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Seok et al.

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(54) **METHOD OF MANUFACTURING LIQUID CRYSTAL DISPLAY**

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(30) **Foreign Application Priority Data**

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G02F 1/13 (2006.01)
G02F 1/141 (2006.01)
G02F 1/1339 (2006.01)

(52) **U.S. Cl.** **349/191**; 349/187; 349/134; 349/190

(58) **Field of Classification Search** .... None
See application file for complete search history.

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(74) *Attorney, Agent, or Firm* — Cantor Colburn LLP

(57) **ABSTRACT**

A method of manufacturing a liquid crystal display includes; forming a mother substrate assembly by disposing a liquid crystal mixture layer having liquid crystals and a light curable alignment supplement between a first mother substrate and a second mother substrate of a liquid crystal display, and disposing a light curable sealant surrounding the liquid crystal mixture layer, pre-tilting liquid crystal molecules of the liquid crystal mixture layer by applying a voltage to the first mother substrate and the second mother substrate, and simultaneously hardening the alignment supplement and the sealant by radiating light to the mother substrate assembly while applying the voltage to the first mother substrate and the second mother substrate.

22 Claims, 19 Drawing Sheets

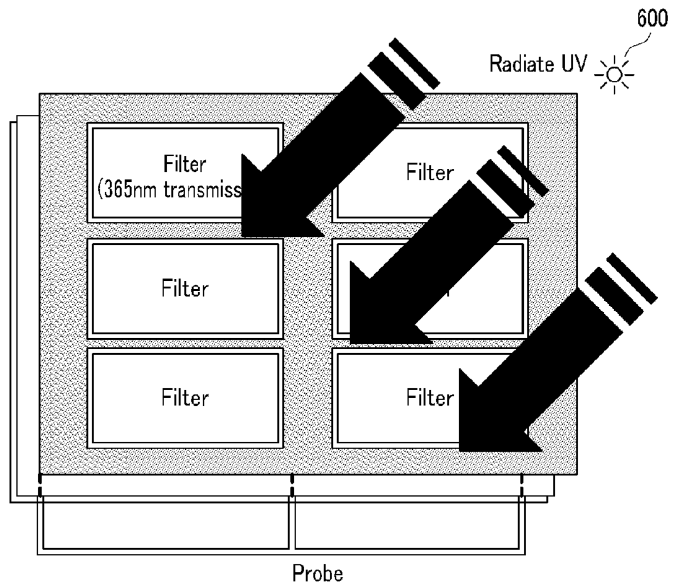


FIG.1

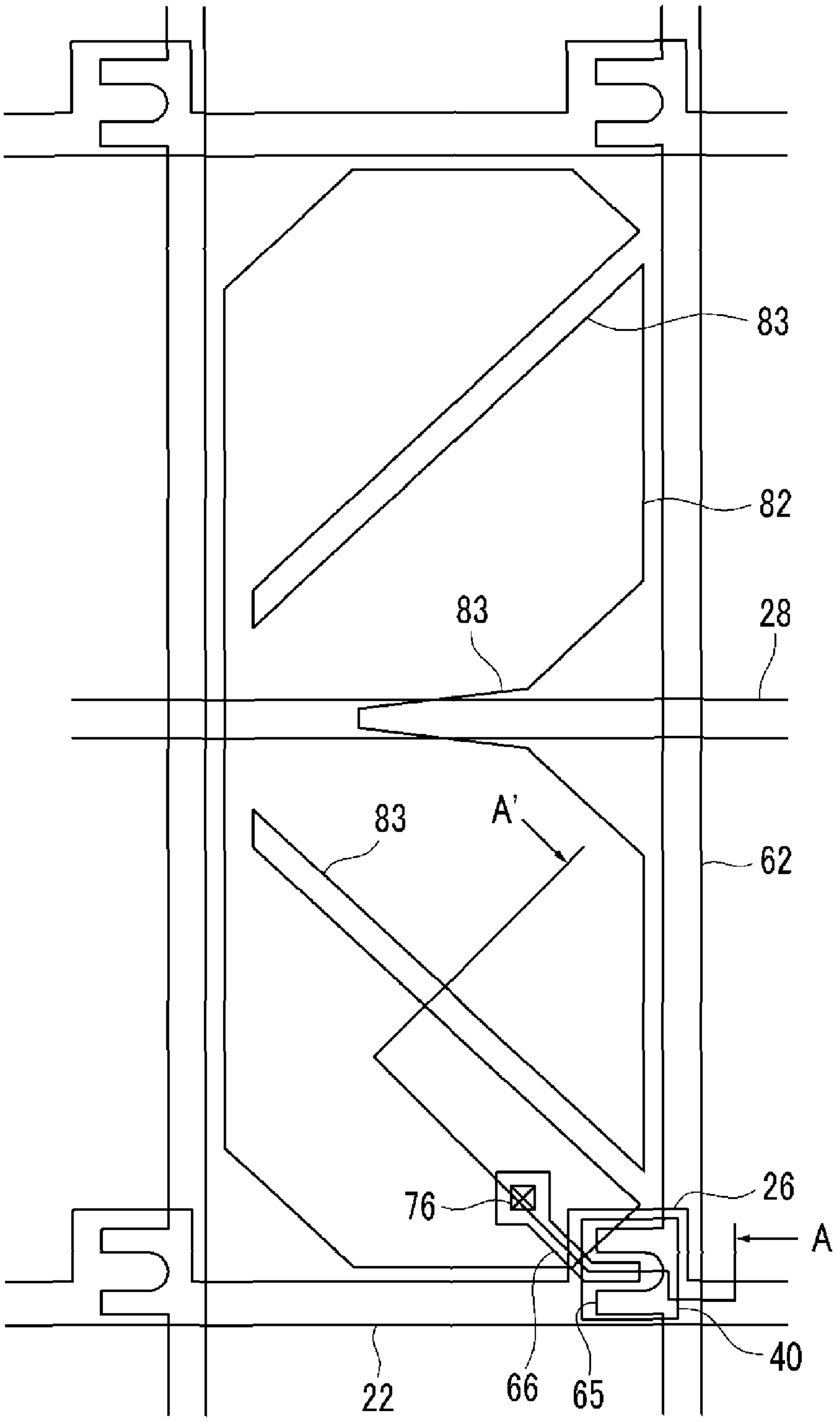
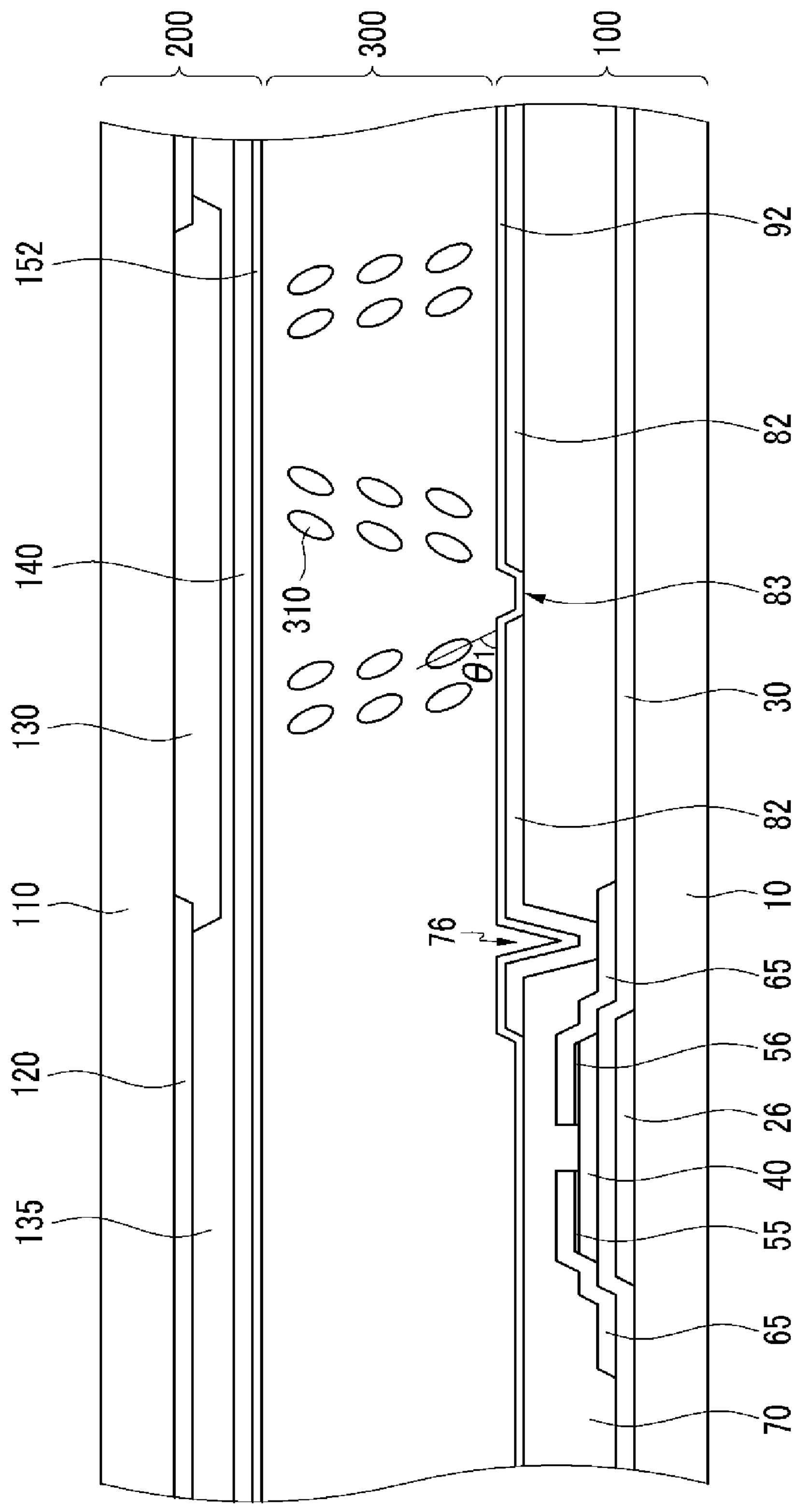


