



US009904087B2

(12) **United States Patent**  
**Lee et al.**

(10) **Patent No.:** **US 9,904,087 B2**  
(45) **Date of Patent:** **Feb. 27, 2018**

(54) **LIQUID CRYSTAL DISPLAY**

(2013.01); **G02F 1/136286** (2013.01); **G02F 1/136209** (2013.01); **G02F 2001/134345** (2013.01); **G02F 2001/136218** (2013.01)

(71) Applicant: **Samsung Display Co., Ltd.**, Yongin-si, Gyeonggi-do (KR)

(58) **Field of Classification Search**

CPC ..... **G02F 1/133377**  
See application file for complete search history.

(72) Inventors: **Sun Hwa Lee**, Yongin-si (KR);  
**Kwang-Chul Jung**, Seongnam-si (KR);  
**Il Gon Kim**, Seoul (KR)

(56) **References Cited**

(73) Assignee: **Samsung Display Co., Ltd.** (KR)

U.S. PATENT DOCUMENTS

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

2013/0321734 A1\* 12/2013 Won ..... **G02F 1/136286**  
349/43  
2015/0138479 A1 5/2015 Lee et al.

FOREIGN PATENT DOCUMENTS

(21) Appl. No.: **15/158,212**

JP 2015-036817 A 2/2015  
KR 10-2005-0000653 A 1/2005  
KR 10-2013-0084842 A 7/2013  
KR 10-2015-0014197 A 2/2015

(22) Filed: **May 18, 2016**

(65) **Prior Publication Data**

US 2017/0115523 A1 Apr. 27, 2017

\* cited by examiner

(30) **Foreign Application Priority Data**

Oct. 22, 2015 (KR) ..... 10-2015-0147612

Primary Examiner — Wen-Ying P Chen

(74) Attorney, Agent, or Firm — Innovation Counsel LLP

(51) **Int. Cl.**

**G02F 1/1343** (2006.01)  
**G02F 1/1333** (2006.01)  
**G02F 1/1339** (2006.01)  
**G02F 1/1335** (2006.01)  
**G02F 1/1368** (2006.01)  
**G02F 1/1362** (2006.01)

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

CPC ..... **G02F 1/133377** (2013.01); **G02F 1/1368** (2013.01); **G02F 1/13439** (2013.01); **G02F 1/133514** (2013.01); **G02F 1/134309**

(57) **ABSTRACT**

A liquid crystal display according to an exemplary embodiment of the present disclosure includes: a substrate; a pixel electrode disposed on the substrate; a roof layer facing the pixel electrode; a liquid crystal layer disposed in a plurality of microcavities between the pixel electrode and the roof layer; a partition disposed between adjacent microcavities among the plurality of microcavities; and a shielding electrode disposed between the substrate and the partition, wherein the shielding electrode is disposed on the same layer as the pixel electrode.

