US 20150234228A1

(19) United States
(12) Patent Application Publication
BYUN et al.
(10) Pub. No.: US 2015/0234228 A1
(43) Pub. Date: Aug. 20, 2015

(54) **LIQUID CRYSTAL DISPLAY AND METHOD OF MANUFACTURING THE SAME**

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(21) Appl. No.: **14/469,443**

(22) Filed: **Aug. 26, 2014**

(30) **Foreign Application Priority Data**

Feb. 17, 2014 (KR) 10-2014-0018049

Publication Classification

(51) **Int. Cl.**

G02F 1/1333	(2006.01)
H01L 27/12	(2006.01)
G02F 1/1339	(2006.01)
G02F 1/1335	(2006.01)
G02F 1/1368	(2006.01)
G02F 1/1341	(2006.01)

(52) **U.S. Cl.**

CPC ***G02F 1/133377*** (2013.01); ***G02F 1/1368*** (2013.01); ***G02F 1/1341*** (2013.01); ***G02F 1/1339*** (2013.01); ***G02F 1/133528*** (2013.01); ***H01L 27/1259*** (2013.01)

(57) **ABSTRACT**

A liquid crystal display is provided. The liquid crystal display according to an exemplary embodiment of the inventive concept includes: a substrate; a thin film transistor disposed on the substrate; a pixel electrode connected to the thin film transistor; a roof layer facing the pixel electrode; an adhesive layer disposed on the roof layer; and a capping layer disposed on the adhesive layer, wherein a plurality of microcavities are formed between the pixel electrode and the roof layer, and the microcavity forms a liquid crystal layer including a liquid crystal material.

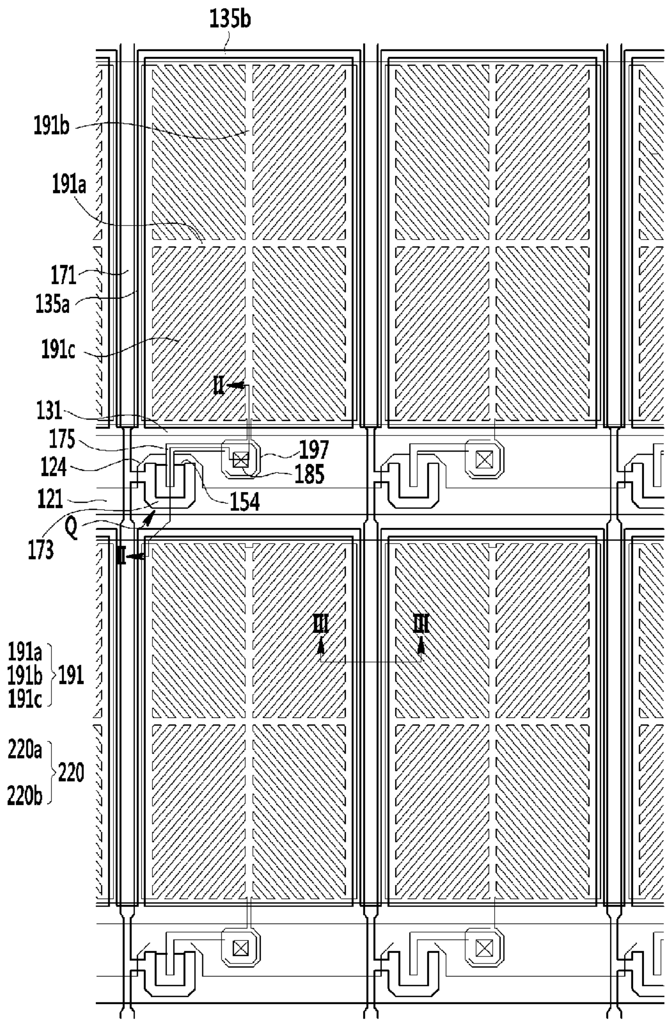

FIG. 1

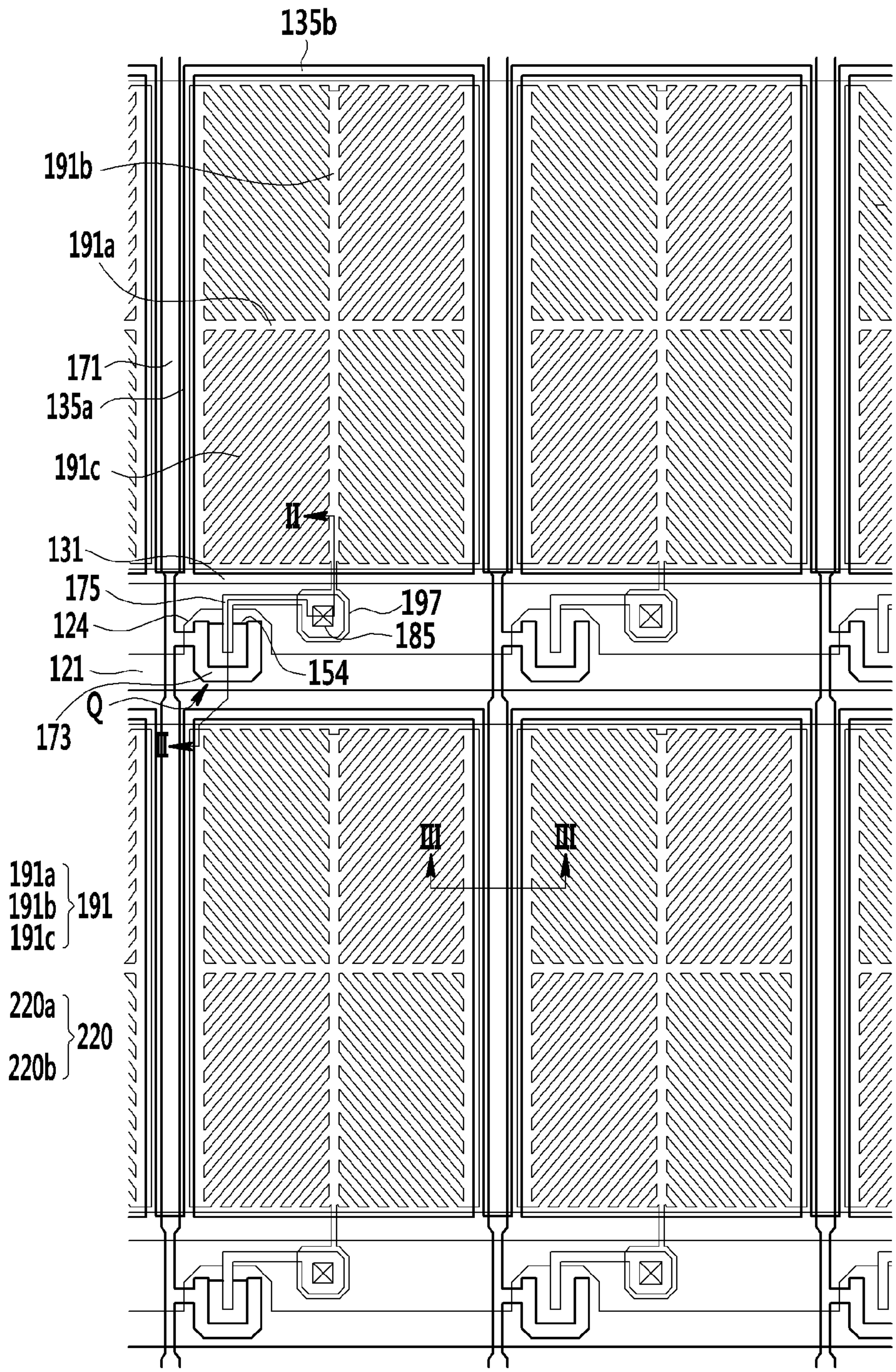
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FIG. 2

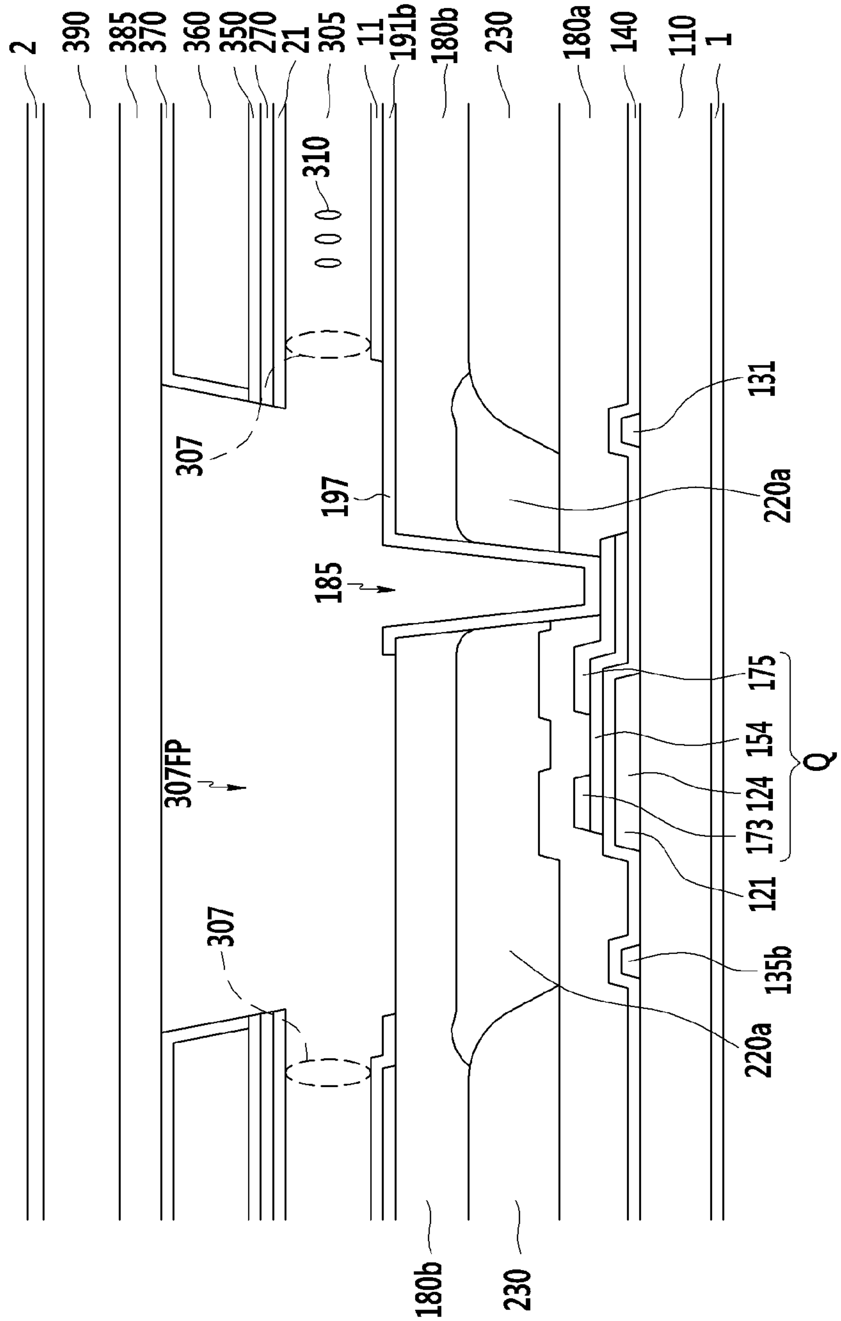
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FIG. 3

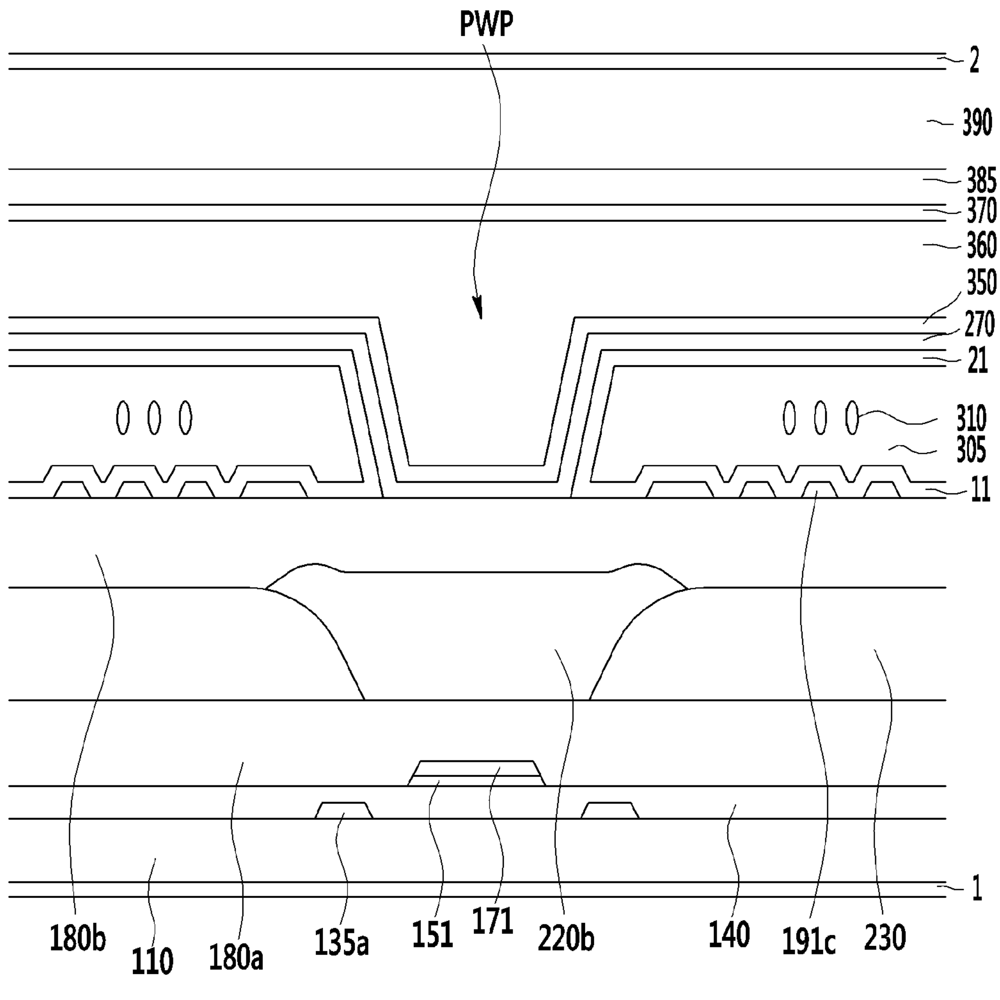
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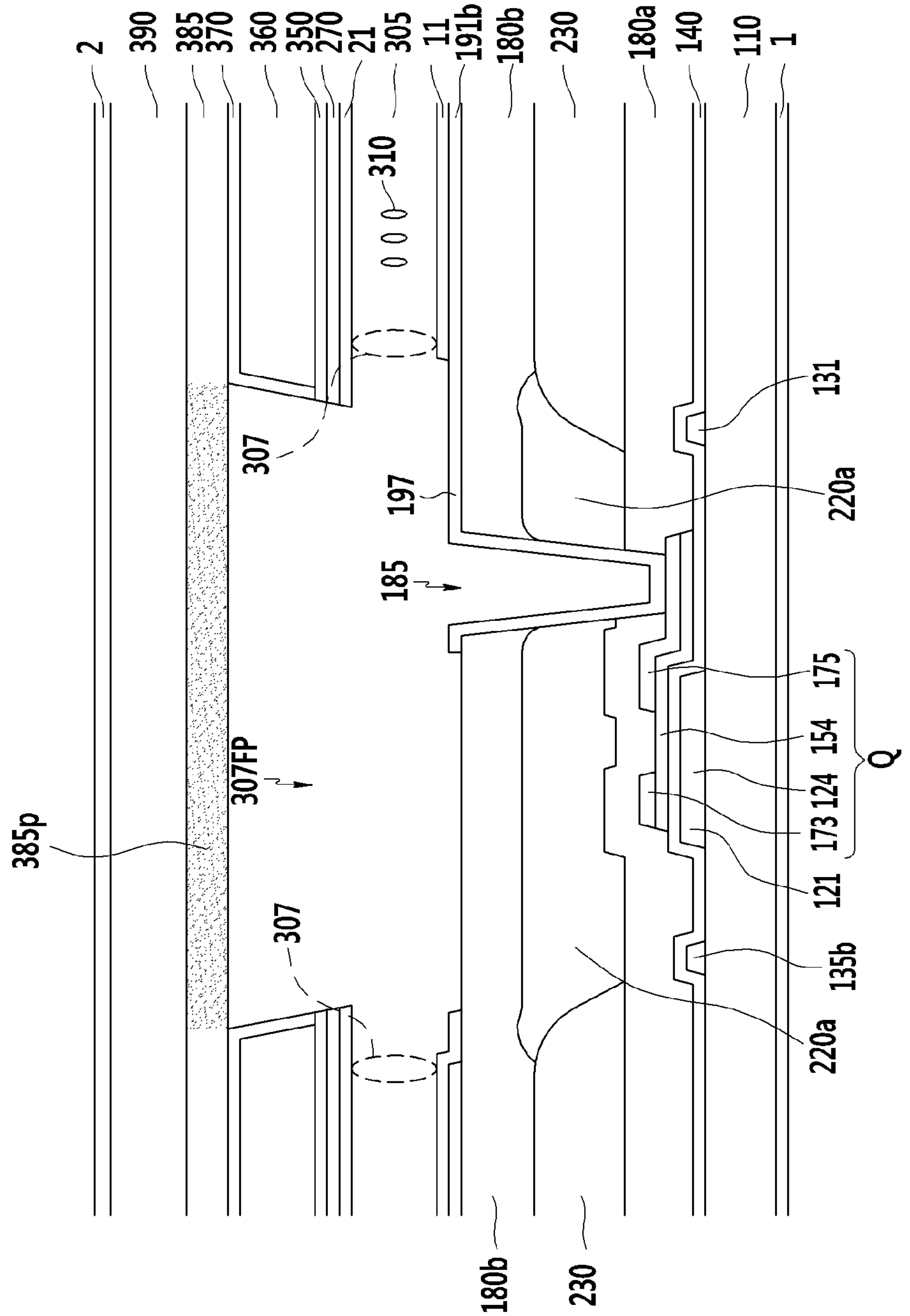
FIG. 4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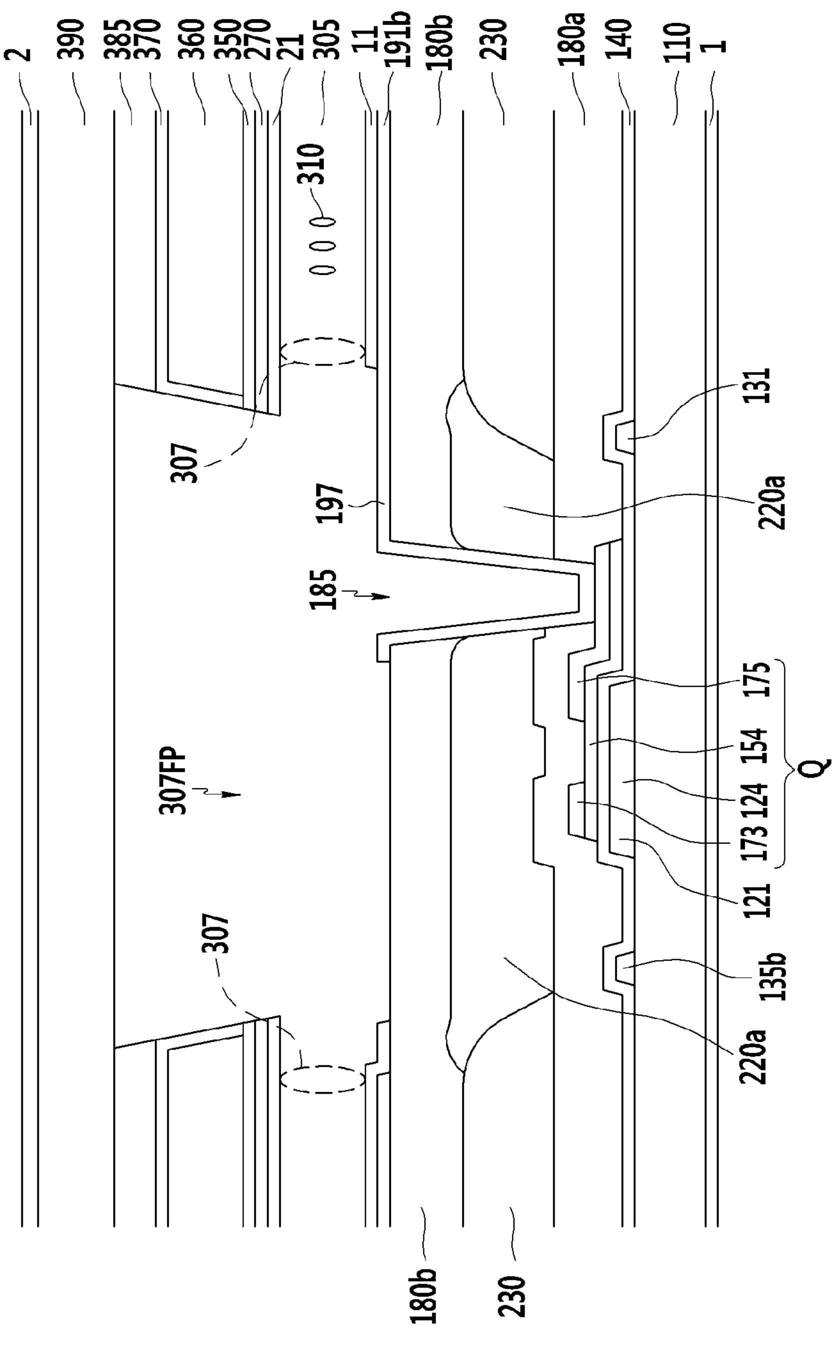
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FIG. 5

