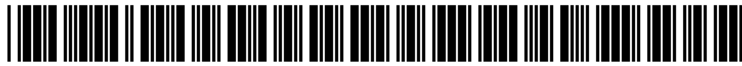

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(54) **DISPLAY PANEL AND MANUFACTURING METHOD THEREOF**

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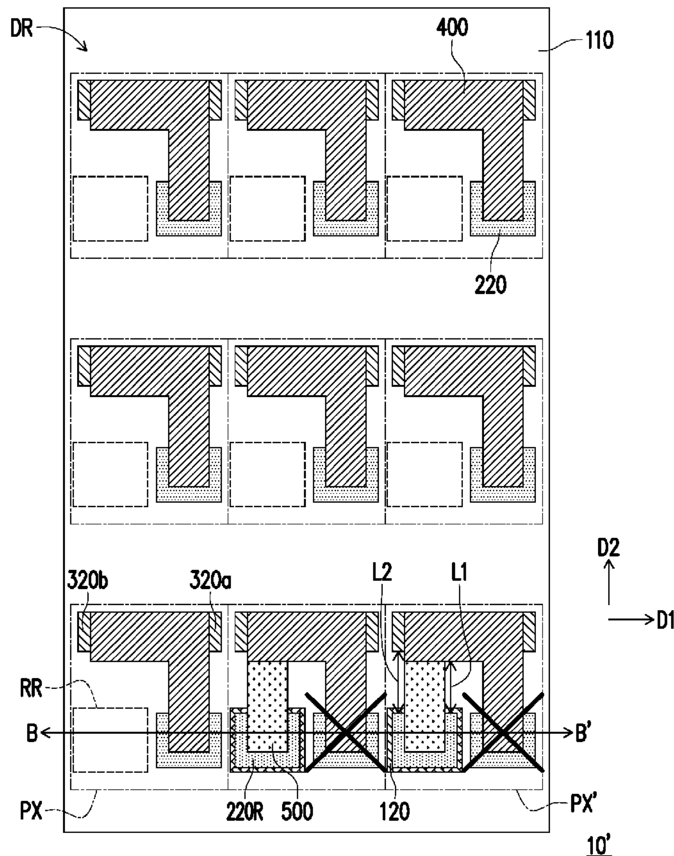
(57) **ABSTRACT**

A display panel includes a circuit substrate, pixel structures and a molding layer. The circuit substrate has first pad structures and second pad structures. The pixel structures are disposed above a display region of the circuit substrate. Each of at least a portion of the pixel structures includes a first light emitting diode, a first conductive block, and a first conductive connection structure. The first light emitting diode is disposed on a corresponding first pad structure. The first conductive block is disposed on a corresponding second pad structure. The first conductive connection structure electrically connects the first light emitting diode to the first conductive block. The molding layer is located above the circuit substrate and surrounds the first light emitting diode and the first conductive block. The first conductive connection structure is located on the molding layer.