**18 Claims, 9 Drawing Sheets**

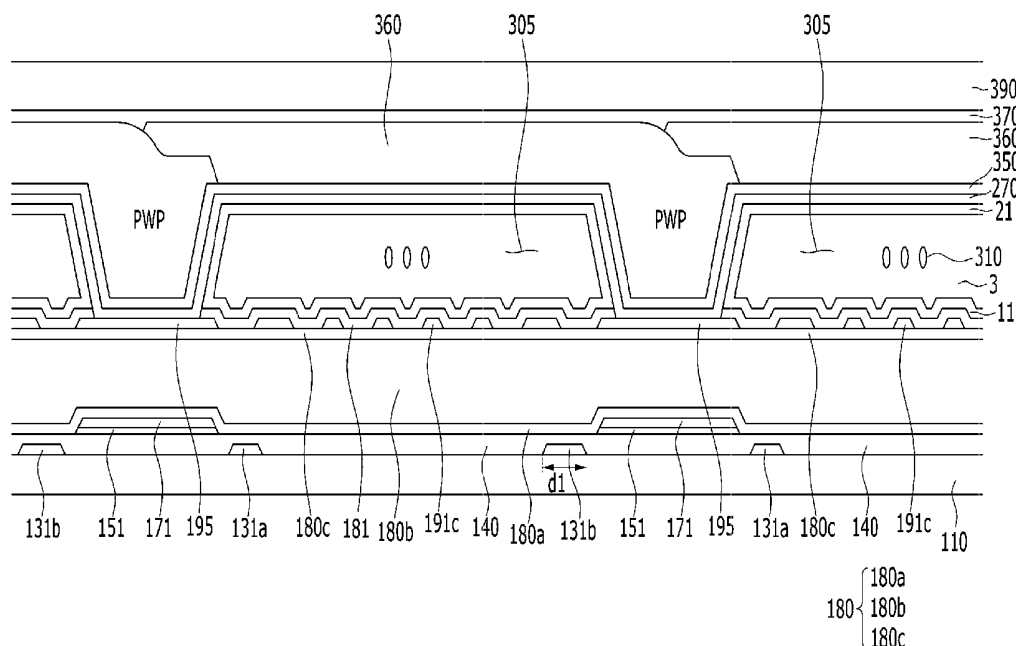


FIG. 1

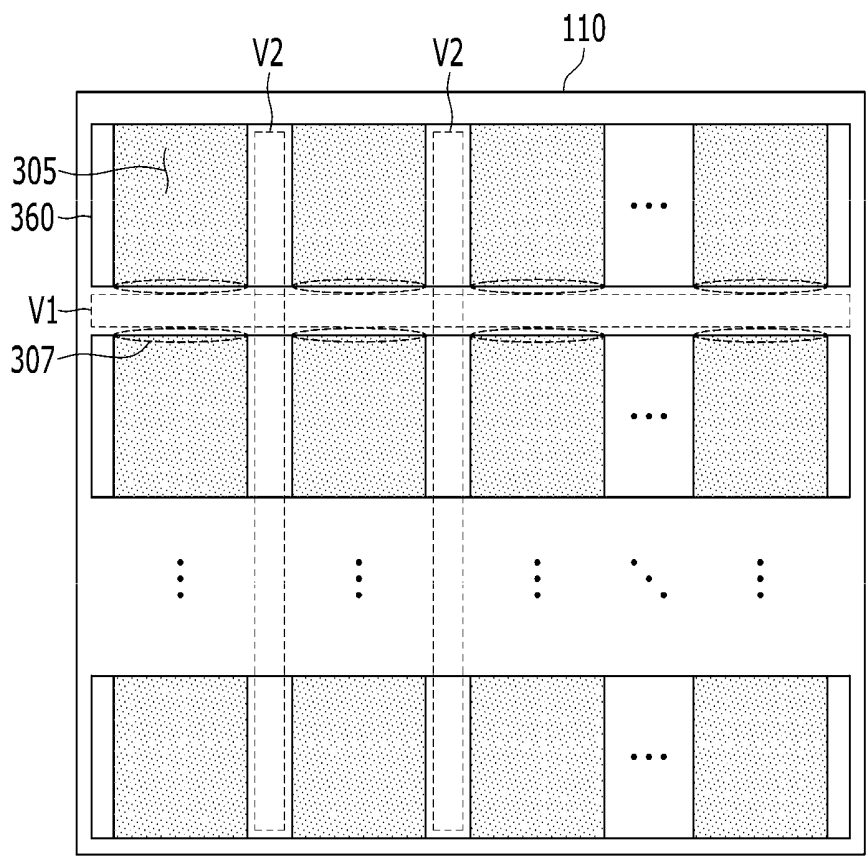


FIG. 2

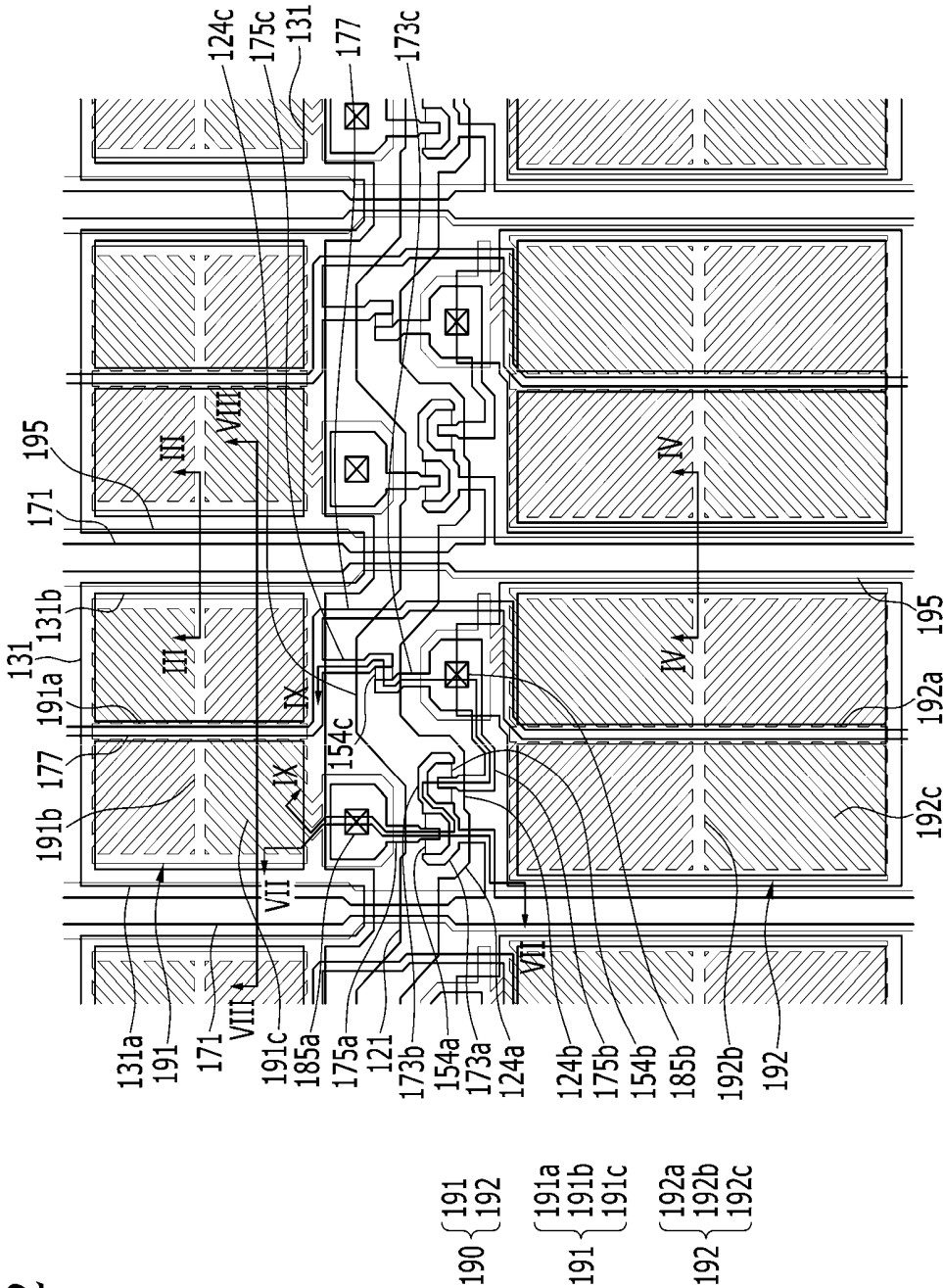


FIG. 3

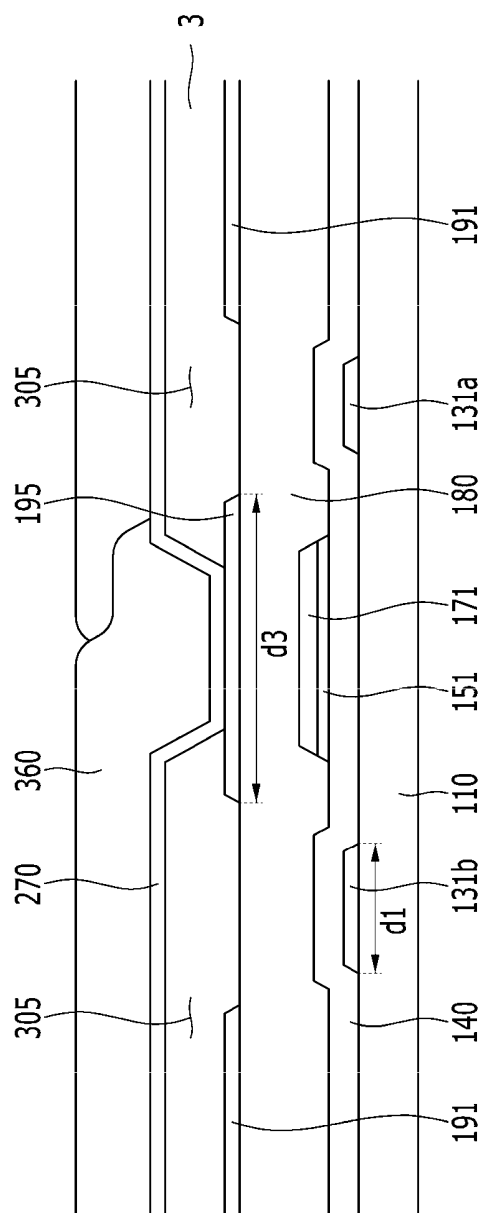


FIG. 4

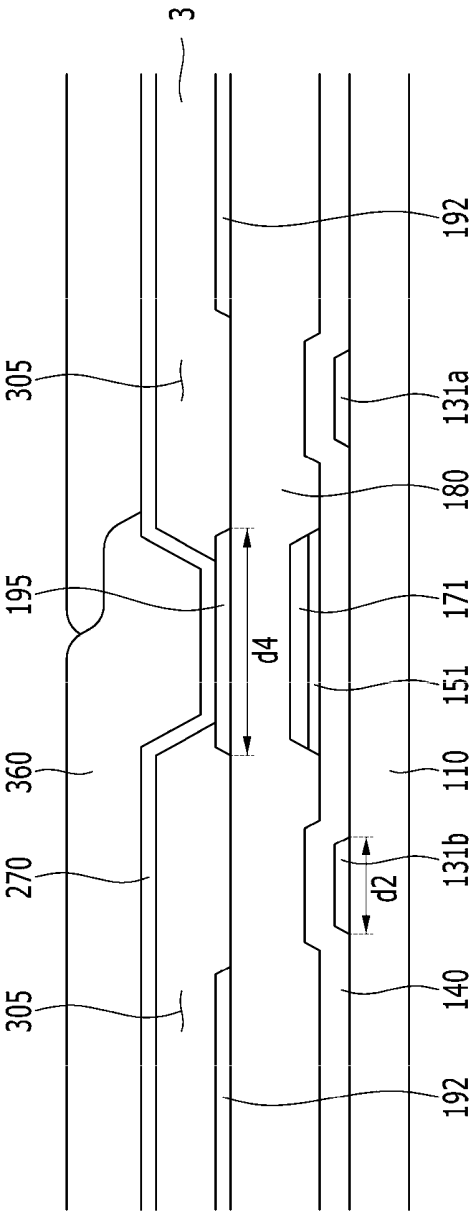


FIG. 5

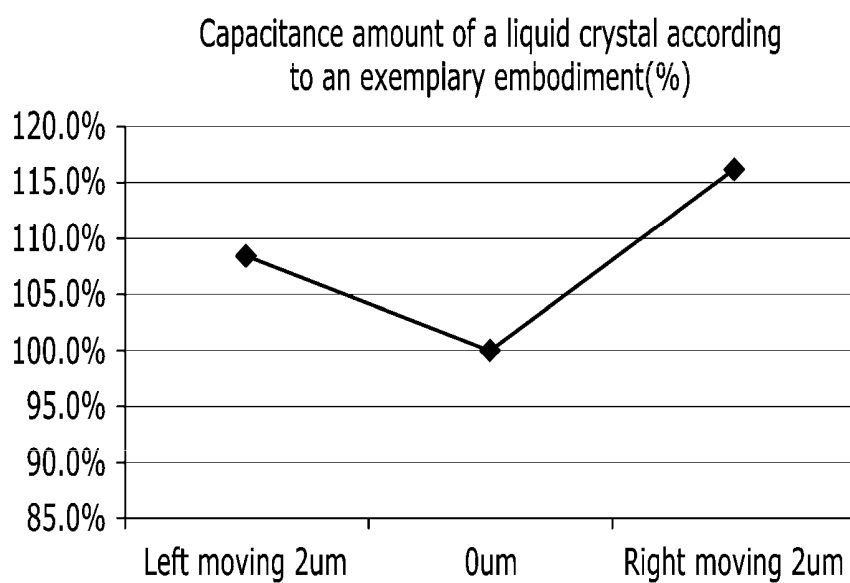


FIG. 6

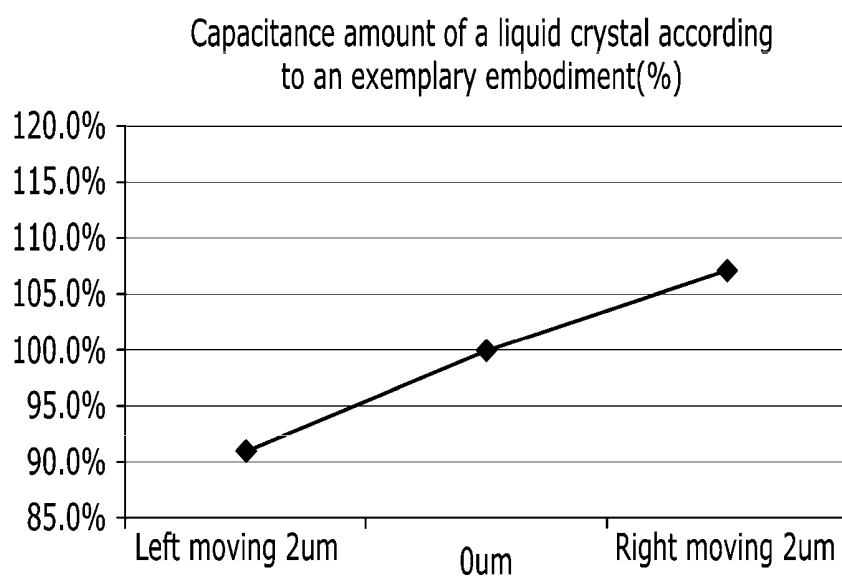


FIG. 7

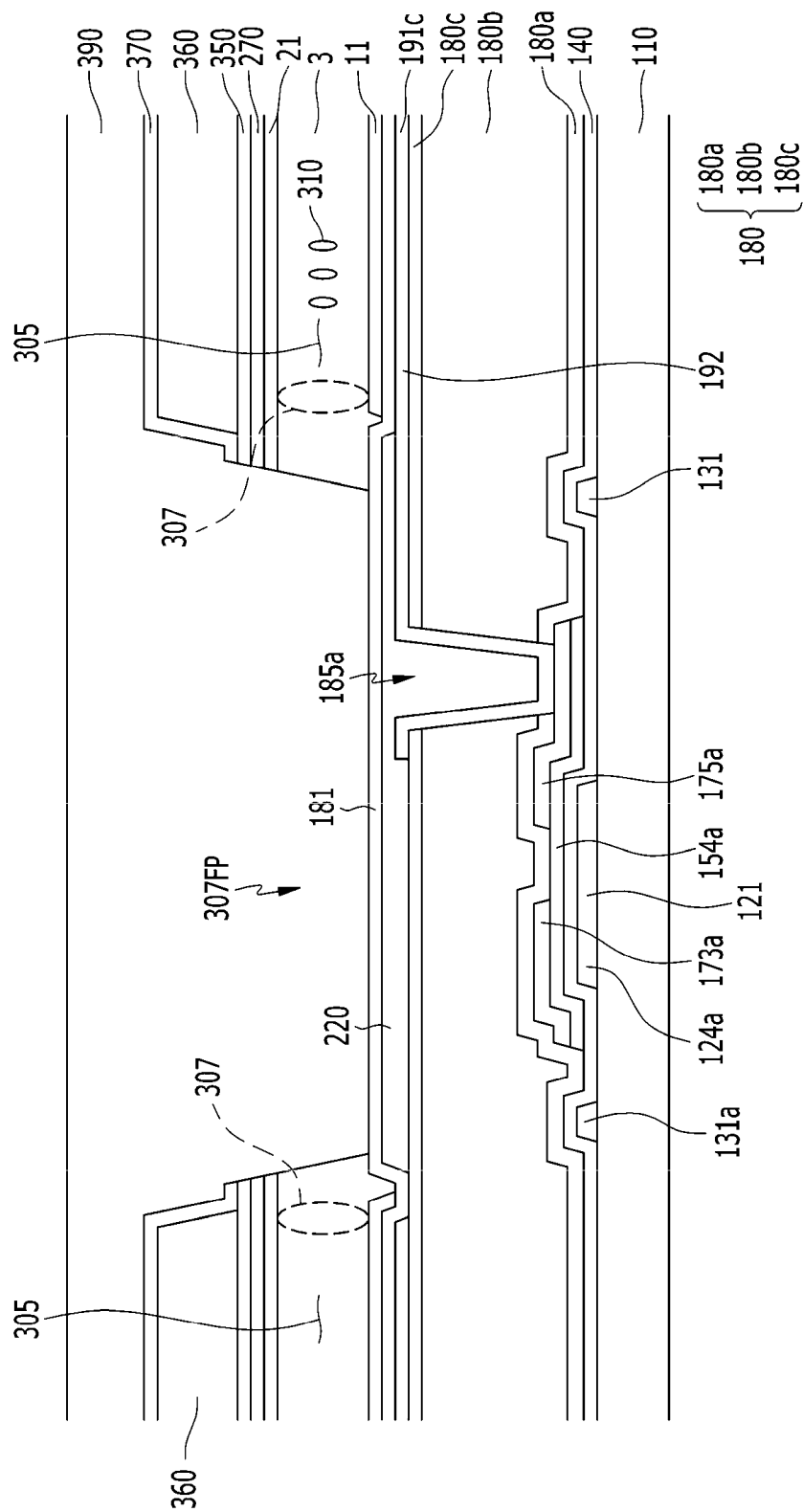


FIG. 8

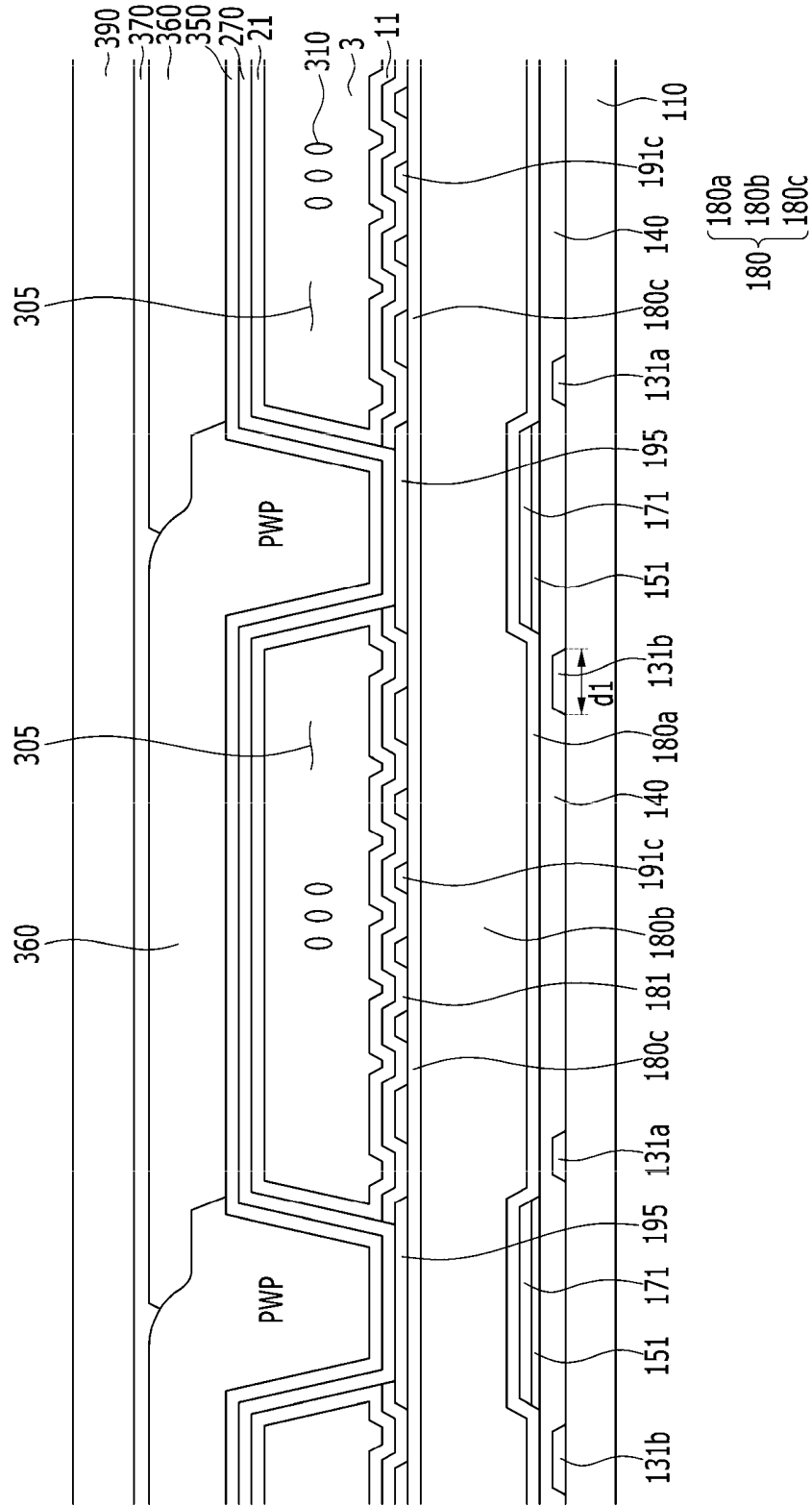
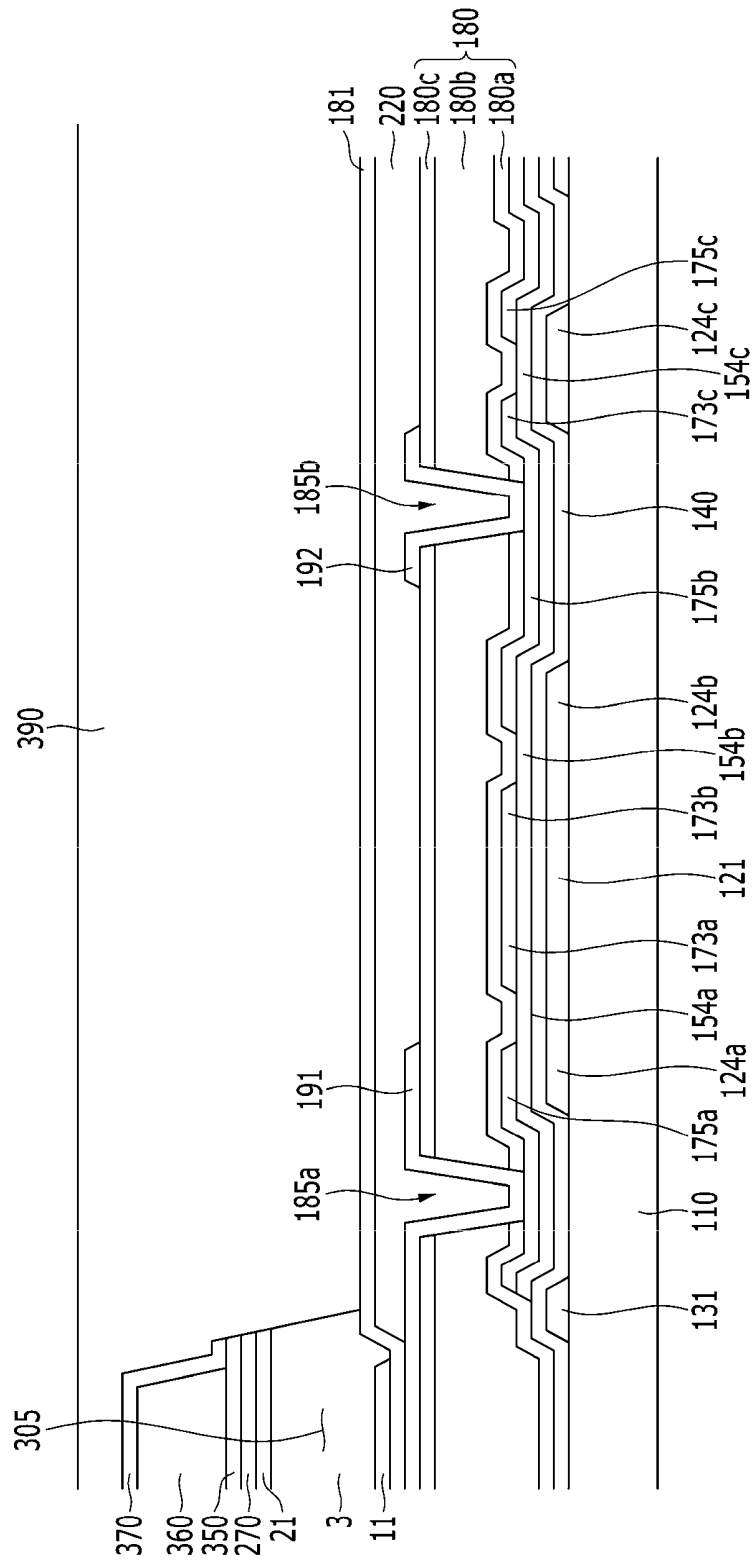


FIG. 9



**LIQUID CRYSTAL DISPLAY****CROSS-REFERENCE TO RELATED APPLICATION**

This application claims priority to and the benefit of Korean Patent Application No. 10-2015-0147612 filed in the Korean Intellectual Property Office on Oct. 22, 2015, the entire contents of which are incorporated herein by reference.

**BACKGROUND****(a) Field**

The present disclosure relates to a liquid crystal display.

**(b) Description of the Related Art**

A liquid crystal display is one of display devices that are widely used, and generally includes two substrates and a liquid crystal layer interposed therebetween.

The liquid crystal display displays an image by generating an electric field on a liquid crystal layer by applying a voltage to the electrodes disposed in the display panel including the substrate, determining alignments of liquid crystal molecules included in the liquid crystal layer, and controlling polarization of incident light.