FIG.2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300
100
152
140
130
110
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76
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83
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40
55
65
70

FIG.3

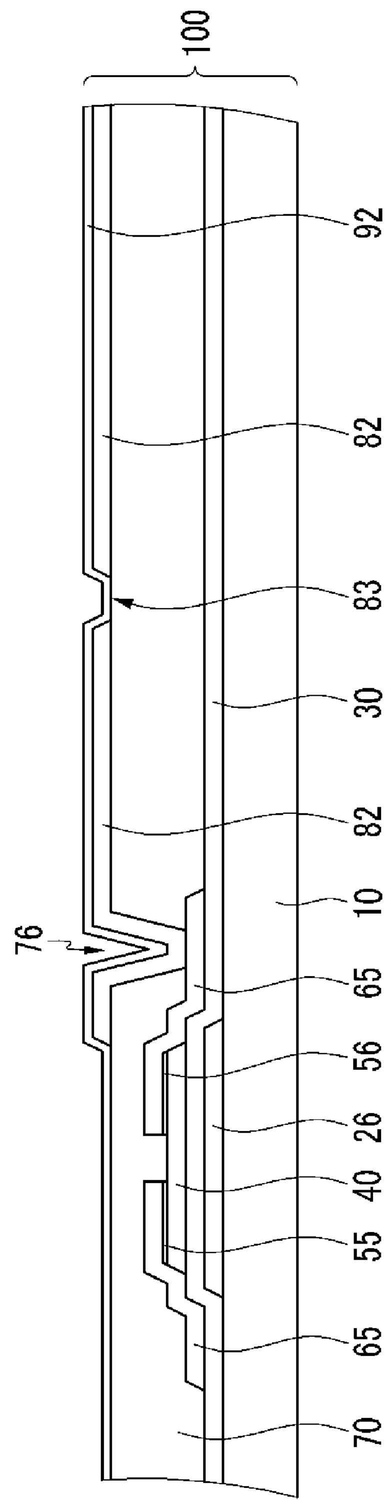
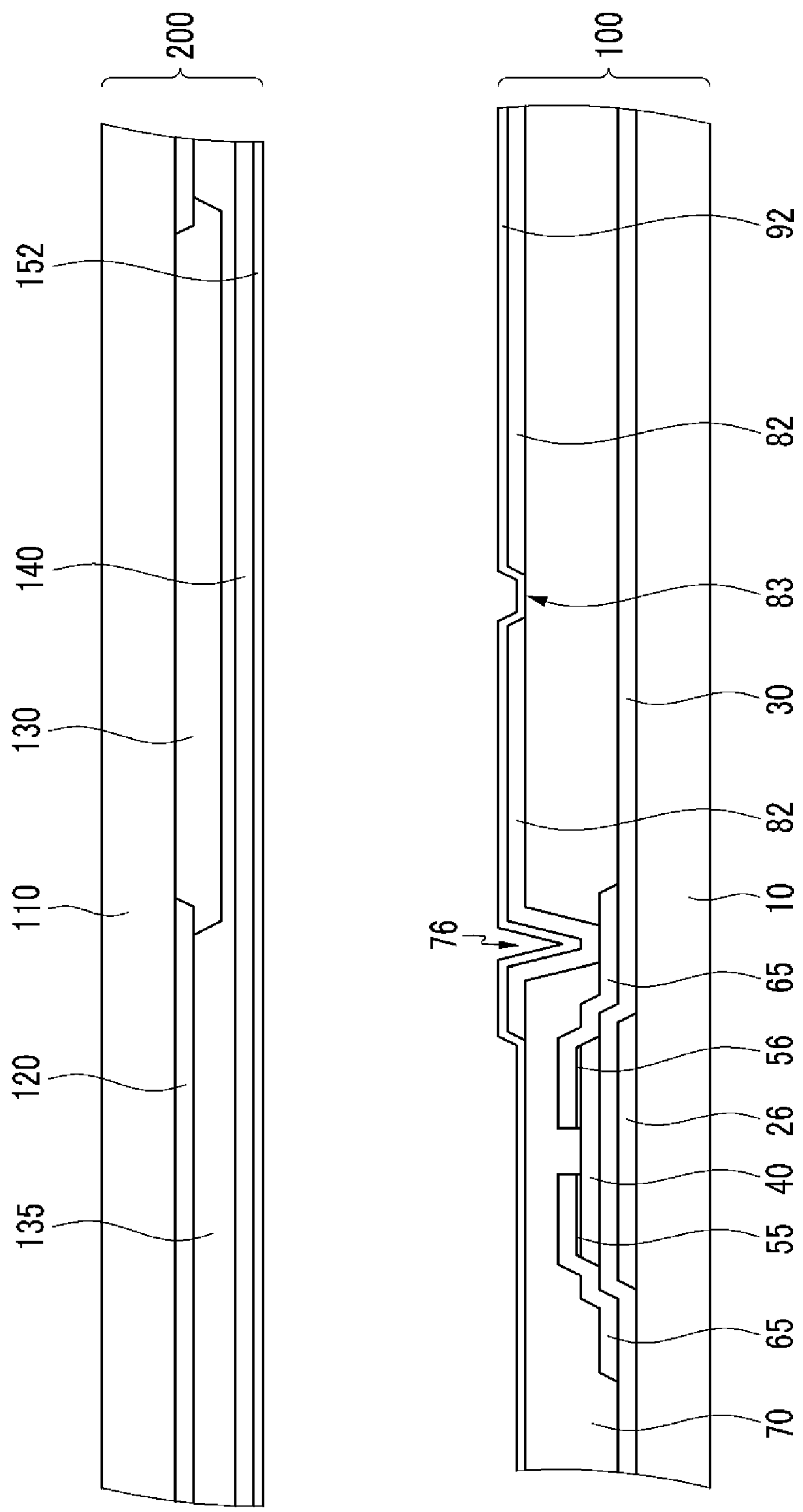


