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(54) **TRANSFLECTIVE LIQUID CRYSTAL
DISPLAY AND MANUFACTURING METHOD
THEREOF**

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G02F 1/1335 (2006.01)

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(58) **Field of Classification Search** 349/106,
349/114

See application file for complete search history.

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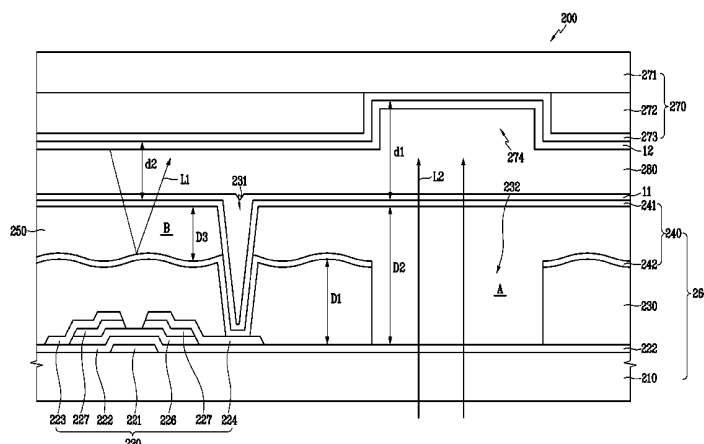
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(57) **ABSTRACT**

The present invention provides a transflective liquid crystal display having reflection regions and transmission regions, including a first substrate, a light transmissive layer formed on the first substrate and having recessed portions corresponding to the transmission regions, color filters formed on the light transmissive layer and having a position-dependent thickness due to the recessed portions of the light transmissive layer, transparent electrodes formed on the first substrate, reflective electrodes disposed on the reflection regions and interposed between the light transmissive layer and the color filters, a second substrate, a common electrode formed on the second substrate, and a liquid crystal layer interposed between the first substrate and the second substrate.

