **2**G. After performing the operation **150** in FIG. **1**, performing the cutting operation C such that the main portion **230***a* of the first encapsulant **230** forms a coplanar surface in community with the second encapsulant **270**, the extension portion **230***b* of the first encapsulant **230**, and the sealant **240**, as shown in FIG. **2**H.

Please refer to FIG. **5**. FIG. **5** is a cross-sectional view of an alternative embodiment in FIG. **2**G to FIG. **2**H. The differences between the package structure **200** in FIG. **2**H and the package structure **200***a* in FIG. **5** are the cutting positions (triangle signs V) in FIG. **2**G. It is understood that the cutting positions in FIG. **2**G may be determined according to the product requirements. If the cutting positions in FIG. **2**G are widened along the direction X without cutting the extension portion **230***b* of the first encapsulant **230**, such that the main portion **230***a* of the first encapsulant **230** forms the coplanar surface in community with the second encapsulant **270** and the sealant **240**, as shown in FIG. **5**. Specifically, the cutting coplanar surface is formed by the side surface of the second encapsulant **270**, the side surface of the main portion **230***a* of the first encapsulant **230**, and the side surface of the sealant **240**. In other words, the sides of the first encapsulant **230** remain T-shaped structures after the cutting operation C.

Please refer to FIG. **2**H again. The package structure **200** includes the circuit substrate **210**, the light emitting diode array **220**, the first encapsulant **230**, the sealant **240**, and the second encapsulant **270**. The light emitting diode array **220** is disposed on the top surface **212** of the circuit substrate **210**. The first encapsulant **230** is disposed above the circuit substrate **210**, the main portion **230***a* of the first encapsulant **230** is disposed parallel to the top surface **212** of the circuit substrate **210**, and the extension portion **230***b* of the first encapsulant **230** extends from the main portion **230***a* of the first encapsulant **230** to the side surface **214** of the circuit substrate **210**. The first encapsulant **230** in FIG. **2**H has a structure similar to an n-shape. The sealant **240** is disposed below the extension portion **230***b* of the first encapsulant **230**. The sealant **240** contacts the first encapsulant **230** and the circuit substrate **210**. The first encapsulant **230** is disposed between the second encapsulant **270** and the sealant **240**, and the second encapsulant **270** does not contact the sealant **240**. The second encapsulant **270** covers the light emitting diode array **220** and the first encapsulant **230**.

In the embodiment of FIG. **2**H, the first encapsulant **230** forms the coplanar surface in community with the sealant **240**. In other words, the main portion **230***a* of the first encapsulant **230**, the extension portion **230***b* of the first encapsulant **230**, and the sealant **240** together form the coplanar surface. In some embodiments, a distance D**1** between the coplanar surface of the package structure **200** and the side surface **214** of the circuit substrate **210** is in a range from 5 μm to 15 μm, such as 8, 10, or 12 μm. In some embodiments, a distance D**3** between the top surface **232** of the main portion **230***a* of the first encapsulant **230** and the top surface **222** of the light emitting diode LED is in a range from 5 μm to 10 μm, such as 6, 7, 8, or 9 μm. The distance D**1** may be determined according to the product requirements in the following LEDs tiling (not shown in the present disclosure).

Please refer to FIG. **5** again. The differences between the package structure **200***a* in FIG. **5** and the package structure **200** in FIG. **2**H are that sides of the first encapsulant **230** of the package structure **200***a* have T-shaped structures. In the embodiment of FIG. **5**, the first encapsulant **230** forms the coplanar surface in community with the sealant **240**. In other words, the main portion **230***a* of the first encapsulant **230** and the sealant **240** forms the coplanar surface. A distance D**2** between the coplanar surface of the package structure **200***a* and the side surface **214** of the circuit substrate **210** is in a range from 45 μm to 55 μm, such as 48, 50, or 52 μm. The distance D**2** may be determined according to the product requirements in the following LEDs tiling (not shown in the present disclosure). It should be understood that, in FIG. **2**H and FIG. **5**, the same or similar elements are given the same reference numerals, and the related descriptions are omitted and the details thereof are not repeatedly described.

FIG. **6** and FIG. **7** are cross-sectional views of package structures **200***b*, **200***c* in accordance with some alternative embodiments of the present disclosure. The same or similar elements are given the same reference numerals, and the related descriptions are omitted and the details thereof are not repeatedly described.

Please refer to FIG. **6**. The differences between the package structure **200***b* in FIG. **6** and the package structure **200** in FIG. **2**H are the height positions of the top surface **232** of the main portions **230***a* of the first encapsulants **230**. Specifically, after the package structure **200***b* undergoes the alternative embodiments in FIG. **4**, the height position of the top surface **232** of the first encapsulant **230** is at the same level as the height position of the bonding pad **224** of the light emitting diode LED. After the cutting operation C in FIG. **2**G, the package structure **200***b* in FIG. **6** is formed, in which the bonding pad **224** is between the light emitting diode LED of the light emitting diode array **220** and the circuit substrate **210**, the height position of the main portion **230***a* of the first encapsulant **230** is substantially the same as the height position of the bonding pad **224**.

Please refer to FIG. **7**. The differences between the package structure **200***c* in FIG. **7** and the package structure **200***a* in FIG. **5** are the height positions of top surfaces **232** of the main portions **230***a* of the first encapsulants **230**. The main portion **230***a* of the first encapsulant **230** forms the coplanar surface in community with the sealant **240**, and the extension portion **230***b* of the first encapsulant **230** is between the coplanar surface and the side surface **214** of the circuit substrate **210**.