FIG.4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100
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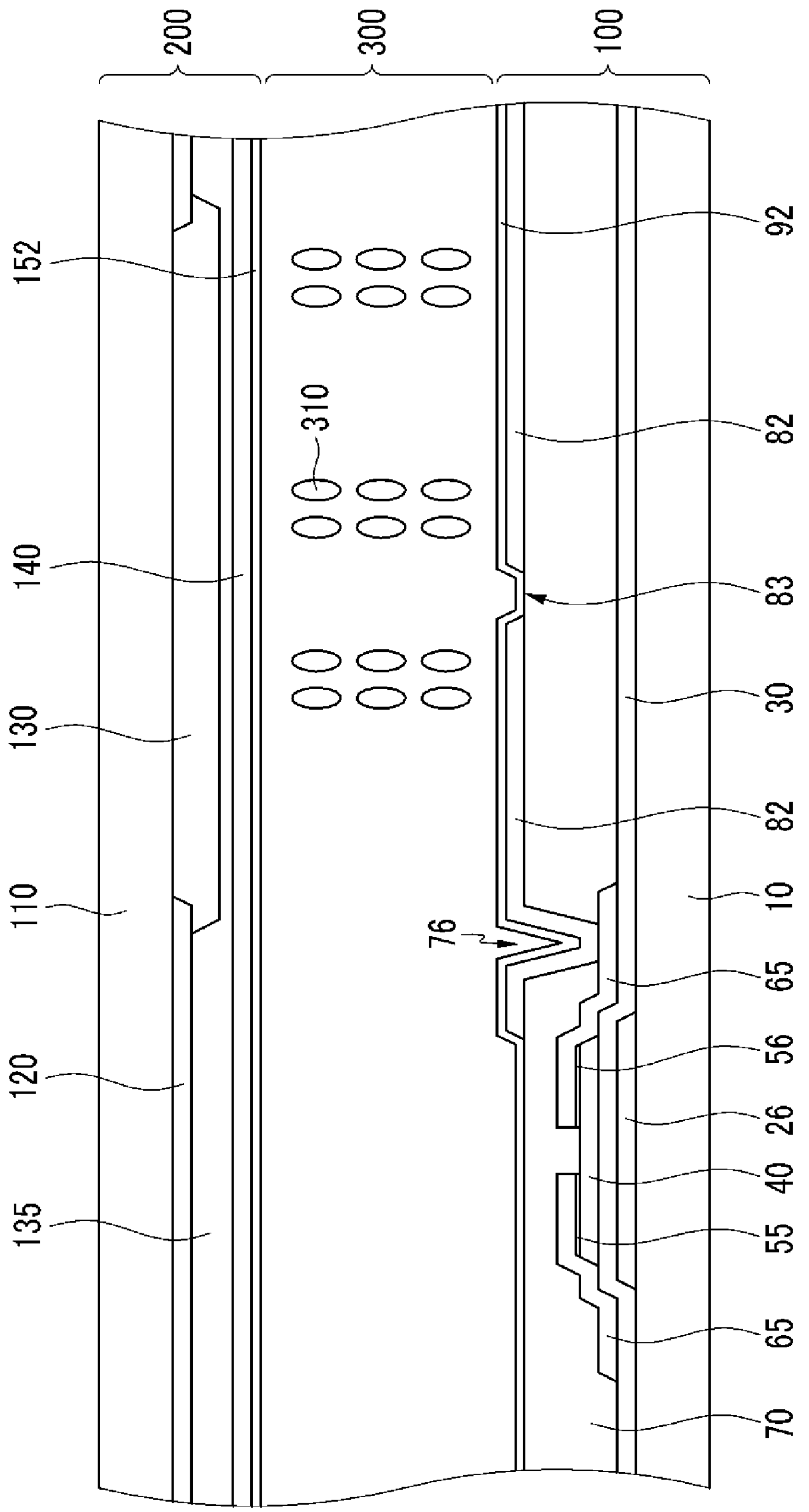