20 Claims, 16 Drawing Sheets



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FIG. 1

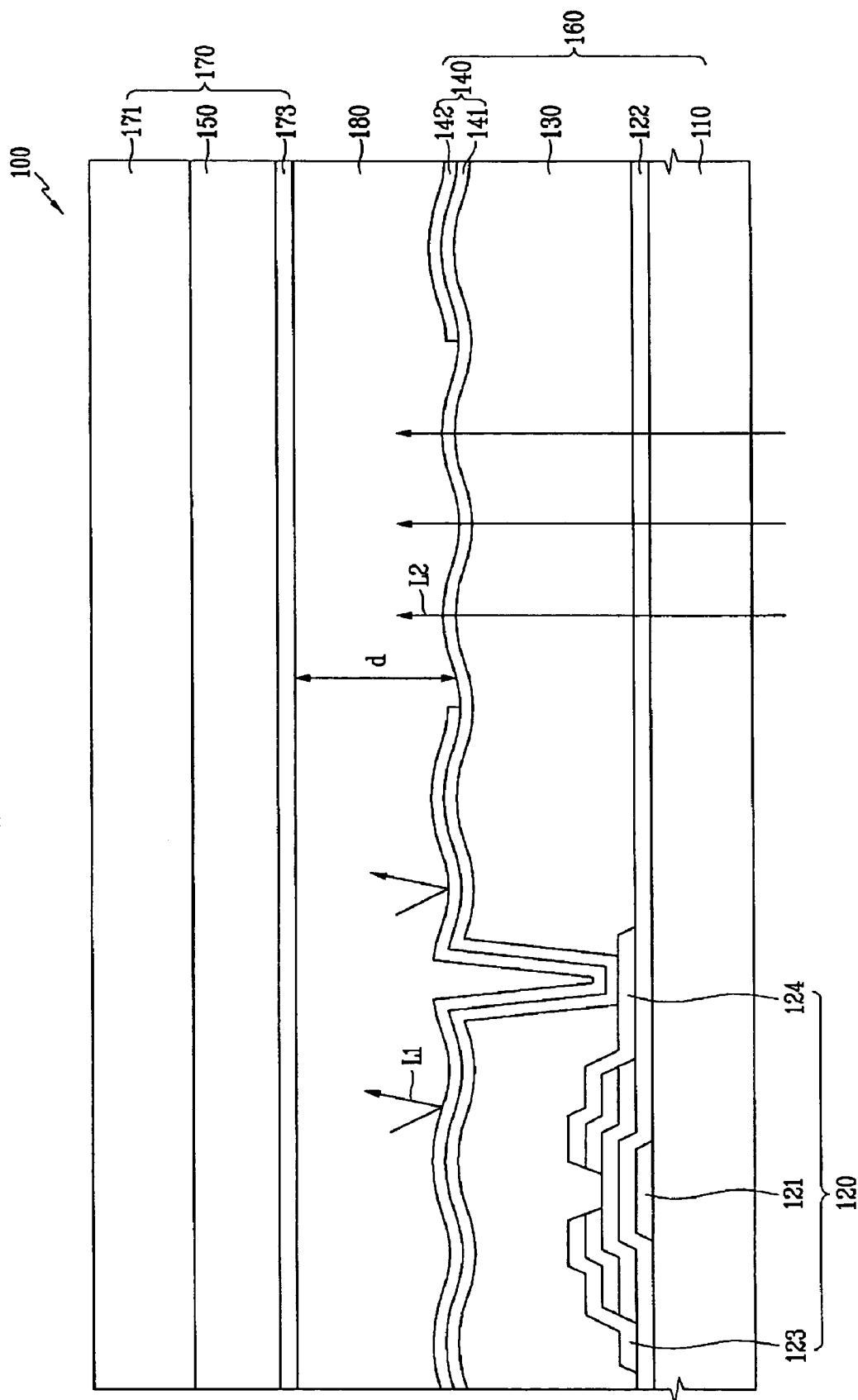


FIG. 2

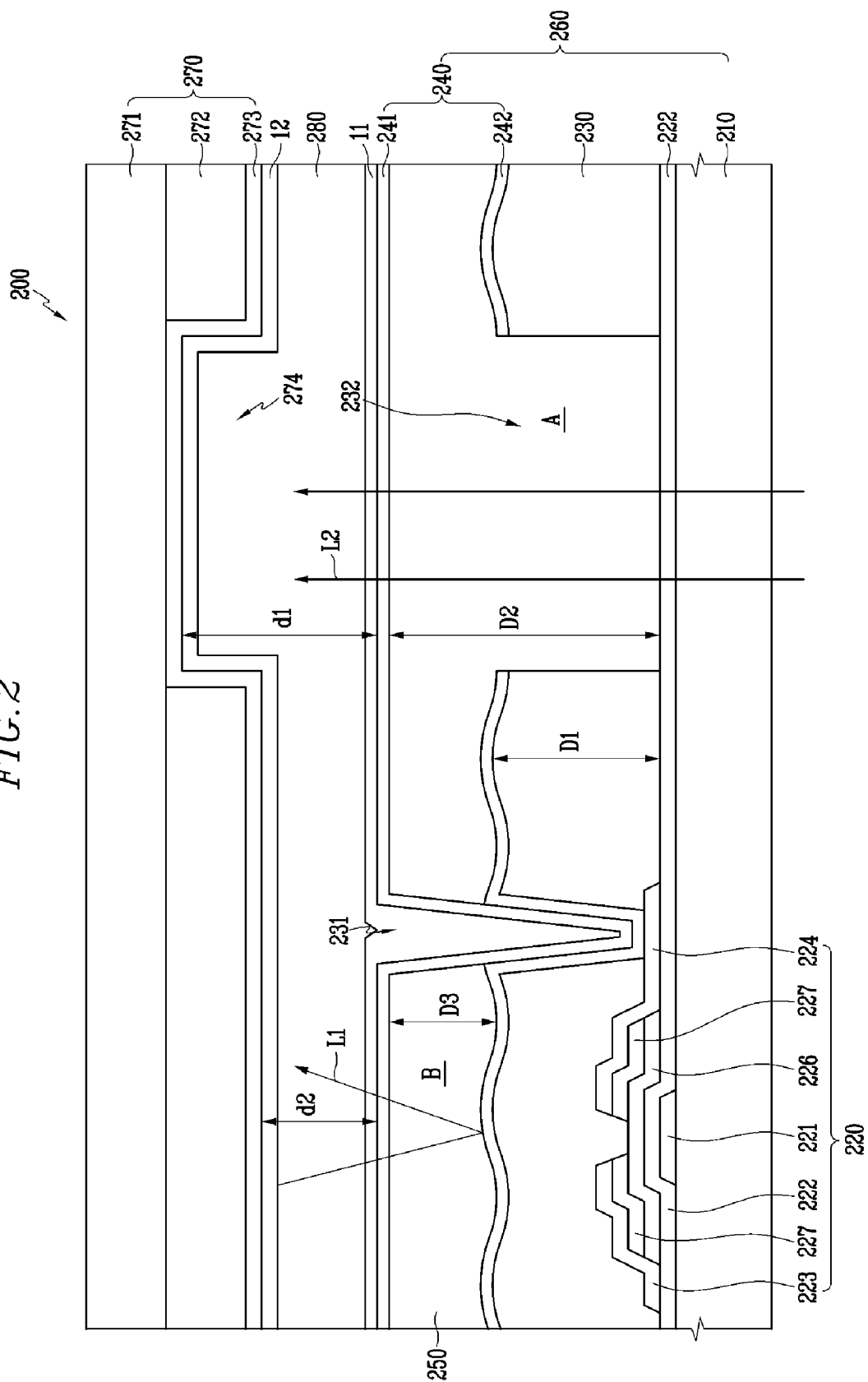


FIG. 3

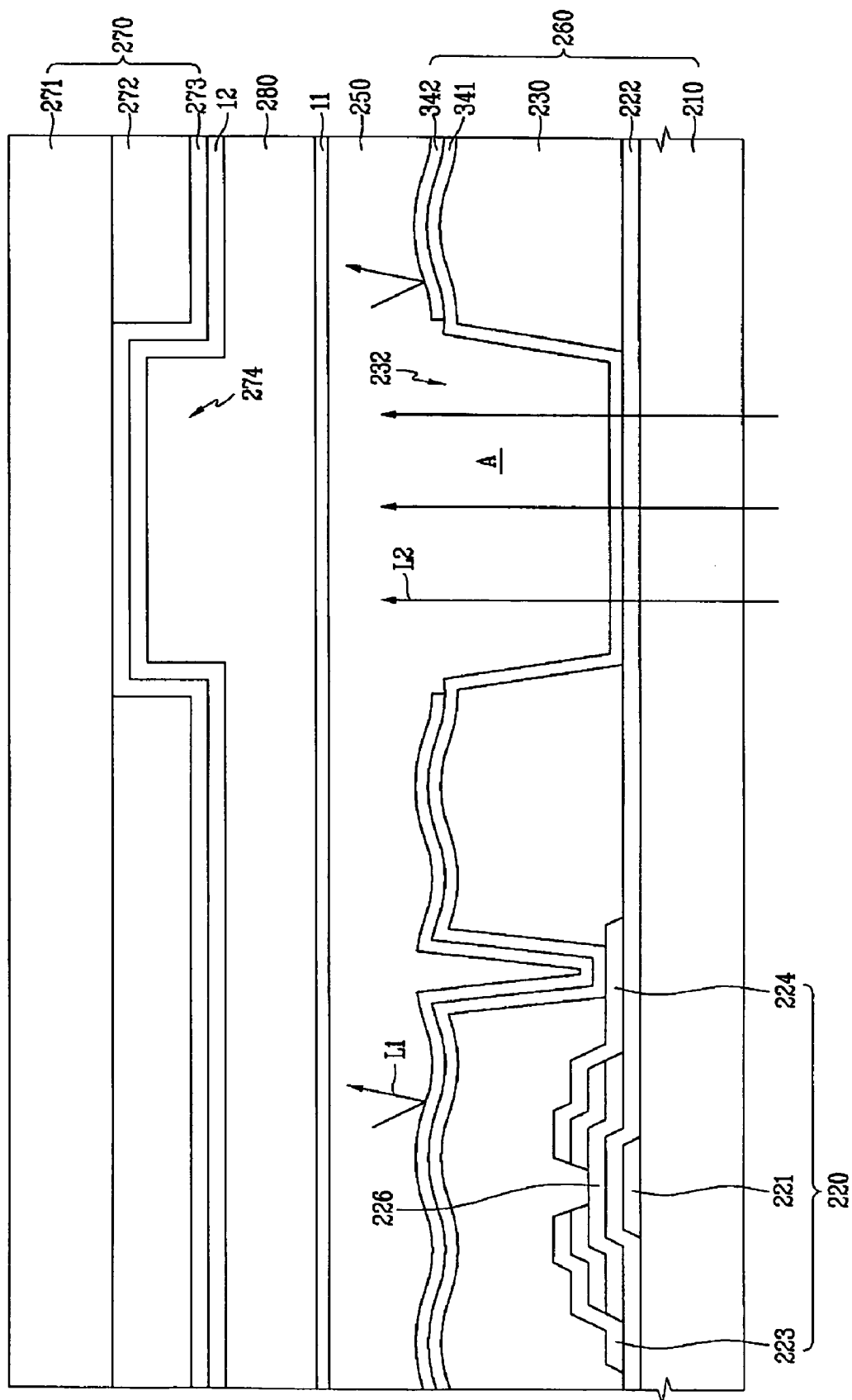


FIG. 5A