FIG. 6

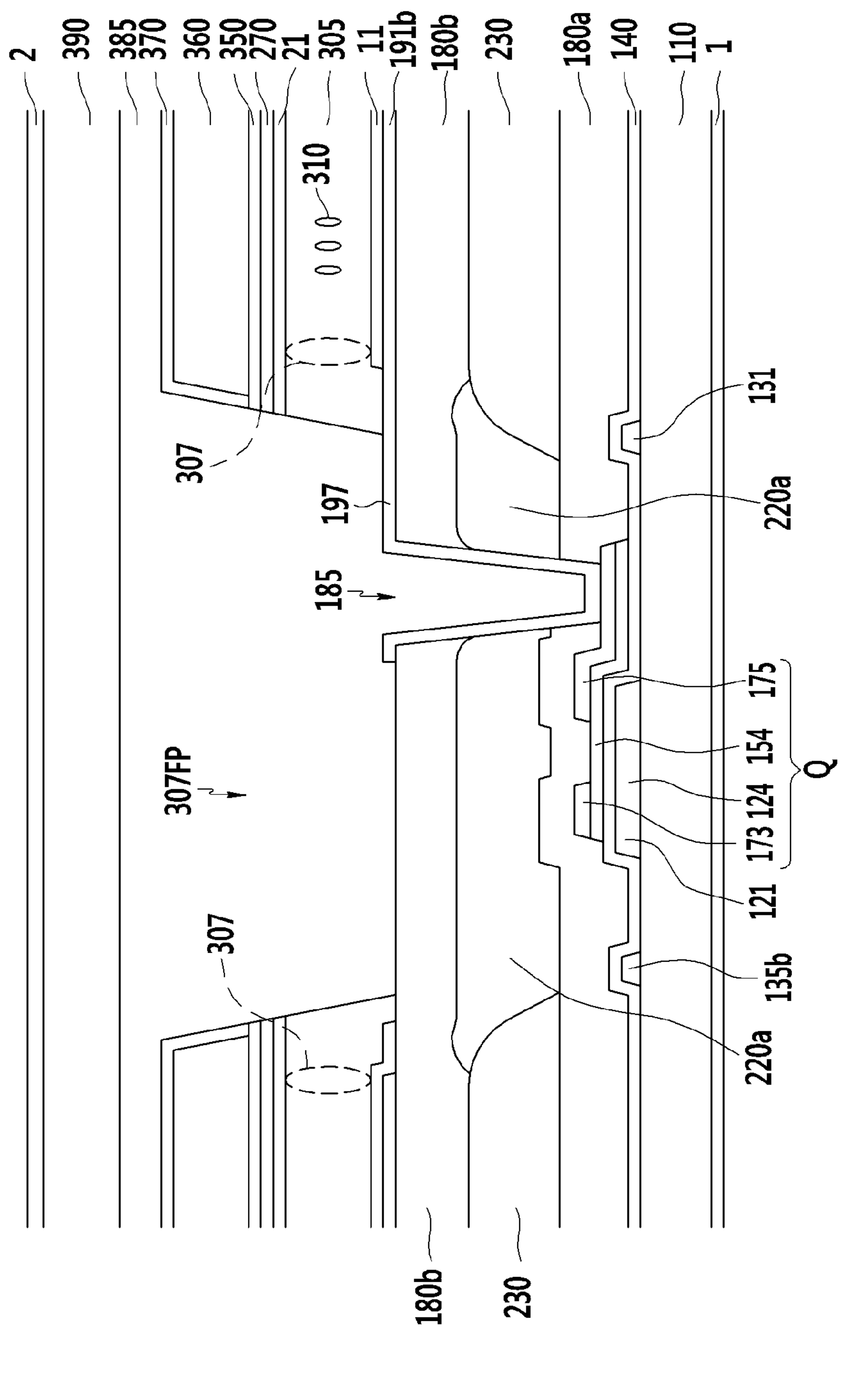
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FIG. 7

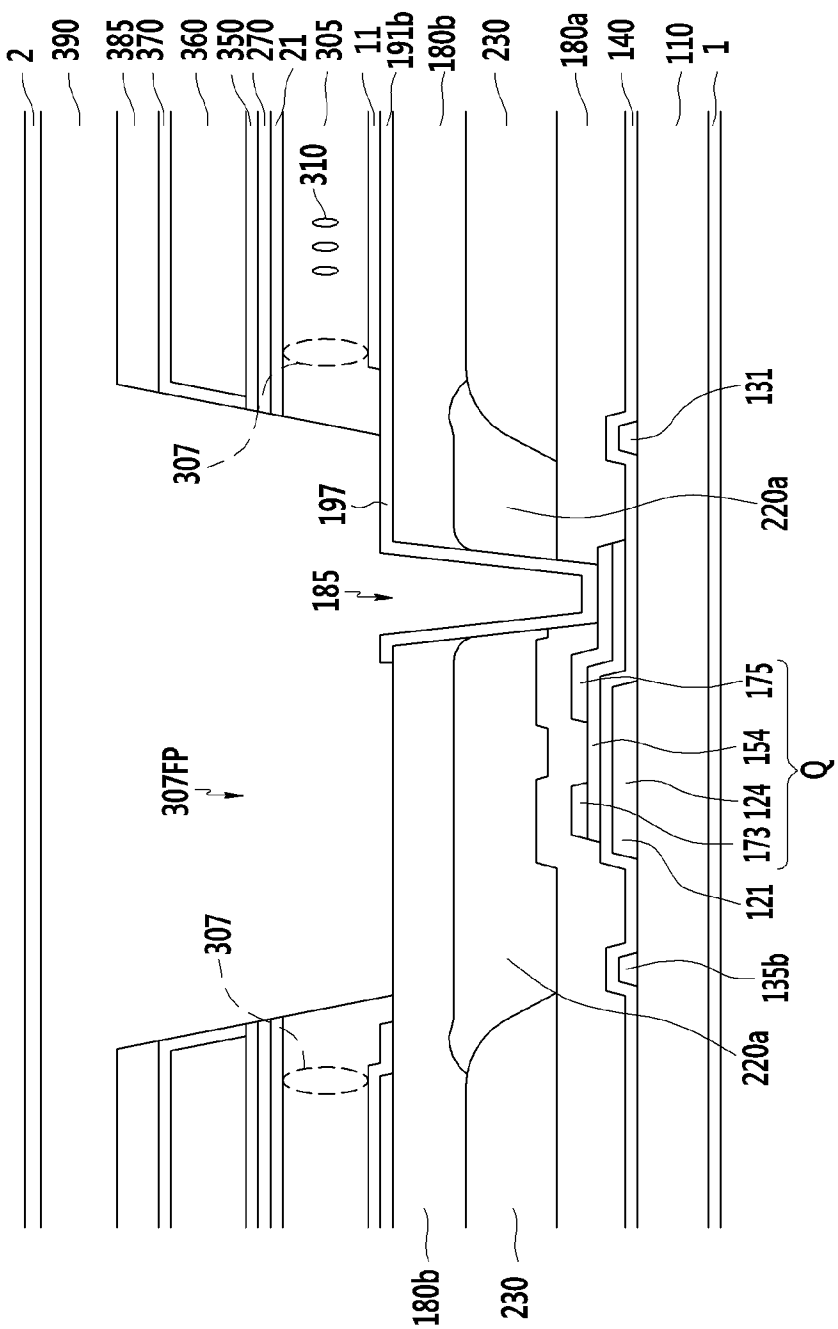

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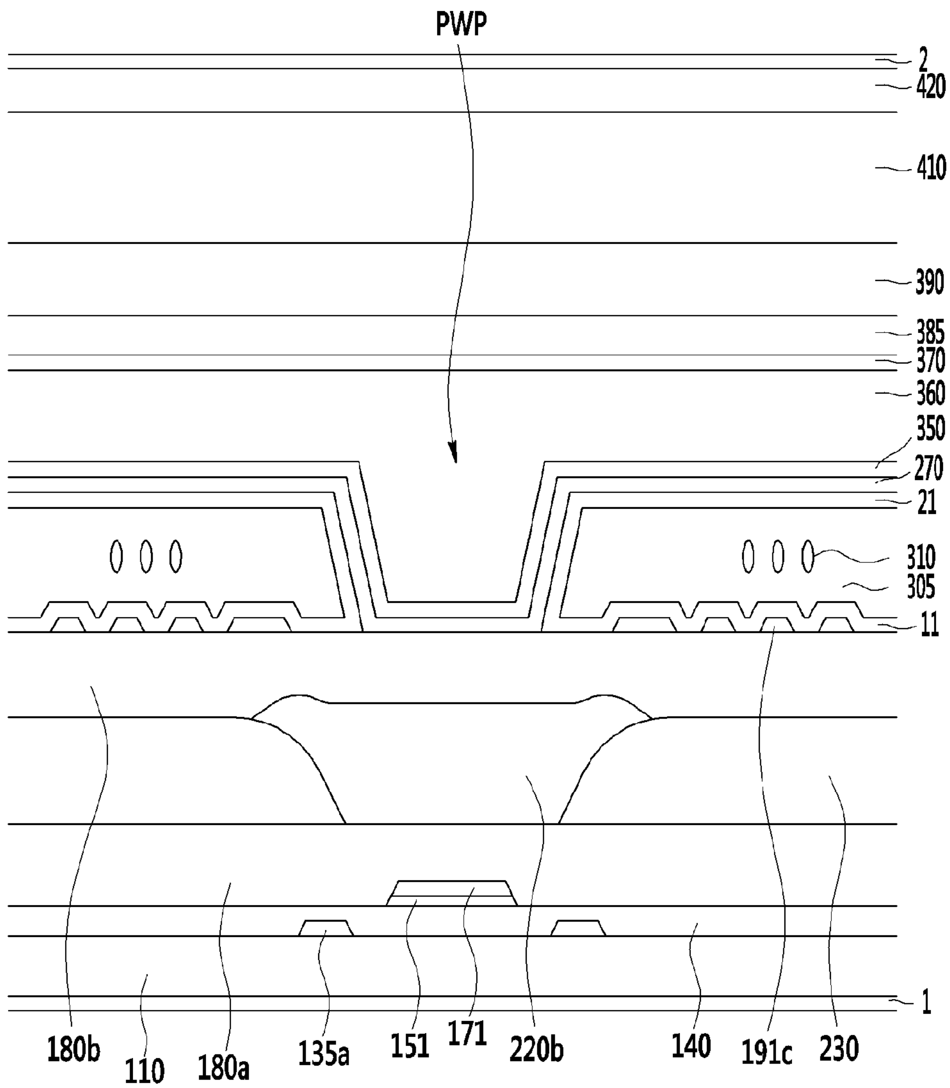
FIG. 8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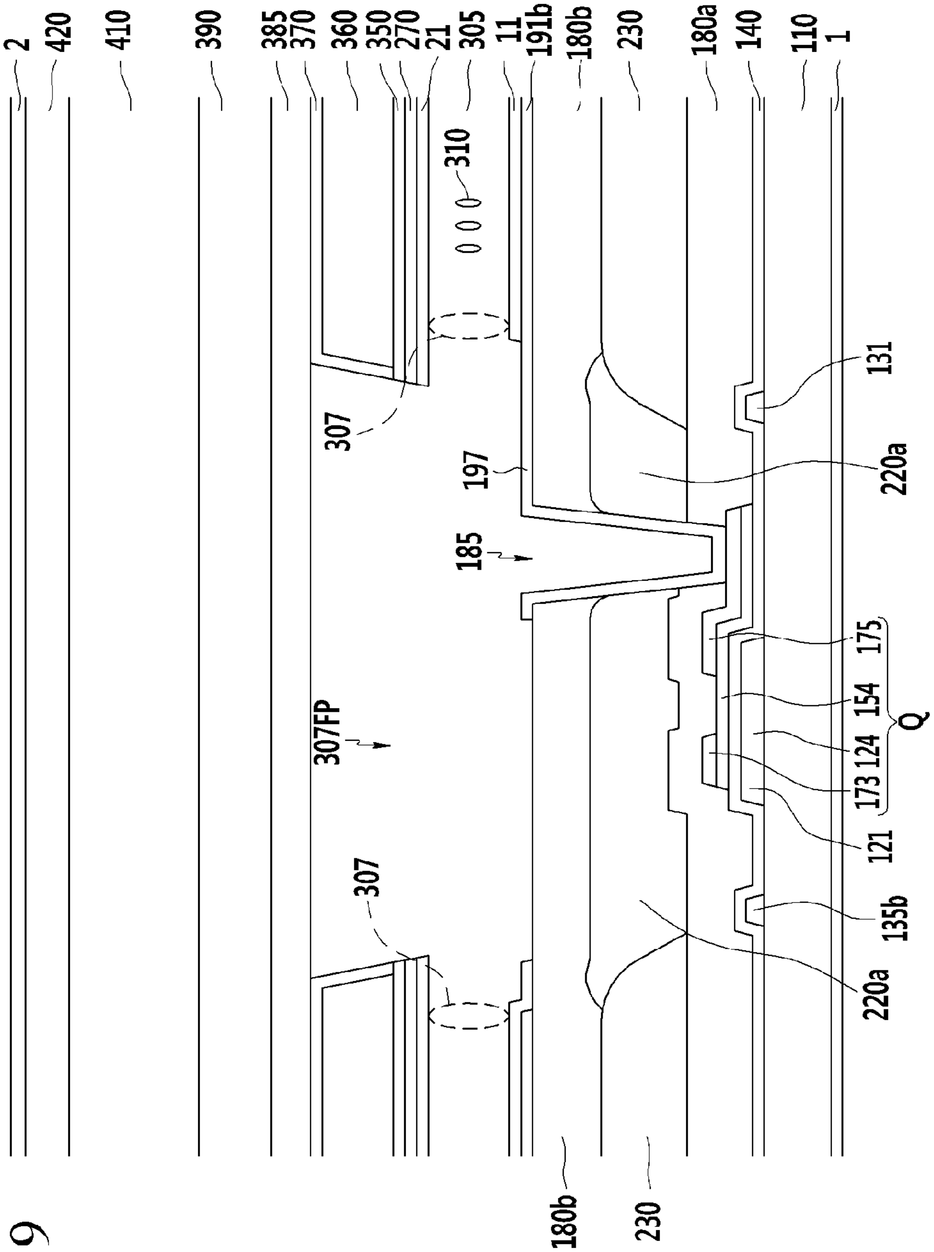
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FIG. 9