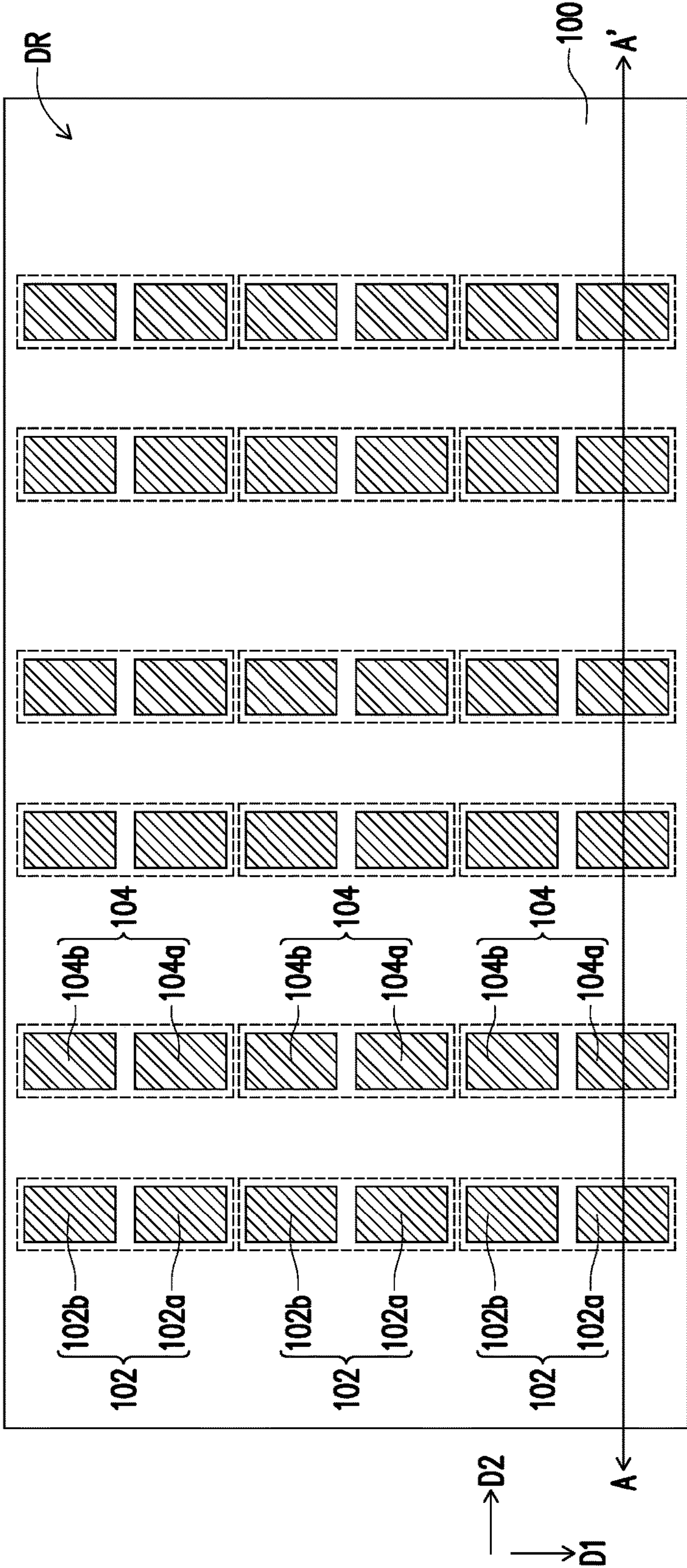


FIG. 1A

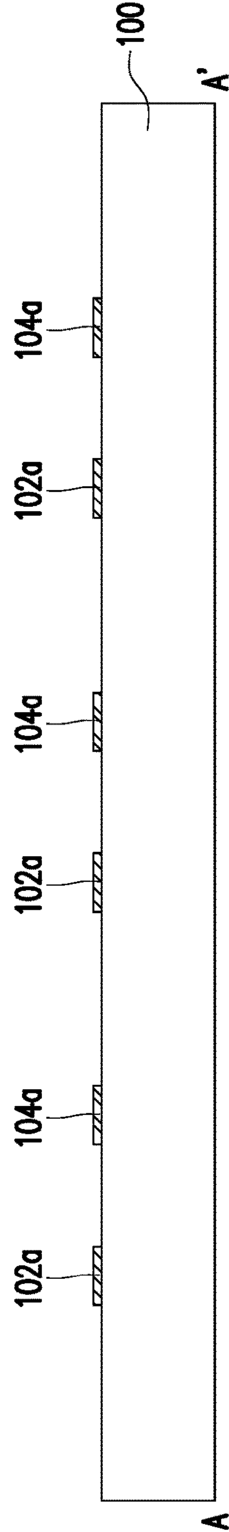


FIG. 1B

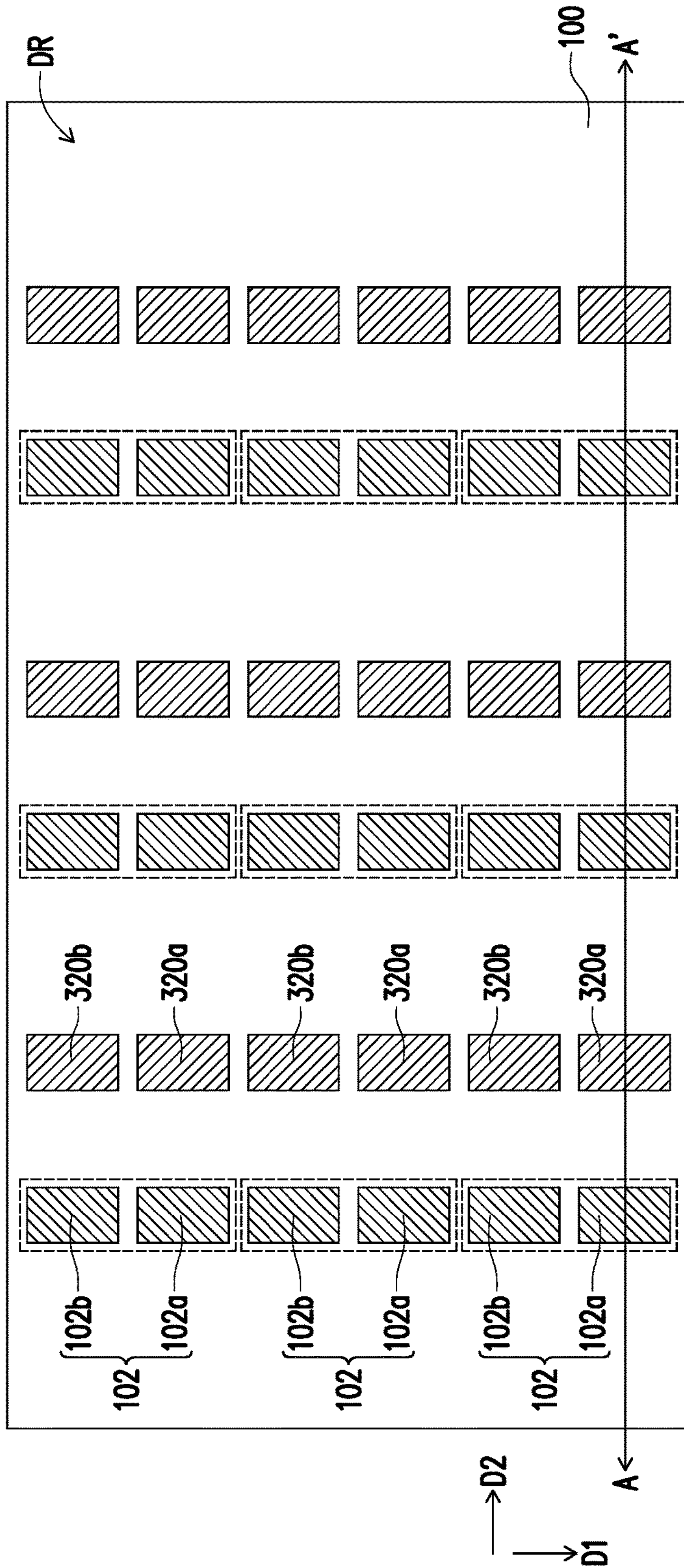


FIG. 2A

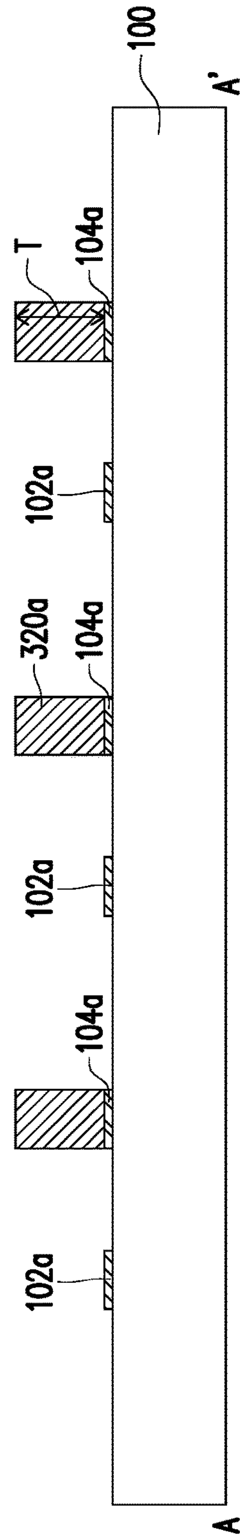


FIG. 2B

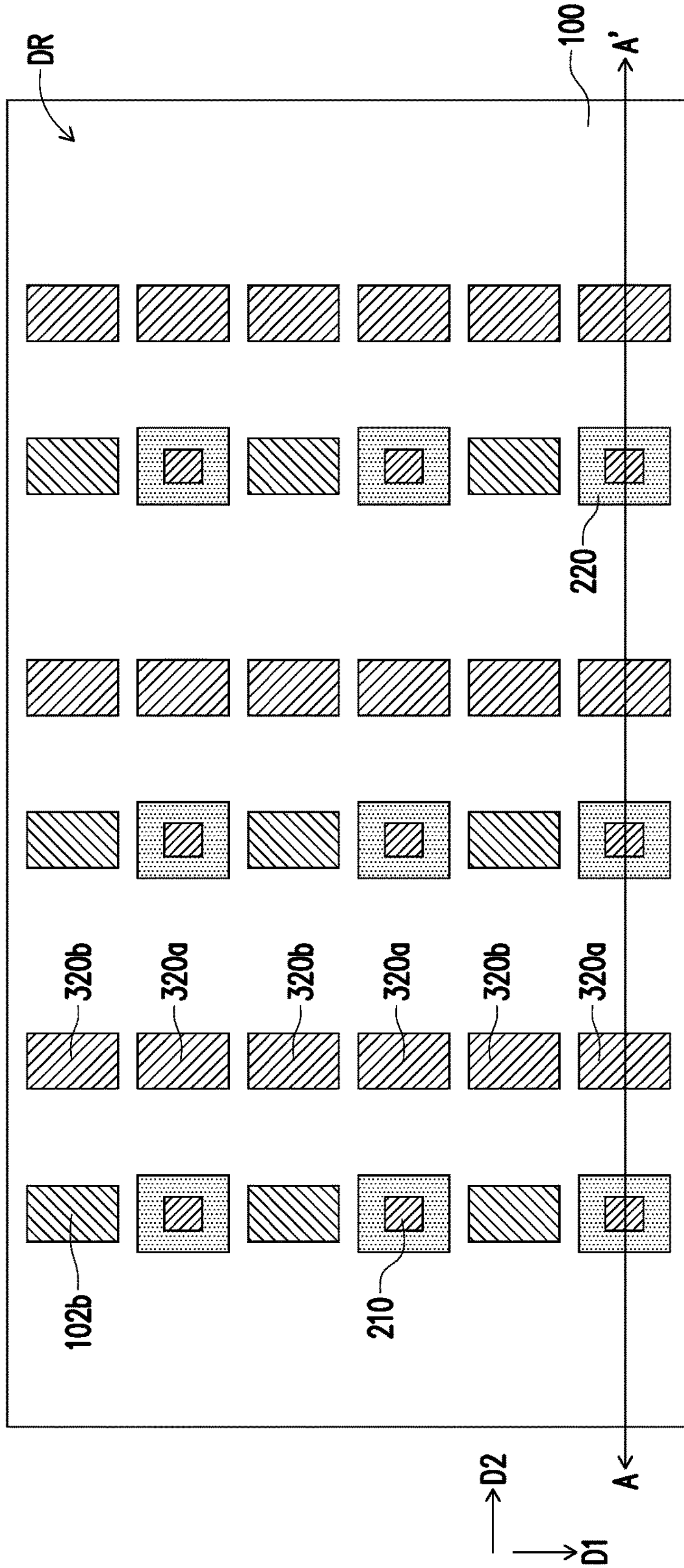


FIG. 3A

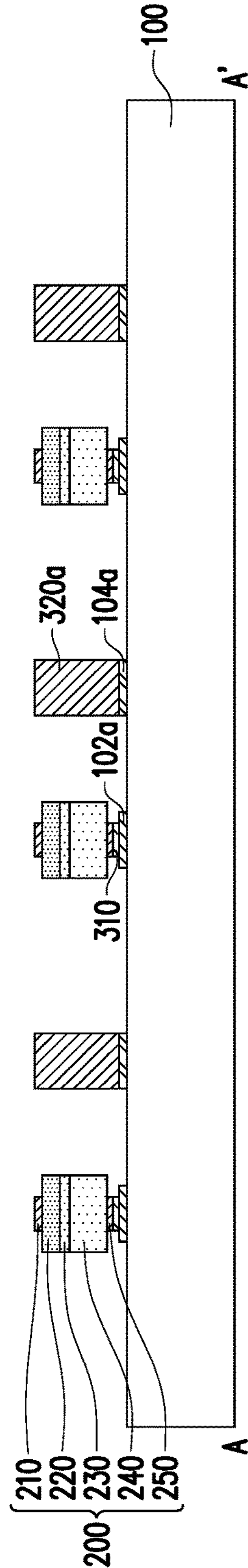


FIG. 3B

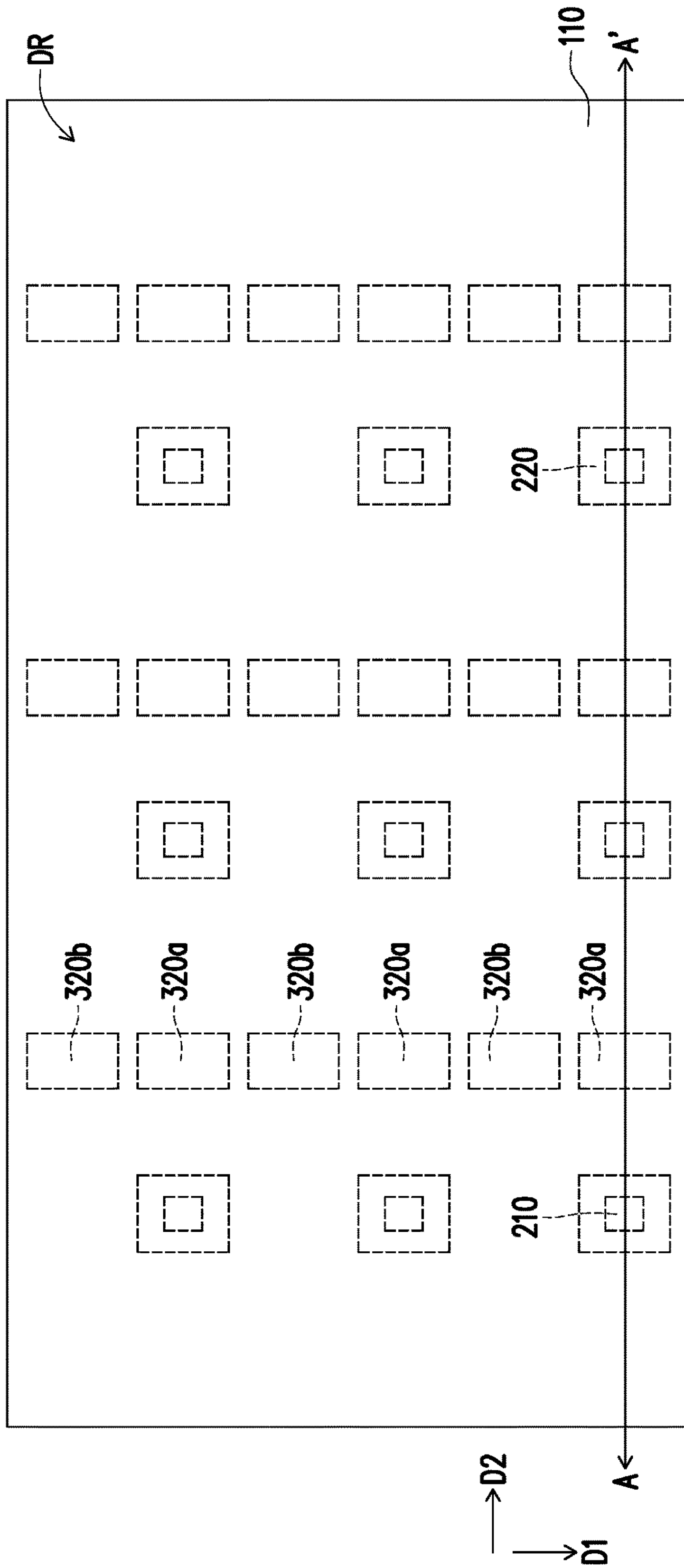


FIG. 4A

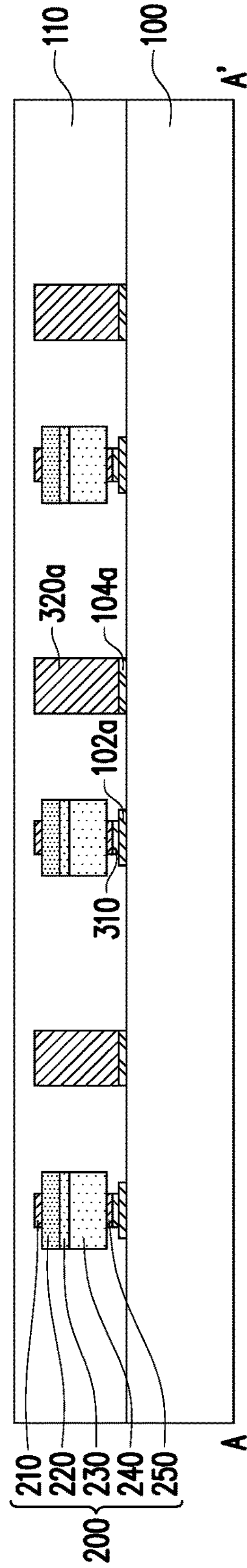


FIG. 4B

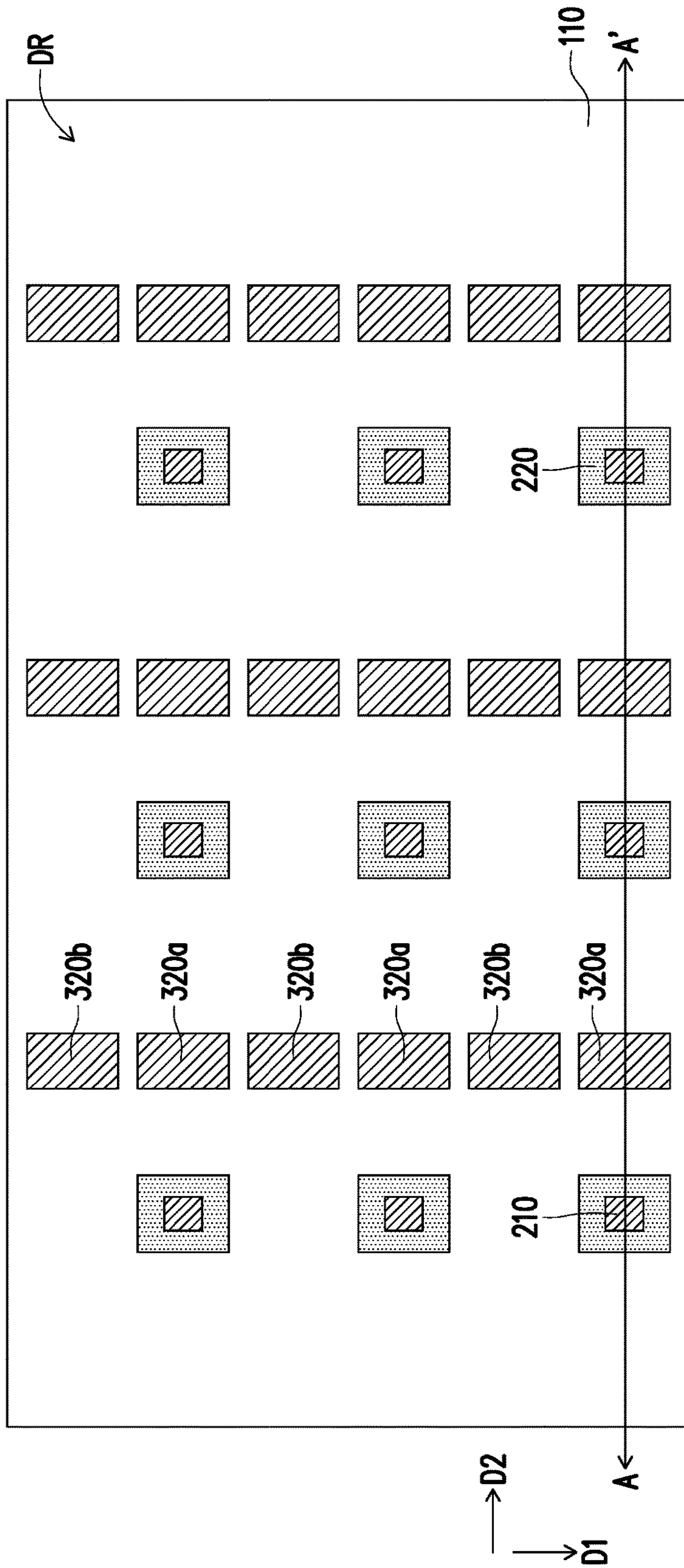


FIG. 5A

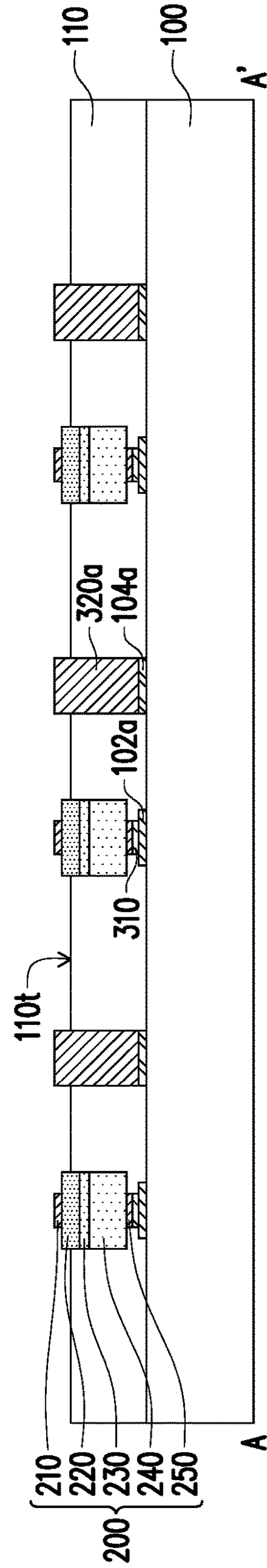


FIG. 5B

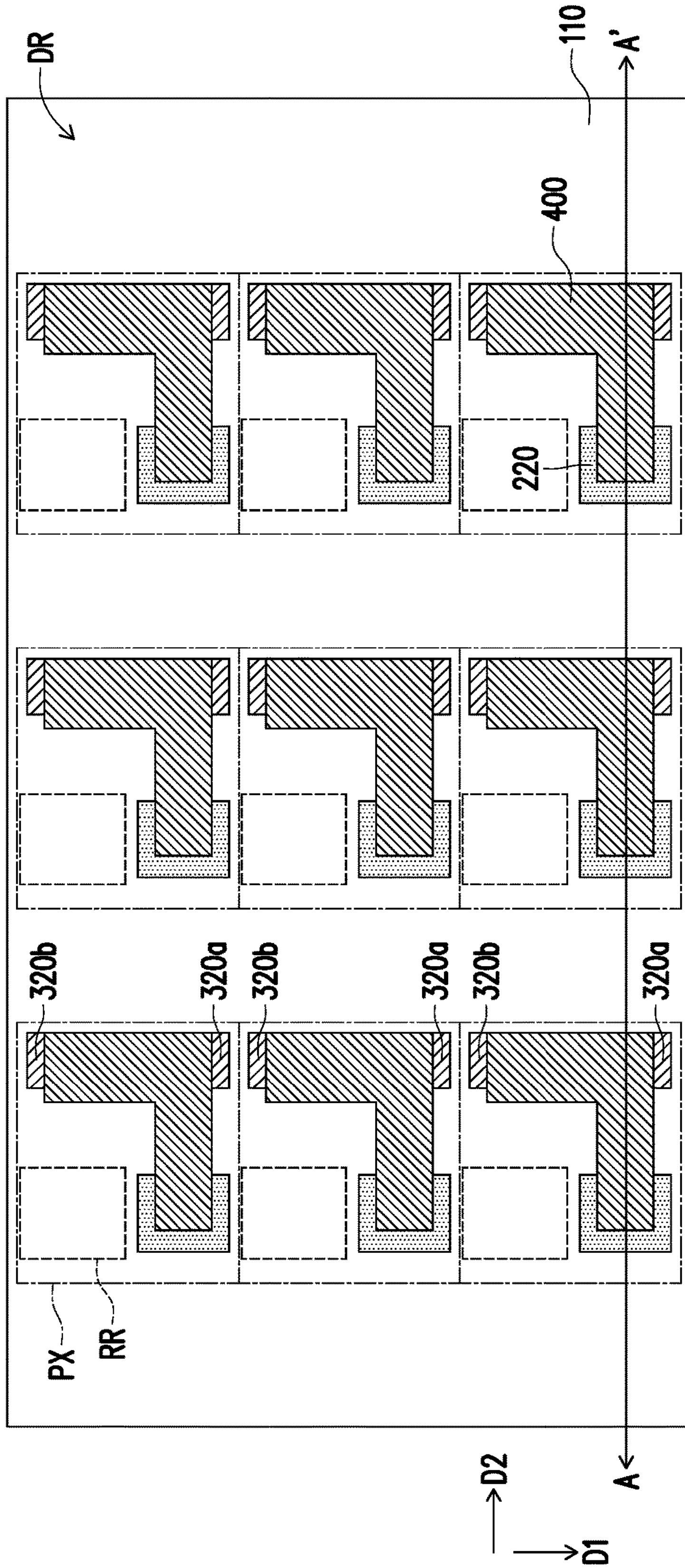


FIG. 6A

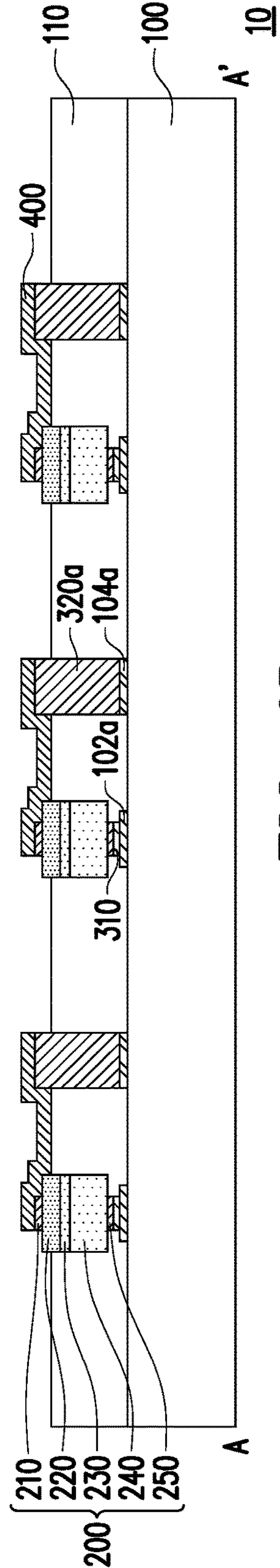


FIG. 6B

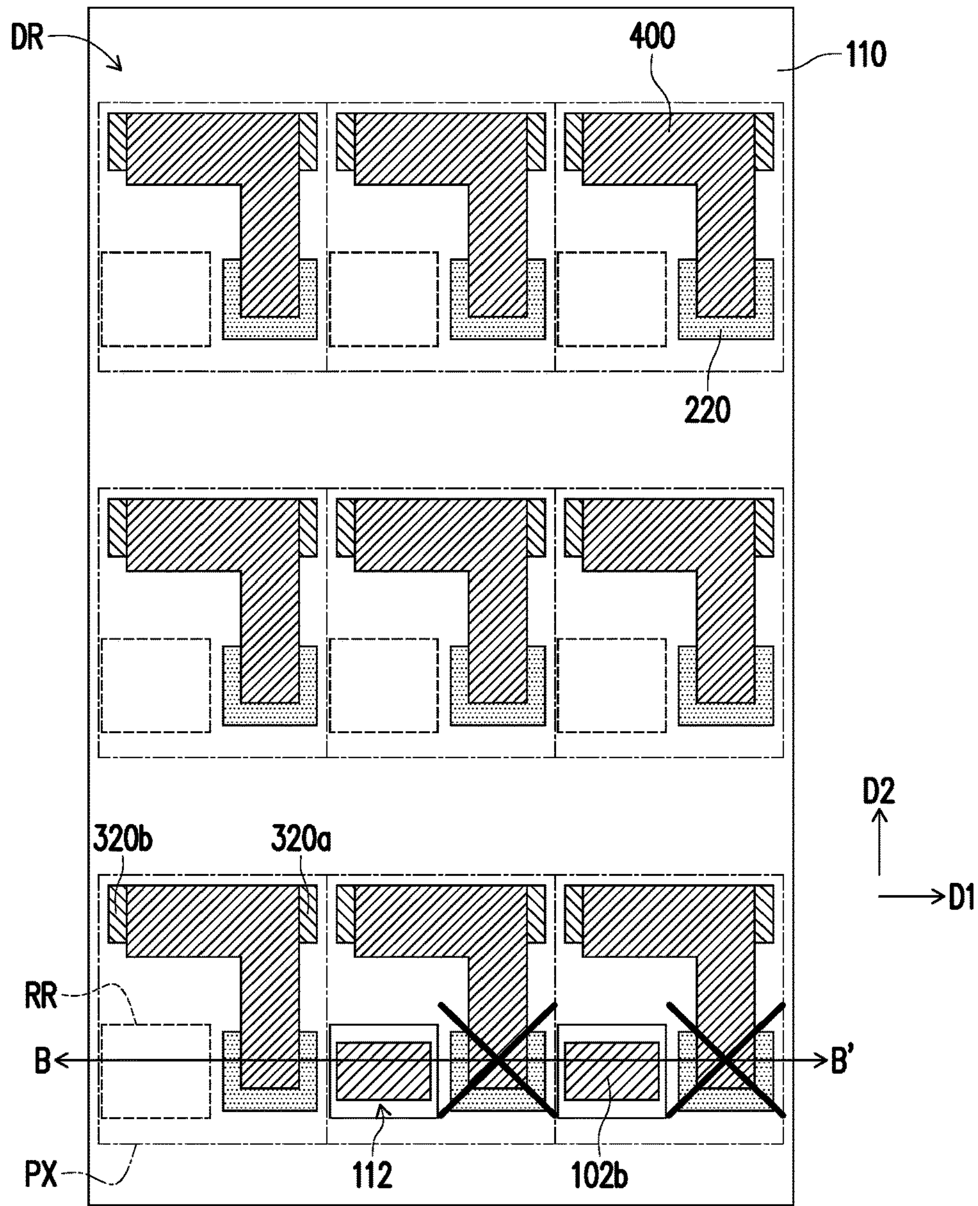


FIG. 7A

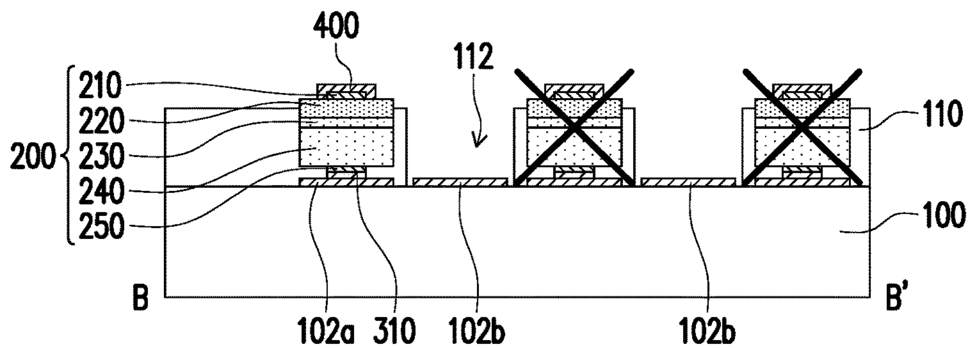


FIG. 7B

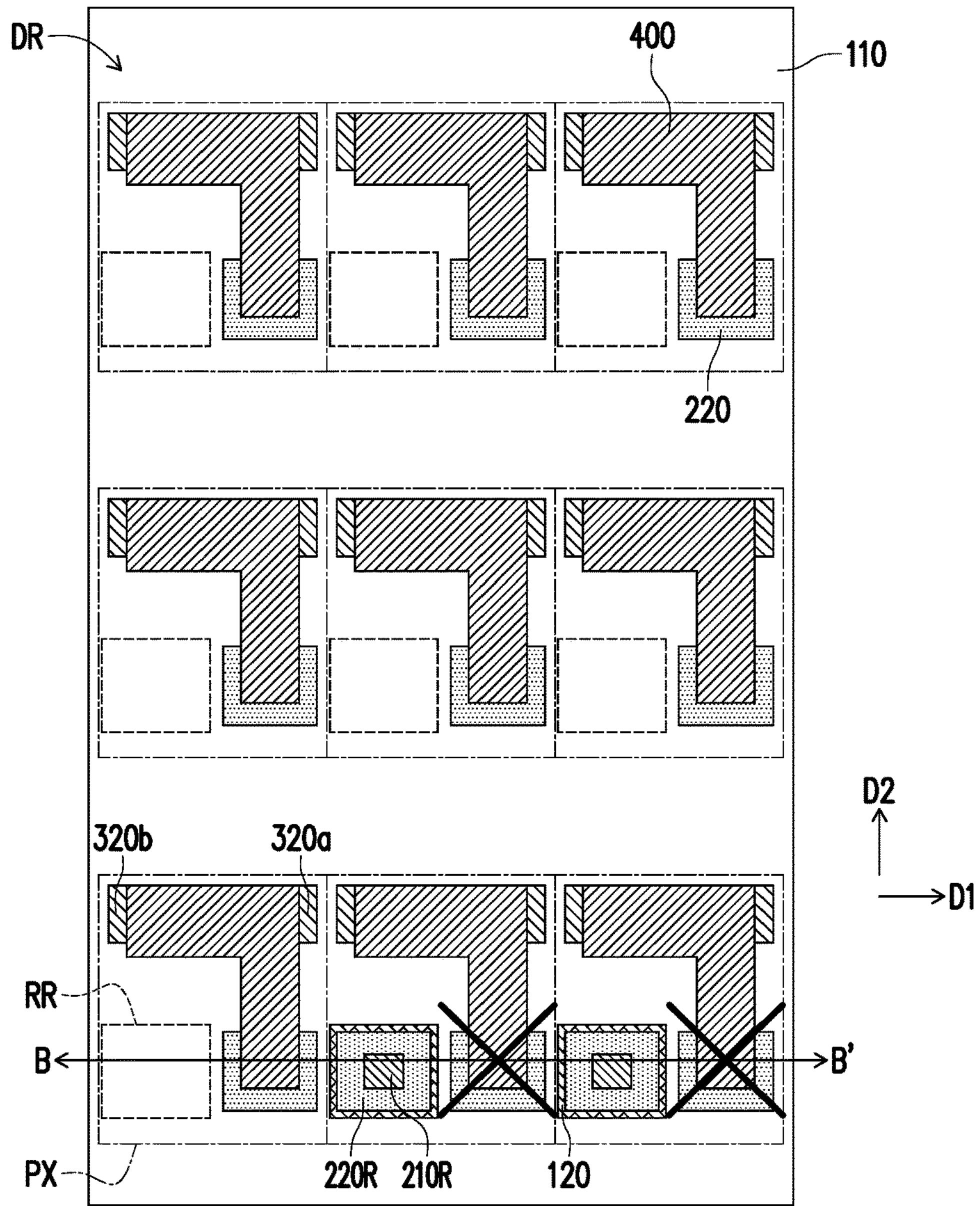


FIG. 8A

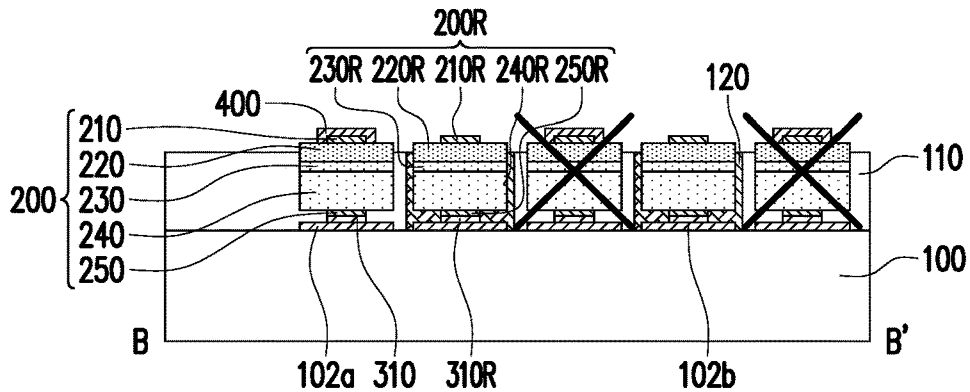


FIG. 8B

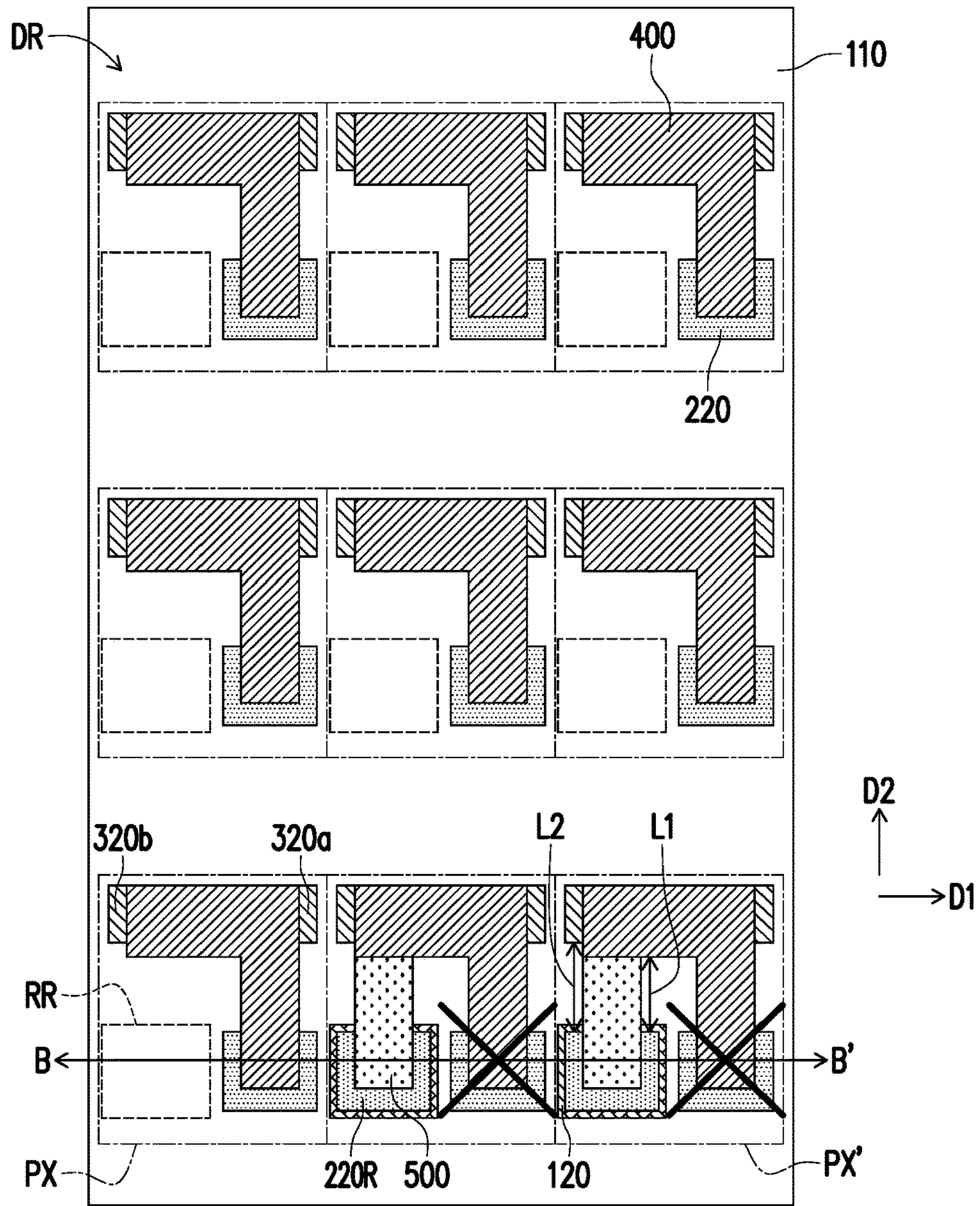


FIG. 9A

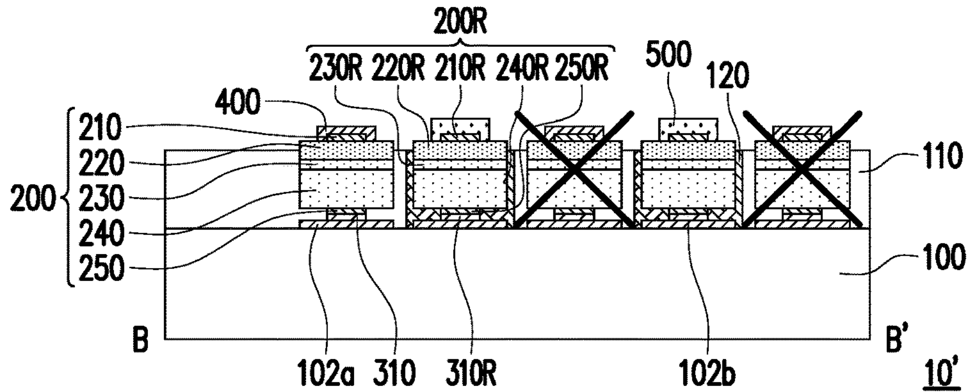


FIG. 9B

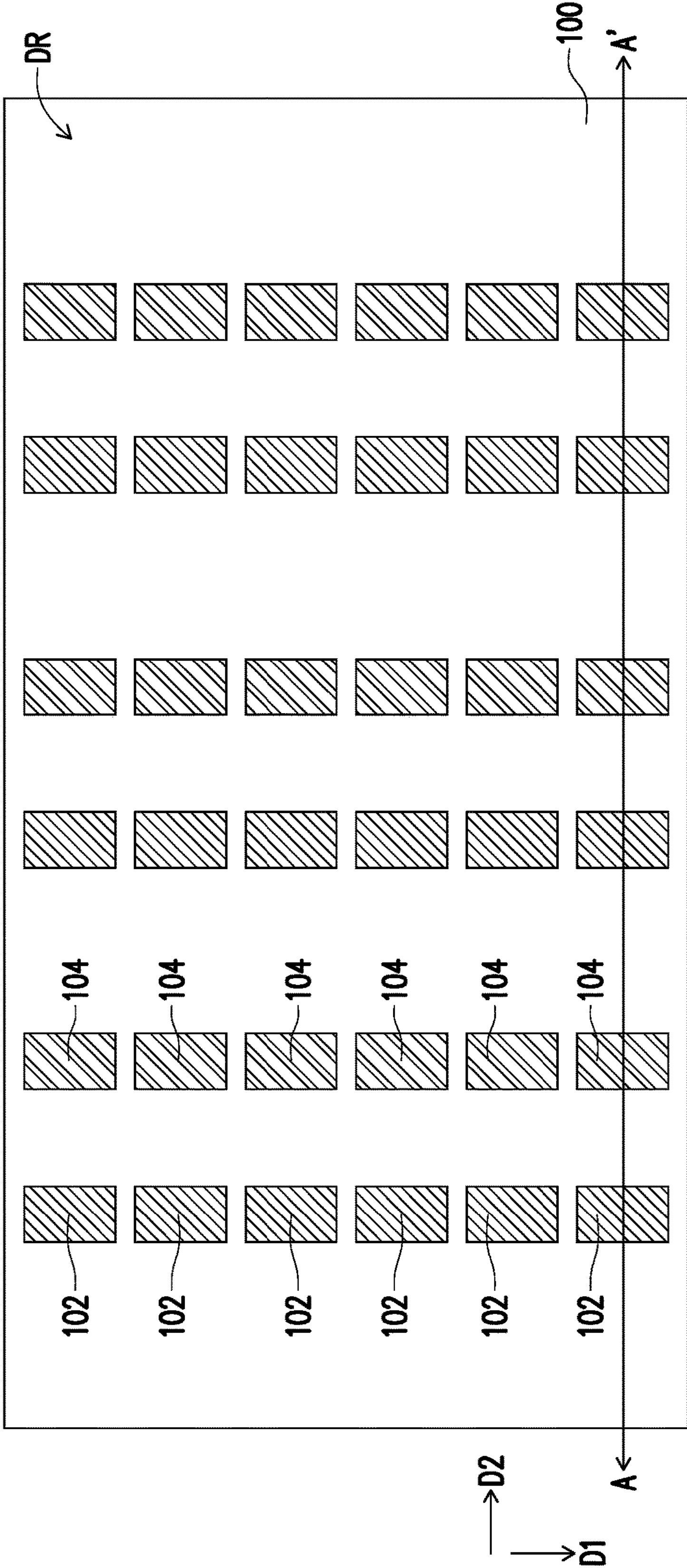


FIG. 10A

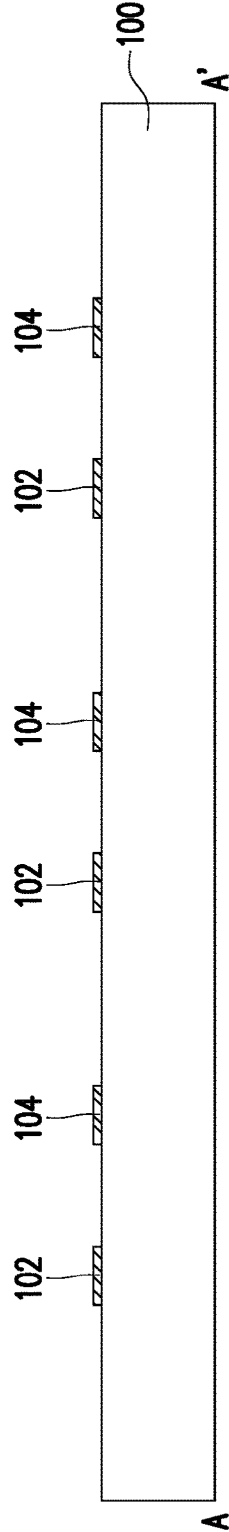


FIG. 10B

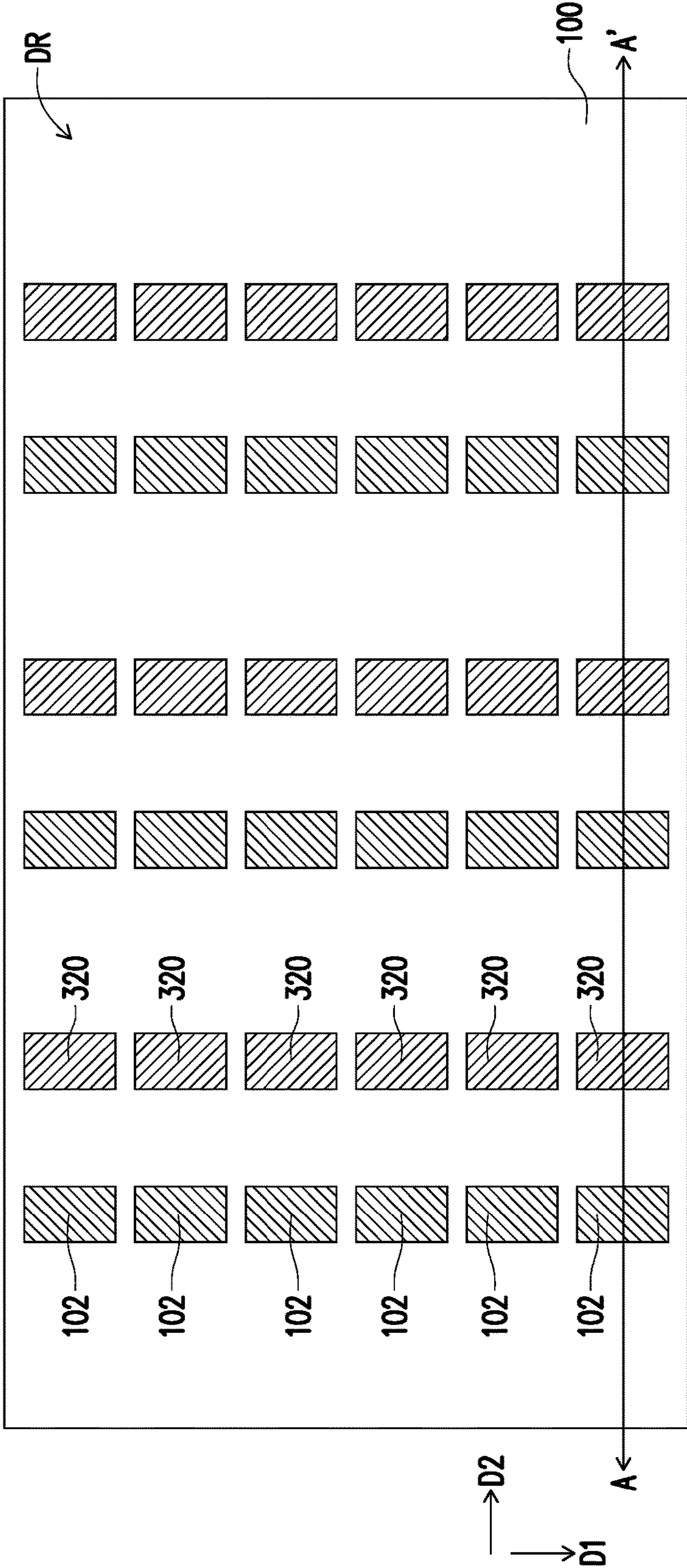


FIG. 11A

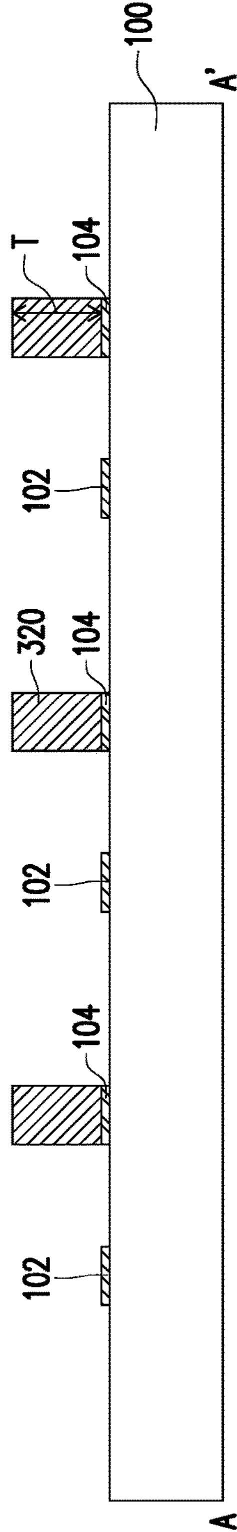


FIG. 11B

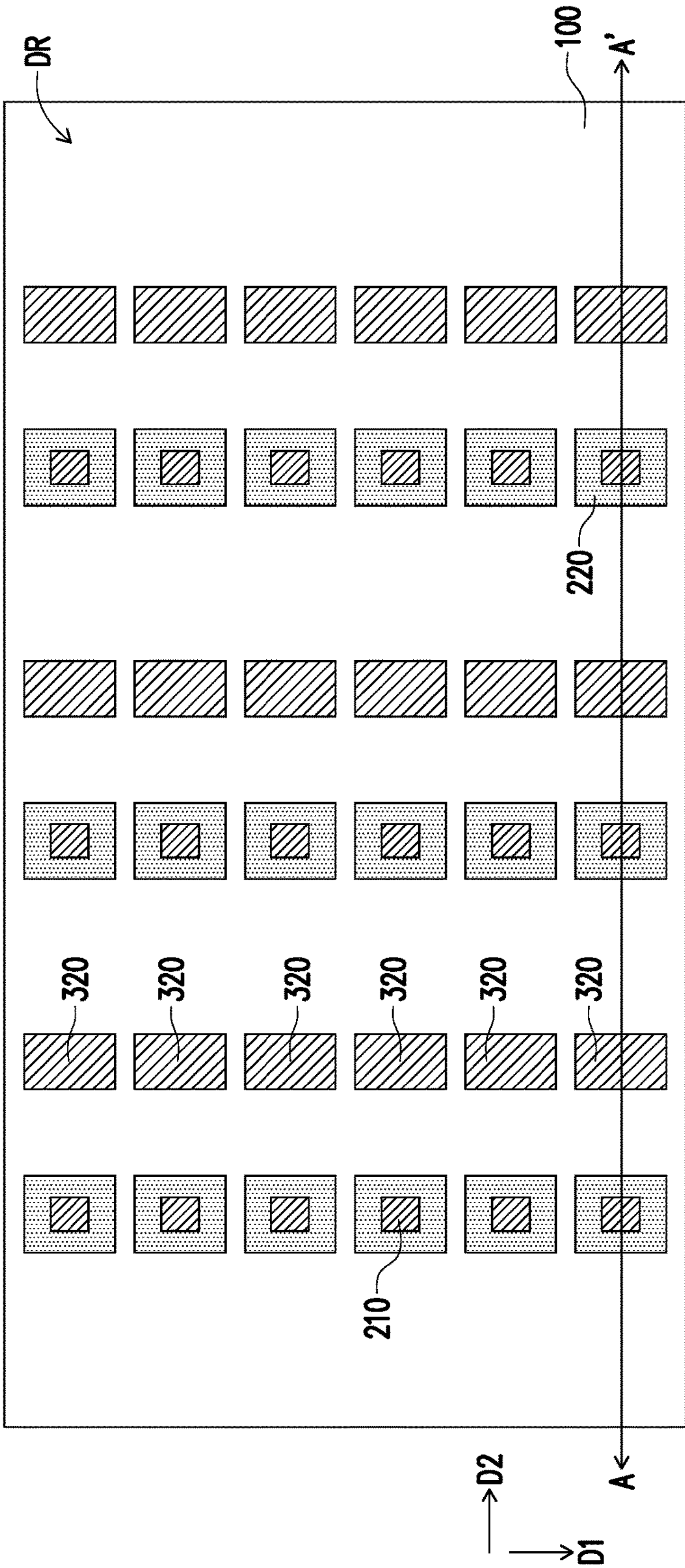


FIG. 12A

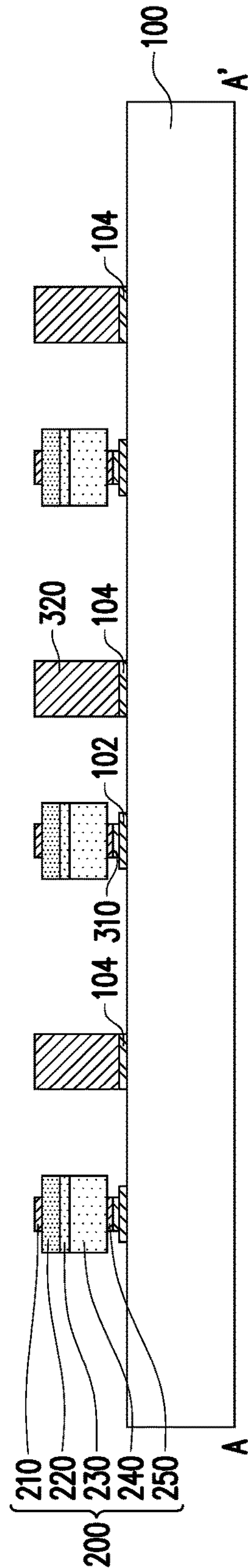


FIG. 12B

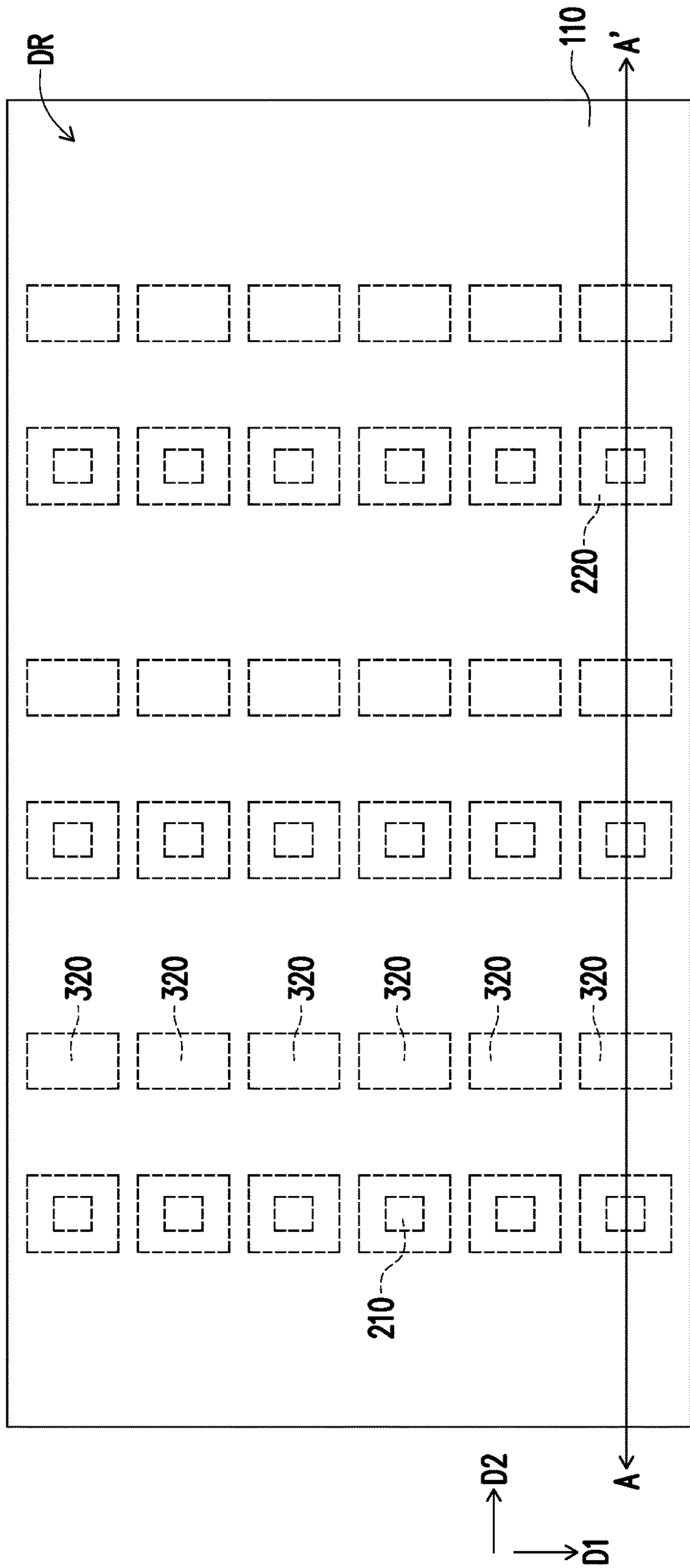


FIG. 13A

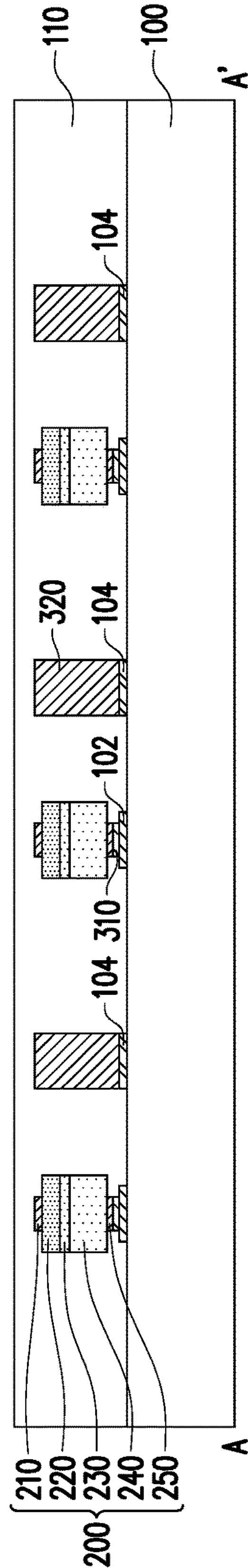


FIG. 13B

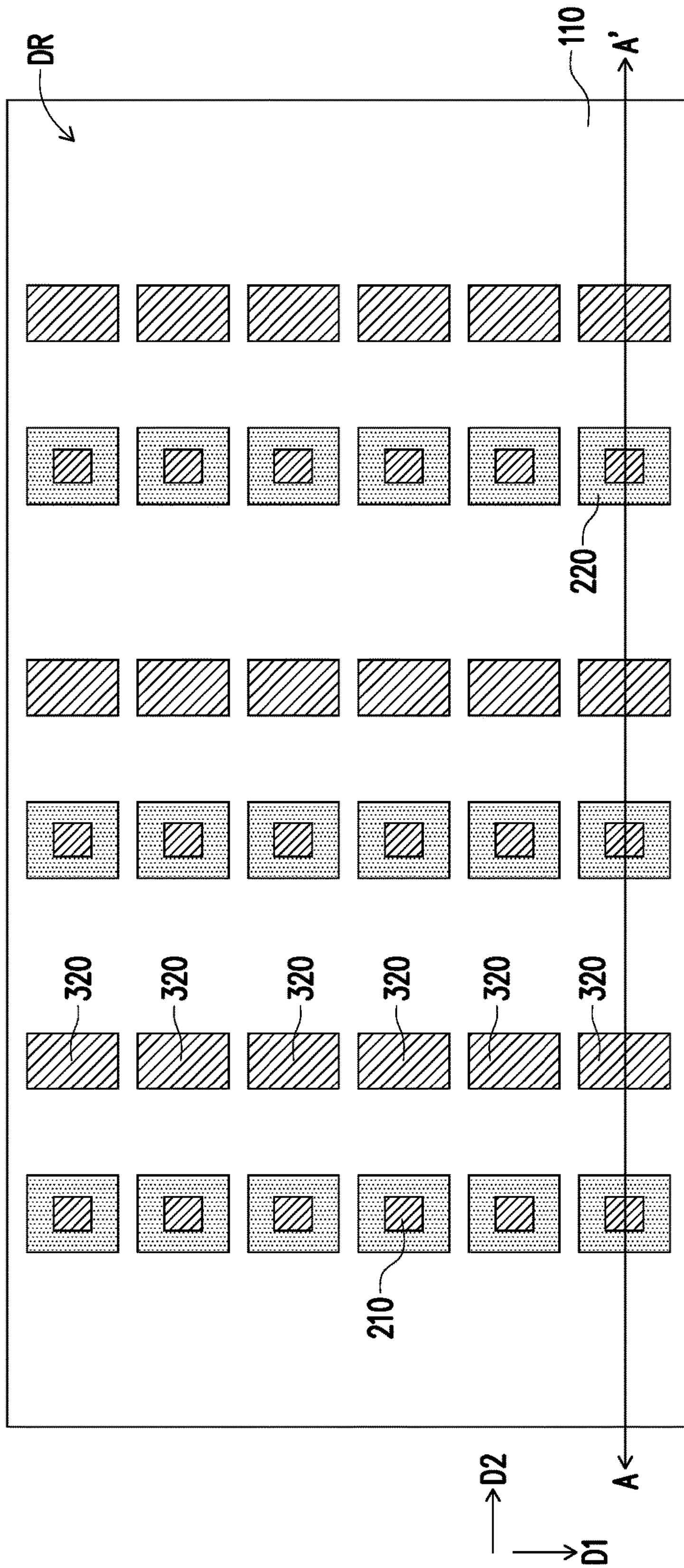


FIG. 14A

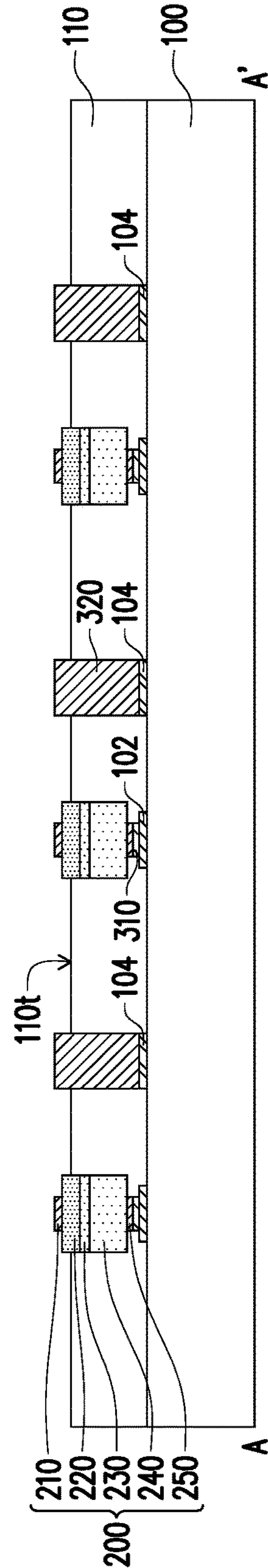


FIG. 14B

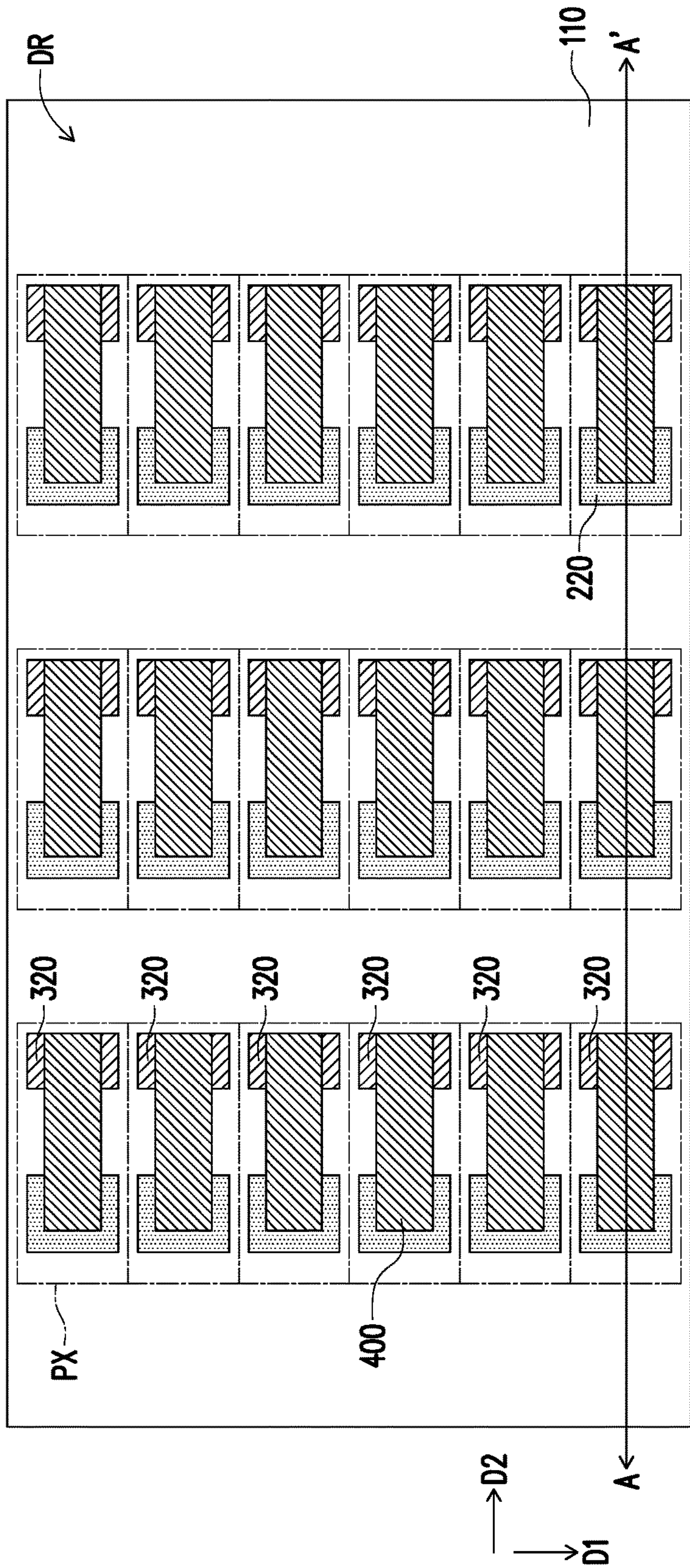


FIG. 15A

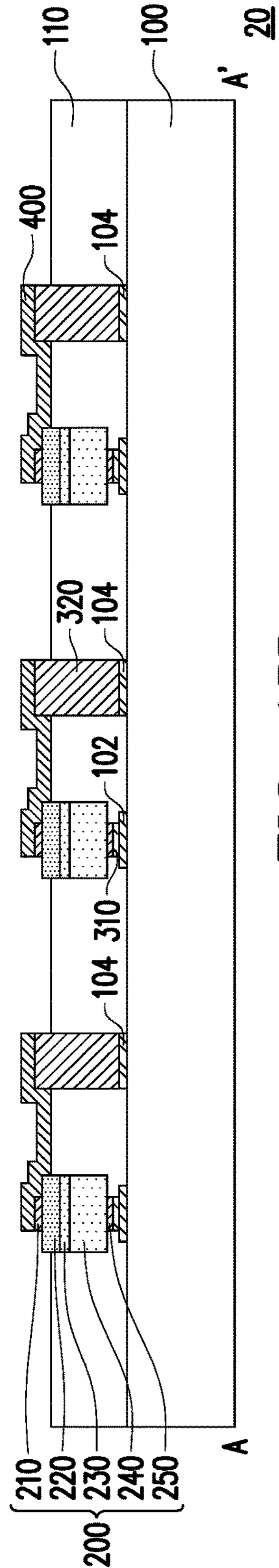


FIG. 15B

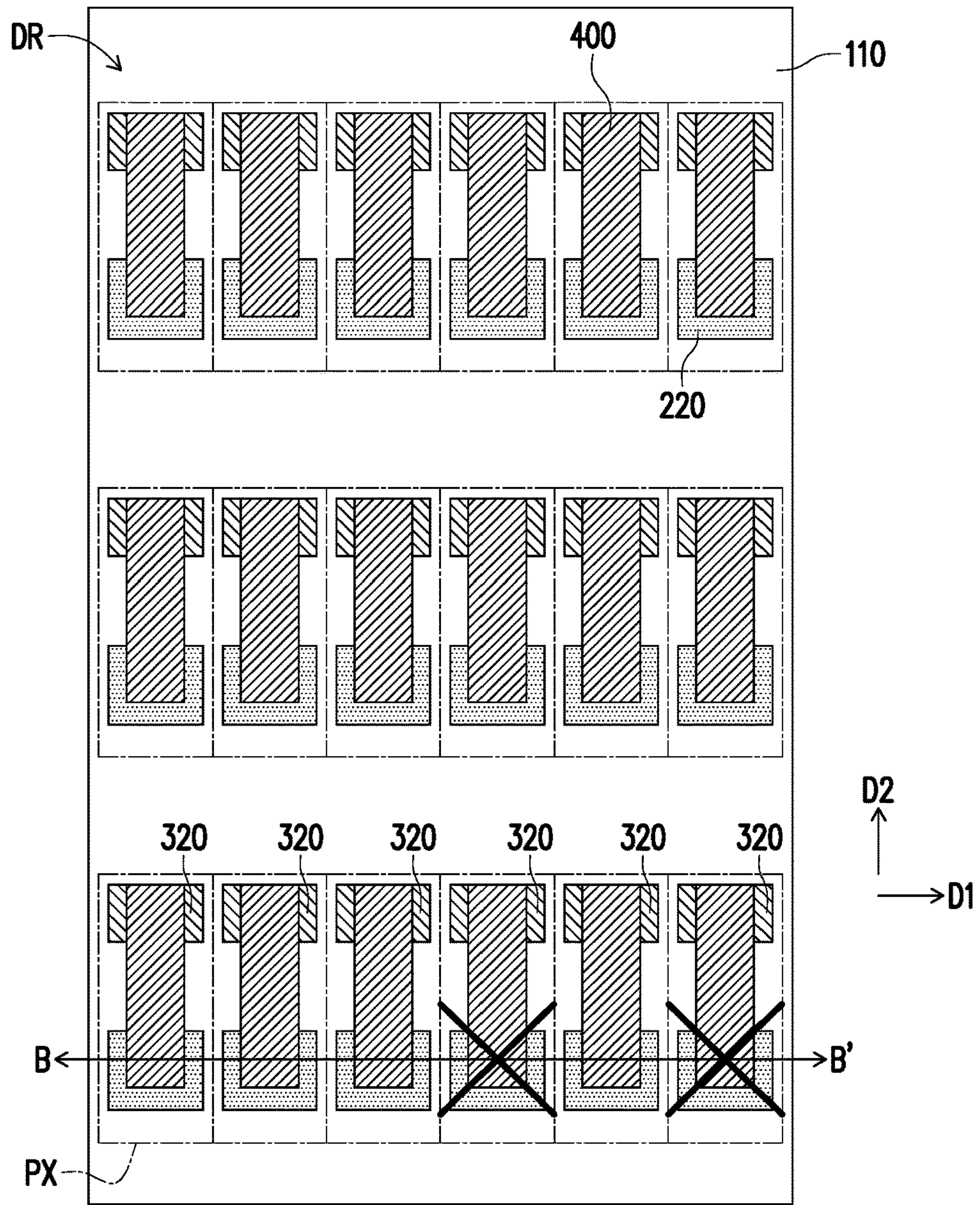


FIG. 16A

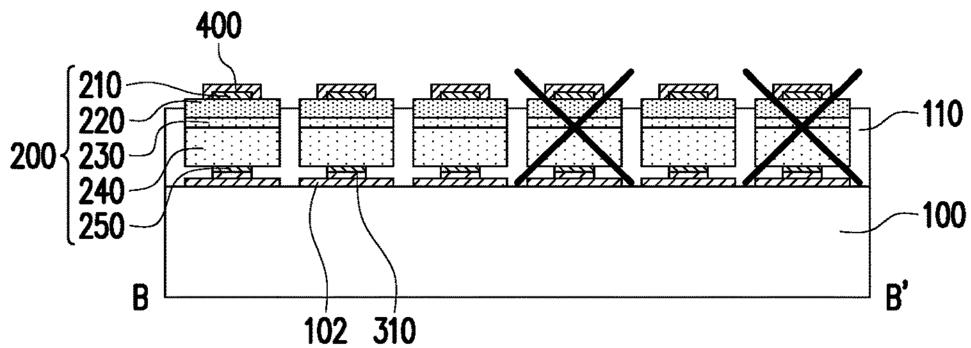


FIG. 16B

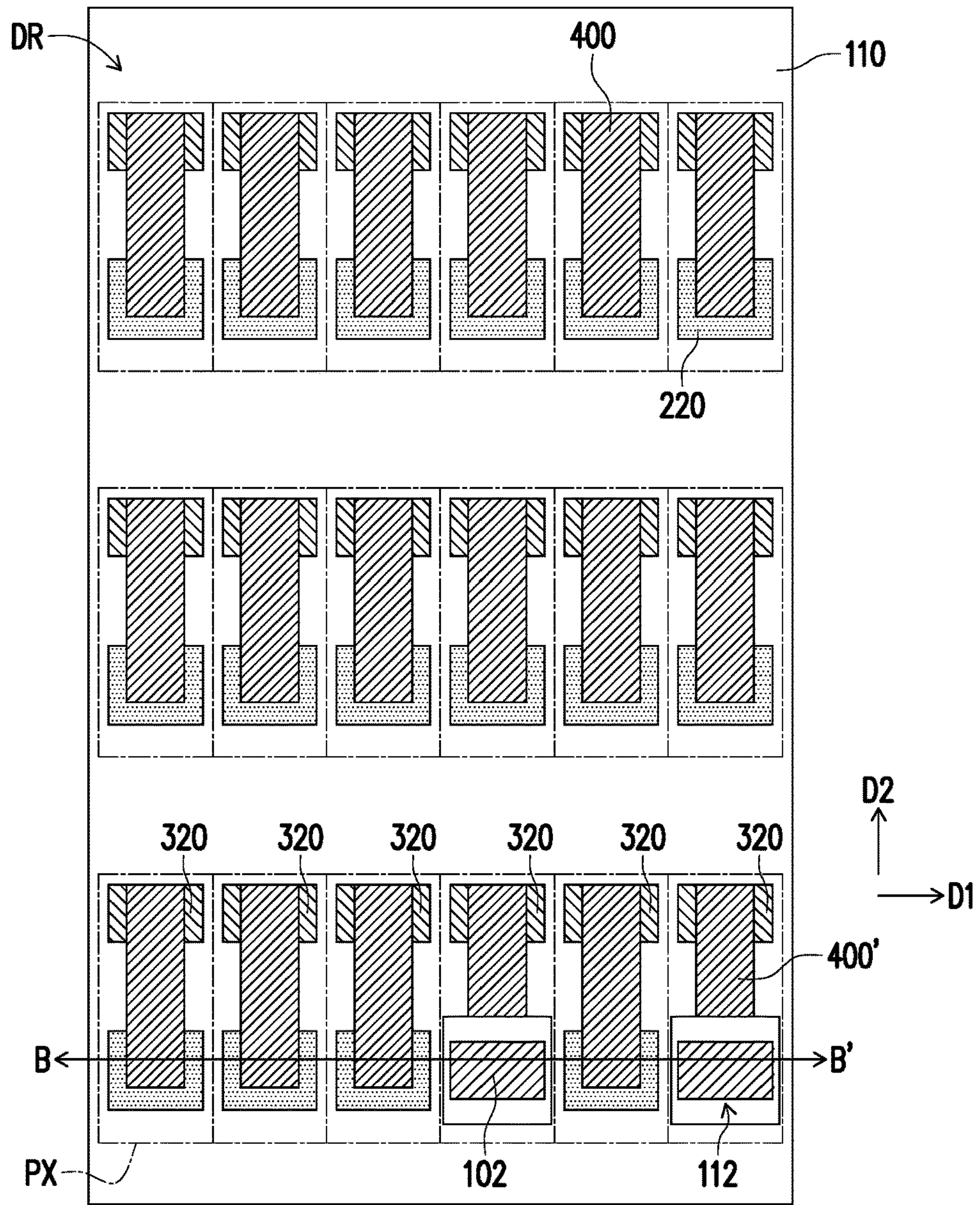


FIG. 17A

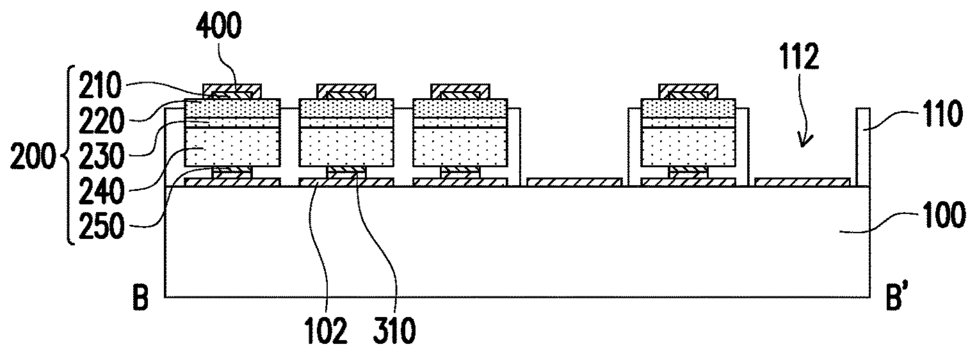


FIG. 17B

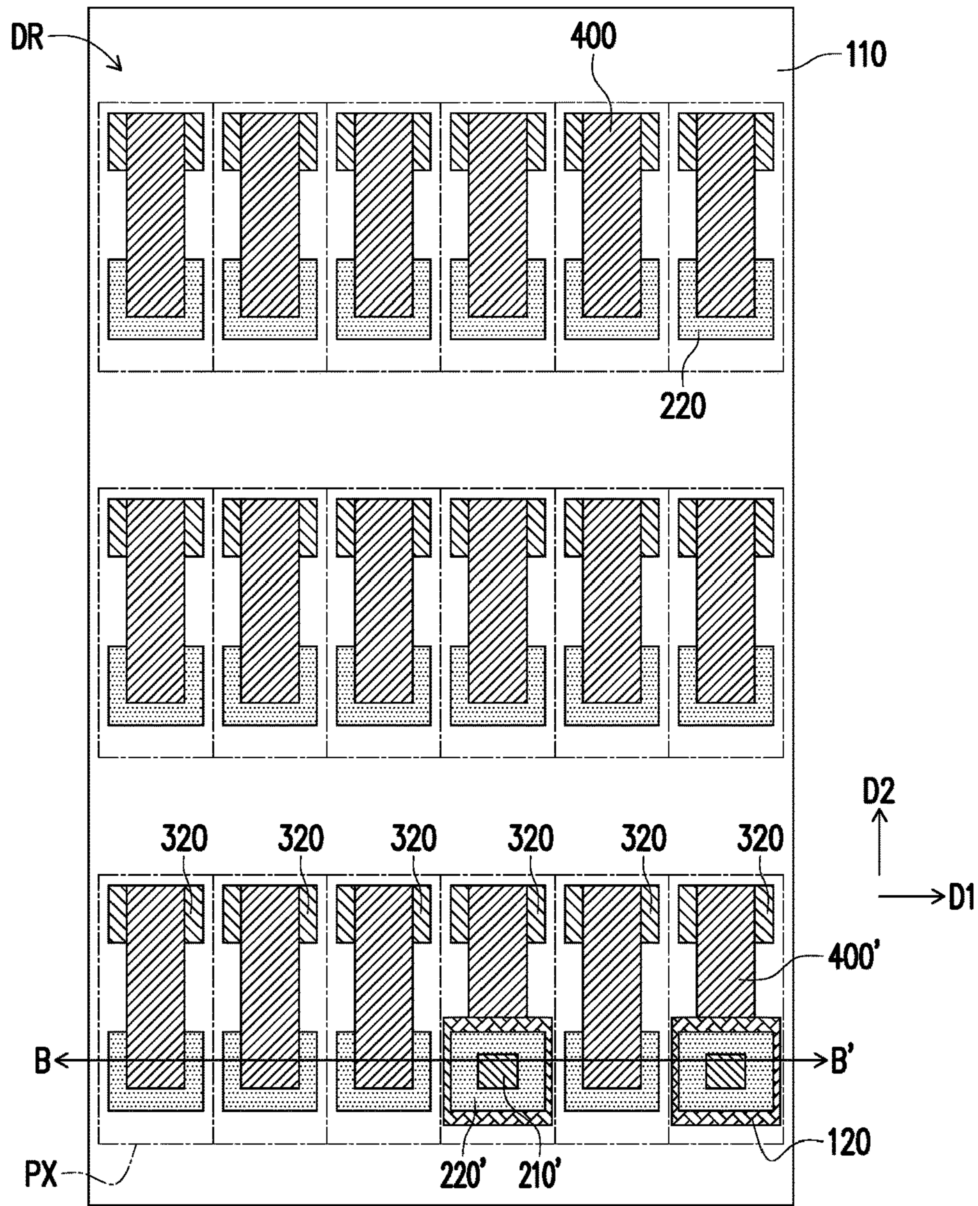


FIG. 18A

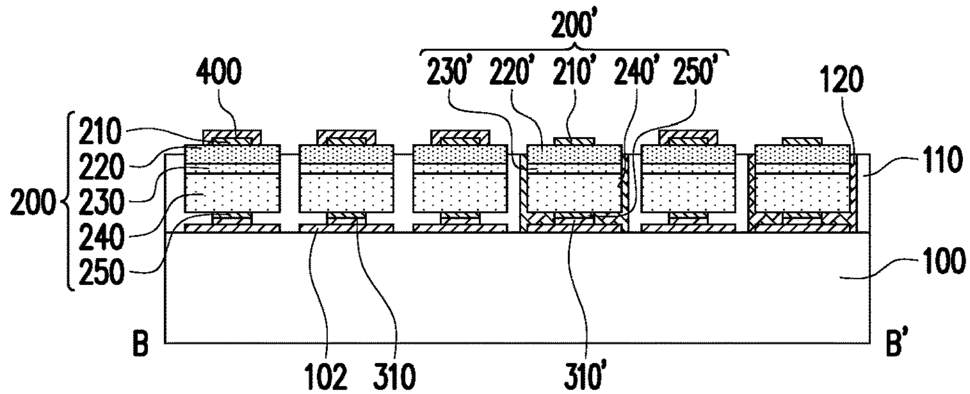


FIG. 18B

DR
400
110
220
D2
D1
320 320 320 320 320 320
400'
500
B
B'
120
PX
220'
PX'
20'

FIG. 19A

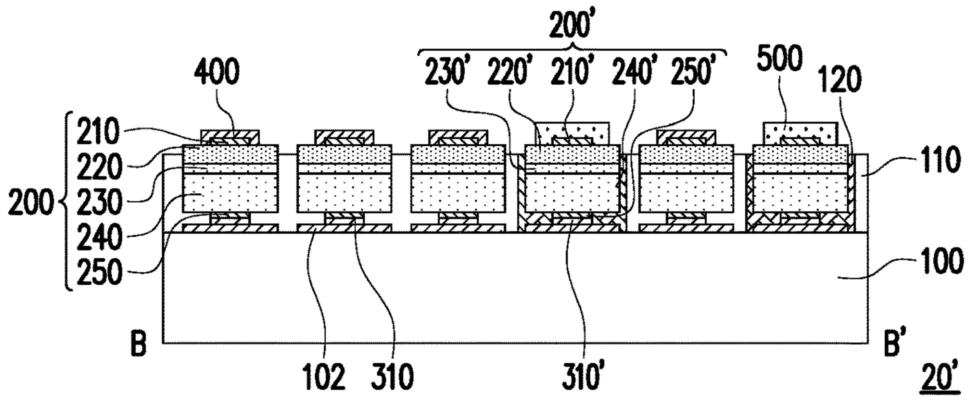


FIG. 19B

FIG. 20

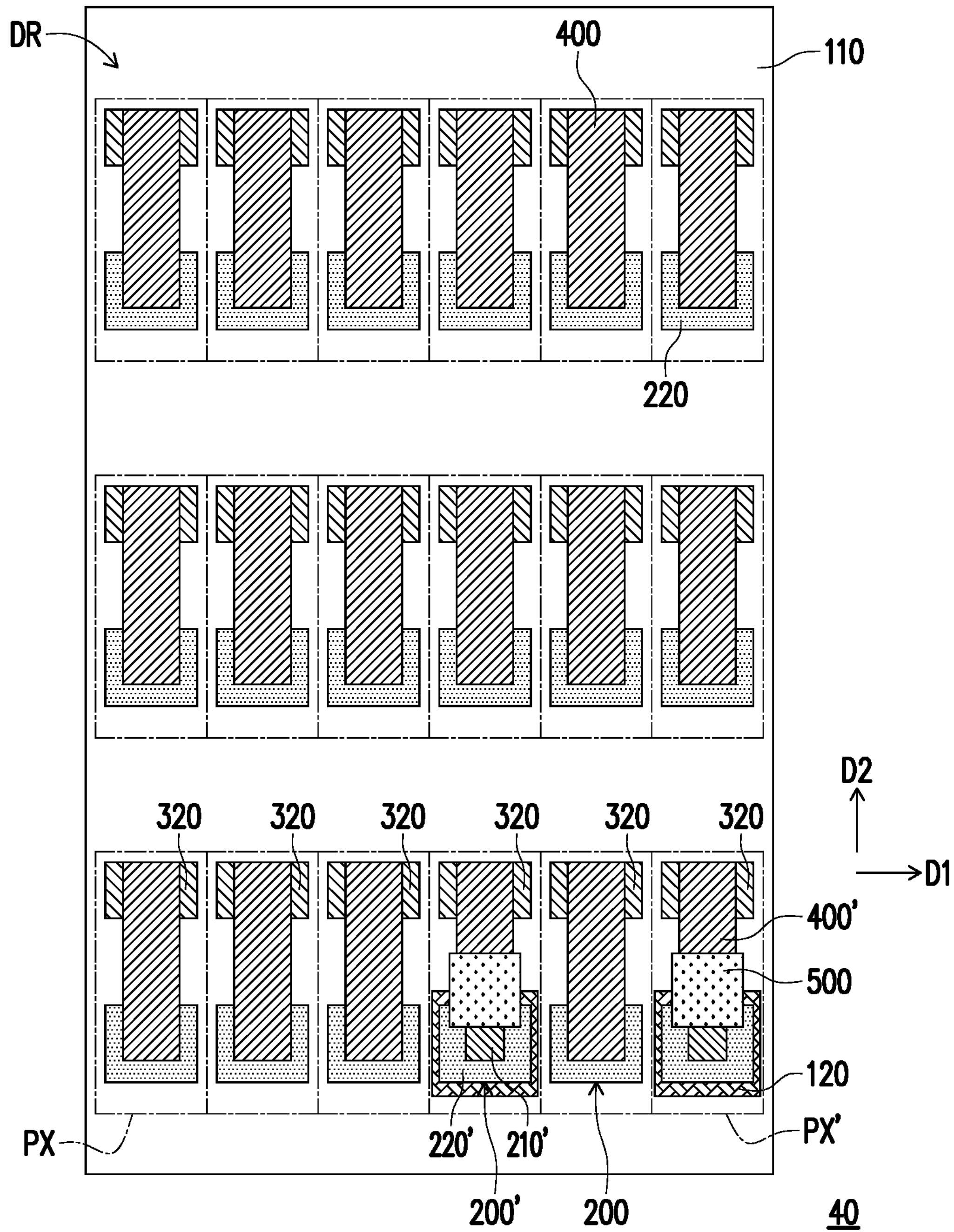


FIG. 21

DISPLAY PANEL AND MANUFACTURING METHOD THEREOF

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the priority benefit of China application serial no. 202211511699.9 filed on Nov. 29, 2022. The entirety of the above-mentioned patent application is hereby incorporated by reference herein and made a part of this specification.

BACKGROUND

Technical Field

[0002] The disclosure relates to a display panel and a manufacturing method thereof.

Description of Related Art