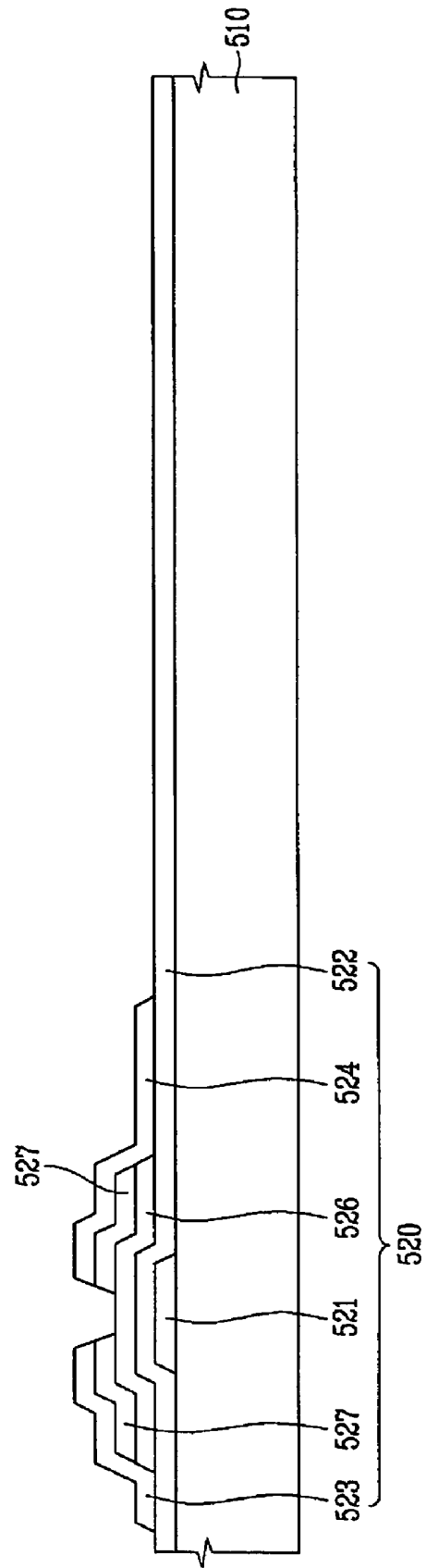


FIG. 5B

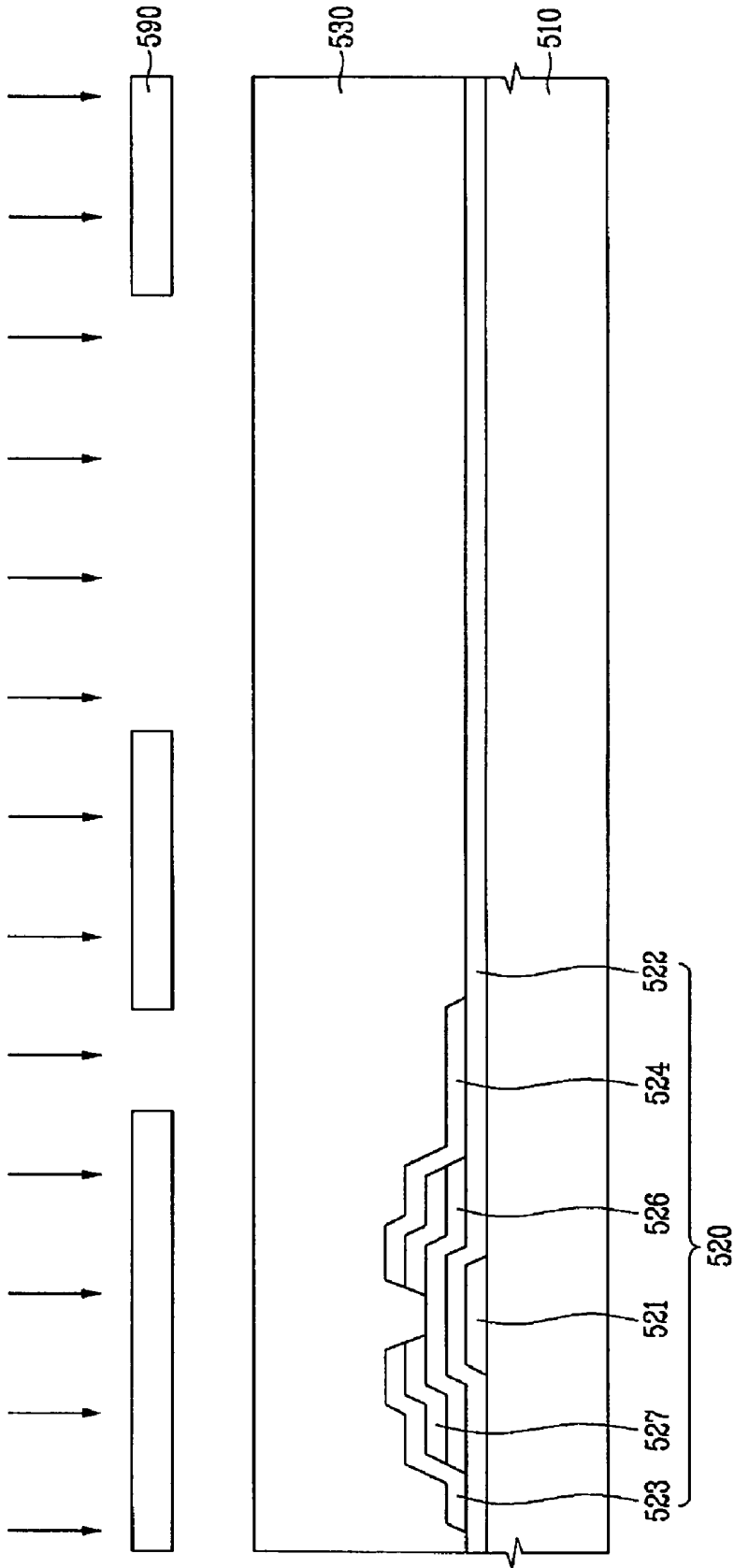


FIG. 5C

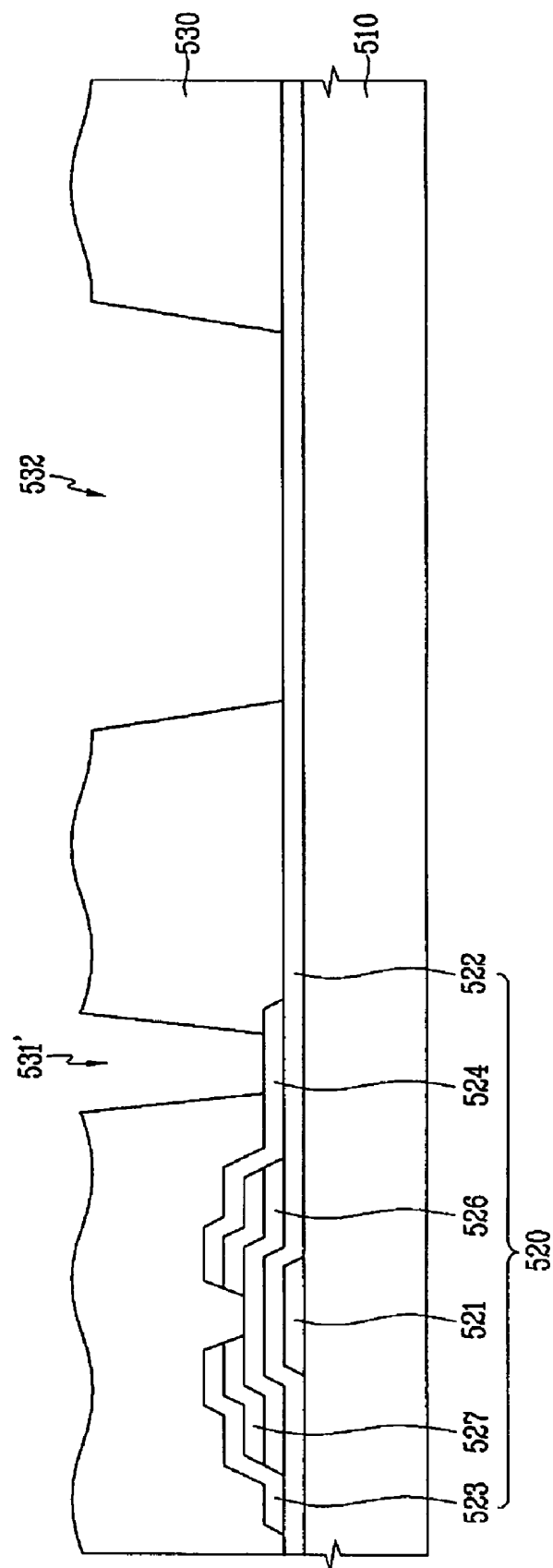


FIG. 5D

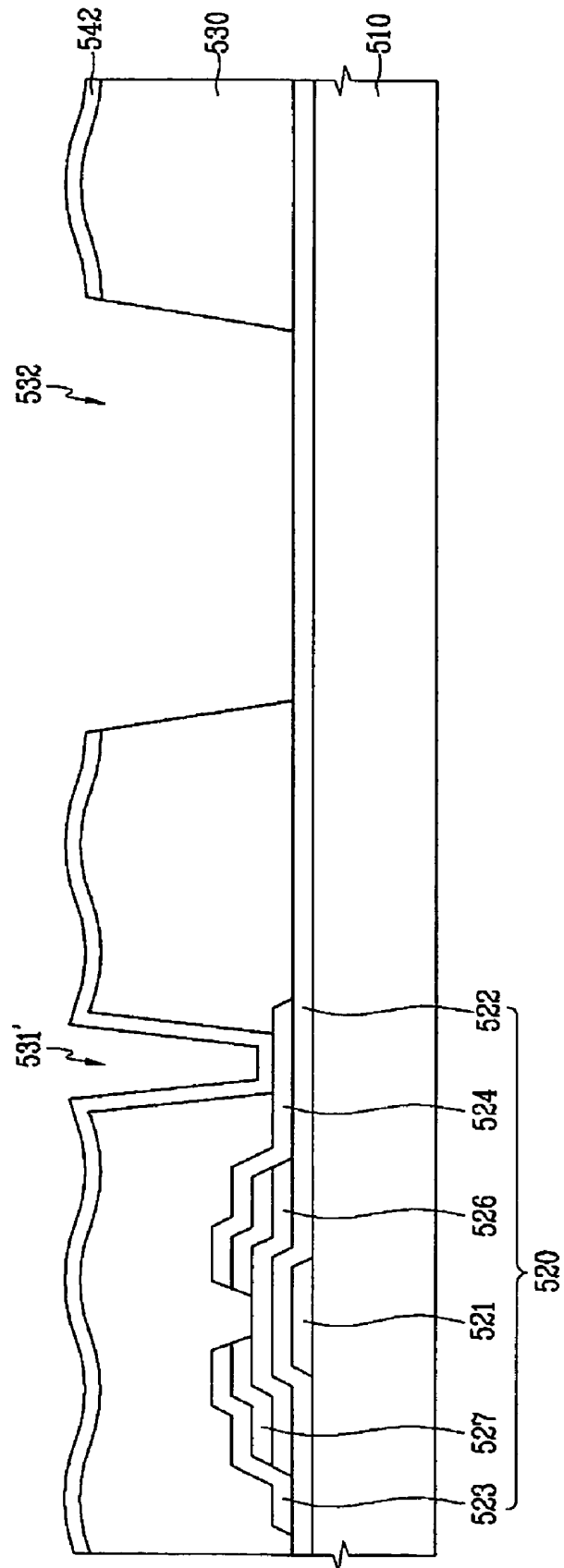


FIG. 5E

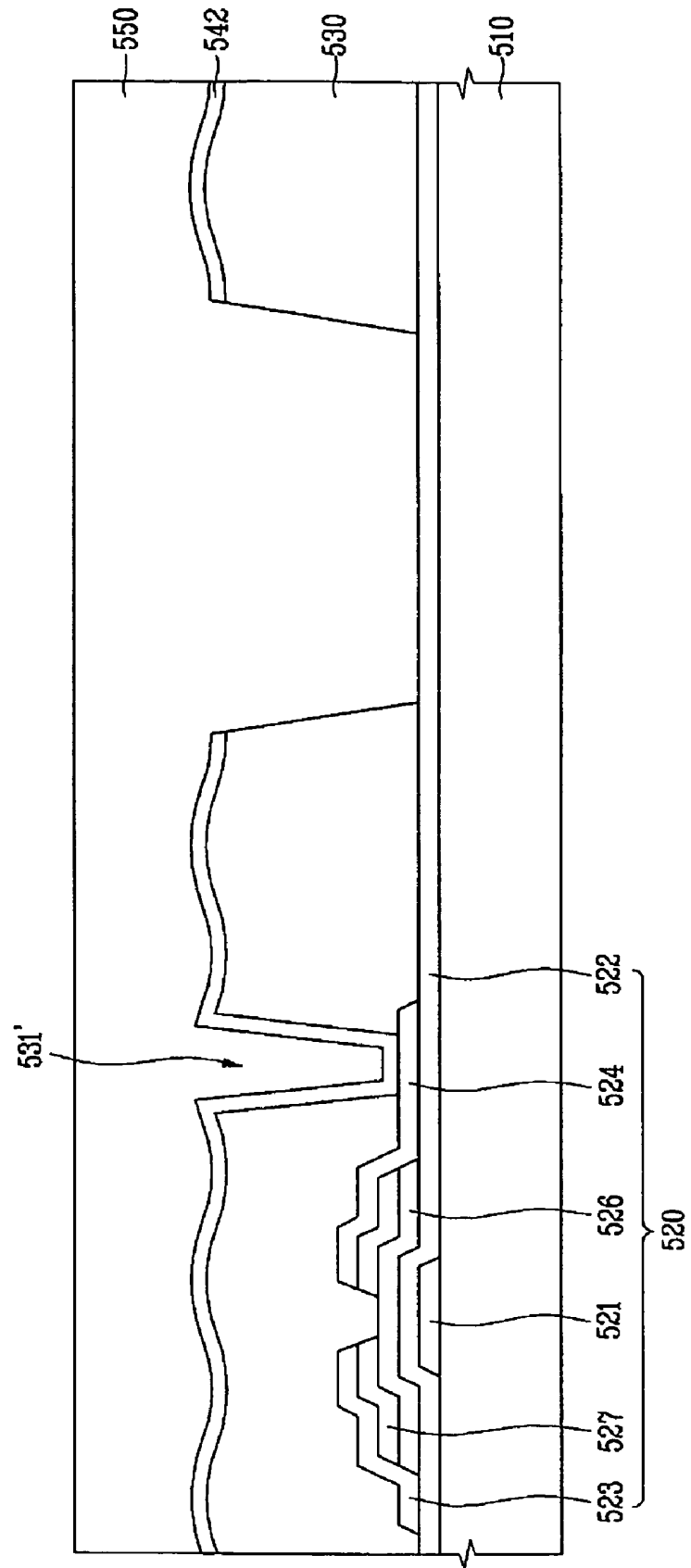