FIG. 10

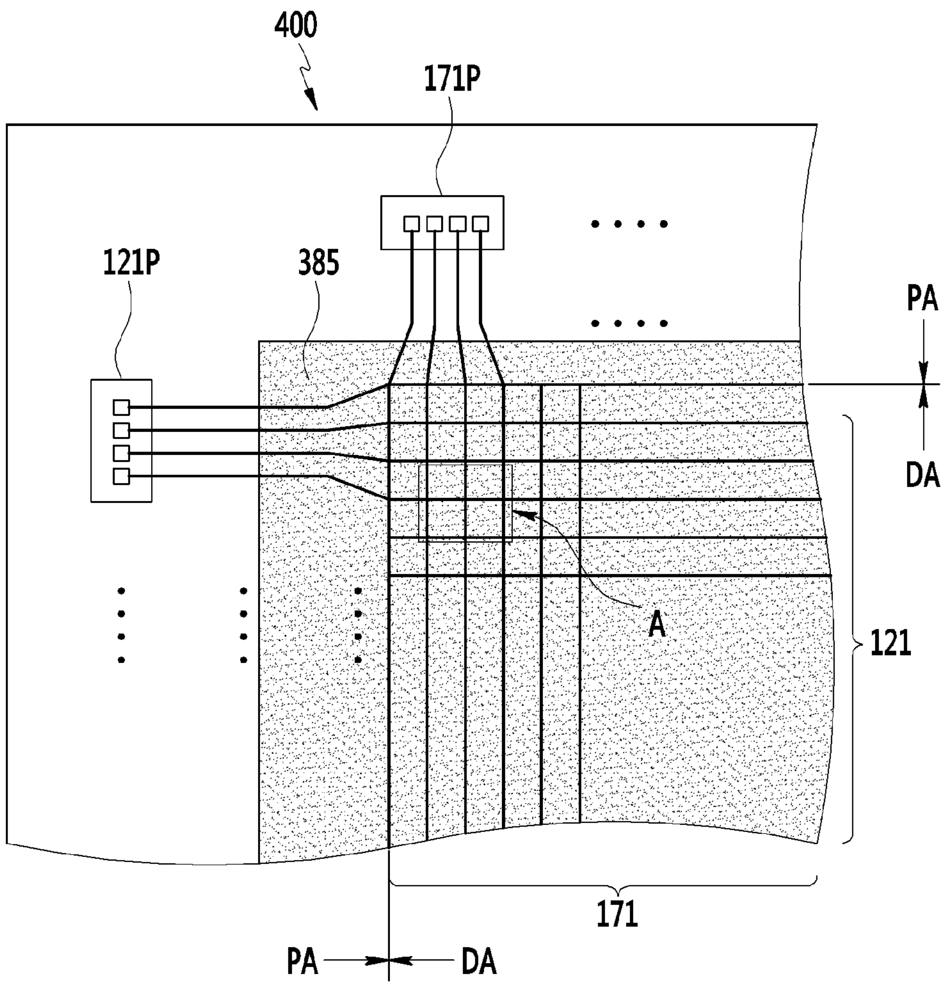

FIG. 11

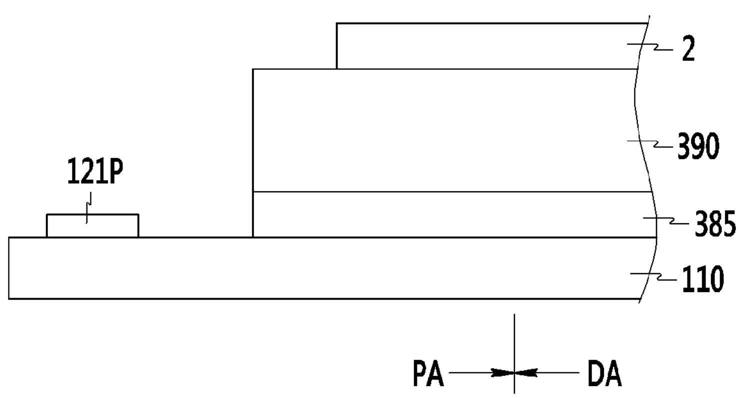

FIG. 12

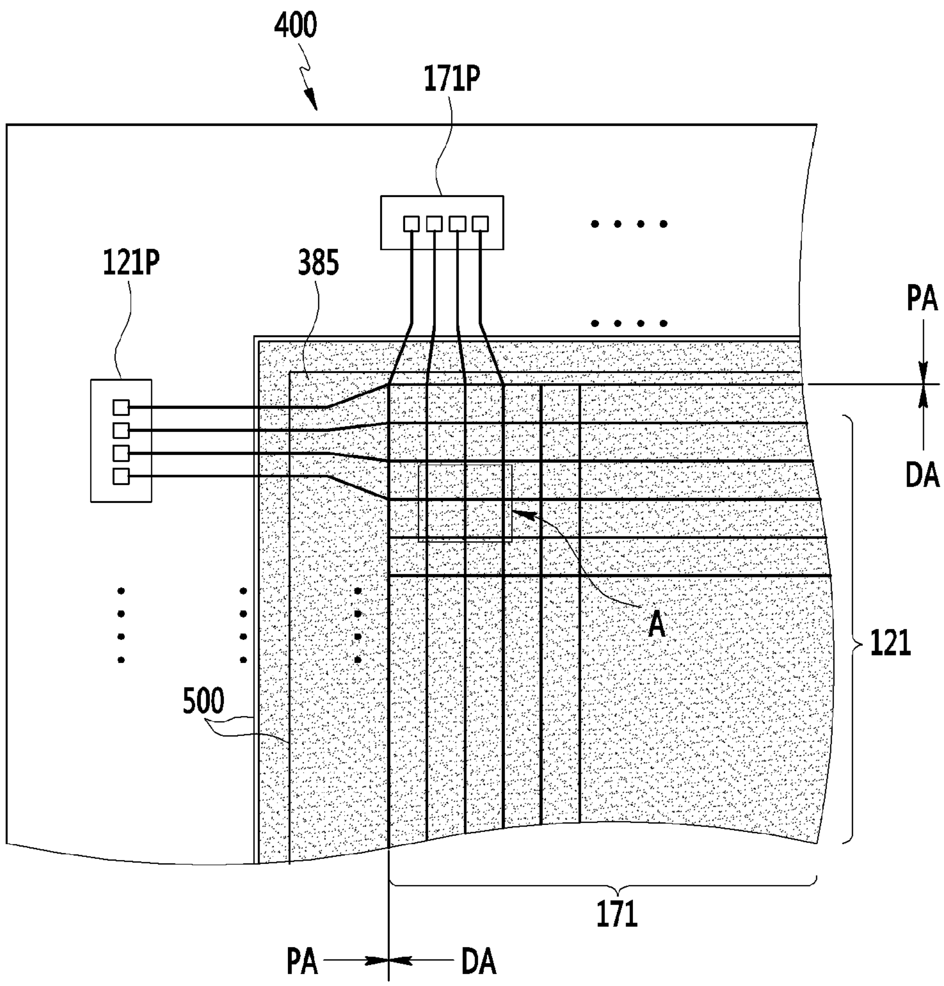

FIG. 13

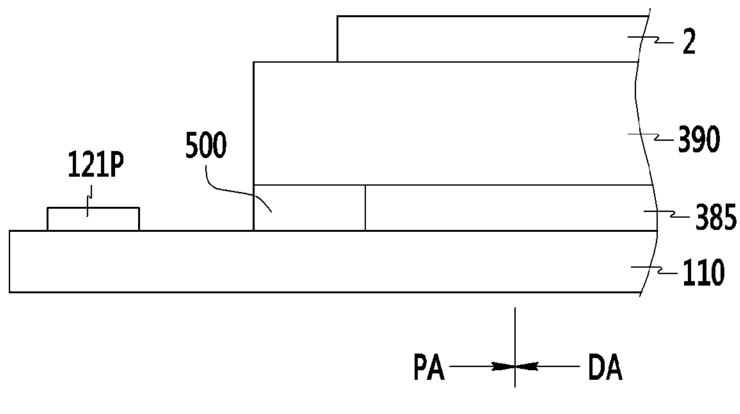

FIG. 14

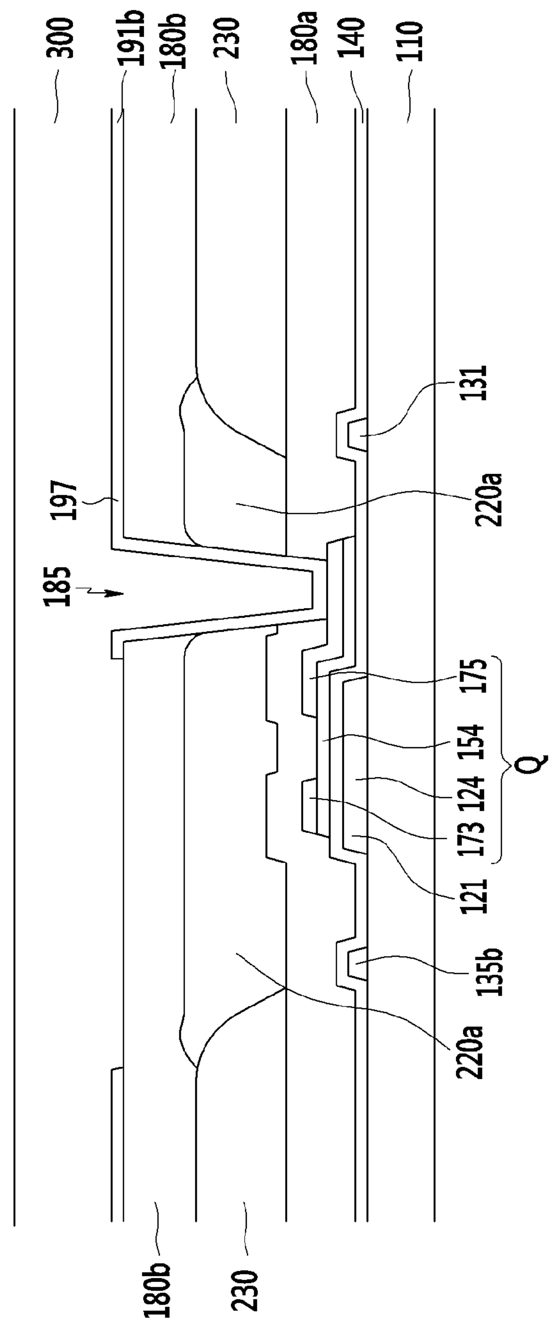
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FIG. 15

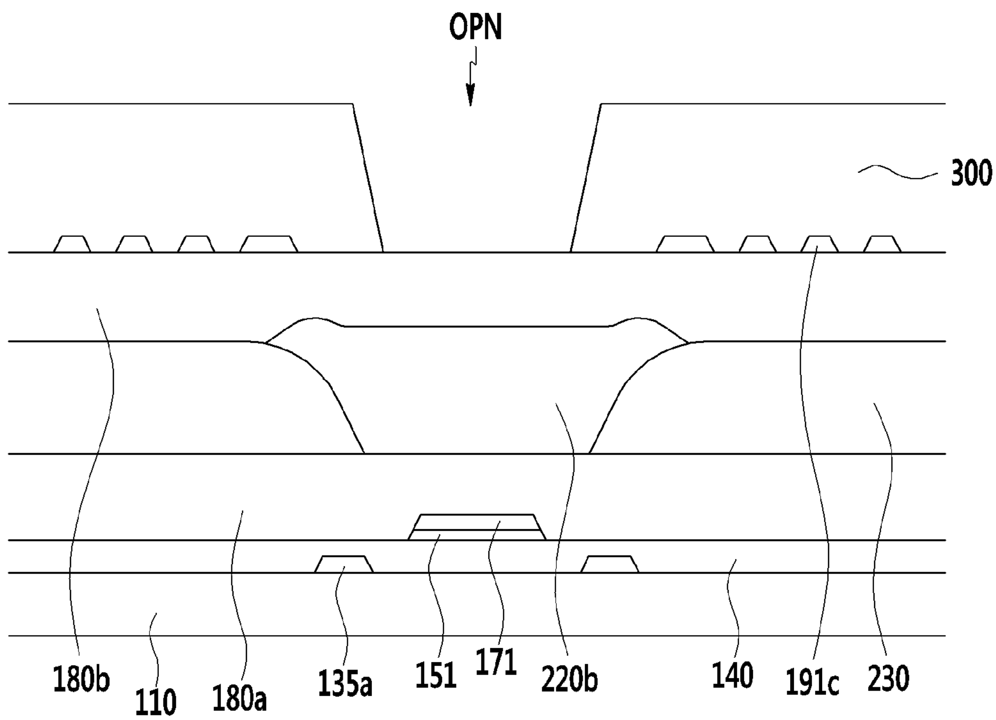

FIG. 16

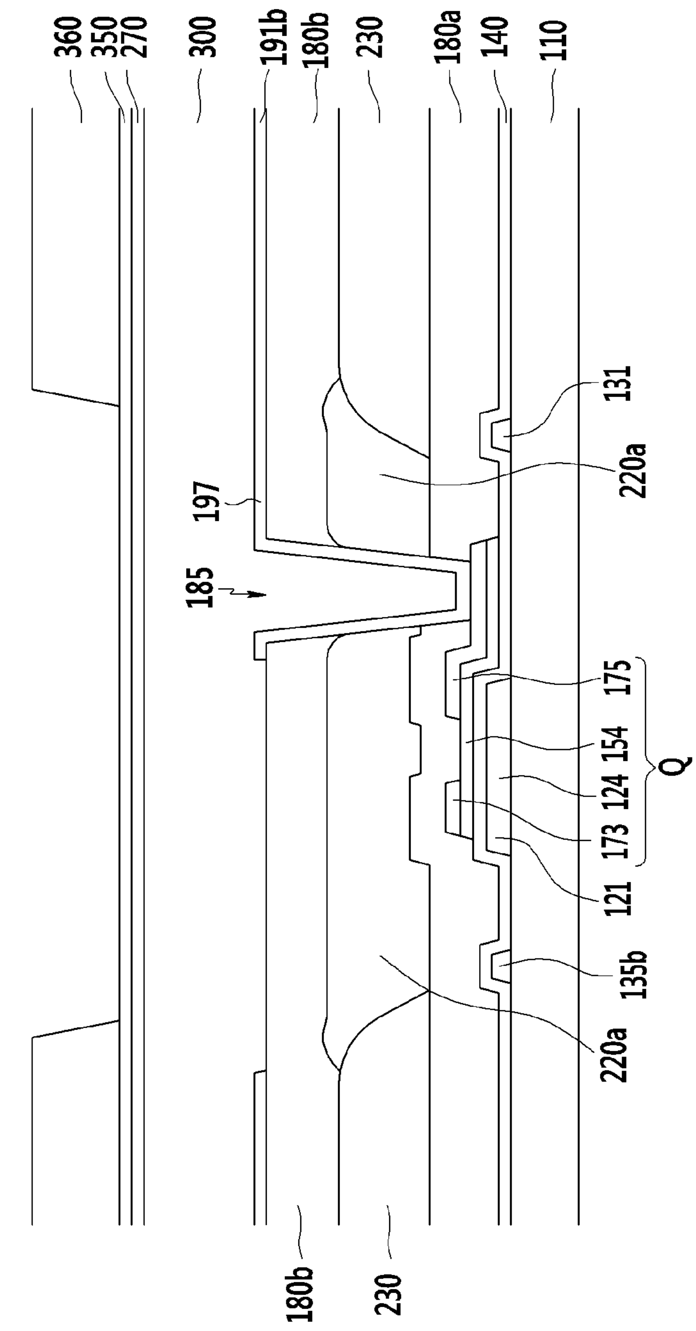
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FIG. 17