As one among the liquid crystal displays, a technique realizing the display by forming a plurality of microcavities and injecting the liquid crystal material therein to form the liquid crystal layer has been developed. Unlike conventional liquid crystal displays which use two opposing substrates, this technique may reduce weight, thickness, and the like thereof by forming the liquid crystal displays on one substrate.

However, in the process forming the pixel electrode and the common electrode to generate the electric field on the liquid crystal layer, if the pixel electrode and the common electrode are misaligned, the liquid crystal capacitance may be changed.

The above information disclosed in this Background section is only for enhancement of understanding of the background of the disclosure and therefore it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

**SUMMARY**

Accordingly, the present disclosure provides a liquid crystal display reducing the change amount of the liquid crystal capacitance.

A liquid crystal display according to an exemplary embodiment of the present disclosure includes: a substrate; a pixel electrode disposed on the substrate; a roof layer facing the pixel electrode; a liquid crystal layer disposed in a plurality of microcavities between the pixel electrode and the roof layer; a partition disposed between adjacent microcavities among the plurality of microcavities; and a shielding electrode disposed between adjacent pixel electrodes, wherein the shielding electrode is disposed on the same layer as the pixel electrode.

The liquid crystal display may further include a common electrode disposed along one surface of the roof layer and the partition protruded toward the liquid crystal layer.

The common electrode may be disposed between a lower surface of the partition and the shielding electrode.

The width of the shielding electrode may be larger than the width of the common electrode contacting the shielding electrode.

The common electrode may contact the shielding electrode.

The partition may include the same material as the roof layer.

5 The partition may include a color filter.

The pixel electrode may include a first sub-pixel electrode and a second sub-pixel electrode, the shielding electrode may include a first shielding electrode adjacent to the first sub-pixel electrode and a second shielding electrode adjacent to the second sub-pixel electrode, and the width of the first shielding electrode may be different from that of the second shielding electrode.

The liquid crystal display may further include: a data line disposed on the substrate; and a first storage electrode line and a second storage electrode line disposed on a left side and a right side of the data line, respectively, wherein widths of the first storage electrode line and the second storage electrode line may be different from each other.