FIG. 5F

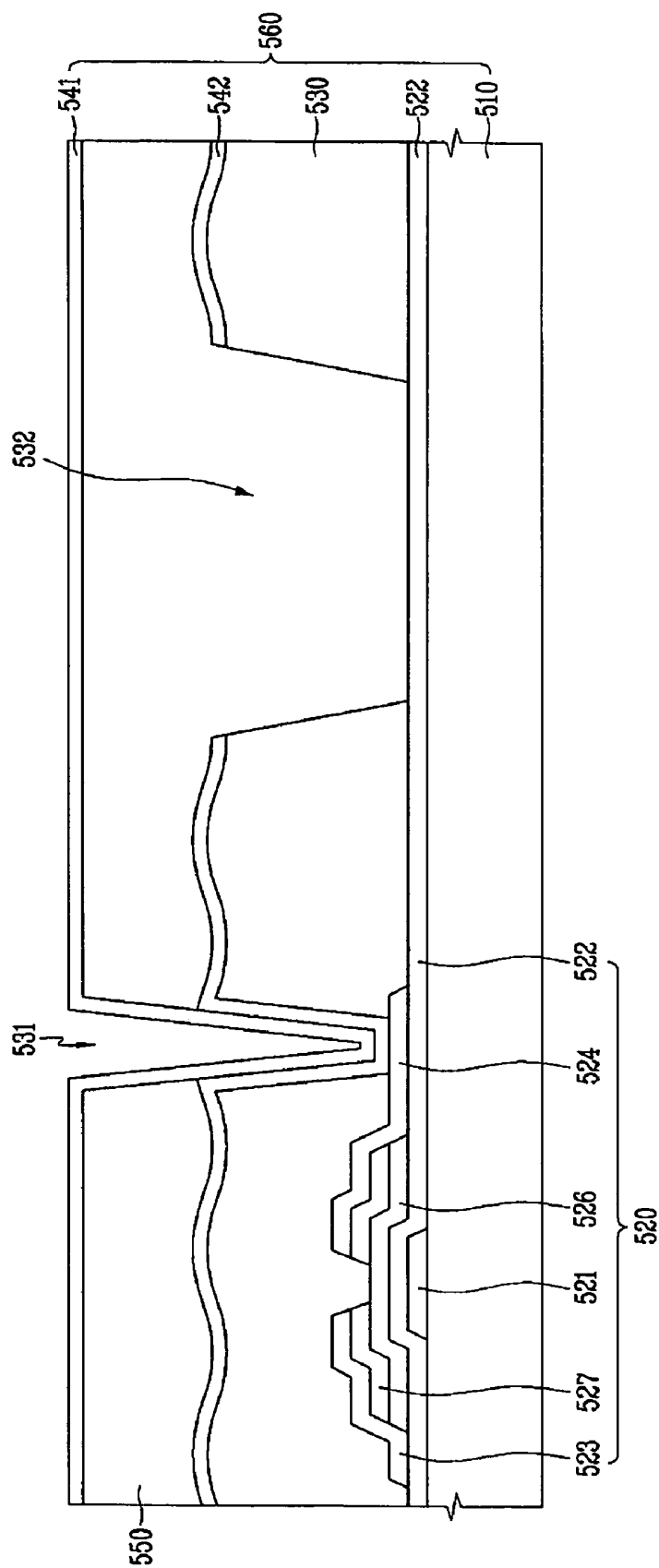


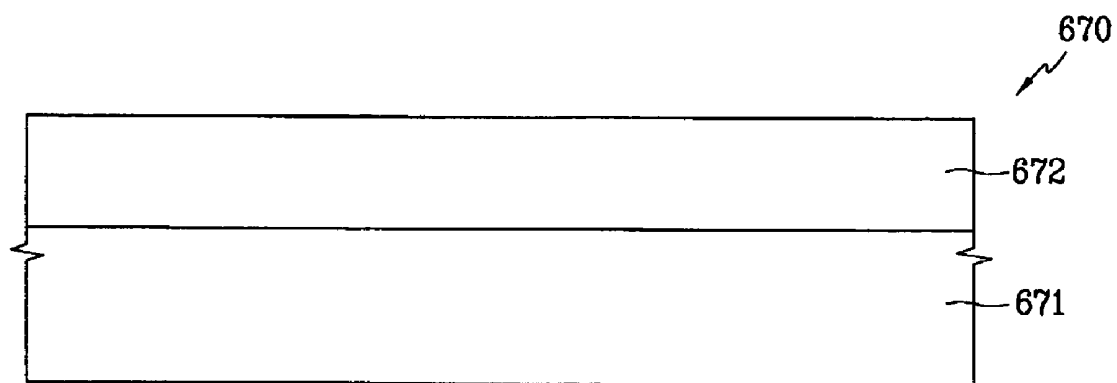
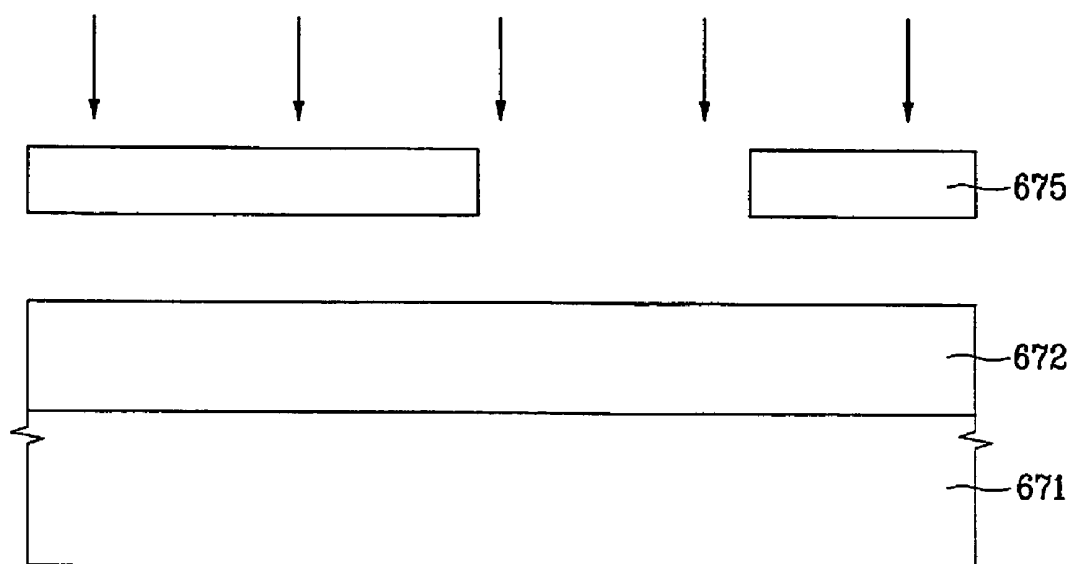
FIG. 6A*FIG. 6B*

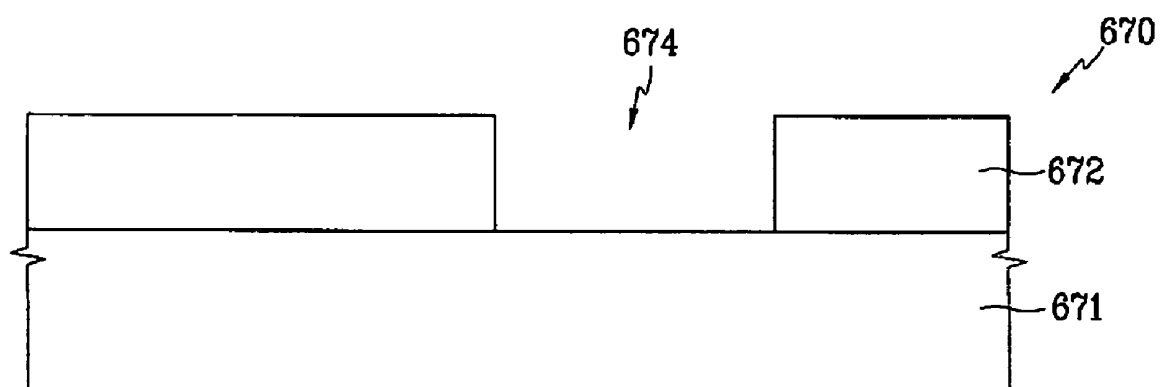
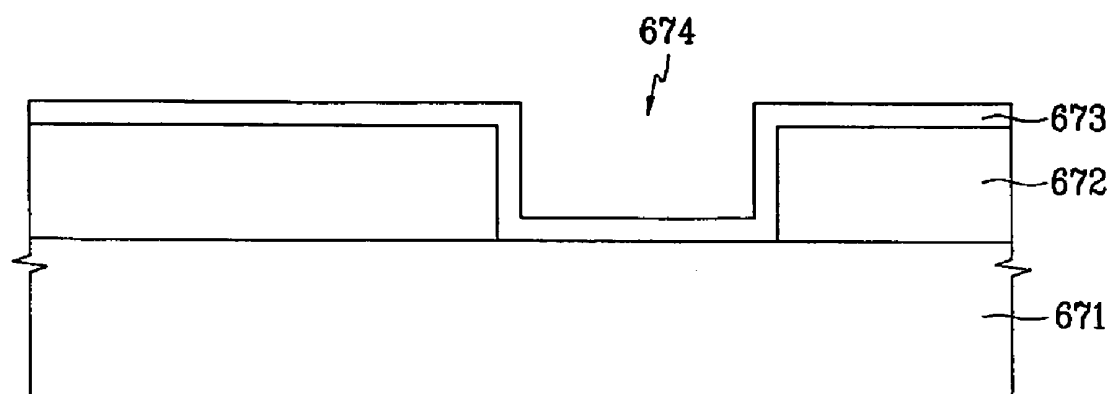
FIG. 6C*FIG. 6D*