[0003] A light emitting diode is a kind of electroluminescent semiconductor element, which has the advantages of high efficiency, long service life, not easy to break, fast response speed, and high reliability. Generally speaking, the key technology for manufacturing micro light emitting diode displays is how to transfer a large number of micro light emitting diodes to the pixel array substrate. However, the transfer technology is a mechanical operation, and the effectiveness of the transfer technology depends on the precision of the machine and the precision and yield of the transfer device itself. When extracting the micro LEDs, one may encounter machine actuation errors and transfer device accuracy errors. When placing the micro LEDs, one may face another machine actual alignment deviation. If the micro LEDs are not placed in the correct position, or if there is damage during the transfer and placement process, the micro LEDs might not work properly. Generally speaking, pixels that are not working properly are repaired through a maintenance process. Therefore, many manufacturers are currently devoting themselves to developing methods that may improve the yield of the aforementioned maintenance process.

SUMMARY

[0004] The disclosure provides a display panel, which may improve the problem of poor electrical connection between the light emitting diode and the pad due to the step difference.

[0005] The disclosure provides a manufacturing method of a display panel, which may improve the yield of the maintenance process.

[0006] At least one embodiment of the disclosure provides a display panel. The display panel includes a circuit substrate, multiple pixel structures, and a molding layer. The circuit substrate has multiple first pad structures and multiple second pad structures. The pixel structures are disposed above a display region of the circuit substrate. Each of at least a portion of the pixel structures includes a first light emitting diode, a first conductive block, and a first conductive connection structure. The first light emitting diode is disposed on a corresponding first pad structure. The first conductive block is disposed on a corresponding second pad structure. The first conductive connection structure electrically connects the first light emitting diode to the first conductive block. The molding layer is located above the circuit substrate and surrounds the first light emitting diode and the first conductive block. The first conductive connection structure is located on the molding layer.