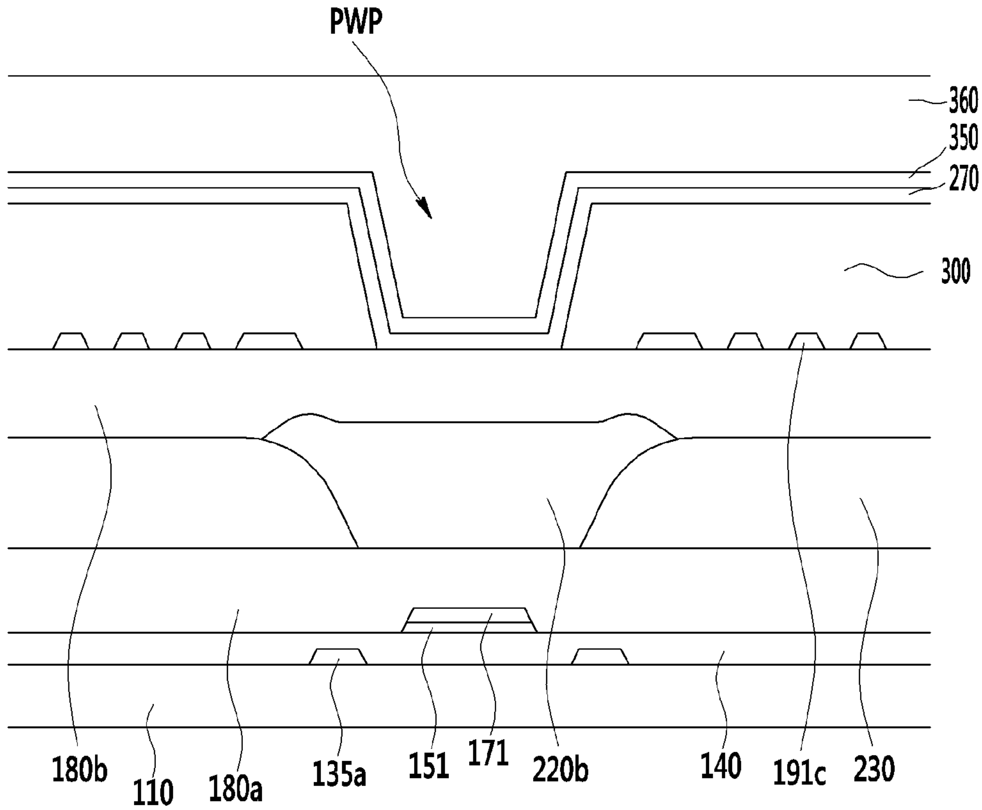
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FIG. 18

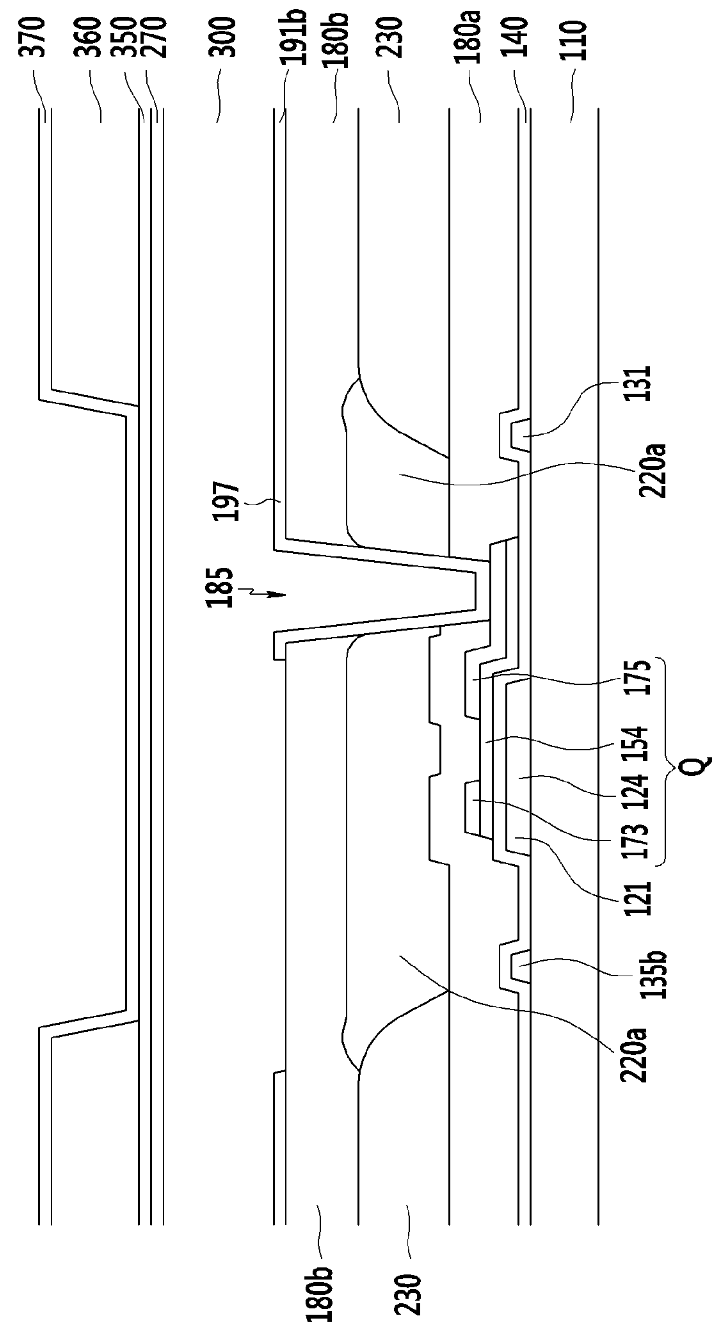
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FIG. 19

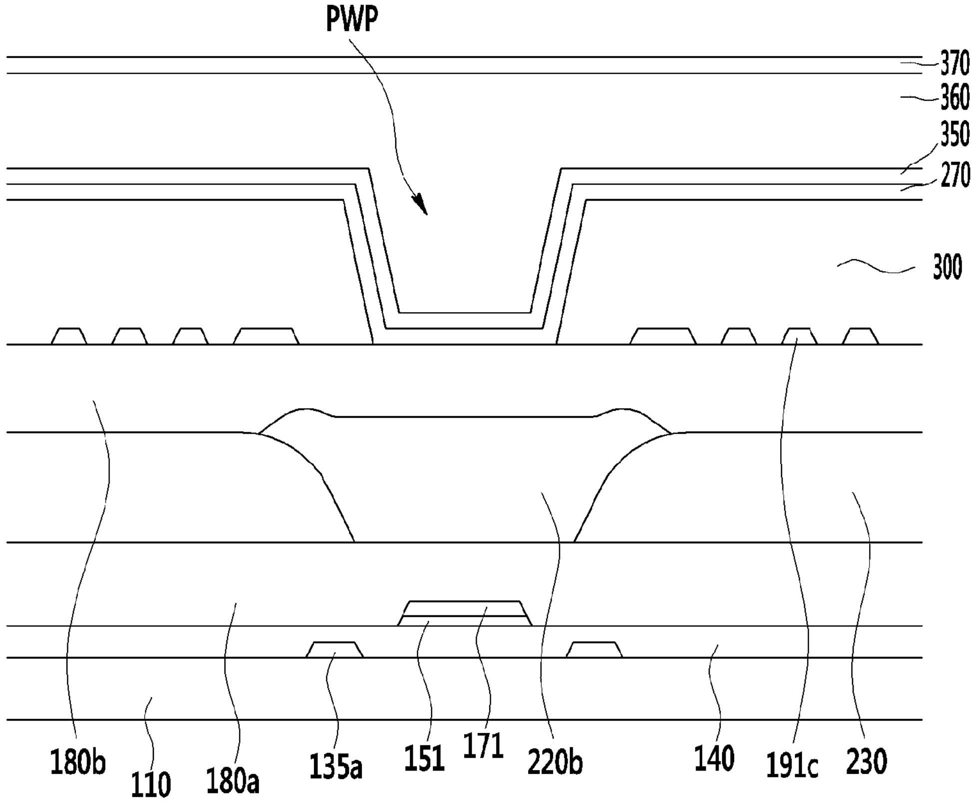
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FIG. 20

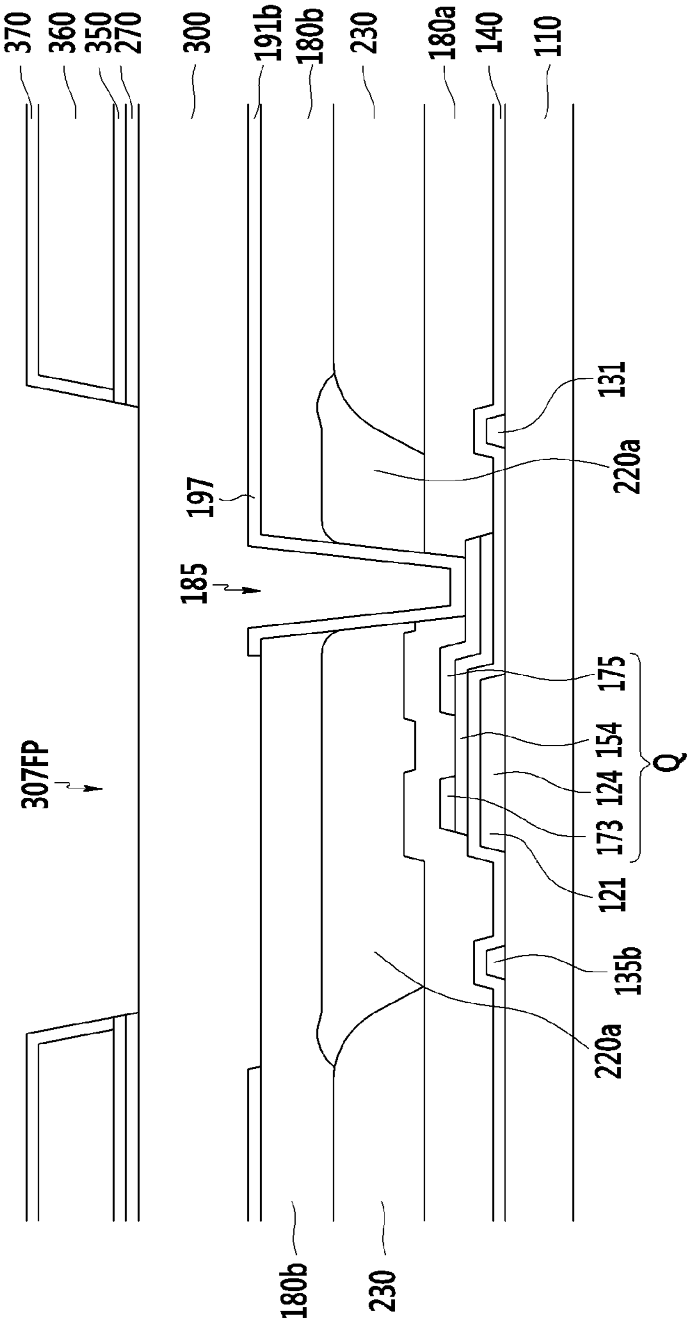
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FIG. 21

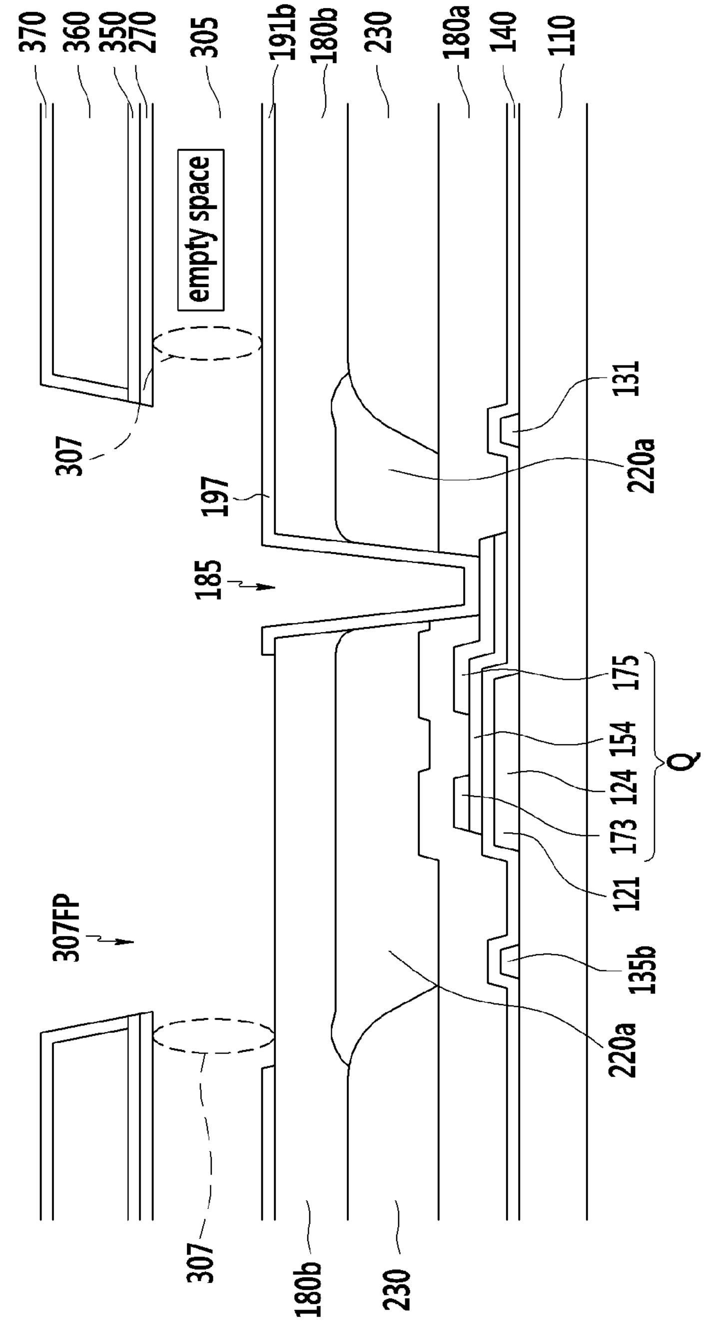
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FIG. 22

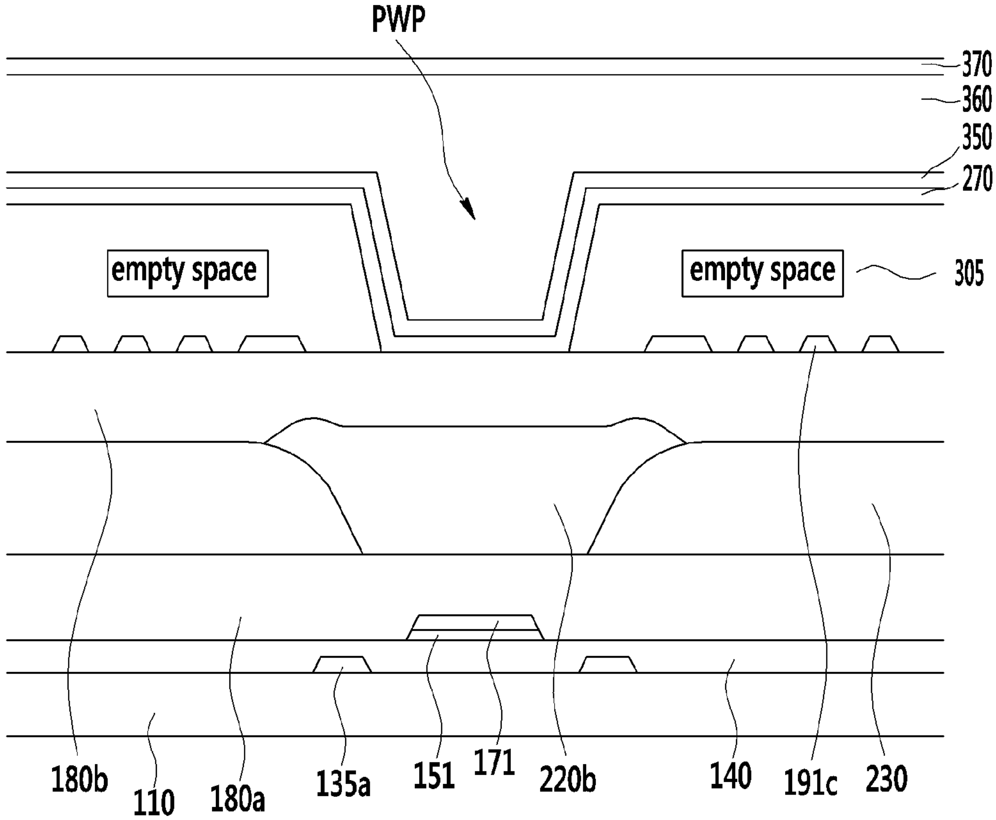
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FIG. 23