A liquid crystal display according to an exemplary embodiment of the present disclosure includes: a substrate; a roof layer facing the substrate; a liquid crystal layer disposed in a plurality of microcavities between the substrate and the roof layer; a partition disposed between adjacent microcavities among the plurality of microcavities; and a shielding electrode disposed between adjacent pixel electrodes, wherein a width of the shielding electrode is larger than the width of the lower surface of the partition.

The liquid crystal display may further include a common electrode disposed along one surface of the roof layer and the partition protruded toward the liquid crystal layer.

The common electrode may be disposed between the lower surface of the partition and the shielding electrode.

The common electrode may contact the shielding electrode.

35 The width of the shielding electrode may be larger than the width of the common electrode contacting the shielding electrode.

The partition includes the same material as the roof layer.

The partition may include a color filter.

40 The liquid crystal display may include a pixel electrode disposed on the substrate and including a first sub-pixel electrode and a second sub-pixel electrode, the shielding electrode may include a first shielding electrode adjacent to the first sub-pixel electrode and a second shielding electrode adjacent to the second sub-pixel electrode, and the width of the first shielding electrode and the width of the second shielding electrode may be different.

The liquid crystal display may include a pixel electrode disposed on the substrate, and the shielding electrode may be on the same layer as the pixel electrode.

55 The liquid crystal display may include: a data line disposed on the substrate; and a first storage electrode line and a second storage electrode line disposed on a left side and a right side of the data line, wherein widths of the first storage electrode line and the second storage electrode line may be different.

As described above, in the liquid crystal display according to an exemplary embodiment of the present disclosure, even if the arrangement between the pixel electrode and the common electrode is misaligned, the change amount of the liquid crystal capacitance may be reduced.

**BRIEF DESCRIPTION OF THE DRAWINGS**

FIG. 1 is a schematic top plan view of a liquid crystal display according to an exemplary embodiment of the present disclosure.

FIG. 2 is an enlarged view of a portion of FIG. 1.

FIG. 3 is a cross-sectional view taken along a line III-III of FIG. 2.

FIG. 4 is a cross-sectional view taken along a line IV-IV of FIG. 2.

FIG. 5 is a graph showing a change of a liquid crystal capacitance according to a comparative example.

FIG. 6 is a graph showing a change of a liquid crystal capacitance in a liquid crystal display according to an exemplary embodiment of the present disclosure.

FIG. 7 is a cross-sectional view taken along a line VII-VII of FIG. 2.

FIG. 8 is a cross-sectional view taken along a line VIII-VIII of FIG. 2.

FIG. 9 is a cross-sectional view taken along a line IX-IX of FIG. 2.

### DETAILED DESCRIPTION OF THE EMBODIMENTS

The present disclosure will be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the disclosure 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 present disclosure.

The drawings and description are to be regarded as illustrative in nature and not restrictive. Like reference numerals designate like elements throughout the specification.

Further, since sizes and thicknesses of constituent members shown in the accompanying drawings are arbitrarily given for better understanding and ease of description, the present disclosure is not limited thereto. In the drawings, the thickness of layers, films, panels, regions, etc., are exaggerated for clarity. In the drawings, for better understanding and ease of description, the thicknesses of some layers and areas are exaggerated.

Also, it will be understood that when an element such as a layer, film, region, or substrate is referred to as being "on" another element, it can be directly on the other element or intervening elements may also be present. In contrast, when an element is referred to as being "directly on" another element, there are no intervening elements present. In addition, the word "on" means positioning on or below the object portion, but does not essentially mean positioning on the upper side of the object portion based on a gravity direction.

In addition, unless explicitly described to the contrary, the word "comprise" and variations such as "comprises" or "comprising" will be understood to imply the inclusion of stated elements but not the exclusion of any other elements.

Further, in the specification, the word "in a plan view" means when an object portion is viewed from above, and the word "in a cross-section" means when a cross-section taken by vertically cutting an object portion is viewed from the side.

FIG. 1 is a schematic top plan view of a liquid crystal display according to an exemplary embodiment of the present disclosure.

Referring to FIG. 1, a liquid crystal display according to the present exemplary embodiment includes a plurality of microcavities 305 disposed between a substrate 110 and a plurality of roof layers 360. The microcavities 305 are formed in a manufacturing process, and are spaces in which

an alignment material and a liquid crystal material are injected to be an alignment layer and a liquid crystal layer that are described later.

A first region V1 is disposed between the roof layers 360 that are vertically adjacent as shown in FIG. 1 among the plurality of roof layers 360, and the roof layer 360 may not exist in the first region V1. The first region V1 may be covered by a capping layer that is described later or the liquid crystal material. An inlet part 307 is formed near the boundary of the first region V1 and the microcavities 305 to inject the alignment material and/or the liquid crystal material into the microcavities 305 before covering the first region V1 by the capping layer or the liquid crystal material. The inlet part 307 is covered by the capping layer or the liquid crystal material in the final structure. The inlet part 307 may be disposed on both edges of the microcavities 305. Here, both edges of the microcavities 305 may be portions facing each other in the direction that the second region V2 extends.

The plurality of roof layers 360 may be respectively elongated in the horizontal direction, and as shown in FIG. 1, a partition that is described later may be disposed in the second region V2 extending in the vertical direction. The partition has a function of defining the microcavities 305 adjacent to each other based on the second region V2. The partition may be a portion where the roof layer 360 is protruded in the direction toward the substrate 110. In other words, the partition may be made of the same material as and may be formed in one body with the roof layer 360. However, the partition structure is not limited thereto, and may be separately formed from the roof layer 360.

The structure of the above-described liquid crystal display according to an exemplary embodiment of the present disclosure is only one example and numerous variations may be possible. For example, the arrangement shape of the microcavities 305, the first region V1, and the second region V2 may be changed, and the plurality of roof layers 360 may be connected to each other in the first region V1. Also, the partition disposed in the second region V2 does not exist or partially exists such that a path connecting the microcavities 305 adjacent to each other based on the second region V2 may be formed.

Next, the liquid crystal display according to an exemplary embodiment of the present disclosure will be described with reference to FIG. 2 to FIG. 4.

FIG. 2 is an enlarged view of a portion of FIG. 1. FIG. 3 is a cross-sectional view taken along a line of FIG. 2. FIG. 4 is a cross-sectional view taken along a line IV-IV of FIG. 2.

FIG. 2 shows a two pixel areas arranged along the horizontal direction and this pixel area may be repeatedly arranged up, down, left, and right in the liquid crystal display according to an exemplary embodiment of the present disclosure.

Referring to FIG. 2 to FIG. 4, the liquid crystal display according to an exemplary embodiment of the present disclosure is disposed with a storage electrode line including a first storage electrode line 131a and a second storage electrode line 131b respectively disposed on a right side and a left side of a data line 171 on the substrate 110. The first and second storage electrode lines 131a and 131b may be connected to each other by a storage electrode 131 as shown in FIG. 2. The first and second storage electrode lines 131a and 131b may be disposed to be parallel to the data line 171.

In the present exemplary embodiment, a first width d1 of the second storage electrode line 131b disposed between a first sub-pixel electrode 191 which is a high pixel electrode

and the data line **171** of an adjacent pixel column shown in FIG. **3** is larger than a second width **d2** of the second storage electrode line **131b** disposed between a second sub-pixel electrode **192** which is a low pixel electrode and the data line **171** of the adjacent pixel column shown in FIG. **4**. The width of the first storage electrode line **131a** disposed between the first sub-pixel electrode **191** and the data line **171** of a present pixel column and the width of the first storage electrode line **131a** disposed between the second sub-pixel electrode **192** and the data line **171** of the present pixel column may be substantially the same as the second width **d2**.

A gate insulating layer **140** is disposed on the first and second storage electrode lines **131a** and **131b**, a semiconductor stripe layer **151** is disposed on the gate insulating layer **140**, and the data line **171** is disposed on the semiconductor stripe layer **151**.

A passivation layer **180** is disposed on the gate insulating layer **140** and the data line **171**, and a pixel electrode **190** including the first sub-pixel electrode **191** and a second sub-pixel electrode **192** is disposed on the passivation layer **180**. In the present exemplary embodiment, a shielding electrode **195** is disposed with the same layer as the first and second sub-pixel electrodes **191** and **192**. The shielding electrode **195** is disposed to be separated from the first sub-pixel electrode **191** and the second sub-pixel electrode **192**.