[0007] At least one embodiment of the disclosure provides a manufacturing method of a display panel, including the following operation. A circuit substrate is provided, in which the circuit substrate has multiple first pad structures and multiple second pad structures. Multiple conductive blocks are formed on the second pad structures. Multiple first light emitting diodes are disposed on the first pad structures. A molding layer is formed to surround the conductive blocks and the first light emitting diodes. Multiple first conductive connection structures are formed on the molding layer, in which the first conductive connection structures electrically connect at least a portion of the first light emitting diodes to at least a portion of the conductive blocks to form multiple pixel structures. A portion of the molding layer is removed to form an opening exposing at least a portion of the first pad structures. A second light emitting diode is disposed in the opening, and the second light emitting diode is bonded to at least a portion of the first pad structures. A second conductive connection structure is formed on the molding layer, in which the second conductive connection structure electrically connects the second light emitting diode to a corresponding one of the conductive blocks.

BRIEF DESCRIPTION OF THE DRAWING

[0008] FIG. **1**A, FIG. **2**A, FIG. **3**A, FIG. **4**A, FIG. **5**A, FIG. **6**A, FIG. **7**A, FIG. **8**A, and FIG. **9**A are top schematic views of a manufacturing method of a display panel according to an embodiment of the disclosure.

[0009] FIG. **1**B, FIG. **2**B, FIG. **3**B, FIG. **4**B, FIG. **5**B, and FIG. **6**B are cross-sectional schematic views along a line A-A' of FIG. **1**A, FIG. **2**A, FIG. **3**A, FIG. **4**A, FIG. **5**A, and FIG. **6**A, respectively.

[0010] FIG. **7**B, FIG. **8**B, and FIG. **9**B are cross-sectional schematic views along a line B-B' of FIG. **7**A, FIG. **8**A, and FIG. **9**A, respectively.

[0011] FIG. **10**A, FIG. **11**A, FIG. **12**A, FIG. **13**A, FIG. **14**A, FIG. **15**A, FIG. **16**A, FIG. **17**A, FIG. **18**A, and FIG. **19**A are top schematic views of a manufacturing method of a display panel according to an embodiment of the disclosure.

[0012] FIG. **10**B, FIG. **11**B, FIG. **12**B, FIG. **13**B, FIG. **14**B, and FIG. **15**B are cross-sectional schematic views along the line A-A' of FIG. **10**A, FIG. **11**A, FIG. **12**A, FIG. **13**A, FIG. **14**A, and FIG. **15**A, respectively.

[0013] FIG. **16**B, FIG. **17**B, FIG. **18**B, and FIG. **19**B are cross-sectional schematic views along the line B-B' of FIG. **16**A, FIG. **17**A, FIG. **18**A, and FIG. **19**A, respectively.