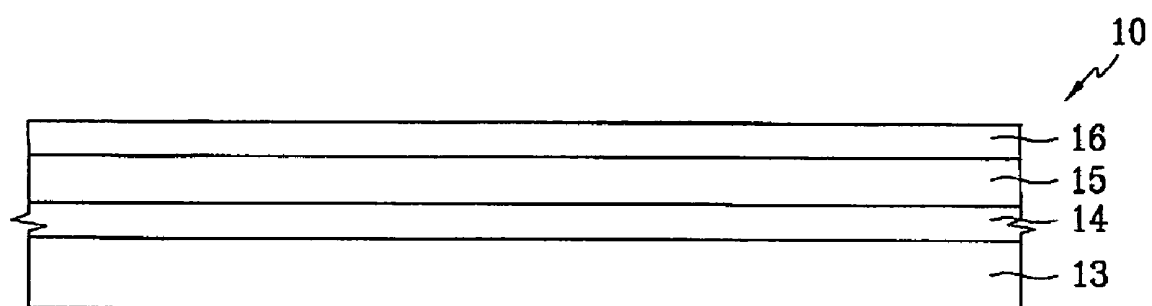
FIG. 7

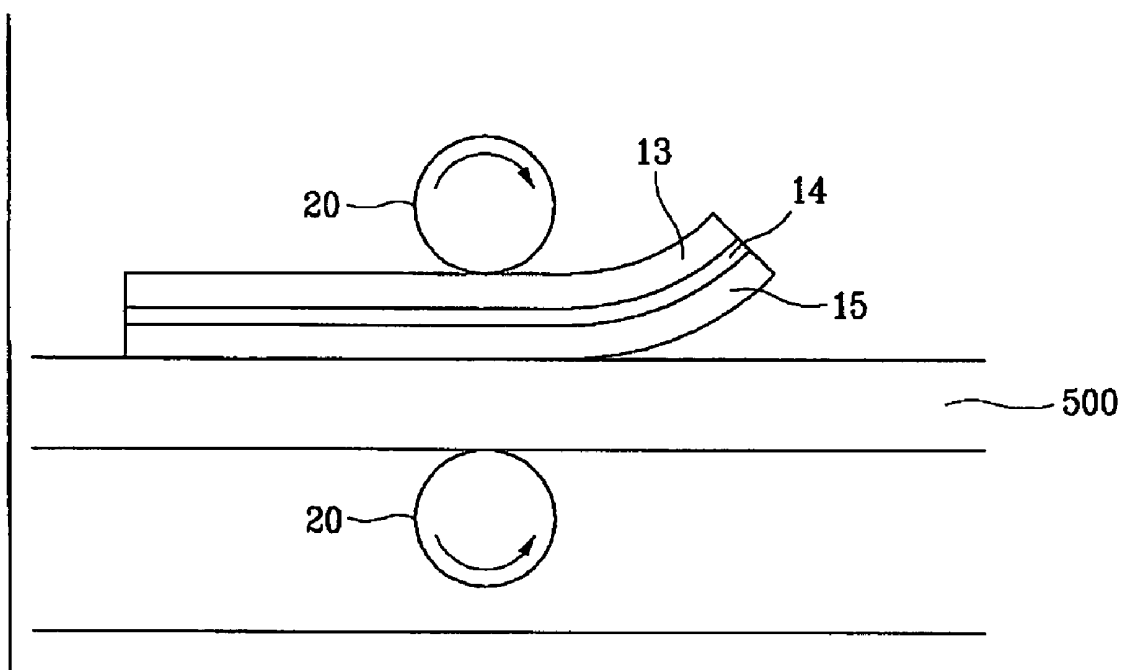
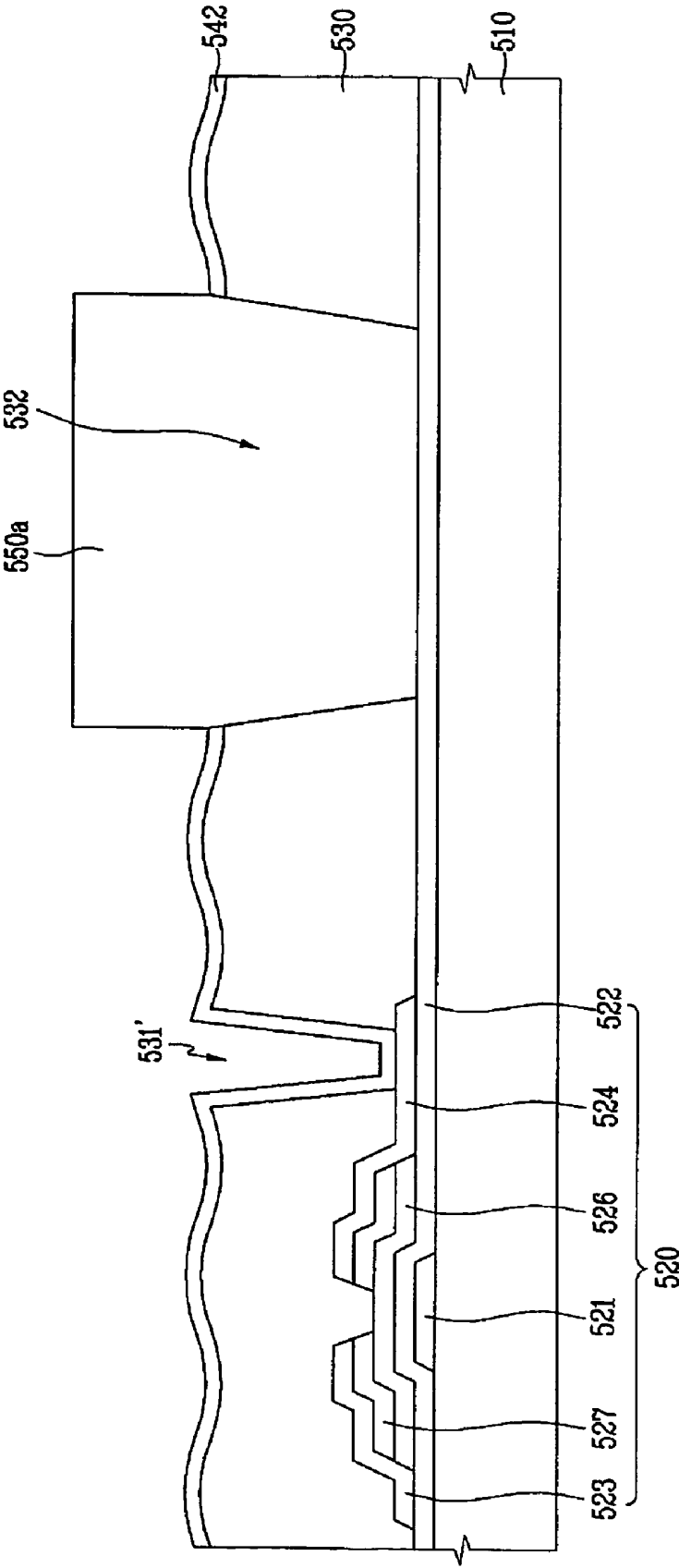
FIG. 8

FIG. 9A



TRANSFLECTIVE LIQUID CRYSTAL DISPLAY AND MANUFACTURING METHOD THEREOF

BACKGROUND OF THE INVENTION

(a) Field of the Invention

The present disclosure relates to a transflective liquid crystal display (LCD) and a manufacturing method thereof.

(b) Description of Related Art

LCDs are classified into a transmissive LCD and a reflective LCD according to the light source. The transmissive LCD has a backlight as the light source, while the reflective LCD uses external light as the light source.

A transflective LCD which uses both a backlight and external light as the light source is also under development. The transflective LCD has merits of both the transmissive LCD and the reflective LCD. The merits of the reflective LCD are low power consumption and good visibility in a bright environment, and merits of the transmissive LCD are good visibility in a dark environment such as an indoor situation. Accordingly, the transflective LCD can be used regardless of brightness of the environment, and is useful for a mobile display due to its low power consumption.

FIG. 1 is a sectional view of a conventional transflective LCD.

Referring to FIG. 1, a conventional transflective LCD 100 has a thin film transistor (TFT) array panel 160 having a plurality of TFTs, a color filter array panel 170 facing the TFT array panel 160 and having a plurality of color filters 150 and a common electrode 173, and a liquid crystal layer 180 interposed between the two panels 160 and 170.

The TFT array panel 160 has a first insulating substrate 110, a plurality of TFTs 120, a plurality of pixel electrodes 140 composed of transparent electrodes 141 and reflective electrodes 142 and connected to the TFTs 120, and an organic insulating layer 130 interposed between the TFTs 120 and the pixel electrodes 140. Each TFT 120 includes a gate electrode 121, a source electrode 123 and a drain electrode 124.

The area of each pixel electrode 140 is classified as a reflection region B where the reflective electrode 142 is disposed, and a transmission region A where the transparent electrode 141 is disposed.

The color filter array panel 170 has a second insulating substrate 171, a plurality of color filters 150 formed on the second substrate 171, and a common electrode 173 covering the color filters 150.

Such a transflective LCD has two different modes of operation: a transmission mode and a reflection mode. In the reflection mode, images are displayed by using external light L1 that is introduced through the color filter array panel 170 and is reflected back at the reflective electrode 142. In the transmission mode, images are displayed by using a back light (L2) that comes from a back light unit disposed on the back side of the TFT array panel 160 and passes out of the TFT array panel 160, the liquid crystal layer 180, and the color filter array panel 170.

In the reflection mode, the external light L1 passes through the color filter 150 twice to display an image, but in the transmission mode, the back light L2 passes through the color filter 150 just once to display an image. Accordingly, a difference in color reproduction is induced between the two modes.

Furthermore, in the reflection mode, the external light (L1) passes through the liquid crystal layer 180 twice so the length of light passage in the liquid crystal layer 180 is 2d. However, in the transmission mode, the back light L2 passes through the

liquid crystal layer 180 just once so the length of light passage in the liquid crystal layer 180 is d. Such a difference of light passage length induces a difference of optical characteristics between the two modes.

SUMMARY OF THE INVENTION

The present invention provides a transflective LCD having minimal discrepancy in color reproduction between the transmission mode and the reflection mode, and a manufacturing method of the same.

The present invention provides a transflective LCD having minimal discrepancy in optical characteristics between the transmission mode and the reflection mode, and a manufacturing method of the same.