A common electrode **270** is disposed to face the first and second sub-pixel electrodes **191** and **192**. The common electrode **270** may be made of a transparent conductive material such as ITO or IZO. The plurality of microcavities **305** are disposed between the first and second sub-pixel electrodes **191** and **192** and the common electrode **270**, and a liquid crystal layer **3** is disposed in the plurality of microcavities **305**. The liquid crystal layer **3** includes the liquid crystal material.

The roof layer **360** is disposed on the common electrode **270**, and in the present exemplary embodiment, the roof layer **360** may be formed of a color filter. The roof layer **360** may be formed of a plurality of color filters, and each edge of the plurality of color filters may be overlapped on the portion corresponding to the data line **171**. In order to form the microcavities **305** adjacent to each other, the roof layer **360** may have a portion that is protruded in the direction toward the substrate **110**, and this protruded portion may form a partition PWP between adjacent microcavities **305**. The partition PWP may be made of the same material as the roof layer **360** and may be formed in one body.

In the present exemplary embodiment, the common electrode **270** may directly contact one surface of the roof layer **360** and the partition PWP. Also, the common electrode **270** may contact the shielding electrode **195** while being disposed between the partition PWP and the shielding electrode **195**.

In the present exemplary embodiment, a third width **d3** of the shielding electrode **195** disposed to be adjacent to the first sub-pixel electrode **191** shown in FIG. **3** is larger than a fourth width **d4** of the shielding electrode **195** disposed to be adjacent to the second sub-pixel electrode **192** shown in FIG. **4**. As described above, since the first width **d1** of the second storage electrode line **131b** disposed between the first sub-pixel electrode **191** and the data line **171** of the adjacent pixel column is larger than the second width **d2** of the second storage electrode line **131b** disposed between the second sub-pixel electrode **192** and the data line **171** of the adjacent pixel column, the change of the liquid crystal

capacitance which is caused by a misalignment of the pixel electrode **190** and/or the common electrode **270** may be optimally controlled.

In the present exemplary embodiment, it is preferable for the width of the shielding electrode **195** to be larger than the width of the common electrode **270** which contacts the shielding electrode **195**. In the liquid crystal display in which the liquid crystal layer **3** is disposed in the plurality of microcavities **305**, since the common electrode **270** extends from one surface of the roof layer **360** toward the liquid crystal layer **3** and is disposed along the side of the partition PWP which is protruded toward the liquid crystal layer **3**, when the misalignment between the pixel electrode **190** and/or the common electrode **270** is occurred, the change of the liquid crystal capacitance may be increased. However, in the present exemplary embodiment, since the shielding electrode **195** connected to the common electrode **270** is disposed between adjacent pixel electrodes **190**, the electric field between the common electrode **270** disposed on the side of the partition PWP and the pixel electrode **190** may be reduced. Accordingly, even if the misalignment of the pixel electrode **190** and/or the common electrode **270** is occurred, the change of the liquid crystal capacitance may be suppressed from being increased.

FIG. **5** is a graph showing a change of a liquid crystal capacitance according to a comparative example. FIG. **6** is a graph showing a change of a liquid crystal capacitance in a liquid crystal display according to an exemplary embodiment of the present disclosure. The comparative example of FIG. **5** shows the change of the liquid crystal capacitance when the pixel electrode is moved right or left by  $2\ \mu\text{m}$  with respect to the data line without the shielding electrode.

Referring to FIG. **5**, when there is no shielding electrode, if the pixel electrode is moved in the left direction or the right direction with reference to the data line, an increased amount of the capacitance between a portion of the common electrode disposed on the lateral surface of the partition and the pixel electrode is larger than an decreased amount of the capacitance between a portion of the common electrode disposed on the lateral surface of the partition and the pixel electrode within a pixel.

Referring to FIG. **6**, when the pixel electrode is moved left with respect to the data line **171**, the overlapping area of the shielding electrode **195** and the underlying storage electrode line **131b** is increased such that the capacitance between the common electrode disposed on the side of the partition and the pixel electrode is reduced, thereby reducing the liquid crystal capacitance. When the pixel electrode is moved right with respect to the data line, the overlapping area of the shielding electrode **195** and the storage electrode line **131a** is increased such that the capacitance effect between the common electrode disposed on the lateral surface of the partition and the pixel electrode may be reduced, however the shielding electrode exists between adjacent pixel electrodes **190** such that the change of the liquid crystal capacitance may be reduced by about 10% compared with the comparative example. Here, since the shielding electrode is formed of the same material in the same process as the pixel electrode, the shielding electrode may be moved along the moving of the pixel electrode.

In the exemplary embodiment of FIG. **6**, the misalignment of the pixel electrode is described, and since the capacitance is generated between the shielding electrode **195** and the pixel electrode **190** when the common electrode is moved to the right or the left with respect to the data line **171**, the change of the liquid crystal capacitance depending on the

capacitance effect between the common electrode disposed on the side of the partition and the pixel electrode may be reduced.

The liquid crystal display according to the present exemplary embodiment includes the shielding electrode between the adjacent pixel electrodes **195** such that the effect of the capacitance between the common electrode disposed on the side of the partition and the pixel electrode may be reduced.

Next, a thin film transistor structure and a pixel structure of the liquid crystal display according to an exemplary embodiment of the present disclosure will be described with reference to FIG. 2 and FIG. 7 to FIG. 9.

FIG. 7 is a cross-sectional view taken along a line VII-VII of FIG. 2. FIG. 8 is a cross-sectional view taken along a line VIII-VIII of FIG. 2. FIG. 9 is a cross-sectional view taken along a line IX-IX of FIG. 2.

Referring to FIG. 2 and FIG. 7 to FIG. 9, a gate line **121**, a first storage electrode line **131a**, a second storage electrode line **131b**, and a storage electrode **131** are formed on a substrate **110** made of transparent glass or plastic. The gate line **121** includes a first gate electrode **124a**, a second gate electrode **124b**, a third gate electrode **124c**, and a wide end (not shown) for connection with other layers or an external driving circuit.

The gate line **121**, the first storage electrode line **131a**, the second storage electrode line **131b**, and the storage electrode **131** may be formed of an aluminum-based metal such as aluminum (Al) or an aluminum alloy, a silver-based metal such as silver (Ag) or a silver alloy, a copper-based metal such as copper (Cu) or a copper alloy, a molybdenum-based metal such as molybdenum (Mo) or a molybdenum alloy, chromium (Cr), tantalum (Ta), and titanium (Ti). The gate line **121** may have a multilayer structure which includes at least two conductive layers having different physical properties.

The first storage electrode line **131a** and the second storage electrode line **131b** are respectively disposed between the pixel electrode **190** and the data line **171**. The first storage electrode line **131a** and the second storage electrode line **131b** may reduce signal interference between the pixel electrode **190** and the data line **171**, and the storage electrode **131** may reduce signal interference between the pixel electrode **190** and the gate line **121**.

The storage electrode **131** and the first and second storage electrode lines **131a** and **131b** are applied with a predetermined voltage such as a common voltage. The storage electrode **131** and the first and second storage electrode lines **131a** and **131b** have a structure enclosing the first sub-pixel electrode **191** and the second sub-pixel electrode **192** that are described later. In the present exemplary embodiment, the first width d1 of the second storage electrode line **131b** disposed between the first sub-pixel electrode **191** and the data line **171** of the adjacent pixel column may be larger than the width of the first storage electrode line **131a** disposed between the first sub-pixel electrode **191** and the data line **171** of the present pixel column. Also, the first width d1 of the second storage electrode line **131b** disposed between the first sub-pixel electrode **191** and the data line **171** of the adjacent pixel column may be larger than the width of the second storage electrode line **131b** disposed between the second sub-pixel electrode **192** and the data line **171** of the adjacent pixel column. The width of the first storage electrode line **131a** disposed between the second sub-pixel electrode **192** and the data line **171** of the present pixel column and the width of the second storage electrode line **131b** disposed between the second sub-pixel electrode **192** and the data line **171** is substantially the same as the width

of the first storage electrode line **131a** disposed between the first sub-pixel electrode **191** and the data line **171** of the present pixel column.