[0014] FIG. **20** is a top schematic view of a display panel according to an embodiment of the disclosure.

[0015] FIG. **21** is a top schematic view of a display panel according to an embodiment of the disclosure.

DETAILED DESCRIPTION OF DISCLOSED EMBODIMENTS

[0016] FIG. **1**A, FIG. **2**A, FIG. **3**A, FIG. **4**A, FIG. **5**A, FIG. **6**A, FIG. **7**A, FIG. **8**A, and FIG. **9**A are top schematic views of a manufacturing method of a display panel according to an embodiment of the disclosure. FIG. **1**B, FIG. **2**B, FIG. **3**B, FIG. **4**B, FIG. **5**B, and FIG. **6**B are cross-sectional schematic views along a line A-A' of FIG. **1**A, FIG. **2**A, FIG.

3A, FIG. 4A, FIG. 5A, and FIG. 6A, respectively. FIG. 7B, FIG. 8B, and FIG. 9B are cross-sectional schematic views along a line B-B' of FIG. 7A, FIG. 8A, and FIG. 9A, respectively. More specifically, FIG. 1A to FIG. 6B are schematic views of a manufacturing method of a display panel **10**. When it is found that a portion of the pixel structures PX in the display panel **10** is faulty, the maintenance process shown in FIG. 7A to FIG. 9B is further performed to obtain the display panel **10'**.

[0017] Referring to FIG. **1**A and FIG. **1**B, a circuit substrate **100** is provided. The circuit substrate **100** has multiple first pad structures **102** and multiple second pad structures **104** located on the surface. For example, the circuit substrate **100** includes a substrate and a circuit structure located on the substrate. The circuit structure includes conductive lines, active elements, passive elements, the first pad structure **102**, the second pad structure **104**, and other suitable components. For convenience of illustration, FIG. **1**B and FIG. **1**A show the first pad structure **102** and the second pad structure **104** in the circuit substrate **100**, and other circuit structures in the circuit substrate **100** are omitted. The first pad structure **102** and the second pad structure **104** are disposed in the display region DR of the circuit substrate **100**.

[0018] In this embodiment, the first pad structure **102** includes a first portion **102***a* and a second portion **102***b* that are separated from each other. The first portion **102***a* and the second portion **102***b* of the first pad structure **102** are electrically connected to each other through other conductive lines (not shown) or circuit structures. In other words, the same signal is applied to the first portion **102***a* and the second portion **102***b*. In other embodiments, the first portion **102***a* and the second portion **102***b* are connected to each other, in other words, the first pad structure **102** are not divided into two separate portions.