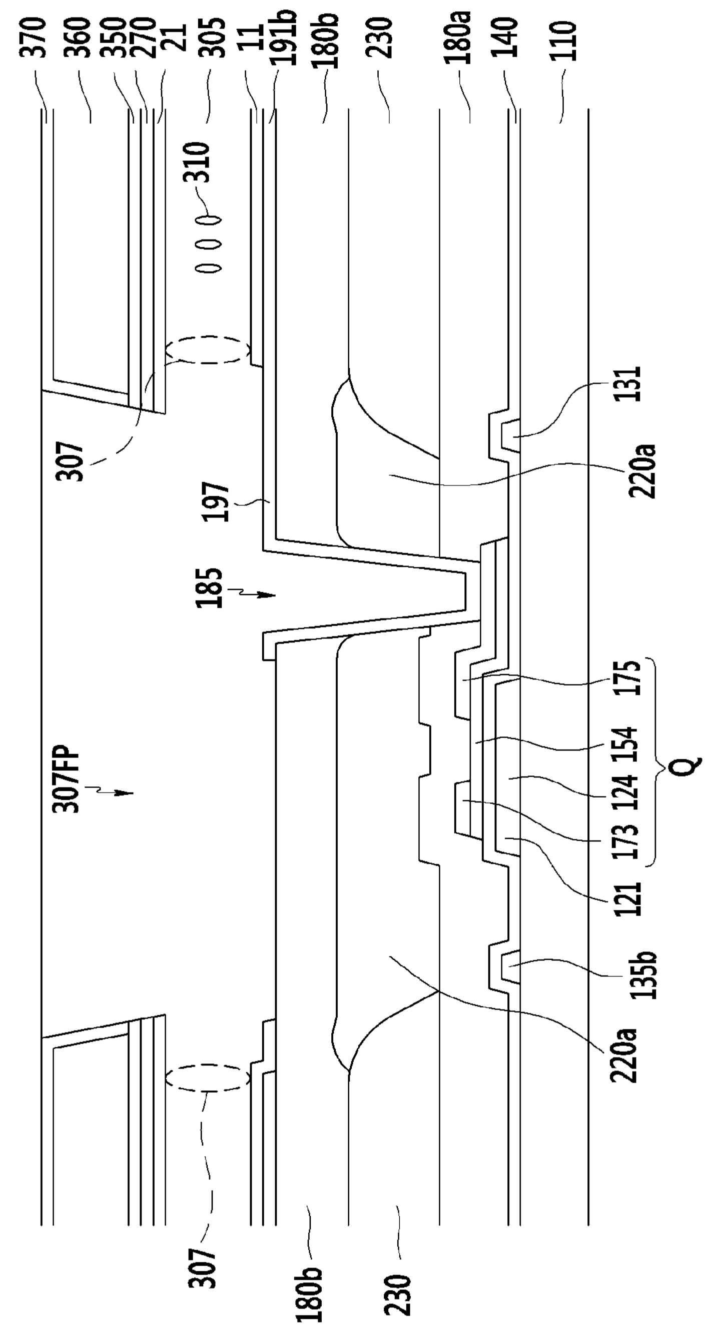
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FIG. 24

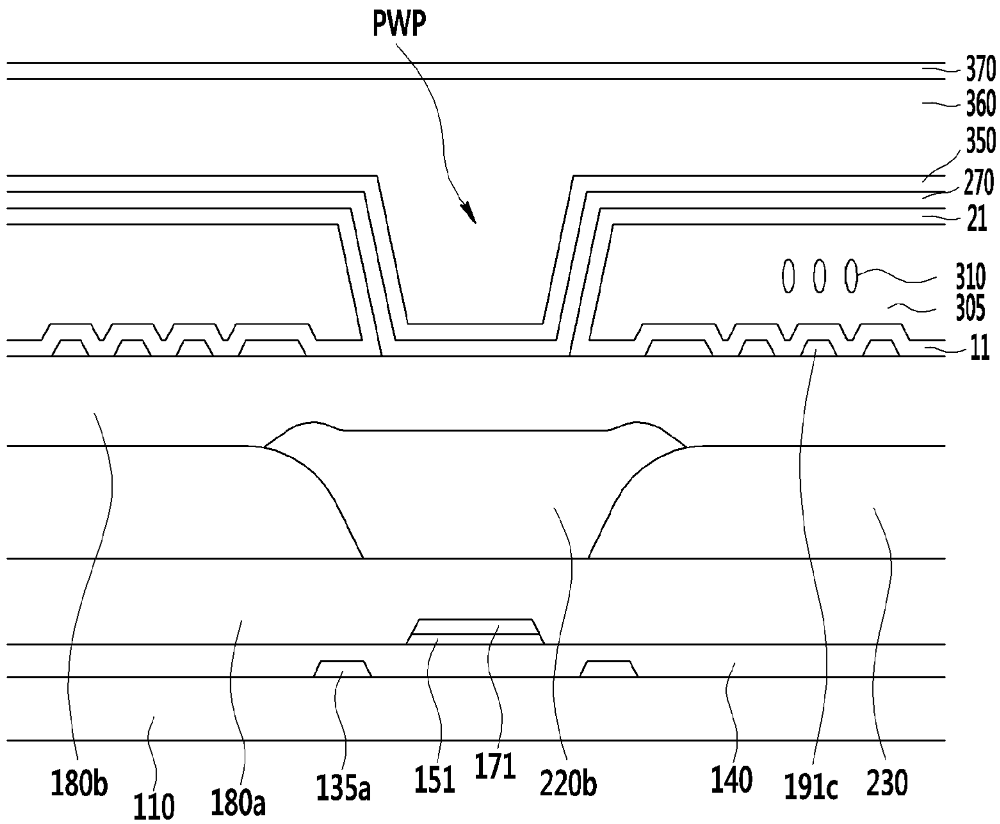
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FIG. 25

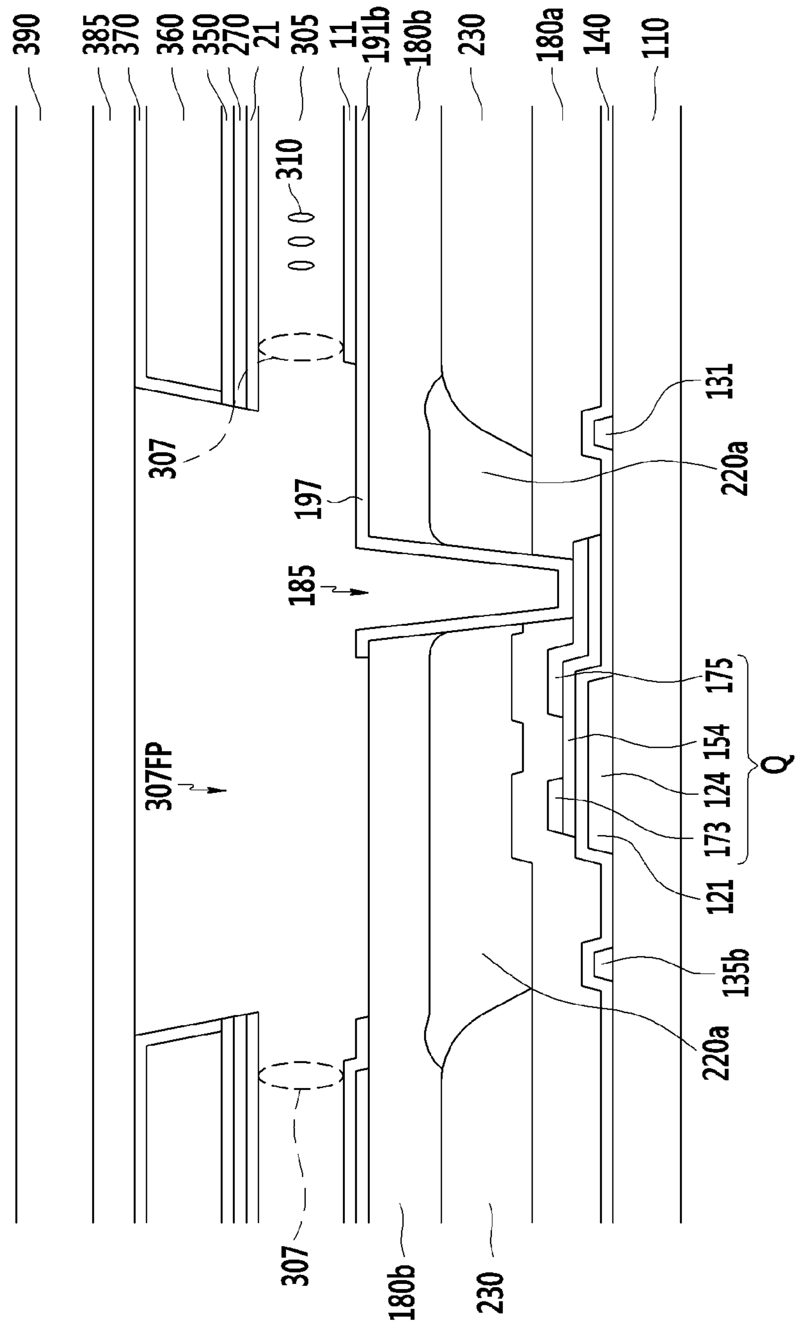
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FIG. 26

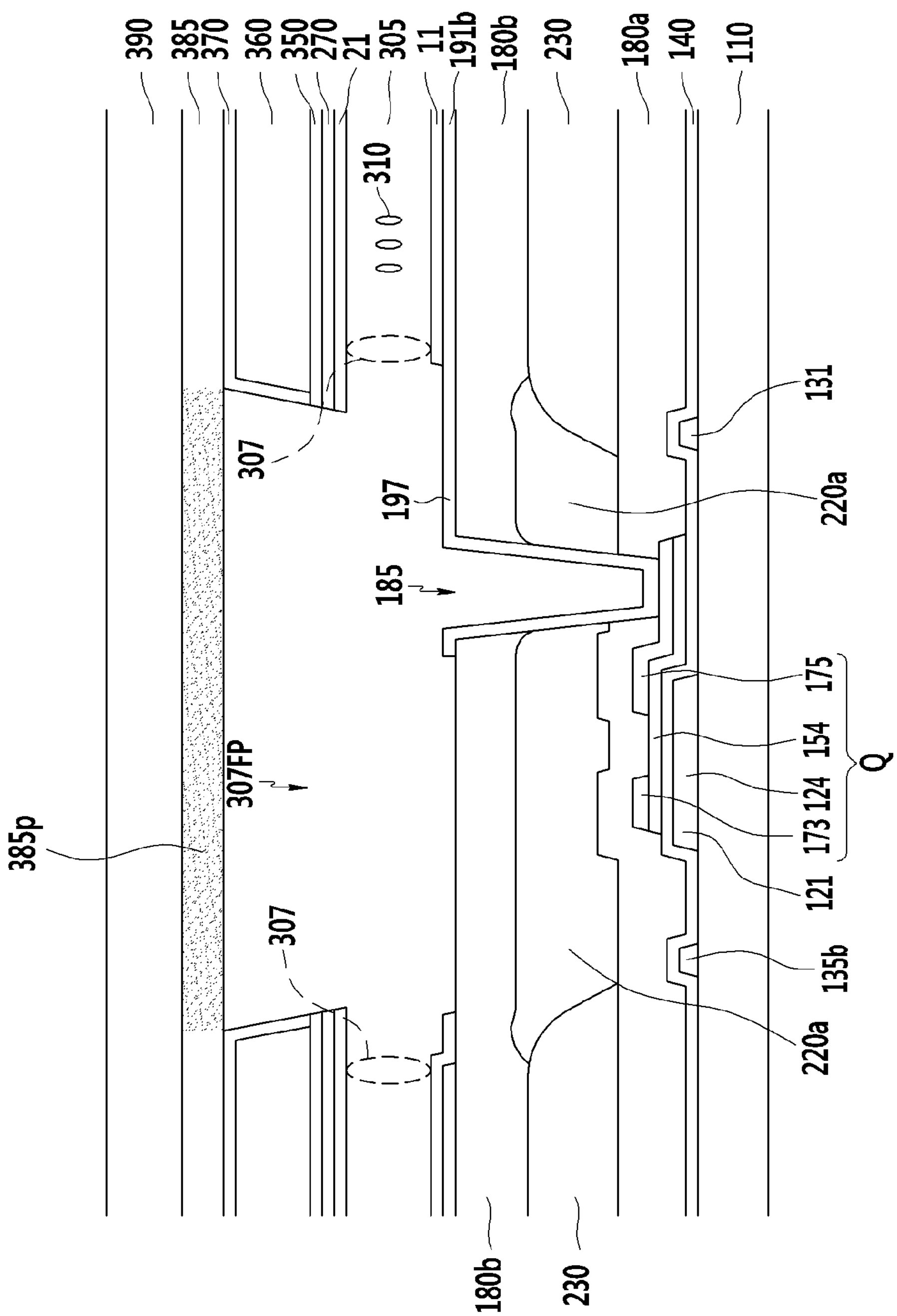
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FIG. 27

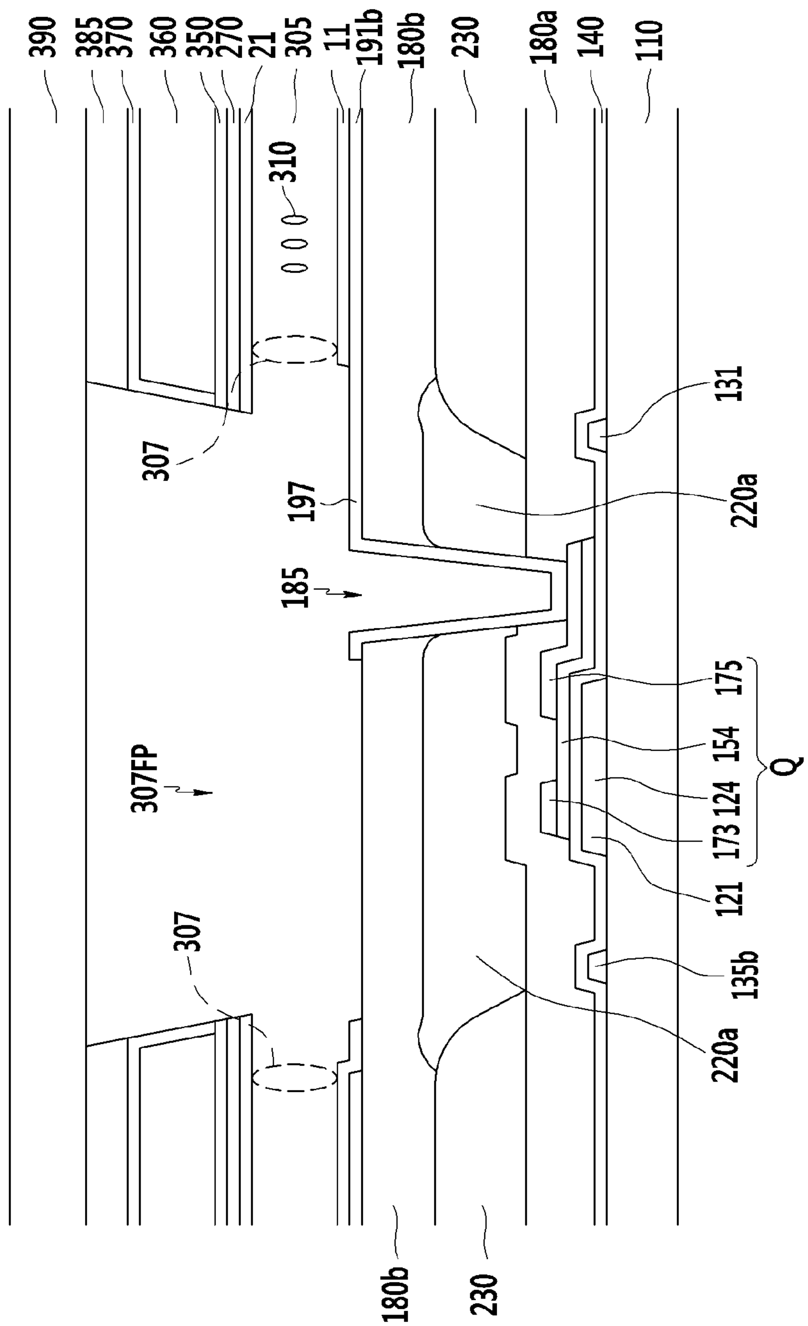
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FIG. 28