FIG.5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82
83
30
82
10
65
56
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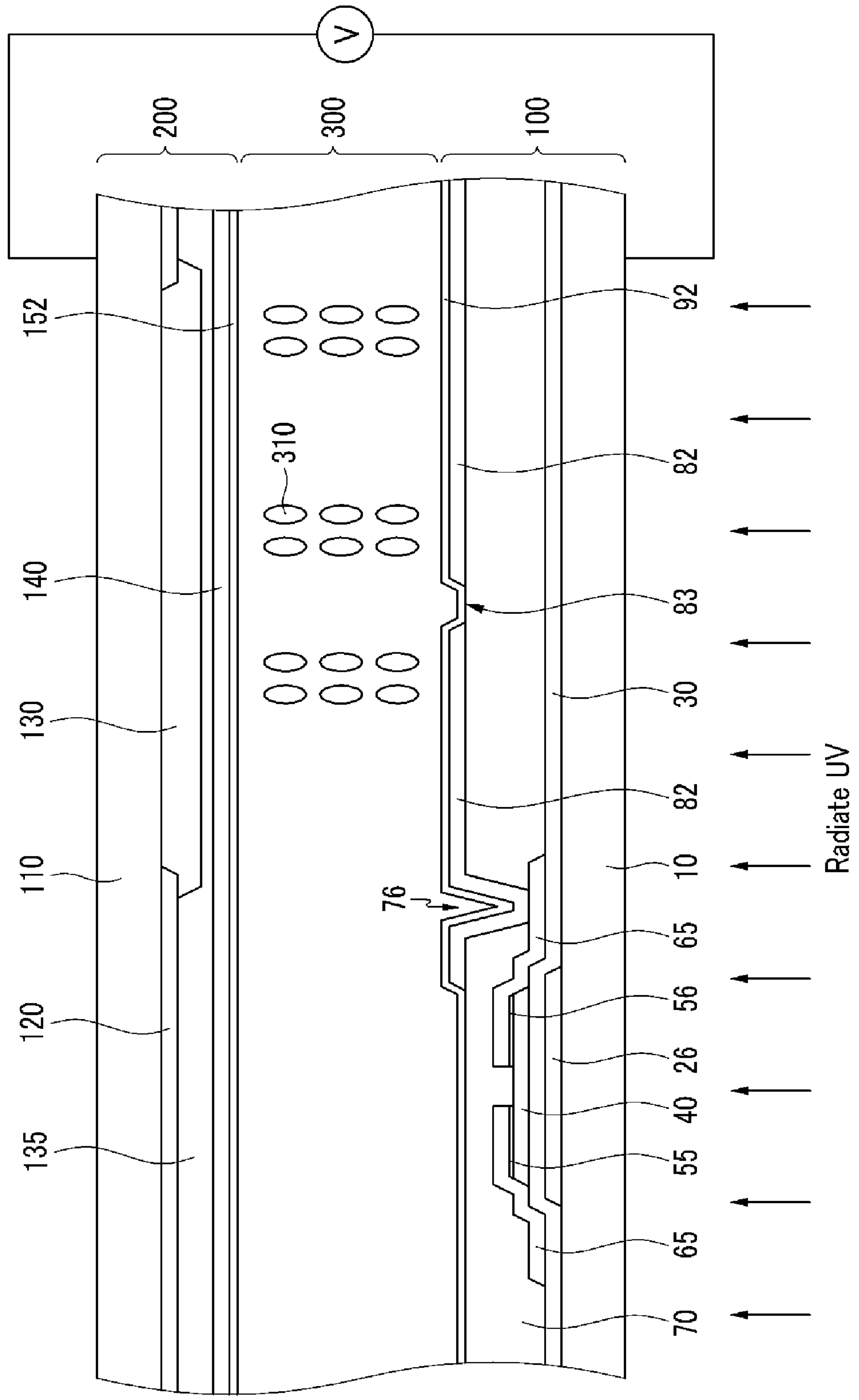
40
55
65
70