[0019] In this embodiment, the second pad structure **104** includes a third portion **104***a* and a fourth portion **104***b* that are separated from each other. The third portion **104***a* and the fourth portion **104***b* of the second pad structure **104** are electrically connected to each other through other conductive lines (not shown) or circuit structures. In other words, the same signal is applied to the third portion **104***a* and the fourth portion **104***b*. In other embodiments, the third portion **104***a* and the fourth portion **104***b* are connected to each other, in other words, the second pad structure **104** are not divided into two separate portions.

[0020] In this embodiment, in the first direction D**1**, the first portion **102***a* and the second portion **102***b* are arranged alternately, and the third portion **104***a* and the fourth portion **104***b* are arranged alternately. In the second direction D**2**, the first portion **102***a* and the third portion **104***a* are arranged alternately, and the second portion **102***b* and the fourth portion **104***b* are arranged alternately. In this embodiment, the first direction D**1** is perpendicular to the second direction D**2**.

[0021] In this embodiment, the first pad structure **102** and the second pad structure **104** belong to the same patterned conductive layer. For example, the first pad structure **102** and the second pad structure **104** are formed by patterning the same conductive material layer. In some embodiments, the materials of the first pad structure **102** and the second pad structure **104** include metal, metal oxide, or other suitable materials. In some examples, each of the first pad structure **102** and the second pad structure **104** is a single-layer or multi-layer structure.

[0022] Referring to FIG. **2**A and FIG. **2**B, multiple first conductive blocks **320***a* and multiple second conductive blocks **320***b* are formed on the second pad structure **104**. The first conductive block **320***a* is formed on the third portion **104***a* of the second pad structure **104**, and the second conductive block **320***b* is formed on the fourth portion **104***b* of the second pad structure **104**. The first conductive block **320***a* is separated from the second conductive block **320***b*.