A gate insulating layer **140** is disposed on the gate line **121**. The gate insulating layer **140** may be made of a silicon nitride (SiNx) or a silicon oxide (SiOx). The gate insulating layer **140** may be made of a multilayer structure including at least two insulating layers having different physical properties. A first semiconductor layer **154a**, a second semiconductor layer **154b**, a third semiconductor layer **154c**, and a semiconductor stripe layer **151** are disposed on the gate insulating layer **140**. Each of the first semiconductor layer **154a**, the second semiconductor layer **154b**, and the third semiconductor layer **154c** may include a channel region. The semiconductor stripe layer **151** may be disposed under a data line **171** that is described later. A plurality of ohmic contacts (not shown) may be disposed on the first semiconductor layer **154a**, the second semiconductor layer **154b**, and the third semiconductor layer **154c**.

The second semiconductor layer **154b**, and the third semiconductor layer **154c**, a data conductor including a first source electrode **173a**, a second source electrode **173b**, a third source electrode **173c**, a first drain electrode **175a**, a second drain electrode **175b**, a third drain electrode **175c**, a data line **171** connected to the first source electrode **173a**, and a reference voltage line **177** connected to the third drain electrode **175c** is disposed on the first semiconductor layer **154a**.

The data conductor and the underlying semiconductor layer may be simultaneously formed by using one mask.

The data line **171** includes a wide end (not shown) for connection with other layers or an external driving circuit. The data line **171** may function as a light blocking member.

The data conductor is preferably made of a refractory metal such as copper, molybdenum, chromium, tantalum, and titanium, or alloys thereof, and may have a multilayer structure include the refractory metal layer (not shown) and a low resistance conductive layer (not shown).

The reference voltage line **177** is directly connected to the third drain electrode **175c**, and may be disposed while overlapping longitudinal stems **191a** and **192a** of the pixel electrode **190** that is described later. The reference voltage line **177** is disposed to overlap the longitudinal stems **191a** and **192a**, thereby preventing a reduction of the aperture ratio. A level of the voltage applied to the reference voltage line **177** may be higher than the level of the common voltage applied to the common electrode.

The first gate electrode **124a**, the first source electrode **173a**, and the first drain electrode **175a** form a first thin film transistor along with the first semiconductor layer **154a**, and the channel region of the thin film transistor is formed in the portion of the first semiconductor layer **154a** between the first source electrode **173a** and the first drain electrode **175a**. Similarly, the second gate electrode **124b**, the second source electrode **173b**, and the second drain electrode **175b** form a second thin film transistor along with the second semiconductor **154b** and the channel region of the thin film transistor is formed in the portion of the semiconductor portion **154b** between the second source electrode **173b** and the second drain electrode **175b**, and the third gate electrode **124c**, the third source electrode **173c**, and the third drain electrode **175c** form a third thin film transistor along with the third semiconductor **154c** and the channel region of the thin film transistor is formed in the portion of the semiconductor portion **154c** between the third source electrode **173c** and the third drain electrode **175c**.

A passivation layer **180** is disposed on the data conductor and the portion of the semiconductor layers **154a**, **154b**, and **154c** formed with the channel region. The passivation layer **180** includes a first passivation layer **180a**, a second passivation layer **180b**, and a third passivation layer **180c**.

The first passivation layer **180a** may include the inorganic material such as a silicon nitride (SiNx) and a silicon oxide (SiOx). The second passivation layer **180b** and the third passivation layer **180c** may be disposed on the first passivation layer **180a**. The second passivation layer **180b** may include the organic material, and the third passivation layer **180c** may include the inorganic material such as a silicon nitride

(SiNx) and a silicon oxide (SiOx). As one example of the second passivation layer **180b**, the second passivation layer **180b** is made of the organic material, thereby substantially flattening the surface having a step. Differently from the present exemplary embodiment, one or two among the first passivation layer **180a**, the second passivation layer **180b**, and the third passivation layer **180c** may be omitted.

The passivation layer **180** has contact holes **185a** and **185b** exposing the first drain electrode **175a** and the second drain electrode **175b**.

The pixel electrode **190** including the first sub-pixel electrode **191** and the second sub-pixel electrode **192** is disposed on the passivation layer **180**. The pixel electrode **190** may be made of the transparent conductive material such as ITO or IZO. The shielding electrode **195** is disposed on the portion overlapping the data line **171** on the passivation layer **180**. The shielding electrode **195** may be formed of the same material as the pixel electrode **190**. Also, the shielding electrode **195** may be disposed with the same layer as the pixel electrode **190**. The shielding electrode **195** includes a first shielding electrode disposed on the portion adjacent to the first sub-pixel electrode **191** and a second shielding electrode disposed on the portion adjacent to the second sub-pixel electrode **192**, and the width of the first shielding electrode and the width of the second shielding electrode may be different from each other. In this case, the width of the first shielding electrode may be larger than the width of the second shielding electrode.

The first sub-pixel electrode **191** and the second sub-pixel electrode **192** are adjacent in the vertical direction as shown in FIG. 2, and the entire shape is a quadrangle. The first sub-pixel electrode **191** and the second sub-pixel electrode **192** respectively include a crossed stem including longitudinal stems **191a** and **192a** and transverse stems **191b** and **192b** crossing the longitudinal stems **191a** and **192a**. Also, the pixel is divided into four sub-regions by the transverse stems **191b** and **192b** and the longitudinal stems **191a** and **192a**, and each sub-region includes a plurality of minute branches **191c** and **192c**.

The first sub-pixel electrode **191** and the second sub-pixel electrode **192** are physically and electrically connected to the first drain electrode **175a** and the second drain electrode **175b** through contact holes **185a** and **185b**, thereby receiving the data voltage from the first drain electrode **175a** and the second drain electrode **175b**. In this case, some of the data voltage applied to the second drain electrode **175b** is divided through the third drain electrode **175c**, and thus the voltage applied to the second subpixel electrode **190b** is smaller than that of the voltage applied to the first subpixel electrode **190a**.

However, the area of the second sub-pixel electrode **192** may be more than one time to less than two times the area of the first sub-pixel electrode **191**. In an exemplary embodiment of the present disclosure, it is preferable that the area

of the second sub-pixel electrode **192** may be more than 1 time to less than 1.5 times the area of the first sub-pixel electrode **191**.

The description of the above-described thin film transistor and the pixel electrode **190** is only one example, and the structure of the thin film transistor and the design of the pixel electrode may be changed to improve the lateral visibility.

A light blocking member **220** covering the region in which the thin film transistor is formed is disposed on the pixel electrode **190**. The light blocking member **220** according to the present exemplary embodiment may be formed along the direction in which the gate line **121** extends. The light blocking member **220** may be made of the material blocking the light.

A fourth passivation layer **181** may be disposed on the light blocking member **220**, and the fourth passivation layer **181** may cover the light blocking member **220** and extend on the pixel electrode **190**. As shown in FIG. 8, the fourth passivation layer **181** may not exist on the portion corresponding to the data line **171** such that a common electrode **270** that is described later and the shielding electrode **195** may be in contact. The fourth passivation layer **181** may be omitted.

A lower alignment layer **11** is formed on the pixel electrode **190**, and the lower alignment layer **11** may be a vertical alignment layer. The lower alignment layer **11**, which is a liquid crystal alignment layer, such as polyamic acid, polysiloxane, or polyimide, may be formed of any one among generally-used materials. Also, the lower alignment layer **11** may be a photo-alignment layer.

An upper alignment layer **21** is disposed 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**. The liquid crystal material including liquid crystal molecules **310** is injected into the microcavity **305**, and as shown in FIG. 7, the inlet parts **307** are disposed near both edges of the microcavities **305**. The inlet part **307** is a portion corresponding to the boundary of the trench region **307FP** covered by a capping layer **390** that is described later and the microcavities **305**. The alignment material and/or the liquid crystal material may be injected to the microcavities **305** through the inlet part **307**. In the present exemplary embodiment, the alignment material for the alignment layers **11** and **21** and the liquid crystal material including the liquid crystal molecules **310** may be injected into the microcavities **305** by using a capillary force.

As the microcavities **305** are divided in the vertical direction by the trench region **307FP** disposed at the portion overlapping the gate line **121** to form the plurality of microcavities **305**, the plurality of microcavities **305** may be formed along the column direction of the pixel electrode **190**, in other words, the vertical direction. Also, the microcavity **305** is divided in the horizontal direction by a partition portion PWP that will be described later, thereby forming the plurality of microcavities **305**, and a 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 correspond to each of the pixel areas or two or more pixel areas, and the pixel areas may correspond to the image display area.