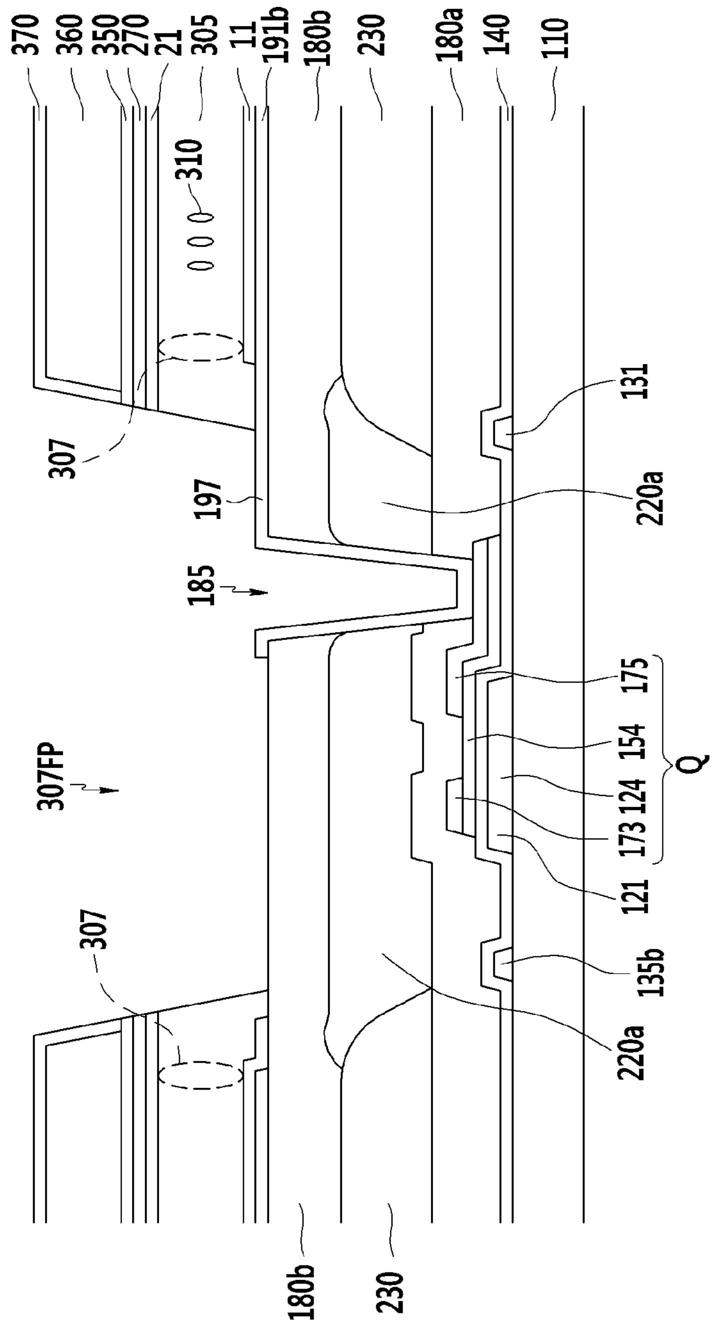
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FIG. 29

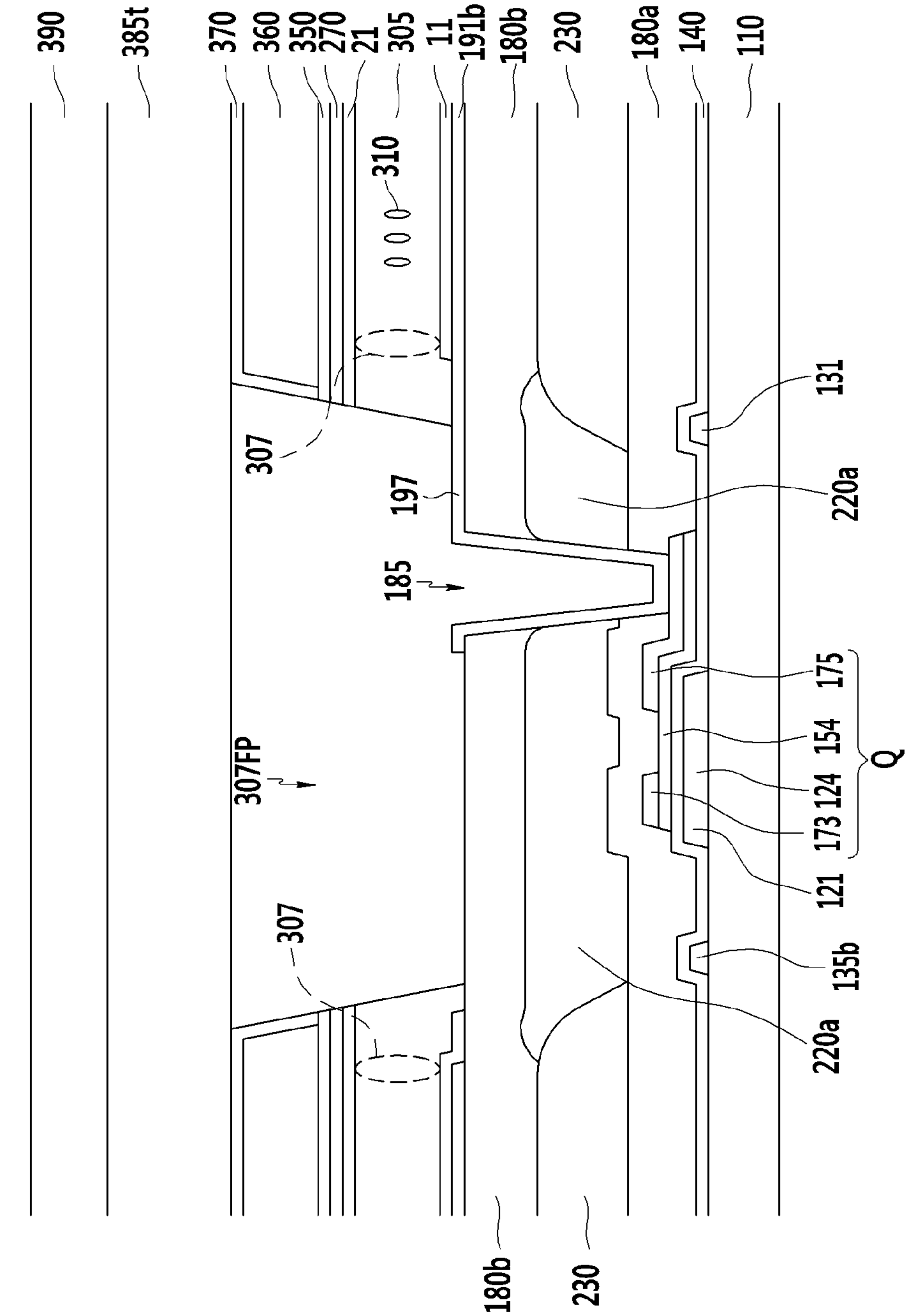
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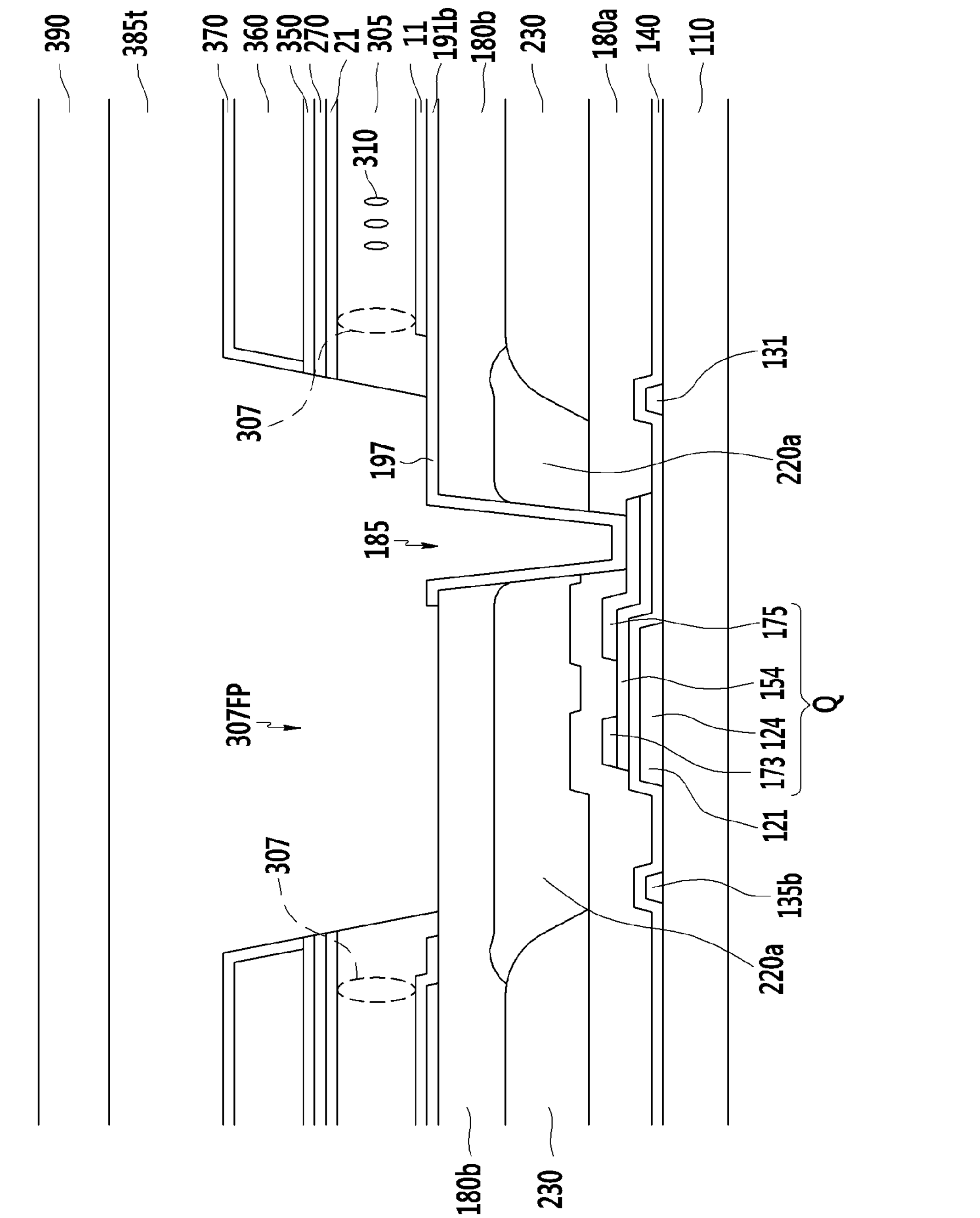
FIG. 30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LIQUID CRYSTAL DISPLAY AND METHOD OF MANUFACTURING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to and the benefit of Korean Patent Application No. 10-2014-0018049 filed in the Korean Intellectual Property Office on Feb. 17, 2014, the entire contents of which are incorporated herein by reference.

BACKGROUND

[0002] (a) Field

[0003] The inventive concept relates to a liquid crystal display and a manufacturing method thereof.

[0004] (b) Description of the Related Art

[0005] A liquid crystal display as one of flat panel display devices that are widely used includes two display panels where field generating electrodes such as pixel electrodes and a common electrode are formed, and a liquid crystal layer interposed therebetween.

[0006] The liquid crystal display generates an electric field in the liquid crystal layer by applying voltages to the field generating electrodes, to determine orientations of liquid crystal molecules of the liquid crystal layer and control polarization of incident light, thereby displaying an image.

[0007] A technique of implementing a display by forming a plurality of microcavities in a pixel and filling a liquid crystal therein has been developed for one of the liquid crystal displays. Two sheets of substrates are used in a liquid crystal display in the related art, but the technique of forming constituent elements on one substrate may reduce weight, thickness, and the like of the device.

[0008] A process of forming the display by filling the liquid crystal in the microcavities includes a process of forming a capping layer after the liquid crystal is injected into the microcavities. To form the capping layer, if a hardening process is performed after coating a liquid phase of the coating material, contamination of the liquid crystal by impurities in the coating material due to the contact between the liquid crystal and the coating material is inevitably occurred and stains due to non-uniform coating of the coating material may be generated.

[0009] The above information disclosed in this Background section is only for enhancement of understanding of the background of the inventive concept and therefore it may contain information that does not form the prior art.

SUMMARY

[0010] The inventive concept provides a liquid crystal display in which liquid crystal contamination and stain generation are prevented, and a manufacturing method thereof.

[0011] A liquid crystal display according to an exemplary embodiment of the inventive concept includes: a substrate; a thin film transistor disposed on the substrate; a pixel electrode connected to the thin film transistor; a roof layer facing the pixel electrode; an adhesive layer disposed on the roof layer; and a capping layer disposed on the adhesive layer, wherein a plurality of microcavities are formed between the pixel electrode and the roof layer, and each micro-cavity forms a liquid crystal layer including a liquid crystal material.

[0012] A liquid crystal injection hole formation region may be formed between a plurality of microcavities, and the liquid crystal material may be disposed at the liquid crystal injection hole formation region.

[0013] A lower portion of the capping layer corresponding to the liquid crystal injection hole formation region may be substantially flat.

[0014] The adhesive layer may be disposed on the roof layer, and may be removed in the liquid crystal injection hole formation region.

[0015] The substrate may further include a sealing member and the sealing member surrounds a display area and is disposed at the peripheral area in which image in not displayed.

[0016] A liquid crystal injection hole formation region may be formed between the plurality of microcavities, and the adhesive layer may be disposed at the liquid crystal injection hole formation region.

[0017] The adhesive layer may have a characteristic that viscosity is changed according to temperature.

[0018] The liquid crystal injection hole formation region may be formed between a plurality of microcavities, the capping layer may be disposed at the liquid crystal injection hole formation region, and the adhesive layer may be disposed on the roof layer and may be removed at the liquid crystal injection hole formation region.

[0019] A polarizer disposed on the capping layer may be further included, and an upper surface of the capping layer that is exposed between an end of the polarizer and an end of the capping layer may be flat.

[0020] The end of the polarizer and the end of the capping layer may be disposed at the peripheral area of the substrate.

[0021] A protection film disposed on the capping layer may be further included.

[0022] The liquid crystal injection hole formation region may be formed between a plurality of microcavities, and the adhesive layer may include a hardened adhesion region disposed at a portion corresponding to the liquid crystal injection hole formation region.

[0023] A manufacturing method of a liquid crystal display according to an exemplary embodiment of the inventive concept includes: forming a thin film transistor on a substrate; forming a pixel electrode to be connected to one terminal of the thin film transistor; forming a sacrificial layer on the pixel electrode; forming a roof layer on the sacrificial layer; removing the sacrificial layer to form a plurality of microcavities; injecting a liquid crystal material into the microcavities; and attaching a capping layer on the roof layer.

[0024] The capping layer may have an adhesive layer on at least one surface and attaching a capping layer on the roof layer is performed by the adhesive.

[0025] The method may further include forming a liquid crystal injection hole formation region between a plurality of microcavities, and the injecting of the liquid crystal material may include forming a liquid crystal material at the liquid crystal injection hole formation region.

[0026] The capping layer may include a first portion corresponding to the roof layer and a second portion corresponding to the liquid crystal injection hole formation region, and the adhesive layer may be formed at the first portion and may be removed at the second portion in the forming of the adhesive layer.

[0027] The method may further include forming a sealing member at the peripheral area in which image in not displayed and the sealing member may surround a display area.

[0028] The method may further include forming a liquid crystal injection hole formation region between a plurality of microcavities and removing the liquid crystal material on the liquid crystal injection hole formation region.

[0029] The adhesive layer may have a characteristic that viscosity is changed according to temperature, and the forming of the adhesive layer may include heat-treating the adhesive layer to reflow the adhesive layer into the liquid crystal injection hole formation region.

[0030] The method may further include forming a sealing member at the peripheral area in which image in not displayed and the sealing member may surround a display area.

[0031] The forming of the capping layer may include heat-treating the capping layer to reflow the capping layer into the liquid crystal injection hole formation region.

[0032] The method may further include forming a polarizer on the capping layer, and an upper surface of the capping layer exposed between an end of the polarizer and an end of the capping layer may be flat.

[0033] The end of the polarizer and the end of the capping layer may be formed to be disposed in the peripheral area of the substrate.

[0034] The method may further include forming a protection film on the capping layer.

[0035] The method may further include: forming a liquid crystal injection hole formation region between a plurality of microcavities; forming an adhesive layer between the roof layer and the capping layer; and heat-treating or irradiating UV to a portion of the adhesive layer corresponding to the liquid crystal injection hole formation region to form a hardened adhesion region.

[0036] According to an exemplary embodiment of the inventive concept, after injecting the liquid crystal to the microcavity, the capping layer is formed by a film lamination process such that liquid crystal contamination caused by conventional liquid coating and stains caused by coating non-uniformity may be prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037] FIG. **1** is a top plan view of a liquid crystal display according to an exemplary embodiment of the inventive concept.

[0038] FIG. **2** is a cross-sectional view taken along a line II-II of FIG. **1**.

[0039] FIG. **3** is a cross-sectional view taken along a line III-III of FIG. **1**.

[0040] FIG. **4** is a cross-sectional view of a variation of a liquid crystal display according to an exemplary embodiment of FIG. **2**.

[0041] FIG. **5** is a cross-sectional view of a variation of a liquid crystal display according to an exemplary embodiment of FIG. **2**.

[0042] FIG. **6** is a cross-sectional view of a variation of a liquid crystal display according to an exemplary embodiment of FIG. **2**.

[0043] FIG. **7** is a cross-sectional view of a variation of a liquid crystal display according to an exemplary embodiment of FIG. **6**.

[0044] FIG. **8** and FIG. **9** are cross-sectional views of a liquid crystal display according to an exemplary embodiment of the inventive concept.

[0045] FIG. **10** is a top plan view partially showing a peripheral area and a display area in a liquid crystal display according to an exemplary embodiment of the inventive concept.