As discussed above, the package structures of the present disclosure have the sealant (side sealant) surrounding the circuit substrate. The sealant provides good adhesion such that the circuit substrate and the first encapsulant are tightly bonded. The disclosed package structures would not occur degumming during manufacturing processes (for example, the etching and/or the cleaning operation), thereby avoiding the damage to the display area of the display panel because of the degumming (peeling) issue. Therefore, the disclosed first encapsulant of the package structures could be effectively removed from the surfaces of LEDs, and so LEDs could provide good luminous efficiency. Furthermore, the disclosed first encapsulant of the package structure has an extension portion extending to the side surface of the circuit substrate. This extension portion could further prevent the damage to the display area of the display panel caused by the degumming (peeling) of the circuit substrate and the first encapsulant.

The present disclosure has been disclosed as hereinabove, however it is not used to limit the present disclosure. Those skilled in the art may make various changes, substitutions, and alterations herein without departing from the spirit and scope of the present disclosure. Therefore, the scope of protection of the present disclosure shall be subject to the scope of the claim attached in the application and its equivalent constructions.

What is claimed is:

1. A package structure, comprising:

a circuit substrate comprising a top surface and a side surface;

a light emitting diode array disposed on the top surface of the circuit substrate;

a first encapsulant disposed above the circuit substrate, wherein the first encapsulant comprises a main portion and an extension portion, the main portion is disposed parallel to the top surface, and the extension portion extends from the main portion to the side surface of the circuit substrate; and

a sealant disposed below the extension portion of the first encapsulant, wherein the sealant contacts the first encapsulant and the circuit substrate, and the first encapsulant forms a coplanar surface in community with the sealant.

2. The package structure of claim **1**, wherein the first encapsulant comprises 5~20 wt % of black particles.

3. The package structure of claim **1**, wherein a cutting profile of the first encapsulant and a cutting profile of the sealant form a continuous structure on the coplanar surface.

4. The package structure of claim **1**, wherein a material of the sealant comprises acrylic resin.

5. The package structure of claim **1**, wherein an optical density of the sealant is greater than 3.

6. The package structure of claim **1**, wherein the main portion of the first encapsulant forms the coplanar surface in community with the extension portion of the first encapsulant and the sealant.

7. The package structure of claim **1**, wherein the main portion of the first encapsulant forms the coplanar surface in community with the sealant, and the extension portion of the first encapsulant is between the coplanar surface and the side surface of the circuit substrate.

8. The package structure of claim **1**, further comprising a second encapsulant covering the light emitting diode array and the first encapsulant.

9. The package structure of claim **8**, wherein the first encapsulant forms the coplanar surface in community with the sealant and the second encapsulant.

10. The package structure of claim **1**, wherein a distance between the coplanar surface and the side surface of the circuit substrate is in a range from 5 μm to 15 μm.

11. The package structure of claim **1**, wherein a distance between the coplanar surface and the side surface of the circuit substrate is in a range from 45 μm to 55 μm.

12. The package structure of claim **1**, wherein the light emitting diode array comprises a light emitting diode, and a distance between a top surface of the main portion of the first encapsulant and a top surface of the light emitting diode is in a range from 5 μm to 10 μm.

13. The package structure of claim **1**, wherein the light emitting diode array comprises a light emitting diode, the light emitting diode array comprises a bonding pad between the light emitting diode and the circuit substrate, and a height position of the main portion of the first encapsulant is substantially the same as a height position of the bonding pad.

14. A manufacturing method for a package structure, comprising:

forming a first encapsulant on a circuit substrate and a light emitting diode array, wherein the light emitting diode array is disposed on the circuit substrate, the circuit substrate comprises a top surface and a side surface, the first encapsulant comprises a main portion and an extension portion, the main portion is disposed parallel to the top surface, and the extension portion extends from the main portion to the side surface of the circuit substrate;

forming a sealant on the side surface of the circuit substrate, the sealant contacts the side surface of the circuit substrate and the extension portion of the first encapsulant;

performing an etching operation to mostly remove the first encapsulant above the light emitting diode array;

performing a dry cleaning operation to completely remove an ashing portion of the first encapsulant above the light emitting diode array and expose a top surface of the light emitting diode array; and

forming a second encapsulant on the light emitting diode array and the first encapsulant, wherein the first encapsulant is between the light emitting diode array.

15. The manufacturing method for the package structure of claim **14**, further comprising:

performing a cutting operation after forming the sealant on the side surface of the circuit substrate, and thereby the main portion of the first encapsulant forms a coplanar surface in community with the sealant.

16. The manufacturing method for the package structure of claim **14**, further comprising:

performing a cutting operation after forming the sealant on the side surface of the circuit substrate, and thereby the main portion of the first encapsulant forms a coplanar surface in community with the extension portion of the first encapsulant, and the sealant.

17. The manufacturing method for the package structure of claim **14**, further comprising:

performing a cutting operation after forming the second encapsulant on the light emitting diode array and on the first encapsulant between the light emitting diode array, and thereby the main portion of the first encapsulant forms a coplanar surface in community with the second encapsulant, the extension portion of the first encapsulant, and the sealant.

18. The manufacturing method for the package structure of claim **14**, further comprising:

performing a cutting operation after forming the second encapsulant on the light emitting diode array and on the first encapsulant between the light emitting diode array, and thereby the main portion of the first encapsulant forms a coplanar surface in community with the second encapsulant, and the sealant.

19. The manufacturing method for the package structure of claim **14**, wherein the first encapsulant comprises 5~20 wt % of black particles.

20. The manufacturing method for the package structure of claim **14**, wherein an optical density of the sealant is greater than 3.

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