The 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

at 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).

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

A roof layer 360 is disposed on the lower insulating layer 350. In the present exemplary embodiment, the roof layer 360 may be made of a color filter. As shown in FIG. 8, among the adjacent color filters, the color filter of one color may form the partition PWP. The partition PWP is disposed between the microcavities 305 adjacent in the horizontal direction. The partition PWP is a portion where the separated space of the microcavities 305 adjacent in the horizontal direction is filled. The partition PWP may be formed along the direction that the data line 171 extends.

In the present exemplary embodiment, the common electrode 270 may be disposed along one surface of the roof layer 360 and the partition PWP protruded toward the liquid crystal layer 3. Also, the common electrode 270 may be disposed between the lower surface of the partition PWP and the shielding electrode 195. In this case, the common electrode 270 and the shielding electrode 195 may be in contact. It is preferable that the width of the common electrode 270 contacting the shielding electrode 195 is larger than the width of the shielding electrode 195. In this case, the width of the common electrode 270 and the width of the shielding electrode 195 may be a distance of the common electrode 270 and the shielding electrode 195 in the direction substantially vertical to the direction that the data line 171 extends, as shown in FIG. 2 and FIG. 8.

The roof layer 360 that may be made of the plurality of color filters may have the structure in which the plurality of color filters overlaps on the edge portions over the partition PWP. The interface where the adjacent color filters meet may be disposed on the portion corresponding to the partition PWP.

In the present exemplary embodiment, the color filters 360 and the partition wall part PWP serve to support the microcavities 305 so that the microcavities 305 may maintain their shapes.

An upper insulating layer 370 is disposed on the roof layer 360. The upper insulating layer 370 may be made of a silicon nitride (SiNx) or a silicon oxide (SiOx). As shown in FIG. 7, the side of the roof layer 360 may be covered by the upper insulating layer 370.

A capping layer 390 is disposed on the upper insulating layer 370. The capping layer 390 is also disposed in a trench region 307FP and covers the inlet part 307 of the microcavities 305 exposed by the trench region 307FP. The capping layer 390 includes the organic material or the inorganic material. Here, the liquid crystal material is removed in the trench region 307FP, however the liquid crystal material that remains after being injected to the microcavities 305 may remain in the trench region 307FP.

In the present exemplary embodiment, the partition PWP is disposed between the microcavities 305 such that the generated stress may be reduced although the substrate 110 is bent and the degree that the cell gap is changed may be reduced.

While this disclosure has been described in connection with what is presently considered to be practical exemplary embodiments, it is to be understood that the invention 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 pixel electrode disposed on the substrate;
- a roof layer overlapping the pixel electrode;
- a liquid crystal layer disposed in a plurality of microcavities between the pixel electrode and the roof layer;
- a partition disposed between adjacent microcavities among the plurality of microcavities; and
- a shielding electrode disposed between the substrate and the partition,

wherein the shielding electrode is disposed on the same layer as the pixel electrode, and

wherein the pixel electrode comprises a first sub-pixel electrode and a second sub-pixel electrode, the shielding electrode comprises a first shielding electrode adjacent to the first sub-pixel electrode and a second shielding electrode adjacent to the second sub-pixel electrode, and a width of the first shielding electrode is different from a width of the second shielding electrode.

2. The liquid crystal display of claim 1, further comprising a common electrode disposed along one surface of the roof layer and the partition protruded toward the liquid crystal layer.

3. The liquid crystal display of claim 2, wherein the common electrode is disposed between a lower surface of the partition and the shielding electrode.

4. The liquid crystal display of claim 3, wherein the common electrode contacts the shielding electrode.

5. The liquid crystal display of claim 4, wherein the width of the shielding electrode is larger than the width of the common electrode contacting the shielding electrode.

6. The liquid crystal display of claim 1, wherein the partition comprises the same material as the roof layer.

7. The liquid crystal display of claim 1, wherein the partition comprises a color filter.

8. The liquid crystal display of claim 1, further comprising:

- a data line disposed on the substrate; and
- a first storage electrode line and a second storage electrode line disposed on a left side and a right side of the data line, respectively,

wherein the widths of the first storage electrode line and the second storage electrode line are different from each other.

9. A liquid crystal display comprising:

- a substrate;
- a roof layer facing the substrate;
- a liquid crystal layer disposed in a plurality of microcavities between the substrate and the roof layer;
- a partition disposed between adjacent microcavities among the plurality of microcavities; and
- a shielding electrode disposed between the substrate and the partition,

wherein a width of the shielding electrode is larger than a width of the lower surface of the partition.

10. The liquid crystal display of claim 9, further comprising

## 13

a common electrode disposed along one surface of the roof layer and the partition protruded toward the liquid crystal layer.

11. The liquid crystal display of claim 10, wherein the common electrode is disposed between the lower surface of the partition and the shielding electrode.

12. The liquid crystal display of claim 11, wherein the common electrode contacts the shielding electrode.

13. The liquid crystal display of claim 12, wherein the width of the shielding electrode is larger than the width of the common electrode contacting the shielding electrode.

14. The liquid crystal display of claim 9, wherein the partition comprises the same material as the roof layer.

15. The liquid crystal display of claim 9, wherein the partition comprises a color filter.

16. The liquid crystal display of claim 9, further comprising

a pixel electrode disposed on the substrate and including a first sub-pixel electrode and a second sub-pixel electrode,

## 14

the shielding electrode comprises a first shielding electrode adjacent to the first sub-pixel electrode and a second shielding electrode adjacent to the second sub-pixel electrode, and

the width of the first shielding electrode and the width of the second shielding electrode are different.

17. The liquid crystal display of claim 9, further comprising

a pixel electrode disposed on the substrate,

wherein the shielding electrode is disposed on the same layer as the pixel electrode.

18. The liquid crystal display of claim 9, further comprising:

a data line disposed on the substrate; and

a first storage electrode line and a second storage electrode line disposed on a left side and a right side of the data line, respectively,

wherein the widths of the first storage electrode line and the second storage electrode line are different.

\* \* \* \* \*

|                |                                                                                                                         |         |            |
|----------------|-------------------------------------------------------------------------------------------------------------------------|---------|------------|
| 专利名称(译)        | 液晶显示器                                                                                                                   |         |            |
| 公开(公告)号        | <a href="#">US9904087</a>                                                                                               | 公开(公告)日 | 2018-02-27 |
| 申请号            | US15/158212                                                                                                             | 申请日     | 2016-05-18 |
| [标]申请(专利权)人(译) | 三星显示有限公司                                                                                                                |         |            |
| 申请(专利权)人(译)    | 三星DISPLAY CO. , LTD.                                                                                                    |         |            |
| 当前申请(专利权)人(译)  | 三星DISPLAY CO. , LTD.                                                                                                    |         |            |
| [标]发明人         | LEE SUN HWA<br>JUNG KWANG CHUL<br>KIM IL GON                                                                            |         |            |
| 发明人            | LEE, SUN HWA<br>JUNG, KWANG-CHUL<br>KIM, IL GON                                                                         |         |            |
| IPC分类号         | G02F1/1343 G02F1/1362 G02F1/1368 G02F1/1335 G02F1/1339 G02F1/1333                                                       |         |            |
| CPC分类号         | G02F1/133377 G02F1/1368 G02F1/13439 G02F1/133514 G02F1/136286 G02F1/134309 G02F2001/136218 G02F1/136209 G02F2001/134345 |         |            |
| 优先权            | 1020150147612 2015-10-22 KR                                                                                             |         |            |
| 其他公开文献         | US20170115523A1                                                                                                         |         |            |
| 外部链接           | <a href="#">Espacenet</a> <a href="#">USPTO</a>                                                                         |         |            |

#### 摘要(译)

根据本公开的示例性实施例的液晶显示器包括：衬底；设置在基板上的像素电极；面对像素电极的顶层；设置在像素电极和顶层之间的多个微腔中的液晶层；设置在所述多个微腔中的相邻微腔之间的隔壁；以及设置在所述基板和所述隔板之间的屏蔽电极，其中所述屏蔽电极设置在与所述像素电极相同的层上。