[0046] FIG. **11** is a schematic cross-sectional view of a liquid crystal display according to the exemplary embodiment of FIG. **10** in a view of a side surface.

[0047] FIG. **12** is a top plan view partially showing a peripheral area and a display area in a liquid crystal display according to an exemplary embodiment of the inventive concept.

[0048] FIG. **13** is a schematic cross-sectional view of a liquid crystal display according to the exemplary embodiment of FIG. **12** in a view of a side surface.

[0049] FIG. **14** to FIG. **30** are cross-sectional views showing a manufacturing method of a liquid crystal display according to an exemplary embodiment of the inventive concept.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0050] The inventive concept will be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the inventive concept are shown. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the inventive concept. Rather, the exemplary embodiments of the inventive concept are provided so that this disclosure will be thorough and complete, and will fully convey the concept of the inventive concept to those skilled in the art.

[0051] In the drawings, the thickness of layers and regions may be exaggerated for clarity. In addition, when a layer is described to be formed on another layer or on a substrate, this means that the layer may be formed on the other layer or on the substrate, or a third layer may be interposed between the layer and the other layer or the substrate. Like numbers refer to like elements throughout the specification.

[0052] FIG. **1** is a top plan view of a liquid crystal display according to an exemplary embodiment of the inventive concept. FIG. **2** is a cross-sectional view taken along a line II-II of FIG. **1**. FIG. **3** is a cross-sectional view taken along a line III-III of FIG. **1**.

[0053] FIG. **1** shows a 2*2 pixel portion as a center portion of a plurality of pixels, and these pixels may be repeatedly arranged up/ down and right/left in the liquid crystal display according to an exemplary embodiment of the inventive concept.

[0054] Referring to FIG. **1** to FIG. **3**, a gate line **121** and a storage electrode line **131** are formed on a substrate **110** made of transparent glass or plastic. The gate line **121** includes a gate electrode **124**. The storage electrode line **131** mainly extends in a horizontal direction, and transfers a predetermined voltage such as a common voltage Vcom. The storage electrode line **131** includes a pair of vertical storage electrode portions **135***a* substantially extending to be perpendicular to the gate line **121**, and a horizontal storage electrode portion **135***b* connecting ends of the pair of vertical storage electrode portions **135***a* to each other. The storage electrode portions **135***a* and **135***b* have a structure surrounding a pixel electrode **191**.

[0055] A gate insulating layer **140** is formed on the gate line **121** and the storage electrode line **131**. A semiconductor layer **151** provided at a lower portion of a data line **171**, and a semiconductor layer **154** disposed at a lower portion of a source/drain electrode and at a channel portion of a thin film transistor Q is formed on the gate insulating layer **140**.

[0056] A plurality of ohmic contacts may be formed on each of the semiconductor layers **151** and **154**, and between the data line **171** and the source/drain electrode, but this is omitted in the drawings. Data conductors including a source electrode **173**, the data line **171** connected with the source electrode **173**, and a drain electrode **175** are formed on each of the semiconductor layers **151** and **154** and the gate insulating layer **140**.

[0057] According to another embodiment of the inventive concept, the semiconductor layer **151** may not be formed at a lower portion of a data line **171**.

[0058] The gate electrode **124**, the source electrode **173**, and the drain electrode **175** form the thin film transistor Q together with the semiconductor layer **154**, and a channel of the thin film transistor Q is formed on the portion of the semiconductor layer **154** between the source electrode **173** and the drain electrode **175**. A first interlayer insulating layer **180***a* is formed on the data conductors **171**, **173**, and **175** and an exposed portion of the semiconductor layer **154**. The first interlayer insulating layer **180***a* may include an inorganic insulating material such as a silicon nitride (SiNx) and a silicon oxide (SiOx), or an organic insulating material.

[0059] A color filter **230** and a light blocking member **220** are formed on the first interlayer insulating layer **180***a*.

[0060] The light blocking member **220** has a lattice structure having an opening corresponding to a region displaying an image, and is formed of a material that prevents light from being transmitted therethrough. The color filter **230** is formed at an opening of the light blocking member **220**. The light blocking member **220** includes a horizontal light blocking member **220***a* formed in a direction parallel to the gate line **121**, and a vertical light blocking member **220***b* formed in a direction parallel to the data line **171**.

[0061] The color filter **230** may display one of primary colors, such as three primary colors including red, green, and blue. However, the colors are not limited to the three primary colors including red, green, and blue, and the color filter **230** may also display one among a cyan-based color, a magenta-based color, a yellow-based color, and a white-based color. The color filter **230** may be formed of materials displaying different colors for each adjacent pixel.

[0062] A second interlayer insulating layer **180***b* covering the color filter **230** and the light blocking member **220** is formed on the color filter **230** and the light blocking member **220**. The second interlayer insulating layer **180***b* may include an inorganic insulating material such as a silicon nitride (SiNx) and a silicon oxide (SiOx), or the organic insulating material. Unlike the cross-sectional view of FIG. **2**, in a case where a step is generated due to a difference in thickness between the color filter **230** and the light blocking member **220**, the second interlayer insulating layer **180***b* includes an organic insulating material, so that it is possible to decrease or remove the step.

[0063] The color filter **230**, the light blocking member **220**, and the interlayer insulating layer **180***a* and **180***b* have a contact hole **185** exposing the drain electrode **175**.

[0064] A pixel electrode **191** is formed on the second interlayer insulating layer **180***b*. The pixel electrode **191** may be formed of a transparent conductive material such as ITO or IZO.

[0065] An overall shape of the pixel electrode **191** is a quadrangle, and the pixel electrode **191** includes a cross stem having a horizontal stem **191***a* and a vertical stem **191***b* crossing the horizontal stem **191***a*. Further, the pixel electrode **191** is divided into four sub-regions by the horizontal stem **191***a* and the vertical stem **191***b*, and each sub-region includes a plurality of minute branches **191***c*. In the present exemplary embodiment, the pixel electrode **191** may further include an outer stem surrounding an outer circumference of the pixel electrode **191**.

[0066] The minute branches **191***c* of the pixel electrode **191** form an angle of approximately 40° to 45° with the gate line **121** or the horizontal stem **191***a*. Further, the minute branches of two adjacent sub-regions may be perpendicular to each other.

[0067] Furthermore, a width of each minute branch may be gradually increased, or a distance between the minute branches **191***c* may be varied.

[0068] The pixel electrode **191** includes an extension **197** which is connected to a lower end of the vertical stem **191***b* and has a larger area than the vertical stem **191***b*, and is physically and electrically connected with the drain electrode **175** through the contact hole **185** at the extension **197** to receive a data voltage from the data electrode **175**.

[0069] The thin film transistor Q and the pixel electrode **191** described above are just described as examples, and a structure of the thin film transistor and a design of the pixel electrode may be modified in order to improve side visibility.

[0070] A lower alignment layer **11** is formed on the pixel electrode **191**, and may be a vertical alignment layer. The lower alignment layer **11**, as a liquid crystal alignment layer made of a material such as polyamic acid, polysiloxane, polyimide, or the like, may include at least one of generally used materials. Also, the lower alignment layer **11** may be a photo-alignment layer.

[0071] An upper alignment layer **21** is provided at a portion facing the lower alignment layer **11**, and a microcavity **305** is formed between the lower alignment layer **11** and the upper alignment layer **21**. A liquid crystal material including liquid crystal molecules **310** is injected into the microcavity **305** through an injection hole **307**. In the present exemplary embodiment, the alignment material forming the alignment layers **11** and **21** and the liquid crystal material including the liquid crystal molecules **310** may be injected into the microcavity **305** by capillary force. The lower alignment layer **11** and the upper alignment layer **21** may be formed in a same process and be connected each other as disclosed in FIG. **3**.

[0072] A plurality of liquid crystal injection hole formation regions **307**FP are disposed between adjacent microcavity at a portion overlapping the gate line **121**, thereby forming the plurality of microcavities **305**, and a plurality of microcavities **305** may be formed along a column direction of the pixel electrode **191**, that is, in the vertical direction. Also, the microcavity **305** is divided in the horizontal direction by a partition formation part PWP that will be described later, thereby forming the plurality of microcavities **305**, and the plurality of microcavities **305** may be formed along the row direction of the pixel electrode **191**, in other words, the horizontal direction in which the gate line **121** extends. Each of the plurality of microcavities **305** may be formed in a region correspond to a pixel area which display one of the primary colors, and the pixel areas may correspond to a region displaying an image. However, two adjacent microcavities arranged along the column direction may correspond to the pixel area.

[0073] A common electrode **270** and a lower insulating layer **350** are disposed on the upper alignment layer **21**. The common electrode **270** receives the common voltage, and generates an electric field together with the pixel electrode **191** to which the data voltage is applied to determine a direction in which the liquid crystal molecules **310** disposed in the microcavity **305** between the two electrodes are inclined. The common electrode **270** forms a capacitor with the pixel electrode **191** to maintain the received voltage even after the thin film transistor is turned off. The lower insulating layer **350** may be formed of a silicon nitride (SiNx) or a silicon oxide (SiOx).

[0074] In the present exemplary embodiment, it is described that the common electrode **270** is formed on the microcavity **305**, but in another exemplary embodiment, the common electrode **270** is formed under the microcavity **305**, so that liquid crystal driving according to a coplanar electrode (CE) mode is possible.

[0075] A roof layer **360** is disposed on the lower insulating layer **350**. The roof layer **360** serves to make a support so that the microcavity **305**, which is a space between the pixel electrode **191** and the common electrode **270**, is maintained. The roof layer **360** may include a photoresist or other organic materials.

[0076] An upper insulating layer **370** is disposed on the roof layer **360**. The upper insulating layer **370** may contact an upper surface of the roof layer **360**. The upper insulating layer **370** may be formed of a silicon nitride (SiNx) or a silicon oxide (SiOx). The upper insulating layer **370** may be omitted.

[0077] A capping layer **390** having an adhesive layer **385** on one side is attached to the upper insulating layer **370**. The capping layer **390** adheres to the upper insulating layer **370** by an adhesive layer **385**, and when the upper insulating layer **370** is omitted, the capping layer **390** adheres to the roof layer **360** by the adhesive layer **385**. The capping layer **390** includes an organic material or an inorganic material, and may have a film shape. A lower portion of the capping layer **290** corresponding to the liquid crystal injection hole formation region **307**FP may be substantially flat.

[0078] In the present exemplary embodiment, the capping layer **390** is not only disposed on the roof layer **360** but also covers the liquid crystal injection hole formation region **307**FP.

[0079] A lower polarizer **1** is disposed under the substrate **110** and an upper polarizer **2** is disposed on the capping layer **390**.

[0080] In the present exemplary embodiment, the liquid crystal material may remain at the liquid crystal injection hole formation region **307**FP even after the liquid crystal material is injected into the microcavity **305**. The liquid crystal material that remains at the liquid crystal injection hole formation region **307**FP is covered by the capping layer **390** having the adhesive layer **385**.

[0081] In the present exemplary embodiment, as shown in FIG. **3**, a partition wall PWP is disposed between the microcavities **305** adjacent to each other in a horizontal direction. The partition wall formation portion PWP may be formed in an extending direction of the data line **171**, and may be covered by the roof layer **360**. The lower insulating layer **350**, the common electrode **270**, the upper insulating layer **370**, and the roof layer **360** are filled in the partition wall formation portion PWP, and the structure forms the partition wall to partition or define the microcavity **305**. In the present exemplary embodiment, since a partition wall structure such as the partition wall formation portion PWP exists between the microcavities **305**, even if the insulation substrate **110** is bent, generated stress is small, and a change in a cell gap may be considerably reduced.

[0082] FIG. **4** is a cross-sectional view of a variation of a liquid crystal display according to an exemplary embodiment of FIG. **2**.

[0083] The exemplary embodiment described in FIG. **4** is almost the same as the exemplary embodiment described in FIG. **1** to FIG. **3**. Hereafter, a difference between the present exemplary embodiment and the exemplary embodiment of FIG. **1** to FIG. **3** will be described.

[0084] Referring to FIG. **4**, the adhesive layer **385** in an adhesion region **385***p* that is disposed at a portion corresponding to the liquid crystal injection hole formation region **307**FP is hardened. The hardened adhesion region **385***p* may be formed by irradiating UV or applying heat treatment to the adhesive layer **385**. When irradiating UV, a shadow mask may cover a portion except for the portion corresponding to the liquid crystal injection hole formation region **307**FP. In the present exemplary embodiment, the hardened adhesion region **385***p* has decreased reactivity with the liquid crystal material such that the liquid crystal material that remains in the liquid crystal injection hole formation region **307**FP would not react with the adhesive layer **385**, thereby preventing contamination of the liquid crystal.

[0085] Except for the described differences, the contents described in FIG. **1** to FIG. **3** may all be applied to the present exemplary embodiment.

[0086] FIG. **5** is a cross-sectional view of a variation of a liquid crystal display according to an exemplary embodiment of FIG. **2**.

[0087] The exemplary embodiment described in FIG. **5** is almost the same as the exemplary embodiment described in FIG. **1** to FIG. **3**. Hereafter, differences between the present exemplary embodiment and the exemplary embodiment of FIG. **1** to FIG. **3** will be described.

[0088] Referring to FIG. **5**, the adhesive layer **385** on the liquid crystal injection hole formation region **307**FP is removed. However, the adhesive layer **385** on the roof layer **360** is remained.

[0089] In the present exemplary embodiment, the adhesive layer **385** is removed at the liquid crystal injection hole formation region **307**FP, thereby reducing the liquid crystal contamination generated by the contact of the liquid crystal material remaining at the liquid crystal injection hole formation region **307**FP and the adhesive layer **385**.

[0090] Except for the described differences, the contents described in FIG. **1** to FIG. **3** may all be applied to the present exemplary embodiment.

[0091] FIG. **6** is a cross-sectional view of a variation of a liquid crystal display according to an exemplary embodiment of FIG. **2**.

[0092] The exemplary embodiment described in FIG. **6** is almost the same as the exemplary embodiment described in FIG. **1** to FIG. **3**. Hereafter, differences between the present exemplary embodiment and the exemplary embodiment of FIG. **1** to FIG. **3** will be described.

[0093] Referring to FIG. **6**, the liquid crystal material is removed at the liquid crystal injection hole formation region **307**FP on which the adhesive layer **385** is disposed. The adhesive layer **385** disposed on the roof layer **360** fills the liquid crystal injection hole formation region **307**FP. At this time, the adhesive layer **385** may have a characteristic that its viscosity is changed according to change in temperature. The adhesive layer **385** may have high viscosity at room temperature and have low viscosity at high temperature, for example, more than about 100° C., such that the adhesive layer **385** may reflow into the liquid crystal injection hole formation region **307**FP during high temperature heat treatment.

[0094] Except for the described differences, the contents described in FIG. **1** to FIG. **3** may all be applied to the present exemplary embodiment.

[0095] FIG. **7** is a cross-sectional view of a variation of a liquid crystal display according to an exemplary embodiment of FIG. **6**.

[0096] The exemplary embodiment described in FIG. **7** is almost the same as the exemplary embodiment described in FIG. **1** to FIG. **3**. Hereafter, differences between the present exemplary embodiment and the exemplary embodiment of FIG. **1** to FIG. **3** will be described.

[0097] Referring to FIG. **7**, the liquid crystal material is removed at the liquid crystal injection hole formation region **307**FP, and the capping layer **390** is disposed in the liquid crystal injection hole formation region **307**FP. The adhesive layer **385** disposed between the capping layer **390** and the roof layer **360** is disposed at a portion corresponding to the roof layer **360**, and the adhesive layer **385** on the liquid crystal injection hole formation region **307**PF is removed. The capping layer **390** disposed on the adhesive layer **385** may extend to be disposed at the liquid crystal injection hole formation region **307**FP. In this case, the capping layer **390** may have a characteristic that viscosity is changed according to change in temperature. The adhesive layer **385** may have high viscosity at room temperature and have low viscosity at high temperature, for example, more than about 100° C., such that the adhesive layer **385** may reflow into the liquid crystal injection hole formation region **307**FP during high temperature heat treatment.

[0098] Except for the described differences, the contents described in FIG. **6** may all be applied to the present exemplary embodiment.

[0099] FIG. **8** and FIG. **9** are cross-sectional views of a liquid crystal display according to an exemplary embodiment of the inventive concept.

[0100] The exemplary embodiment described in FIG. **8** and FIG. **9** is almost the same as the exemplary embodiment described in FIG. **1** to FIG. **3**. Hereafter, differences between the present exemplary embodiment and the exemplary embodiment of FIG. **1** to FIG. **3** will be described.

[0101] Referring to FIG. **8** and FIG. **9**, an additional capping layer **410** and a protection film **420** are disposed on the capping layer **390**. Here, the additional capping layer **410** may be omitted such that the protection film **420** is disposed on the capping layer **390** without intervening the additional capping layer **410**.

[0102] The additional capping layer **410** includes the same material as the capping layer **390**, and the protection film **420** may include the same material as the generally used protection film to prevent external dust or moisture from entering into the liquid crystal display device. The protection film **420** may be formed of a hybrid layer including organic and inorganic materials.

[0103] The additional capping layer **410** and the protection film **420** may be formed in the exemplary embodiment described in FIG. **2** to FIG. **7**.