In detail, the present invention provides a transflective liquid crystal display having reflection regions and transmission regions and comprising a first substrate, a light transmissive layer formed on the first substrate and having recessed portions corresponding to the transmission regions, color filters formed on the light transmissive layer and having a position-dependent thickness due to the recessed portions of the light transmissive layer, transparent electrodes formed on the first substrate, reflective electrodes disposed on the reflection regions and interposed between the light transmissive layer and the color filters, a second substrate, a common electrode formed on the second substrate, and a liquid crystal layer interposed between the first substrate and the second substrate.

The transflective liquid crystal display may further comprise TFTs having gate electrodes formed on the first substrate, semiconductors formed on or under the gate electrodes and insulated from the gate electrodes, source and drain electrodes connected to the semiconductors, and pixel electrodes connected to the drain electrodes.

The transflective liquid crystal display may further comprise an insulating layer interposed between the second substrate and the common electrode, and having recessed portions facing the recessed portions of the light transmissive layer.

The recessed portions of the light transmissive layer may have a depth substantially the same as the thickness of the color filter on the reflection regions, and the thickness of the light transmissive layer at the recessed portions may be zero. The light transmissive layer may have an embossed surface and the reflective electrodes may have an embossed structure due to the embossed surface of the light transmissive layer.

The color filters may have a substantially flat top surface. The thickness of the color filters on the transmission region may be twice that on the reflection regions.

The transparent electrodes may be interposed between the light transmissive layer and the reflective electrodes, between the first substrate and the light transmissive layer, or they may be disposed on the color filters.

The liquid crystal layer may have liquid crystals aligned parallel to the first and second substrates and in the same direction when no electric field is applied.

The transflective liquid crystal display may further comprise a first alignment layer formed on the color filters and a second alignment layer formed on the common electrode, wherein the rubbing direction of the first alignment layer is parallel with that of the second alignment layer.

The liquid crystal layer may have liquid crystals aligned vertical to the first and second substrates when no electric field is applied.

The present invention provides a manufacturing method of a transflective liquid crystal display, comprising forming

TFTs on a first substrate, forming a light transmissive layer having recessed portions on the first substrate where the TFTs are formed, forming reflective electrodes to have openings corresponding to the recessed portions on the light transmissive layer, forming color filters on the reflective electrodes and the light transmissive layer, forming transparent electrodes on the color filters, forming an insulating layer on a second substrate, forming a common electrode on the insulating layer, assembling the first substrate and the second substrate, and interposing a liquid crystal layer between the first substrate and the second substrate.

The method may further comprise forming an embossed structure at the top surface of the light transmissive layer by exposure through a pattern mask having a slit pattern.

The method may further comprise patterning the insulating layer to have recessed portions corresponding to the recessed portions of the light transmissive layer.

The present invention provides a manufacturing method of a transmissive liquid crystal display, comprising forming TFTs on a first substrate, forming a light transmissive layer having recessed portions on the first substrate where the TFTs are formed, forming transparent electrodes on the light transmissive layer, forming reflective electrodes to have openings corresponding to the recessed portions on the transparent electrodes, forming color filters on the reflective electrodes and the transparent electrodes, forming an insulating layer on a second substrate, forming a common electrode on the insulating layer, assembling the first substrate and the second substrate, and interposing a liquid crystal layer between the first substrate and the second substrate.

The present invention provides a manufacturing method of a transmissive liquid crystal display, comprising, forming TFTs on a first substrate, forming transparent electrodes on a predetermined regions of the first substrate, forming a light transmissive layer having recessed portions corresponding to the transparent electrodes, forming reflective electrodes to have openings corresponding to the recessed portions on the light transmissive layer, forming color filters on the reflective electrodes and the transparent electrodes, forming an insulating layer on a second substrate, forming a common electrode on the insulating layer, assembling the first substrate and the second substrate, and interposing a liquid crystal layer between the first substrate and the second substrate.

The formation of color filters may comprise transferring a color filter layer of a transfer film on the reflective electrodes and the light transmissive layer and patterning the transferred color filter layer.

The formation of color filters may comprise transferring a first color filter layer of a first transfer film on the reflective electrodes and the light transmissive layer; patterning the first color filter layer to form a first color filter filling the recessed portions of the light transmissive layer; transferring a second color filter layer of a second transfer film on the reflective electrodes and the light transmissive layer; and patterning the second color filter layer to form a second color filter disposed on the reflective electrode.

The transfers of the first and second color filter layer may be performed by pressing with a roller.

The first substrate may be heated to a temperature of 100~110° C. and the roller may be heated to a temperature of 120~140° C. during the transfers are performed.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the present invention can be understood in more detail from the following descriptions taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a sectional view of a conventional transmissive LCD;

FIG. 2 is a sectional view of a transmissive LCD according to an embodiment of the present invention;

FIG. 3 is a sectional view of a transmissive LCD according to another embodiment of the present invention;

FIG. 4 is a sectional view of a transmissive LCD according to another embodiment of the present invention;

FIGS. 5A to 5F are sectional views of a TFT array panel for the transmissive LCD according to an embodiment of the present invention in intermediate steps of manufacturing the TFT array panel;

FIGS. 6A to 6D are sectional views of a common electrode panel for the transmissive LCD according to an embodiment of the present invention in intermediate steps of manufacturing the common electrode panel;

FIG. 7 is a sectional view of a color filter transfer film which is used for manufacturing a thin film transistor array panel of a transmissive LCD according to an embodiment of the present invention;

FIG. 8 is a schematic view of color filter forming process by using the color filter transfer film of FIG. 7; and

FIGS. 9A and 9B are sectional views of a TFT array panel for the transmissive LCD according to another embodiment of the present invention in intermediate steps of manufacturing the TFT array panel.

DETAILED DESCRIPTION OF EMBODIMENTS

Preferred embodiments of the present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. The present invention may, however, be embodied in different forms and should not be construed as being limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

In the drawings, the thickness of layers, films, and regions are exaggerated for clarity. Like numerals refer to like elements throughout. 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.

FIG. 2 is a sectional view of a transmissive LCD according to an embodiment of the present invention.

Referring to FIG. 2, a transmissive LCD 200 according to an embodiment of the present invention has a TFT array panel 260, a common electrode panel 270 facing the TFT array panel 260, and a liquid crystal layer 280 interposed between the two panels 260 and 270.

The TFT array panel 260 has a first insulating substrate 210 made of an insulating material such as glass, quartz, or sapphire, a plurality of TFTs 220 formed on the insulating substrate 210, a light transmissive layer 230, and color filters 250.

Each TFT 220 has a gate electrode 221, a gate insulating layer 222, a semiconductor layer 226, a source electrode 223, and a drain electrode 224. FIG. 2 illustrates a bottom gate type of TFT 220 where the gate insulating layer 222 and the semiconductor layer 226 are sequentially formed on the gate electrode. However, a top gate type of TFT where a gate insulating layer and a gate electrode are sequentially formed on the semiconductor layer may also be applied. The semiconductor layer 226 may be made of amorphous silicon or polysilicon.

The light transmissive layer 230 is formed on the TFTs 220 by a method such as spin coating and is made of an insulating

material. The light transmissive layer **230** is made of a photosensitive organic material containing such as bisbenzocyclobutene (BCB) or perfluorocyclobutene (PFCB), or a photosensitive inorganic material containing such as silicon oxide (SiO₂) or silicon nitride (SiNx). The light transmissive layer **230** has contact holes **231** exposing the drain electrodes **224** and transmission windows **232** through which light from the back light **L2** passes. The gate insulating layer **222** is exposed through the transmission windows **232**. Steps **D1** are formed between the transmission windows **232** and remaining portion of the light transmissive layer **230**. The transmission window **232** may be formed by partial removal of the light transmissive layer **230**. The light transmissive layer **230** has an embossed surface, but it may have a substantially flat surface.

A plurality of reflective electrodes **242** are formed on the light transmissive layer **230**. The reflective electrodes **242** is not disposed on the region of the transmission windows **232**, so the regions where the transmission windows **232** are disposed form transmission regions **A** and the regions where the reflective electrodes **242** are disposed form reflection regions **B**. The reflective electrodes **242** are made of a metal having high reflectance, such as Al, Ag, an Al—Cu alloy, or an Al—Si—Cu alloy. The reflective electrodes **242** are formed to have a uniform thickness and have the same surface structure as the light transmissive layer **230**. Accordingly, when the light transmissive layer **242** has an embossed surface, the reflective electrodes **242** also have embossed surfaces. The embossed surfaces of the reflective electrodes **242** enhance reflection characteristics of external light **L1**.

The color filters **250** are disposed on the reflective electrode **242** and the region where the transmission windows **232** are formed. When the color filters **250** are disposed on the TFT array panel **260**, misalignment between the color filters **250** and pixel electrodes **240** is diminished compared with the conventional transreflective LCD. Furthermore, since the color filters **250** having flat surfaces are disposed on the reflective electrodes **242**, calculation of cell gap in the reflection regions **B** is simple. When the reflective electrodes **242** are disposed as a top layer, calculation of cell gap is very complex due to the embossed structure of the reflective electrodes **242**.

The color filters **250** have top surfaces with a uniform height. Accordingly, the thickness **D2** of the color filters **250** on the transmission regions **A** is thicker than the thickness **D3** of the reflection regions **B** due to the steps **D1** formed by the light transmissive layer **230**. As a result, a difference in color reproduction between the transmission regions **A** and the reflection regions **B** decreases. It is preferable that the color filters **250** on the transmission regions **A** have a thickness twice that on the reflection region **B** to make the length the light passes in the color filters **250** on the transmission regions **A** substantially equal to that on the reflection region **B**. Thickness of the color filters **250** may be varied depending on colors.