[0023] In some embodiments, the first conductive block **320***a* and the second conductive block **320***b* further include a seed crystal layer (not shown). For example, the forming method for the first conductive block **320***a* and the second conductive block **320***b* includes the following steps. First, a seed crystal layer and a patterned photoresist layer are formed on the circuit substrate **100**. The seed crystal layer contacts the third portion **104***a* and the fourth portion **104***b* of the second pad structure **104**, and the patterned photoresist layer has multiple openings exposing the third portion **104***a* and the fourth portion **104***b*. Then, a metal material is formed on the seed crystal layer in the openings of the patterned photoresist layer by electroplating. Finally, the patterned photoresist layer and the excess seed crystal layer are removed, and the remaining metal material and seed crystal layer form the first conductive block **320***a* and the second conductive block **320***b*. In some embodiments, the seed crystal layer includes titanium, copper, other suitable conductive materials or a combination of the materials thereof, and the metal material formed by the aforementioned electroplating includes gold, copper, other suitable metal materials or a combination of the materials thereof.

[0024] In some embodiments, the first conductive block **320***a* and the second conductive block **320***b* have the same thickness T, in which the thickness T is 5 microns to 10 microns.

[0025] Referring to FIG. **3**A and FIG. **3**B, multiple first light emitting diodes **200** are disposed on the first pad structure **102**. In this embodiment, the first light emitting diode **200** is located on the first portion **102***a* of the corresponding first pad structure **102**.

[0026] The first light emitting diode **200** is a vertical light emitting diode and includes a first electrode **210**, a first semiconductor layer **220**, a light emitting layer **230**, a second semiconductor layer **240**, and a second electrode **250**. The first semiconductor layer **220**, the light emitting layer **230**, and the second semiconductor layer **240** are stacked in sequence. In some embodiments, one of the first semiconductor layer **220** and the second semiconductor layer **240** is an N-type semiconductor, and the other is a P-type semiconductor. The first electrode **210** and the second electrode **250** are respectively connected to the first semiconductor layer **220** and the second semiconductor layer **240**. In this embodiment, the top surface area of the first electrode **210** is smaller than the top surface area of the first semiconductor layer **220**, but the disclosure is not limited thereto. The top surface area of the first electrode **210** may be adjusted according to actual requirements. For example, in other embodiments, the top surface area of the first electrode **210** is equal to the top surface area of the first semiconductor layer **220**. In some embodiments, the first light emitting diode **200** includes light emitting diodes of different colors. For example, the first light emitting diode **200** includes red light emitting diodes, green light emitting

diodes, blue light emitting diodes, or light emitting diodes of other colors. In some embodiments, the first light emitting diodes **200** of different colors are arranged in the first direction D**1**, and the first light emitting diodes **200** of the same color are arranged in the second direction D**2**, but the disclosure is not limited thereto. In other embodiments, the first light emitting diodes **200** of different colors are arranged in the second direction D**2**, and the first light emitting diodes **200** of the same color are arranged in the first direction D**1**.

[0027] In this embodiment, the second electrode **250** is bonded to the corresponding first portion **102***a* of the first pad structure **102**. For example, the second electrode **250** is bonded to the first portion **102***a* through the conductive connection structure **310**. The conductive connection structure **310** is, for example, anisotropic conductive glue, solder, or other suitable materials. In some embodiments, the second electrode **250** is eutectically bonded to the first portion **102***a* of the first pad structure **102**.

[0028] In some embodiments, after bonding the first light emitting diode **200** to the first portion **102***a*, the top surface of the first light emitting diode **200** (the top surface of the first electrode **210**) is approximately flush with the top surface of the first conductive block **320***a* and the top surface of the second conductive block **320***b*. In other words, based on the circuit substrate **100**, the top surface of the first light emitting diode **200** is approximately at the same horizontal level as the top surface of the first conductive block **320***a* and the top surface of the second conductive block **320***b*.

[0029] Referring to FIG. **4**A and FIG. **4**B, the molding layer **110** is formed on the circuit substrate **100**, and the molding layer **110** surrounds the first conductive block **320***a*, the second conductive block **320***b*, and the first light emitting diode **200**.

[0030] In some embodiments, the molding layer **110** includes transparent material, gray material, or black material. For example, the molding layer **110** includes epoxy resin, silicone, or other suitable materials, and the molding layer **110** selectively includes carbon black, scattering particles, or other filling particles.

[0031] In this embodiment, the molding layer **110** covers the top surface of the first conductive block **320***a*, the top surface of the second conductive block **320***b*, and the top surface of the first light emitting diode **200**. Therefore, plasma treatment must be performed to remove a portion of the molding layer **110** so that the first conductive block **320***a*, the second conductive block **320***b*, and the first light emitting diode **200** may be exposed, as shown in FIG. **5**A and FIG. **5**B. In some embodiments, the aforementioned plasma treatment is performed, for example, by sulfur hexafluoride plasma, carbon tetrafluoride plasma, oxygen plasma, or a combination thereof.

[0032] In some embodiments, the plasma treatment is performed until the top surface **110***t* of the molding layer **110** is lower than the top surface of the first conductive block **320***a*, the top surface of the second conductive block **320***b*, and the top surface of the first light emitting diode **200**. However, in order to reduce the probability of short-circuiting the first light emitting diode **200**, the molding layer **110** preferably covers the light emitting layer **230** and the second semiconductor layer **240**. Specifically, based on the circuit substrate **100**, the height of the top surface **110***t* of the molding layer **110** is preferably higher than the height of the light emitting layer **230** of the first light emitting diode **200**.

[0033] Next, referring to FIG. **6**A and FIG. **6**B, multiple first conductive connection structures **400** are formed on the molding layer **110**. The first conductive connection structure **400** electrically connects at least a portion of the first light emitting diode **200** to at least a portion of the first conductive block **320***a* and the second conductive block **320***b* to form multiple pixel structures PX. In this embodiment, the first pad structure **102** corresponding to each of the pixel structures PX includes a first portion **102***a* and a second portion **102***b* separated from each other, and the second pad structure **104** corresponding to each of the pixel structures PX includes a third portion **104***a* and a fourth portion **104***b* separated from each other.

[0034] In this embodiment, the first conductive connection structure **400** is an L-shaped structure formed by a portion extending along the first direction D**1** and a portion extending along the second direction D**2**, and the first conductive connection structure **400** is simultaneously connected to the first conductive block **320***a* and the second conductive block **320***b*. In other embodiments, the first conductive connection structure **400** is a straight strip structure, in which the first conductive connection structure **400** is connected to the first conductive block **320***a* and not connected to the second conductive block **320***b*.

[0035] In some embodiments, the first conductive connection structure **400** includes a transparent conductive material, such as a conductive oxide (e.g., indium tin oxide, indium zinc oxide, aluminum tin oxide, aluminum zinc oxide, indium gallium zinc oxide, or combination of the materials thereof), therefore, even if the first conductive connection structure **400** covers the top surface of the first light emitting diode **200**, it does not have a great impact on the brightness of the display panel **10**, but the disclosure is not limited thereto. In other embodiments, the first conductive connection structure **400** includes an opaque conductive material, such as metal, therefore, the area of the first conductive connection structure **400** covering the top surface of the first light emitting diode **200** may be reduced. Moreover, as shown in FIG. **20**, the first conductive connection structure **400** only contacts the side of the first electrode **210** of the first light emitting diode **200**, so as to prevent the first conductive connection structure **400** from having a great impact on the brightness of the display panel **30**. In some embodiments, the forming method of the first conductive connection structure **400** includes physical vapor deposition, chemical vapor deposition, atomic layer deposition, printing, inkjet printing, or other suitable methods. In some embodiments, the defining method for the pattern of the first conductive connection structure **400** includes, for example, a lithography process.

[0036] In this embodiment, each of at least a portion of the pixel structures PX includes a first light emitting diode **200**, a first conductive block **320***a*, a second conductive block **320***b*, a first conductive connection structure **400**, and a repair region RR. Both the first light emitting diode **200** and the repairing region RR overlap the first pad structure **102**, in which the first light emitting diode **200** and the repairing region RR respectively overlap the first portion **102***a* and the second portion **102***b*.

[0037] After the first conductive connection structure **400** is formed, the pixel structures PX in the display panel **10** is inspected, and when a portion of the pixel structures PX is found to be faulty, the maintenance process shown in FIG. **7**A to FIG. **9**B is further performed. For example, a portion

of the pixel structures PX is a faulty pixel structure PX. In the faulty pixel structure PX, the first light emitting diode **200** and/or the first conductive connection structure **400** are damaged, causing the first light emitting diode **200** in the faulty pixel structure PX to fail to emit light normally. In FIG. **7**A to FIG. **9**B, a cross mark is marked on the first light emitting diode **200** that cannot emit light normally.

[0038] Referring to FIG. **7**A and FIG. **7**B, a portion of the molding layer **110** is removed to form an opening **112** exposing at least a portion of the first pad structure **102**. Specifically, the opening **112** of the molding layer **110** is located in the repair region RR of the faulty pixel structure PX, and the opening **112** exposes the first pad structure **102** of the faulty pixel structure PX. In this embodiment, the opening **112** exposes the second portion **102***b* of the first pad structure **102**.

[0039] In some embodiments, the removing method for a portion of the molding layer **110** includes a dry etching process (e.g., a laser process) or a wet etching process.

[0040] Referring to FIG. **8**A and FIG. **8**B, the second light emitting diode **200**R is disposed in the opening **112**. The second light emitting diode **200**R is bonded to at least a portion of the first pad structure **102**.

[0041] The second light emitting diode **200**R is a vertical light emitting diode and includes a first electrode **210**R, a first semiconductor layer **220**R, a light emitting layer **230**R, a second semiconductor layer **240**R, and a second electrode **250**R. The first semiconductor layer **220**R, the light emitting layer **230**R, and the second semiconductor layer **240**R are stacked in sequence. In some embodiments, one of the first semiconductor layer **220**R and the second semiconductor layer **240**R is an N-type semiconductor, and the other is a P-type semiconductor. The first electrode **210**R and the second electrode **250**R are respectively connected to the first semiconductor layer **220**R and the second semiconductor layer **240**R. In some embodiments, the second light emitting diode **200**R includes light emitting diodes of different colors. For example, the second light emitting diode **200**R includes red light emitting diodes, green light emitting diodes, blue light emitting diodes, or light emitting diodes of other colors. In some embodiments, the first light emitting diode **200** and the second light emitting diode **200**R in a faulty pixel structure PX are light emitting diodes of the same color.

[0042] In some embodiments, after the second light emitting diode **200**R is disposed in the opening **112**, a filling material **120** is formed to fill the gap between the second light emitting diode **200**R and the opening **112**. The second light emitting diode **200**R and the filling material **120** are filled into the opening **112**, and the filling material **120** surrounds the second light emitting diode **200**R. In some embodiments, the forming method of the filling material **120** includes inkjet printing, glue dispensing, or other suitable processes. In some embodiments, the filling material **120** includes epoxy resin, silicone, acrylic or other suitable materials, and the filling material **120** selectively includes carbon black, scattering particles, or other filling particles. The filling material **120** and the molding layer **110** may include the same or different materials.

[0043] Referring to FIG. **9**A and FIG. **9**B, a second conductive connection structure **500** is formed on the molding layer **110**. The second conductive connection structure **500** electrically connects the second light emitting diode **200**R to a corresponding one of the conductive blocks, and so far the display panel **10'** including the repaired pixel structure PX' is formed.

[0044] In some embodiments, the second conductive connection structure **500** includes a transparent or opaque conductive material formed by glue dispensing, inkjet printing, or other suitable methods, but the disclosure is not limited thereto. In other embodiments, the second conductive connection structure **500** includes conductive materials formed by chemical vapor deposition, such as tungsten, other metal materials, or other suitable conductive materials. In some embodiments, the first conductive connection structure **400** and the second conductive connection structure **500** include the same or different materials.

[0045] Each of the repaired pixel structures PX' includes the first light emitting diode **200**, the second light emitting diode **200**R, the first conductive block **320***a*, the second conductive block **320***b*, the first conductive connection structure **400**, the filling material **120**, and the second conductive connection structure **500**. The first light emitting diode **200** and the second light emitting diode **200**R are respectively disposed on the first portion **102***a* and the second portion **102***b* of the first pad structure **102**. The first conductive block **320***a* and the second conductive block **320***b* are respectively disposed on the third portion **104***a* and the fourth portion **104***b* of the second pad structure **104**. The first conductive connection structure **400** and the second conductive connection structure **500** are located on the molding layer **110**. The second conductive connection structure **500** electrically connects the second light emitting diode **200**R to the second conductive block **320***b*. In this embodiment, the first light emitting diode **200** in the repaired pixel structure PX' is not removed, but the disclosure is not limited thereto. In other embodiments, the first light emitting diode **200** in the repaired pixel structure PX' is removed through an additional process.

[0046] In the repaired pixel structure PX' of this embodiment, since the first conductive connection structure **400** is L-shaped, the second conductive connection structure **500** electrically connects the first electrode **210**R of the second light emitting diode **200**R to the first conductive connection structure **400**, and the second conductive connection structure **500** is electrically connected to the second conductive block **320***b* through the first conductive connection structure **400**. The horizontal distance L**1** between the second light emitting diode **200**R and the first conductive connection structure **400** is smaller than the horizontal distance L**2** between the second light emitting diode **200**R and the second conductive block **320***b*. In other words, with the design of the first conductive connection structure **400**, the second conductive connection structure **500** may be electrically connected to the first conductive block **320***a* and the second conductive block **320***b* without directly contacting the first conductive block **320***a* or the second conductive block **320***b*. Therefore, the size of the second conductive connection structure **500** may be reduced, and the impact of the second conductive connection structure **500** on the brightness of the display panel **10'** may be reduced.

[0047] In this embodiment, since the conductive connection structure **500** is formed on the molding layer **110**, and may be electrically connected to the second pad structure **104** through the first conductive block **320***a* and/or the second conductive block **320***b*, therefore, it is possible to prevent disconnection of the conductive connection struc-

ture **500** caused by the step difference between the first electrode **210**R of the second light emitting diode **200**R and the second pad structure **104** and improve the yield of the maintenance process.

[0048] FIG. **10**A, FIG. **11**A, FIG. **12**A, FIG. **13**A, FIG. **14**A, FIG. **15**A, FIG. **16**A, FIG. **17**A, FIG. **18**A, and FIG. **19**A are top schematic views of a manufacturing method of a display panel according to an embodiment of the disclosure. FIG. **10**B, FIG. **11**B, FIG. **12**B, FIG. **13**B, FIG. **14**B, and FIG. **15**B are cross-sectional schematic views along the line A-A' of FIG. **10**A, FIG. **11**A, FIG. **12**A, FIG. **13**A, FIG. **14**A, and FIG. **15**A, respectively. FIG. **16**B, FIG. **17**B, FIG. **18**B, and FIG. **19**B are cross-sectional schematic views along the line B-B' of FIG. **16**A, FIG. **17**A, FIG. **18**A, and FIG. **19**A, respectively. More specifically, FIG. **10**A to FIG. **15**B are schematic views of a manufacturing method of a display panel **20**. When it is found that a portion of the pixel structures PX in the display panel **20** is faulty, the maintenance process shown in FIG. **16**A to FIG. **19**B is further performed to obtain the display panel **20'**.

[0049] It is noted that the embodiment of FIG. **10**A to FIG. **19**B uses the reference numerals and a part of the contents of the embodiment of FIG. **1**A to FIG. **9**B, and the same or similar reference numerals are used to denote the same or similar elements, and the description of the same technical content is omitted. For the description of the omitted portion, reference may be made to the foregoing embodiment, and details are not described herein.

[0050] Referring to FIG. **10**A and FIG. **10**B, a circuit substrate **100** is provided. The circuit substrate **100** has multiple first pad structures **102** and multiple second pad structures **104** located on the surface. In this embodiment, each of the first pad structures **102** does not include multiple portions separated from each other, and each of the second pad structures **104** does not include multiple portions separated from each other.

[0051] In this embodiment, the first pad structures **102** are arranged along the first direction D**1**, and the second pad structures **104** are arranged along the first direction D**1**. In the second direction D**2**, the first pad structures **102** and the second pad structures **104** are arranged alternately.

[0052] Referring to FIG. **11**A and FIG. **11**B, multiple first conductive blocks **320** are formed on the second pad structures **104**.

[0053] In some embodiments, the first conductive block **320** further includes a seed crystal layer (not shown). For example, the forming method of the first conductive block **320** includes the following steps. First, a seed crystal layer and a patterned photoresist layer are formed on the circuit substrate **100**, in which the seed crystal layer contacts the second pad structure **104**, and the patterned photoresist layer has an opening exposing the second pad structure **104**. Then, a metal material is formed in the opening of the patterned photoresist layer by electroplating. Finally, the patterned photoresist layer and the excess seed crystal layer are removed, and the remaining metal material and seed crystal layer form the first conductive block **320**. In some embodiments, the seed crystal layer includes titanium, chromium, copper, other suitable conductive materials or a combination of the materials thereof, and the metal material formed by the aforementioned electroplating includes gold, copper, other suitable metal materials or a combination of the materials thereof.

[0054] In some embodiments, the thickness T of the first conductive block **320** is 5 microns to 10 microns.