[0104] FIG. **10** is a top plan view partially showing a peripheral area and a display area in a liquid crystal display according to an exemplary embodiment of the inventive concept. FIG. **11** is a schematic cross-sectional view of a liquid crystal display according to the exemplary embodiment of FIG. **10**. FIG. **11** is omitted the lower polarizer **1** shown in FIG. **2**.

[0105] Referring to FIG. **10** and FIG. **11**, the liquid crystal display according to an exemplary embodiment of the inventive concept may include a liquid crystal panel assembly **400** with a gate driver (not shown) and a data driver (not shown) connected thereto, a gray voltage generator (not shown) connected to the data driver, a light source unit (not shown) irradiating light to the liquid crystal panel assembly **400**, a light source driver (not shown) controlling the light source unit, and a signal controller (not shown) controlling them.

[0106] The gate driver and/or the data driver may be integrated in the liquid crystal panel assembly **400**, or may be formed of a separate integrated circuit chip.

[0107] The substrate **110** of the liquid crystal panel assembly **400** includes a display area DA and a non-displaying peripheral area PA. The display area DA is a region where an actual image is displayed, and the non-displaying peripheral region PA is a region where the actual image is not displayed and the gate driver, the data driver, a gate pad portion **121**P and a data pad portion **171**P including a gate pad, a data pad, or the like are disposed. The gate pad is a wide portion disposed at an end of the gate line **121**, and the data pad is a wide portion disposed at an end of the data line **171**.

[0108] The 2*2 pixel portion of the liquid crystal display described in FIG. **1** to FIG. **3** may correspond to a portion A in FIG. **10**.

[0109] Again referring to FIG. **11**, the upper polarizer **2** is disposed on the capping layer **390**, and the upper polarizer **2** exposes a portion of the upper surface of the capping layer **390** by considering an adhesion margin. In the present exemplary embodiment, the upper surface of the capping layer **390** that is exposed between the end of the polarizer **2** and the end of the capping layer **390** may be flat. This structure is generated due to the capping layer **390** that is formed by the lamination method.

[0110] The end of the polarizer **2** and the end of the capping layer **390** may be disposed at the peripheral area PA.

[0111] The characteristics of the liquid crystal display according to exemplary embodiments of the inventive concept described in FIG. **1** to FIG. **9** may be applied to the exemplary embodiment described in FIG. **10** and FIG. **11**. The adhesive layer **385** is formed on the whole area on the substrate **110** in FIG. **10**, however the adhesive layer **385** may be removed at the liquid crystal injection hole formation region **307**FP in the exemplary embodiment of FIG. **5** and FIG. **7**, as described above.

[0112] FIG. **12** is a top plan view partially showing a peripheral area and a display area in a liquid crystal display according to an exemplary embodiment of the inventive concept. FIG. **13** is a schematic cross-sectional view of a liquid crystal display according to the exemplary embodiment of FIG. **12**.

[0113] The exemplary embodiment described in FIG. **12** and FIG. **13** is almost the same as the exemplary embodiment described in FIG. **10** and FIG. **11**. Hereafter, differences between the present exemplary embodiment and the exemplary embodiment of FIG. **10** and FIG. **11** will be described.

[0114] Referring to FIG. **12** and FIG. **13**, a sealing member **500** is disposed at the peripheral area PA. The sealing member **500** may be coated at the peripheral area PA of the substrate **110** before the capping layer **390** is adhered to the liquid crystal panel assembly **400** by the lamination method using the adhesive layer **385**. The sealing member **500** may prevent penetration of the external dust or moisture through the peripheral area PA.

[0115] Except for the above difference, the contents described in FIG. **10** and FIG. **11** may all be applied to the present exemplary embodiment.

[0116] Hereafter, an exemplary embodiment of a method of manufacturing the described liquid crystal display will be described with reference to FIG. **14** to FIG. **30**. The following exemplary embodiment may be modified into other methods as an exemplary embodiment of the manufacturing method.

[0117] FIG. **14** to FIG. **30** are cross-sectional views showing a manufacturing method of a liquid crystal display according to an exemplary embodiment of the inventive concept. FIG. **14**, FIG. **16**, FIG. **18**, FIG. **20**, FIG. **21**, FIG. **23**, FIG. **25**, FIG. **26**, FIG. **27**, FIG. **28**, FIG. **29**, and FIG. **30** sequentially show cross-sectional views taken along the line II-II of FIG. **1**. FIG. **15**, FIG. **17**, FIG. **19**, FIG. **22**, and FIG. **24** are cross-sectional views taken along the line III-III of FIG. **1**.

[0118] Referring to FIG. **1**, FIG. **14**, and FIG. **15**, in order to form a generally known switching element on a substrate **110**, the gate line **121** extending in the horizontal direction is formed, and the gate insulating layer **140** is formed on the gate line **121**, the semiconductor layers **151** and **154** are formed on the gate insulating layer **140**, and the source electrode **173** and the drain electrode **175** are formed. In this case, the data line **171** connected with the source electrode **173** may be formed to extend in the vertical direction while crossing the gate line **121**.

[0119] The first interlayer insulating layer **180***a* is formed on the data conductors including the source electrode **173**, the drain electrode **175**, and the data line **171**, and the exposed portion of the semiconductor layer **154**.

[0120] The color filter **230** is formed at a position corresponding to the pixel area on the first interlayer insulating layer **180***a*, and the light blocking members **220***a* and **220***b* are formed between the color filters **230**. The light blocking member **220** includes the horizontal light blocking member **220***a* formed in a direction parallel to the gate line **121**, and the vertical light blocking member **220***b* formed in a direction parallel to the data line **171**.

[0121] The second interlayer insulating layer **180***b* covering the color filter **230** and the light blocking member **220** is formed on the color filter **230** and the light blocking member **220**, and the second interlayer insulating layer **180***b* is formed to have the contact hole **185** electrically and physically connecting the pixel electrode **191** and the drain electrode **175**.

[0122] Next, the pixel electrode **191** including the horizontal stem **191***a*, the vertical stem **191***b* and the minute branches **191***c* is formed on the second interlayer insulating layer **180***b*, and a sacrificial layer **300** is formed on the pixel electrode **191**. As shown in FIG. **15**, an opening OPN is formed in the sacrificial layer **300** along a direction in parallel with the data line **171**. In a subsequent process, the common electrode **270**, the lower insulating layer **350**, the roof layer **360**, and the upper insulating layer **370** are filled in the open portion OPN to form the partition wall formation portion PWP.

[0123] Referring to FIG. **1**, FIG. **16**, and FIG. **17**, the common electrode **270**, the lower insulating layer **350**, and the roof layer **360** are sequentially formed on the sacrificial layer **300**. The roof layer **360** may be removed at the region corresponding to the light blocking member **220** disposed between pixel areas adjacent in the vertical direction by an exposure and development process. The roof layer **360** exposes the lower insulating layer **350** in the region corresponding to the light blocking member **220**. In this case, the common electrode **270**, the lower insulating layer **350**, and the roof layer **360** fill the open portion OPN of the vertical light blocking member **220***b* thereby forming the partition forming portion PWP.

[0124] Referring to FIG. **1**, FIG. **18**, and FIG. **19**, the upper insulating layer **370** is formed in such a way so as to cover the roof layer **360** and the exposed lower insulating layer **350**.

[0125] Referring to FIG. **20**, the upper insulating layer **370**, the lower insulating layer **350**, and the common electrode **270** are dry-etched to partially remove the upper insulating layer **370**, the lower insulating layer **350**, and the common electrode **270**, thereby forming the liquid crystal injection hole formation region **307**FP. In this case, the upper insulating layer **370** may have a structure that covers a side surface of the roof layer **360**, however, it is not limited thereto. The upper insulating layer **370** covering the side surface of the roof layer **360** may be removed so that the side surface of the roof layer **360** may be externally exposed.

[0126] Referring to FIG. **21** and FIG. **22**, the sacrificial layer **300** is removed by an oxygen (O2) ashing process or a wet-etching method through the liquid crystal injection hole formation region **307**FP. At this time, the microcavity **305** having the liquid crystal injection hole **307** is formed. The microcavities **305** are in a state of an empty space according to the removal of the sacrificial layer **300**.

[0127] Referring to FIG. **23** and FIG. **24**, the alignment layers **11** and **21** are formed on the pixel electrode **191** and the common electrode **270** by injecting an aligning material through the liquid crystal injection hole **307**. In detail, a baking process is performed after injecting the aligning material containing a solid content and a solvent through the liquid crystal injection hole **307**.

[0128] Next, the liquid crystal material including the liquid crystal molecules **310** is injected into the microcavities **305** through the liquid crystal injection hole **307** by using an inkjet method and the like. At this time, the liquid crystal material that is injected through the liquid crystal injection hole formation region **307**FP is injected to the microcavity **305** and some of the liquid crystal material may remain in the liquid crystal injection hole formation region **307**FP. The amount of the liquid crystal material may be controlled to fill the liquid crystal injection hole formation region **307**FP by the liquid crystal material.

[0129] Referring to FIG. **25**, the capping layer **390** is adhered to the upper insulating layer **370** by using the lamination method. When omitting the upper insulating layer **370**, the capping layer **390** may be adhered to the roof layer **360**. The adhesive layer **385** is disposed between the capping layer **390** and the upper insulating layer **370**. The adhesive layer **385** may be formed in the whole area at the adhesion surface of the capping layer **390**. Next, if the polarizers **1** and **2** are formed on the capping layer **390** and under the substrate **110**, the liquid crystal display shown in FIG. **2** may be formed.

[0130] Referring to FIG. **26**, before adhering the capping layer **390** on the upper insulating layer **370**, the heat treatment is applied or UV is irradiated to a portion of the adhesive layer **385** formed at the adhesion surface of the capping layer **390** to form the hardened adhesion region **385***p*. Next, the capping layer **390** may be formed on the upper insulating layer **370** for the hardened adhesion region **385***p* to correspond to the liquid crystal injection hole formation region **307**FP. Next, the polarizers **1** and **2** are formed on the capping layer **390** and under the substrate **110**, thereby forming the liquid crystal display as shown in FIG. **4**.

[0131] Referring to FIG. **27**, differently from FIG. **25**, the adhesive layer **385** formed at the adhesion surface of the capping layer **390** may be removed. Next, the capping layer **390** may be formed on the upper insulating layer **370** for the remained adhesive layer **385** so as to correspond to the upper surface of the roof layer **360**. In this case, the adhesive layer **385** is removed in the liquid crystal injection hole formation region **307**FP, and the capping layer **390** covers the liquid crystal injection hole formation region **307**FP. Next, the polarizers **1** and **2** are formed on the capping layer **390** and under the substrate **110**, thereby forming the liquid crystal display shown in FIG. **5**.

[0132] Referring to FIG. **28** to FIG. **30**, differently from the description of FIG. **25** to FIG. **27**, the liquid crystal material is removed in the liquid crystal injection hole formation region **307**FP.

[0133] Referring to FIG. **28**, the liquid crystal material in the liquid crystal injection hole formation region **307**FP is removed by using a cleaning method after the process of FIG. **23** and FIG. **24**.

[0134] Referring to FIG. **29**, an adhesive layer **385***t* having the characteristic that the viscosity is changed according to the temperature is formed at the adhesion surface of the capping layer **390**, and the capping layer **390** is adhered on the upper insulating layer **370** by using the lamination method. Here, the capping layer **390** may be adhered to the upper insulating layer **370** by the adhesive layer **385***t*. At this time, the adhesive layer **385***t* has high viscosity o at room temperature (about 15° C. to 25° C.) thereby maintaining the shape of the adhesive layer **385***t*. Accordingly, as shown in FIG. **29**, the liquid crystal injection hole formation region **307**FP enclosed by the adhesive layer **385***t* and the roof layer **360** is the empty space.

[0135] Referring to FIG. **30**, the high temperature heat treatment of more than about 100° C. is used to decrease the viscosity of the adhesive layer **385***t* such that the adhesive layer **385***t* reflows into the liquid crystal injection hole formation region **307**FP.

[0136] Next, the polarizers **1** and **2** are formed on the capping layer **390** and under the substrate **110** thereby forming the liquid crystal display as shown in FIG. **6**.

[0137] While this inventive concept has been described in connection with what is presently considered to be practical exemplary embodiments, it is to be understood that the inventive concept is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

What is claimed is:

1. A liquid crystal display comprising:

a substrate;

a thin film transistor disposed on the substrate;

a pixel electrode connected to the thin film transistor;

a roof layer facing the pixel electrode;

an adhesive layer disposed on the roof layer; and

a capping layer disposed on the adhesive layer,

wherein a plurality of microcavities are formed between the pixel electrode and the roof layer, and each microcavity forms a liquid crystal layer including a liquid crystal material.

2. The liquid crystal display of claim **1**, wherein a liquid crystal injection hole formation region is formed between a plurality of microcavities, and the liquid crystal material is disposed at the liquid crystal injection hole formation region.

3. The liquid crystal display of claim **2**, wherein a lower portion of the capping layer corresponding to the liquid crystal injection hole formation region is substantially flat.

4. The liquid crystal display of claim **3**, wherein the adhesive layer is disposed on the roof layer and is removed in the liquid crystal injection hole formation region.

5. The liquid crystal display of claim **4**, further comprising a sealing member,

wherein the sealing member surrounds a display area and is disposed at the peripheral area in which image in not displayed.

6. The liquid crystal display of claim **1**, wherein

a liquid crystal injection hole formation region is formed between the plurality of microcavities, and the adhesive layer is disposed at the liquid crystal injection hole formation region.

7. The liquid crystal display of claim **6**, wherein the adhesive layer has a characteristic that viscosity is changed according to temperature.

8. The liquid crystal display of claim **7**, further comprising a sealing member,

wherein the sealing member surrounds a display area and is disposed at the peripheral area in which image in not displayed.

9. The liquid crystal display of claim **1**, wherein

the liquid crystal injection hole formation region is formed between a plurality of microcavities, the capping layer is disposed at the liquid crystal injection hole formation region, and

the adhesive layer is disposed on the roof layer and is removed at the liquid crystal injection hole formation region.

10. The liquid crystal display of claim **1**, further comprising a polarizer disposed on the capping layer, and

wherein an upper surface of the capping layer that is exposed between an end of the polarizer and an end of the capping layer is flat.

11. The liquid crystal display of claim **10**, wherein

the end of the polarizer and the end of the capping layer are disposed at the peripheral area of the substrate.

12. The liquid crystal display of claim **1**, further comprising

a protection film disposed on the capping layer.

13. The liquid crystal display of claim **1**, wherein

the liquid crystal injection hole formation region is formed between a plurality of microcavities, and the adhesive layer includes a hardened adhesion region disposed at a portion corresponding to the liquid crystal injection hole formation region.

14. A method of manufacturing a liquid crystal display, comprising:

forming a thin film transistor on a substrate;

forming a pixel electrode to be connected to one terminal of the thin film transistor;

forming a sacrificial layer on the pixel electrode;

forming a roof layer on the sacrificial layer;

removing the sacrificial layer to form a plurality of microcavities;

injecting a liquid crystal material into the microcavities; and

attaching a capping layer on the roof layer.

15. The method of claim **14**, wherein the capping layer has an adhesive layer on at least one surface and attaching a capping layer on the roof layer is performed by the adhesive.

16. The method of claim **15**, further comprising

forming a liquid crystal injection hole formation region between a plurality of microcavities, and

the injecting of the liquid crystal material includes forming a liquid crystal material at the liquid crystal injection hole formation region.

17. The method of claim **16**, wherein:

the capping layer includes a first portion corresponding to the roof layer and a second portion corresponding to the liquid crystal injection hole formation region; and

the adhesive layer is formed at the first portion and is removed at the second portion in the forming of the adhesive layer.

18. The method of claim **17**, further comprising forming a sealing member at the peripheral area in which image in not displayed,

wherein the sealing member surrounds a display area.

19. The method of claim **15**, further comprising

forming a liquid crystal injection hole formation region between a plurality of microcavities, and

removing the liquid crystal material on the liquid crystal injection hole formation region.

20. The method of claim **19**, wherein

the adhesive layer has a characteristic that viscosity is changed according to temperature, and

the forming of the adhesive layer includes

heat-treating the adhesive layer to reflow the adhesive layer into the liquid crystal injection hole formation region.

21. The method of claim **20**, further comprising forming a sealing member at the peripheral area in which image in not displayed,

wherein the sealing member surrounds a display area.

22. The method of claim **19**, wherein

the forming of the capping layer includes

heat-treating the capping layer to reflow the capping layer into the liquid crystal injection hole formation region.

23. The method of claim **14**, further comprising

forming a polarizer on the capping layer, and

an upper surface of the capping layer exposed between an end of the polarizer and an end of the capping layer is flat.

24. The method of claim **23**, wherein

the end of the polarizer and the end of the capping layer are formed to be disposed in the peripheral area of the substrate.

25. The method of claim **14**, further comprising

forming a protection film on the capping layer.

26. The method of claim **14**, further comprising:

forming a liquid crystal injection hole formation region between a plurality of microcavities;

forming an adhesive layer between the roof layer and the capping layer; and

heat-treating or irradiating UV to a portion of the adhesive layer corresponding to the liquid crystal injection hole formation region to form a hardened adhesion region.

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