A plurality of transparent electrodes **241** are formed on the color filters **250**. The transparent electrodes **241** are made of a transparent conductive material such as indium tin oxide (ITO) or indium zinc oxide (IZO). The transparent electrodes **241** are electrically connected to the drain electrodes **224** and the reflective electrodes **242** through contact holes **231** formed in the light transmissive layer **230** and the color filters **250**. In this embodiment, when the transparent electrodes **241** are formed on the color filters **250**, a contact area between the reflective electrodes **242** and the transparent electrodes **241** decreases and thereby the galvanic effect is reduced.

The common electrode panel **270** has a second insulating substrate **271** made of an insulating material such as glass,

quartz or sapphire, an overcoating layer **272** formed on the second insulating substrate **271** and formed with a photosensitive material, and a common electrode **273** made of a light transmissive material.

The portions of the overcoating layer **272** facing the transmission windows **232** are removed to form recessed portions **274**. Cell gap **d1** of the transmission region **A** is larger than cell gap **d2** of the reflection regions **B** due to the step formed by the recessed portion **274** of the overcoating layer **272**. Accordingly, pass length of the external light **L1** experienced in the liquid crystal layer **280** on the reflection regions **B** can be controlled to be the same as that of the back light **L2** on the transmission regions **A**. As a result, a difference of optical characteristics between the reflection mode and the transmission mode is reduced. The depth of the recesses **274** of the overcoating layer **272** are preferably determined in order that the cell gap **d1** of the transmission region **A** is twice as large as the cell gap **d2** of the reflection regions **B**.

The liquid crystal layer **280** is interposed between the TFT array panel **260** and the common electrode panel **270**. Liquid crystals in the liquid crystal layer **280** may be aligned in a twisted nematic (TN) mode where liquid crystals are aligned to be parallel to the substrates **210** and **271** and to be twisted when no electric field is applied, or in a vertically aligned (VA) mode where liquid crystals are aligned to be vertical to the substrates **210** and **271** when no electric field is applied. In another way, liquid crystals in the liquid crystal layer **280** may be aligned in an electrically controlled birefringence (ECB) mode where liquid crystals are aligned to be parallel to the substrates **210** and **271** and to be parallel to each other when no electric field is applied. Here, alignment of the liquid crystals is determined by rubbing direction and characteristics of alignment layers **11** and **12** formed on the transparent electrodes **241** and the common electrode **273**. In the ECB mode, the rubbing direction of the two alignment layers **11** and **12** may be the same or opposite.

FIG. **3** is a sectional view of a transreflective LCD according to another embodiment of the present invention.

Referring to FIG. **3**, when the LCD of FIG. **3** is compared with the LCD of FIG. **2**, a distinguishing feature of the LCD of FIG. **3** is that transparent electrodes **341** are disposed between a light transmissive layer **230** and reflective electrodes **342**. The transparent electrodes **341** are formed on the light transmissive layer **230** to have an approximately uniform thickness. Accordingly, the transparent electrodes **341** have embossed surfaces due to reflection of embossed surface of the light transmissive layer **230** and are electrically connected to drain electrodes **224** through contact holes **231**.

As shown in FIG. **3**, the contact area between the two electrodes **341** and **342** is wide. Accordingly, the two electrodes **341** and **342** are required to be formed of metals that scarcely react in order to reduce the galvanic effect.

A first alignment layer **11** is formed on the color filters **250** and a second alignment layer **12** is formed on the common electrode **273**. The first and second alignment layers **11** and **12** are formed to align liquid crystals of the liquid crystal layer **280**.

FIG. **4** is a sectional view of a transreflective LCD according to another embodiment of the present invention.

Referring to FIG. **4**, transparent electrodes **441** are formed on an insulating substrate **210** on the same layer of gate electrodes **221**. Transmission windows **232** are disposed on the transparent electrodes **441**. A gate insulating layer **225** has openings to expose the transparent electrodes **441**. Instead of forming contact holes for connecting drain electrodes **224** and reflective electrodes **442**, the drain electrodes **224** are extended to be exposed through the transmission windows

232 and the reflective electrodes 442 are formed on the side-wall of the transmission window 232 and on the transparent electrodes 441 as well as on the light transmissive layer 230 to be electrically connected with the drain electrodes 224 and the transparent electrodes 441.

A first alignment layer 11 is formed on the color filters 250, and a second alignment layer 12 is formed on the common electrode 273. The first and second alignment layers 11 and 12 are formed to align liquid crystals of the liquid crystal layer 280.

Henceforth, a manufacturing method of a TFT array panel 560 according to an embodiment of the present invention will be described with reference to FIGS. 5A to 5F.

FIGS. 5A to 5F are sectional views of the TFT array panel for the transfective LCD shown in FIG. 2 in intermediate steps of manufacturing the TFT array panel.

Referring to FIG. 5A, TFTs 520 respectively having a gate electrode 521, a source electrode 523, and a drain electrode 524 are formed on a first insulating substrate 510.

In detail, a metal layer (not illustrated) made of such as Al, Cr, or MoW is deposited on the insulating substrate 510 and is patterned to form the gate electrodes 521.

A gate insulating layer 522 made of silicon nitride or silicon oxide is deposited on the gate electrodes 521 and the first insulating substrate 510.

Next, an intrinsic amorphous silicon layer and an extrinsic amorphous silicon layer heavily doped with an N-type dopant are sequentially deposited on the gate insulating layer 522 by such as plasma enhanced chemical vapor deposition (PECVD) as an in situ process. Then, the intrinsic amorphous silicon layer and the extrinsic amorphous silicon layer are patterned to form semiconductors 526 and pre-patterns of ohmic contacts 527 disposed on the gate electrodes 521. At this time, the semiconductors 526 may be illuminated with a laser to crystallize the amorphous silicon, thereby turning the semiconductors 526 into polysilicon.

Next, source electrodes 523 and drain electrodes 524 are formed on the pre-patterns of the ohmic contacts 527 and the gate insulating layer 522.

Then, exposed portions of the pre-patterns of the ohmic contacts 527 are etched to form the ohmic contacts 527, and hereby TFTs 520 are formed on the first insulating substrate 510.

Referring to FIG. 5B, a photo sensitive light transmissive layer 530 is coated on the first insulating substrate 510 on which the TFTs 520 are formed. Next, after disposition of a first pattern mask 590 having a predetermined pattern on the light transmissive layer 530, the light transmissive layer 530 is exposed to a light.

Referring to FIG. 5C, the light-exposed light transmissive layer 530 is developed to form contact holes 531', transmission windows 532, and embossed surface. The contact holes 531' expose the drain electrodes 524 of the TFT 520s, and the transmission window 532 expose portions of the gate insulating layer 522. To form an embossed structure at the surface of the light transmissive layer 530, the first pattern mask may have a slit pattern (not illustrated).

Referring to FIG. 5D, reflective electrodes 542 are formed on the light transmissive layer 530 to have openings corresponding to the transmission windows 532. The reflective electrodes 542 are electrically connected to the drain electrodes 524 through the contact holes 531'.

Next, referring to FIG. 5E, color filters 550 are formed on the reflective electrodes 542 to fill the transmission windows 532. The color filters 550 may include red, green, and blue filters, and the color filters 550 may have different thicknesses according to their color. The color filters 550 are formed to

have a substantially flat top surface, and have contact holes 531 corresponding to the contact holes 531' of the light transmissive layer 530 to expose the drain electrodes 524.

Next, referring to FIG. 5F, transparent electrodes 541 are formed on the color filters 550. The transparent electrodes 541 are formed to have a substantially uniform thickness, and are connected to the drain electrodes 524 and the reflective electrodes 542 through the contact holes 531.

A manufacturing method of a common electrode panel according to an embodiment of the present invention will be described with reference to FIGS. 6A to 6D.

FIGS. 6A to 6D are sectional views of a common electrode panel for the transfective LCD according to an embodiment of the present invention in intermediate steps of manufacturing the common electrode panel.

Referring to FIG. 6A, an overcoating layer 672 of photo-sensitive material is coated on an insulating substrate 671 by a method such as spin coating.

Next, referring to FIG. 6B, a second pattern mask 675 having a photo pattern to remove the overcoating layer 672 at portions corresponding to the transmission window 532 of the TFT array panel 560 is disposed on the overcoating layer 672 and is exposed to light.

Then, referring to FIG. 6C, the light-exposed overcoating layer 672 is developed to form recessed portions 674.

Referring to FIG. 6D, a common electrode 673 made of a light transmissive material is formed on the overcoating layer 673 having the recessed portions 674. Thereby a common electrode panel 670 is completely manufactured.

In embodiments of the present invention, color filters are formed to have different thicknesses between the reflection regions and the transmission regions. Accordingly, a difference in color reproduction between the transmission regions and the reflection regions is eliminated.

In embodiments of the present invention, cell gap of the transmission regions is formed to be twice as large as that of the reflection regions. Accordingly, a difference of optical characteristics between the reflection mode and the transmission mode is reduced.

Another embodiment of the present invention will now be described hereinafter with reference to the accompanying drawings.

FIG. 7 is a sectional view of a color filter transfer film which is used for manufacturing a thin film transistor array panel of a transfective LCD according to an embodiment of the present invention.

A color filter transfer film 10 comprises a base film 13 playing the role of a supporter, a cushion layer 14 uniformly dispersing roller pressure when a transfer is performed, a color filter layer 15 to be a color filter by transfer, and a cover film 16 for protecting the color filter layer 15.

An oxygen intercepting layer (not shown) may be further comprised between the color filter layer 15 and the cushion layer 14 to increase strength of the color filter layer 15 by intercepting oxygen coming from exterior. The oxygen intercepting layer enhances smoothness of layer surface.

Since thickness of the color filter layer 15 of the color filter transfer film 10 is easily controlled, the color filter transfer film 10 is useful to form color filters having various thicknesses.

A forming method of color filters using the color filter transfer film 10 will be described with reference to FIG. 8.

FIG. 8 is a schematic view of color filter forming process by using the color filter transfer film of FIG. 7.