[0055] Referring to FIG. **12**A and FIG. **12**B, multiple first light emitting diodes **200** are disposed on the first pad structure **102**. In some embodiments, the first light emitting diode **200** includes light emitting diodes of different colors. For example, the first light emitting diode **200** includes red light emitting diodes, green light emitting diodes, blue light emitting diodes, or light emitting diodes of other colors. In some embodiments, the first light emitting diodes **200** of different colors are arranged in the first direction D**1**, and the first light emitting diodes **200** of the same color are arranged in the second direction D**2**, but the disclosure is not limited thereto. In other embodiments, the first light emitting diodes **200** of different colors are arranged in the second direction D**2**, and the first light emitting diodes **200** of the same color are arranged in the first direction D**1**. In some embodiments, two rows of the first light emitting diodes **200** of the same color are arranged together. For example, two rows of red light emitting diodes are arranged together, two rows of green light emitting diodes are arranged together, and two rows of blue light emitting diodes are arranged together. In this case, two adjacent light emitting diodes of the same color may be turned on and off at the same time.

[0056] In this embodiment, the second electrode **250** is bonded to the corresponding first pad structure **102**. For example, the second electrode **250** is bonded to the first pad structure **102** through the conductive connection structure **310**. In some embodiments, the second electrode **250** is eutectically bonded to the first pad structure **102**.

[0057] In some embodiments, after bonding the first light emitting diode **200** to the first pad structure **102**, the top surface of the first light emitting diode **200** (the top surface of the first electrode **210**) is approximately flush with the top surface of the first conductive block **320**. In other words, based on the circuit substrate **100**, the top surface of the first light emitting diode **200** is approximately at the same horizontal level as the first conductive block **320**.

[0058] Referring to FIG. **13**A and FIG. **13**B, the molding layer **110** is formed on the circuit substrate **100**, and the molding layer **110** surrounds the first conductive block **320** and the first light emitting diode **200**.

[0059] In this embodiment, the molding layer **110** covers the top surface of the first conductive block **320** and the top surface of the first light emitting diode **200**. Therefore, plasma treatment must be performed to remove a portion of the molding layer **110** so that the first conductive block **320** and the first light emitting diode **200** may be exposed, as shown in FIG. **14**A and FIG. **14**B. In some embodiments, the aforementioned plasma treatment is performed, for example, by sulfur hexafluoride plasma, carbon tetrafluoride plasma, oxygen plasma, or a combination thereof.

[0060] In some embodiments, the plasma treatment is performed until the top surface **110***t* of the molding layer **110** is lower than the top surface of the first conductive block **320** and the top surface of the first light emitting diode **200**. However, in order to reduce the probability of short-circuiting the first light emitting diode **200**, the molding layer **110** preferably covers the light emitting layer **230** and the second semiconductor layer **240**. Specifically, based on the circuit substrate **100**, the height of the top surface **110***t* of the molding layer **110** is preferably higher than the height of the light emitting layer **230** of the first light emitting diode **200**.

[0061] Next, referring to FIG. **15**A and FIG. **15**B, multiple first conductive connection structures **400** are formed on the molding layer **110**. The first conductive connection structure **400** electrically connects at least a portion of the first light emitting diode **200** to at least a portion of the first conductive block **320** to form multiple pixel structures PX. In this embodiment, the first conductive connection structure **400** is a straight strip extending along the first direction D**1**.

[0062] In this embodiment, each of the pixel structures PX corresponds to a first pad structure **102** and a second pad structure **104**. In this embodiment, each of at least a portion of the pixel structures PX includes a first light emitting diode **200**, a first conductive block **320**, and a first conductive connection structure **400**. The first light emitting diode **200** and the first conductive block **320** respectively overlap the first pad structure **102** and the second pad structure **104**.

[0063] In other embodiments, each of the pixel structures PX corresponds to two adjacent first pad structures **102** and corresponding two second pad structures **104**, and each of at least a portion of the pixel structures PX includes two adjacent first light emitting diodes **200**, two adjacent first conductive blocks **320**, and two adjacent first conductive connection structures **400**. In the case that each of the pixel structures PX includes two first light emitting diodes **200**, even if one of the first light emitting diodes **200** in the pixel structure PX is damaged, one may choose not to repair the pixel structure PX.

[0064] After the first conductive connection structure **400** is formed, the pixel structures PX in the display panel **20** is inspected, and when a portion of the pixel structures PX is found to be faulty, the maintenance process shown in FIG. **16**A to FIG. **19**B is further performed. For example, a portion of the pixel structures PX is a faulty pixel structure PX. In the faulty pixel structure PX, the first light emitting diode **200** and/or the first conductive connection structure **400** are damaged, causing the first light emitting diode **200** in the faulty pixel structure PX to fail to emit light normally. In FIG. **16**A to FIG. **19**B, a cross mark is marked on the first light emitting diode **200** that cannot emit light normally.

[0065] Referring to FIG. **17**A and FIG. **17**B, a portion of the molding layer **110** is removed to form an opening **112** exposing at least a portion of the first pad structure **102**. In this embodiment, at least one faulty first light emitting diode **200** is located in the removed portion of the molding layer **110**, and the faulty first light emitting diode **200** is removed, so that at least a portion of the first pad structure **102** under the faulty first light emitting diode **200** is exposed.

[0066] In some embodiments, the removing method for a portion of the molding layer **110** includes a dry etching process (e.g., a laser process) or a wet etching process. In some embodiments, the removing method of the faulty first light emitting diode **200** includes a laser (e.g., ultraviolet laser or infrared laser) process, vacuum extraction, or other suitable methods.

[0067] In this embodiment, a portion of the first conductive connection structure **400** is also removed to form the first conductive connection structure **400'**. For example, at least a portion of the first conductive connection structure **400** on the first light emitting diode **200** in the faulty pixel structure PX is removed. The size of the first conductive connection structure **400'** in the faulty pixel structure PX is smaller than the size of the first conductive connection structure **400** in the non-faulty pixel structure PX.

[0068] Referring to FIG. **18**A and FIG. **18**B, the first light emitting diode **200'** for repairing is disposed in the opening **112**. The first light emitting diode **200'** is bonded to at least a portion of the first pad structure **102**.

[0069] The first light emitting diode **200'** is a vertical light emitting diode and includes a first electrode **210'**, a first semiconductor layer **220'**, a light emitting layer **230'**, a second semiconductor layer **240'**, and a second electrode **250'**. The first semiconductor layer **220'**, the light emitting layer **230'**, and the second semiconductor layer **240'** are stacked in sequence. In some embodiments, one of the first semiconductor layer **220'** and the second semiconductor layer **240'** is an N-type semiconductor, and the other is a P-type semiconductor. The first electrode **210'** and the second electrode **250'** are respectively connected to the first semiconductor layer **220'** and the second semiconductor layer **240'**. In some embodiments, the first light emitting diode **200'** includes light emitting diodes of different colors. For example, the first light emitting diode **200'** includes red light emitting diodes, green light emitting diodes, blue light emitting diodes, or light emitting diodes of other colors. In some embodiments, the first light emitting diode **200'** used for repairing the faulty pixel structure PX and the original first light emitting diode **200** in the pixel structure PX are light emitting diodes of the same color.

[0070] In some embodiments, after the first light emitting diode **200'** is disposed in the opening **112**, a filling material **120** is formed to fill the gap between the first light emitting diode **200'** and the opening **112**. The first light emitting diode **200'** and the filling material **120** are filled into the opening **112**, and the filling material **120** surrounds the first light emitting diode **200'**. In some embodiments, the forming method of the filling material **120** includes inkjet printing, glue dispensing, or other suitable processes. In some embodiments, the filling material **120** includes epoxy resin, silicone, acrylic or other suitable materials, and the filling material **120** selectively includes carbon black, scattering particles, or other filling particles. The filling material **120** and the molding layer **110** may include the same or different materials.

[0071] Referring to FIG. **19**A and FIG. **19**B, a second conductive connection structure **500** is formed on the molding layer **110**. The second conductive connection structure **500** electrically connects the first light emitting diode **200'** to a corresponding one of the conductive blocks, and so far the display panel **20'** including the repaired pixel structure PX' is formed.

[0072] Each of the repaired pixel structures PX' includes the first light emitting diode **200'**, the first conductive block **320**, the first conductive connection structure **400'**, the filling material **120**, and the second conductive connection structure **500**. The first light emitting diode **200'** is disposed on the first pad structure **102**. The first conductive block **320** is disposed on the second pad structure **104**. The first conductive connection structure **400'** and the second conductive connection structure **500** are located on the molding layer **110**. The second conductive connection structure **500** and the first conductive connection structure **400'** electrically connect the first light emitting diode **200'** to the first conductive block **320**.

[0073] In this embodiment, since the conductive connection structure **500** is formed on the molding layer **110**, and may be electrically connected to the second pad structure **104** through the first conductive block **320**, therefore, it is

possible to prevent disconnection of the conductive connection structure **500** caused by the step difference between the first electrode **210'** of the first light emitting diode **200'** and the second pad structure **104** and improve the yield of the maintenance process.

[0074] FIG. **20** is a top schematic view of a display panel according to an embodiment of the disclosure. It is noted that the embodiment of FIG. **20** uses the reference numerals and a part of the contents of the embodiment of FIG. **1**A to FIG. **9**B, and the same or similar reference numerals are used to denote the same or similar elements, and the description of the same technical content is omitted. For the description of the omitted portion, reference may be made to the foregoing embodiment, and details are not described herein.

[0075] The difference between the display panel **30** in FIG. **20** and the display panel **10'** in FIG. **9**B is that: in the display panel **30**, the first conductive connection structure **400** and the second conductive connection structure **500** do not overlap at least a portion of the top surface of the first electrode **210** of the first light emitting diode **200** and at least a portion of the top surface of the first electrode **210**R of the second light emitting diode **200**R.

[0076] Referring to FIG. **20**, in this embodiment, both the first conductive connection structure **400** and the second conductive connection structure **500** include a metal material, which is formed through a chemical vapor deposition process. In order to reduce the area covered by the first conductive connection structure **400** and the second conductive connection structure **500**, the first conductive connection structure **400** is connected to the side surface of the first electrode **210** of the first light emitting diode **200** and exposes at least a portion of the top surface of the first electrode **210**, and the second conductive connection structure **500** is connected to the side surface of the first electrode **210**R of the second light emitting diode **200**R and exposes at least a portion of the top surface of the first electrode **210**R.

[0077] In this embodiment, it is taken as an example that both the first conductive connection structure **400** and the second conductive connection structure **500** include opaque conductive materials, but the disclosure is not limited thereto. In other embodiments, the first conductive connection structure **400** includes a transparent conductive material, and the second conductive connection structure **500** includes an opaque conductive material. In this case, even if the first conductive connection structure **400** covers the top surface of the first electrode **210** of the first light emitting diode **200**, it does not have a great impact on the brightness of the display panel **30**.

[0078] FIG. **21** is a top schematic view of a display panel according to an embodiment of the disclosure. It is noted that the embodiment of FIG. **21** uses the reference numerals and a part of the contents of the embodiment of FIG. **10**A to FIG. **19**B, and the same or similar reference numerals are used to denote the same or similar elements, and the description of the same technical content is omitted. For the description of the omitted portion, reference may be made to the foregoing embodiment, and details are not described herein.

[0079] The difference between the display panel **40** in FIG. **21** and the display panel **20'** in FIG. **19**B is that: in the display panel **40**, the second conductive connection structure **500** does not overlap at least a portion of the top surface of the first electrode **210'** of the first light emitting diode **200'**.

[0080] Referring to FIG. **21**, in this embodiment, the first conductive connection structure **400** includes a transparent conductive material, and the second conductive connection structure **500** includes an opaque conductive material. Even if the first conductive connection structure **400** covers the top surface of the first electrode **210** of the first light emitting diode **200**, it does not have a great impact on the brightness of the display panel **40**.

[0081] In this embodiment, the second conductive connection structure **500** includes a metal material and is formed through a chemical vapor deposition process. In order to reduce the area covered by the second conductive connection structure **500**, the second conductive connection structure **500** is connected to the side surface of the first electrode **210'** of the first light emitting diode **200'** and exposes the top surface of the first electrode **210'**.

[0082] To sum up, through the disposition of the molding layer and the conductive block, the problem of poor electrical connection between the light emitting diode and the pad due to the step difference may be improved.

What is claimed is:

1. A display panel, comprising:

a circuit substrate, having a plurality of first pad structures and a plurality of second pad structures;

a plurality of pixel structures, disposed above a display region of the circuit substrate, and each of at least a portion of the pixel structures comprising:

a first light emitting diode, disposed on a corresponding first pad structure among the first pad structures;

a first conductive block, disposed on a corresponding second pad structure among the second pad structures; and

a first conductive connection structure, electrically connecting the first light emitting diode to the first conductive block; and

a molding layer, located above the circuit substrate and surrounding the first light emitting diodes and the first conductive blocks, wherein the first conductive connection structures are located on the molding layer.

2. The display panel according to claim **1**, wherein one of the pixel structures is a repaired pixel structure, and the repaired pixel structure further comprises a second light emitting diode and a second conductive block, the second light emitting diode and the second conductive block are respectively disposed on the corresponding first pad structure and the corresponding second pad structure, and the repaired pixel structure further comprises:

a second conductive connection structure, electrically connecting the second light emitting diode to the second conductive block, wherein the second conductive connection structure is located on the molding layer.

3. The display panel according to claim **2**, wherein in the repaired pixel structure, the first light emitting diode and the second light emitting diode are respectively located on a first portion and a second portion of the corresponding first pad structure, wherein the first portion and the second portion are structurally separated from each other.

4. The display panel according to claim **2**, wherein in the repaired pixel structure, the first conductive block and the second conductive block are respectively disposed on a third portion and a fourth portion of the corresponding second pad

structure, wherein the third portion and the fourth portion are structurally separated from each other.

5. The display panel according to claim **2**, further comprising:

a filling material, wherein the second light emitting diode and the filling material are filled into an opening of the molding layer, and the filling material surrounds the second light emitting diode.

6. The display panel according to claim **2**, wherein the second conductive connection structure electrically connects a first electrode of the second light emitting diode to the first conductive connection structure, wherein a horizontal distance between the second light emitting diode and the first conductive connection structure is smaller than a horizontal distance between the second light emitting diode and the second conductive block.

7. The display panel according to claim **2**, wherein the second conductive connection structure is connected to a side surface of an electrode of the second light emitting diode, and the second conductive connection structure does not overlap at least a portion of the top surface of the electrode of the second light emitting diode.

8. The display panel according to claim **1**, wherein the first conductive connection structure is connected to a side surface of an electrode of the first light emitting diode, and the first conductive connection structure does not overlap at least a portion of the top surface of the electrode of the first light emitting diode.

9. The display panel according to claim **1**, wherein taking the circuit substrate as a basis, a height of a top surface of the molding layer is higher than a height of a light emitting layer of the first light emitting diode.

10. The display panel according to claim **1**, wherein the first conductive connection structure and the second conductive connection structure comprise different materials.

11. The display panel according to claim **1**, wherein the molding layer comprises transparent material, gray material, or black material.

12. The display panel according to claim **1**, wherein each of the at least a portion of the pixel structures further comprises a second conductive block, the second conductive block is disposed on the corresponding second pad structure, and the first conductive connection structure is connected to the first conductive block and the second conductive block simultaneously.

13. The display panel according to claim **1**, wherein a thickness of the first conductive block is 5 microns to 10 microns.

14. The display panel according to claim **1**, wherein one of the at least a portion of the pixel structures is a repaired pixel structure, and the repaired pixel structure further comprises:

a second conductive connection structure, electrically connected to the first light emitting diode and the first conductive block, wherein the second conductive connection structure is located on the molding layer.

15. A manufacturing method of a display panel, comprising:

providing a circuit substrate, wherein the circuit substrate has a plurality of first pad structures and a plurality of second pad structures;

forming a plurality of conductive blocks on the second pad structures;

disposing a plurality of first light emitting diodes on the first pad structures;

forming a molding layer to surround the conductive blocks and the first light emitting diodes;

forming a plurality of first conductive connection structures on the molding layer, wherein the first conductive connection structures electrically connect at least a portion of the first light emitting diodes to at least a portion of the conductive blocks to form a plurality of pixel structures;

removing a portion of the molding layer to form an opening exposing at least a portion of the first pad structures;

disposing a second light emitting diode in the opening, and bonding the second light emitting diode to the at least a portion of the first pad structures; and

forming a second conductive connection structure on the molding layer, wherein the second conductive connection structure electrically connects the second light emitting diode to a corresponding one of the conductive blocks.

16. The manufacturing method of the display panel according to claim **15**, wherein forming the conductive blocks comprises electroplating.

17. The manufacturing method of the display panel according to claim **15**, further comprising:

forming a filling material to fill a gap between the second light emitting diode and the opening after disposing the second light emitting diode in the opening.

18. The manufacturing method of the display panel according to claim **15**, further comprising:

wherein one of the first light emitting diodes is located in the portion of the molding layer, and the one of the first light emitting diodes is removed to expose the at least a portion of the first pad structures under the one of the first light emitting diodes.

19. The manufacturing method of the display panel according to claim **15**, wherein each of the pixel structures comprises a repair region, and the opening of the molding layer is located in a portion of the repair regions.

20. The manufacturing method of the display panel according to claim **19**, wherein each of the first pad structures comprises a first portion and a second portion separated from each other, wherein the first light emitting diodes are disposed on the first portion, and the repair regions overlap the second portions.

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