Referring to FIG. 8, after removing the cover film 16, the color filter transfer film 10 is disposed on a subject substrate

500 to have the color filter layer **15** contact the top surface of the subject substrate **500**, where a predetermined thin film pattern is formed.

Next, the color filter transfer film **10** is pressed by a roller **20** to attach the color filter layer **15** to the subject substrate **500**. At this time, the subject substrate **500** is heated to a temperature of 100~110° C. and the roller **20** is heated to a temperature of 120~140° C.

When the roller **20** presses the color filter transfer film **10**, the cushion layer **14** is liquefied by heat and uniformly distributes the roller **20** pressure. Due to distribution of pressure by the cushion layer **14**, transferred color filter layer **15** has a substantially flat top surface regardless of unevenness of the top surface of the subject substrate **500**.

Next, after removing the base film **13** and the cushion layer **14**, the transferred color filter layer **15** is exposed to a light through a predetermined mask and is developed to form color filter having predetermined shapes.

A manufacturing method of a TFT array panel **260** of FIG. 2 according to another embodiment of the present invention will be described with reference to drawings.

FIGS. 9A and 9B are sectional views of a TFT array panel for the transfective LCD according to another embodiment of the present invention in intermediate steps of manufacturing the TFT array panel.

Processes to form TFTs **520**, a light transmissive layer **530** and reflective electrode **542** are the same as the processes illustrated in FIGS. 5A to 5D.

Next, a first color filter layer of a first transfer film is transferred on the reflective electrode **542** and is illuminated and developed to form a color filter layer **550a** for the transmission regions, which fills the transmission window **532**.

Next, a second color filter layer of a second transfer film is transferred on the reflective electrode **542** and is illuminated and developed to form a color filter layer **550b** of the reflection regions, which fills the transmission window **532**.

The color filter layers **550a** and **550b** are formed to have a substantially flat top surface, and have contact holes **531** corresponding to the contact holes **531'** of the light transmissive layer **530** to expose the drain electrodes **524**. Here the color filter layer of the first transfer film is twice thicker than that of the second transfer film.

In the present embodiment, the color filter layer **550a** for the transmission region is formed with the first transfer film and the color filter layer **550b** for the reflection region is formed with the first transfer film. Differently from the present embodiment, a partial thickness (for example, thickness to fill the transmission window **532**) of the color filter layer **550a** for the transmission region may be formed with a first transfer film and the remaining thickness of the color filter layer **550a** for the transmission region and the color filter layer **550b** for the reflection region may be formed with a second transfer film.

Red, green and blue color filters are formed by repeating the above described color filter forming processes.

As described above, when the color filter transfer film is used, a color filter having two different thickness is easily formed. Accordingly, processing time for forming color filters is reduced to enhance productivity. Further, since a dispersion liquid is not required to use, pollution of environment is reduced.

Henceforth, manufacturing methods of the TFT array panels for the transfective LCD shown in FIGS. 3 and 4 will be described.

At first, the TFT array panel shown in FIG. 3 is manufactured by a method that has a different feature in that the transparent electrode **341** is formed on the light transmissive

layer **230** before forming the reflective electrode **342** from the method illustrated in FIGS. 5A to 5F.

FIG. 4 is a sectional view of a transfective LCD according to another embodiment of the present invention;

In detail, a metal layer (not illustrated) made of such as Al, Cr, or MoW is deposited on the insulating substrate **210** and is patterned to form the gate electrodes **221**. A transparent conductive layer such as ITO and IZO is deposited on the insulating substrate **210** and is patterned to form the transparent electrodes **441**.

Next, a gate insulating layer **225** made of silicon nitride or silicon oxide is deposited on the gate electrodes **221** and the transparent electrodes **441**.

Next, an intrinsic amorphous silicon layer and an extrinsic amorphous silicon layer heavily doped with an N-type dopant are sequentially deposited on the gate insulating layer **225** by such as plasma enhanced chemical vapor deposition (PECVD) as an in situ process. Then, the intrinsic amorphous silicon layer and the extrinsic amorphous silicon layer are patterned to form semiconductors **226** and pre-patterns of ohmic contacts **227** disposed on the gate electrodes **221**. At this time, the semiconductors **226** may be illuminated with a laser to crystallize the amorphous silicon, thereby turning the semiconductors **226** into polysilicon.

Next, source electrodes **223** and drain electrodes **224** are formed on the pre-patterns of the ohmic contacts **227** and the gate insulating layer **225**.

Then, exposed portions of the pre-patterns of the ohmic contacts **227** are etched to form the ohmic contacts **227**, and hereby TFTs **220** are formed on the first insulating substrate **210**.

Next, a photo sensitive light transmissive layer **230** is coated on the first insulating substrate **210** on which the TFTs **220** are formed. Next, after disposition of a pattern mask having a predetermined pattern on the light transmissive layer **230**, the light transmissive layer **230** is exposed to a light.

Referring to FIG. 4, the light-exposed light transmissive layer **230** is developed to form the light transmissive layer **230** having a predetermined pattern. In detail, the light transmissive layer **230** has transmission windows **232** exposing the transparent electrodes **441**. The transmission windows **232** also expose the drain electrodes **224** of the thin film transistor.

Next, reflective electrodes **242** are formed on the light transmissive layer **230** to have openings corresponding to the transmission windows **232**. The reflective electrodes **242** are extended to the bottom of the transmission windows **232** to be electrically connected to the drain electrodes **524** and the transparent electrodes **441** through the transmission windows **232**.

Next, color filter layers are coated on the reflective electrodes **242** and the transparent electrodes **441** and patterned to form color filters **250**. Here, color filter transfer films may be used to form the color filters **250**.

Although preferred embodiments of the present invention have been described in detail hereinabove, it should be clearly understood that many variations and/or modifications of the basic inventive concepts herein taught, which may appear to those skilled in the present art, will still fall within the spirit and scope of the present invention, as defined in the appended claims.

What is claimed is:

1. A transfective liquid crystal display having reflection regions and transmission regions, and comprising:

a first substrate;

a light transmissive layer disposed on the first substrate and including recessed portions corresponding to the transmission regions;

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color filters disposed on the light transmissive layer and including a position-dependent thickness due to the recessed portions of the light transmissive layer; transparent electrodes disposed on the first substrate; reflective electrodes electrically connected to the transparent electrodes and interposed between the light transmissive layer and the color filters; a second substrate; a common electrode disposed on the second substrate; and a liquid crystal layer interposed between the first substrate and the second substrate.

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

TFTs having gate electrodes formed on the first substrate, semiconductors formed on or under the gate electrodes and insulated from the gate electrodes, source and drain electrodes connected to the semiconductors; and wherein pixel electrodes are composed of the transparent electrodes and the reflective electrodes, which are connected to the drain electrodes.

3. The transfective liquid crystal display of claim 2, further comprising an insulating layer interposed between the second substrate and the common electrode and having recessed portions facing the recessed portions of the light transmissive layer.

4. The transfective liquid crystal display of claim 3, wherein the recessed portions of the light transmissive layer have a depth substantially the same as the thickness of the color filter on the reflection regions.

5. The transfective liquid crystal display of claim 1, wherein the thickness of the light transmissive layer at the recessed portions is zero.

6. The transfective liquid crystal display of claim 1, wherein the light transmissive layer has an embossed surface and the reflective electrodes have an embossed structure due to the embossed surface of the light transmissive layer.

7. The transfective liquid crystal display of claim 6, wherein the transparent electrodes are disposed on the color filters.

8. The transfective liquid crystal display of claim 6, further comprising an insulating layer interposed between the second substrate and the common electrode and having recessed portions facing the recessed portions of the light transmissive layer.

9. The transfective liquid crystal display of claim 8, wherein the recessed portions of the light transmissive layer

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have a depth substantially the same as the thickness of the color filter on the reflection regions.

10. The transfective liquid crystal display of claim 1, wherein the color filters have a substantially flat top surface.

11. The transfective liquid crystal display of claim 1, wherein the thickness of the color filters on the transmission region is twice that on the reflection regions.

12. The transfective liquid crystal display of claim 11, wherein the transparent electrodes are disposed on the color filters.

13. The transfective liquid crystal display of claim 11, further comprising an insulating layer interposed between the second substrate and the common electrode and having recessed portions facing the recessed portions of the light transmissive layer.

14. The transfective liquid crystal display of claim 13, wherein the recessed portions of the light transmissive layer have a depth substantially the same as the thickness of the color filter on the reflection regions.

15. The transfective liquid crystal display of claim 1, wherein the transparent electrodes is disposed on the color filters.

16. The transfective liquid crystal display of claim 15, further comprising an insulating layer interposed between the second substrate and the common electrode and having recessed portions facing the recessed portions of the light transmissive layer.

17. The transfective liquid crystal display of claim 16, wherein the recessed portions of the light transmissive layer have a depth substantially the same as the thickness of the color filter on the reflection regions.

18. The transfective liquid crystal display of claim 1, wherein the liquid crystal layer has liquid crystals aligned in parallel to the first and second substrates and in a same direction when no electric field is applied.

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

a first alignment layer formed on the color filters; and a second alignment layer formed on the common electrode, wherein the rubbing direction of the first alignment layer is parallel with that of the second alignment layer.

20. The transfective liquid crystal display of claim 1, wherein the liquid crystal layer has liquid crystals aligned vertical to the first and second substrates when no electric field is applied.

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摘要(译)

本发明提供一种具有反射区域和透射区域的半透半反液晶显示器，包括第一基板，形成在第一基板上并具有与透射区域对应的凹陷部分的透光层，形成在透光层上的滤色器由于透光层的凹陷部分，在第一基板上形成的透明电极，设置在反射区域上并插入在透光层和滤色器之间的反射电极，第二基板，公共电极，取决于位置的厚度形成在第二基板上的液晶层和插入在第一基板和第二基板之间的液晶层。