FIG.6


V
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300
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152
310
140
130
110
120
135
76
92
82
83
30
82
10
65
56
26
40
55
65
70
Radiate UV

FIG.7A

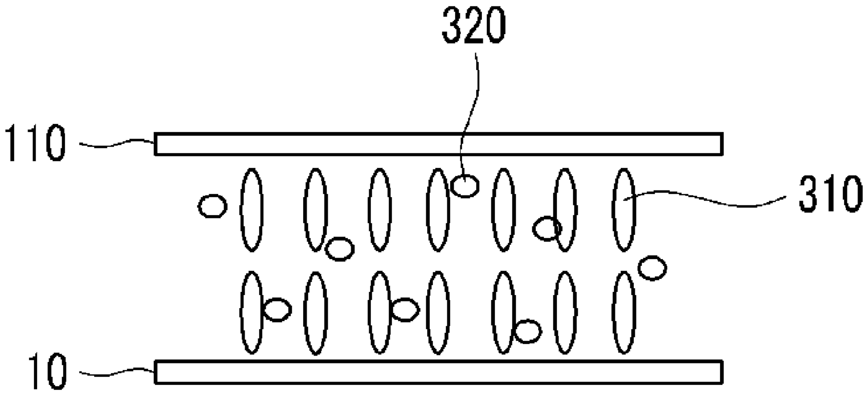


FIG.7B

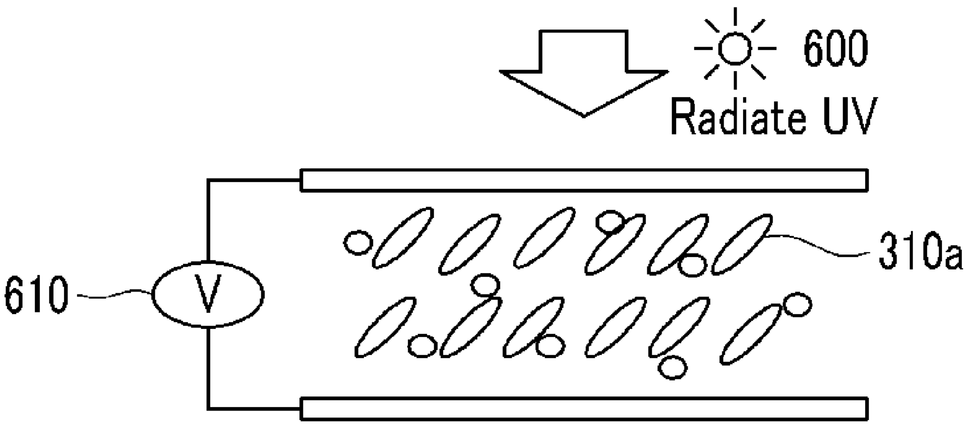


FIG.8

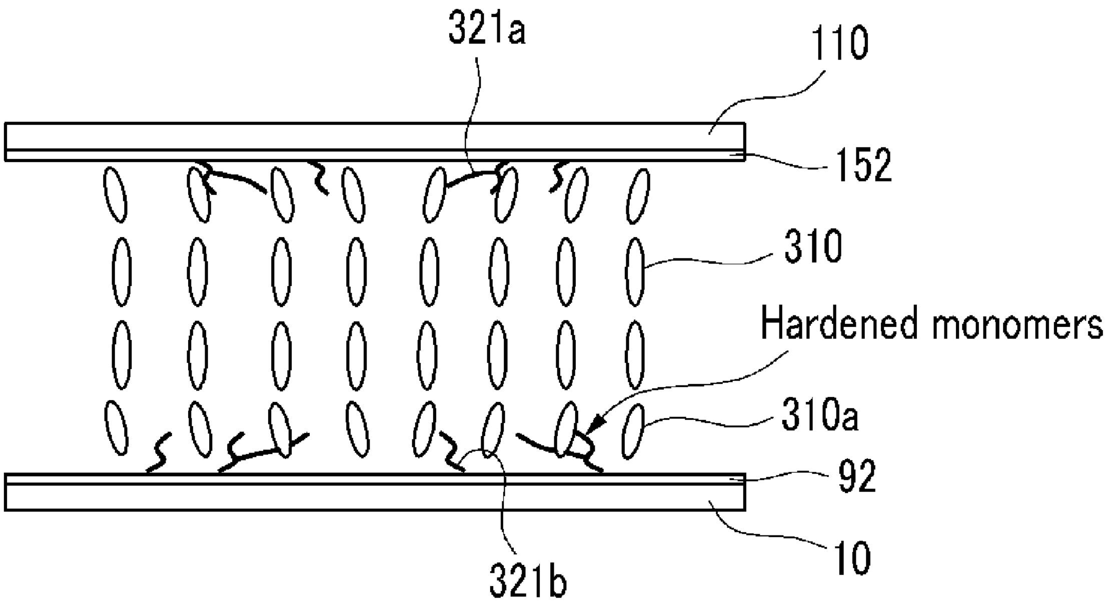


FIG.9

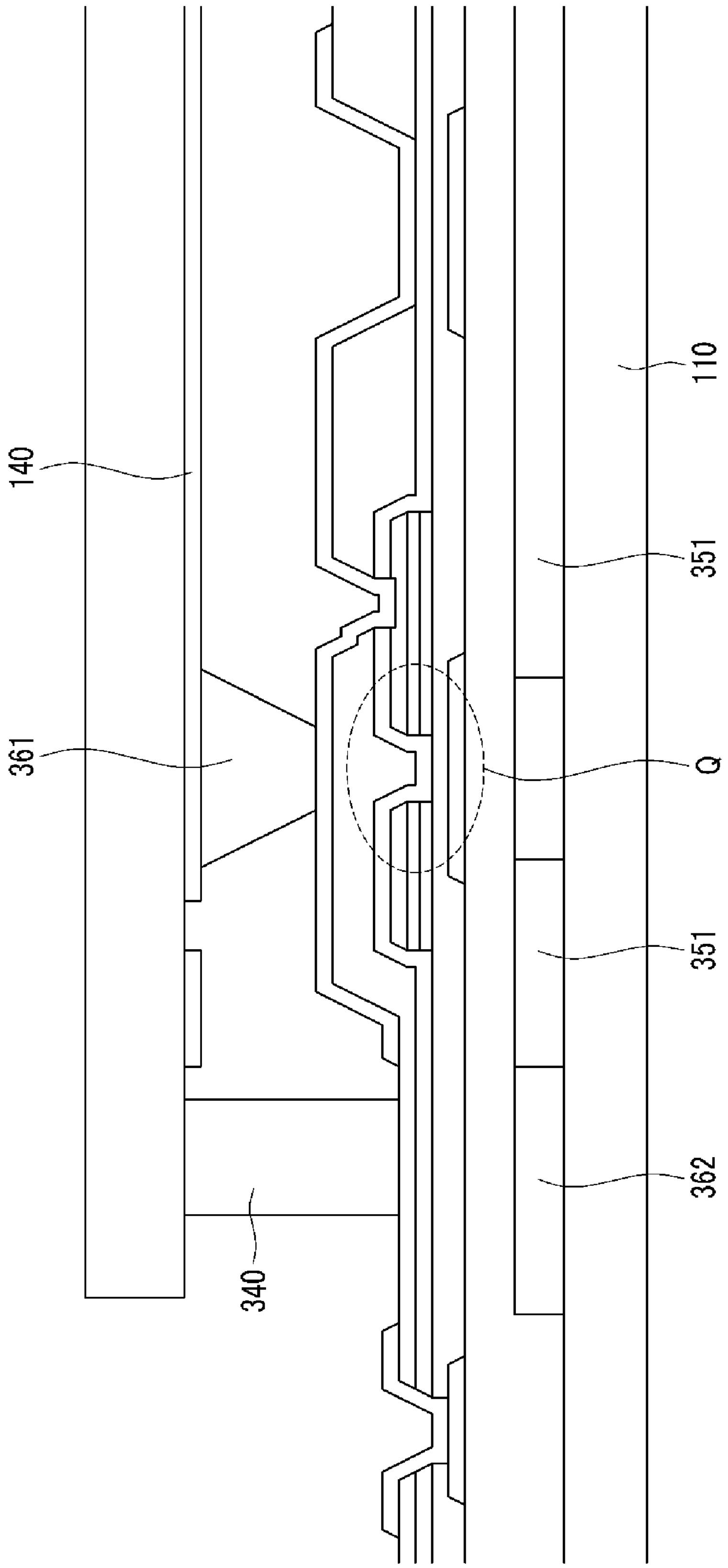


FIG.10

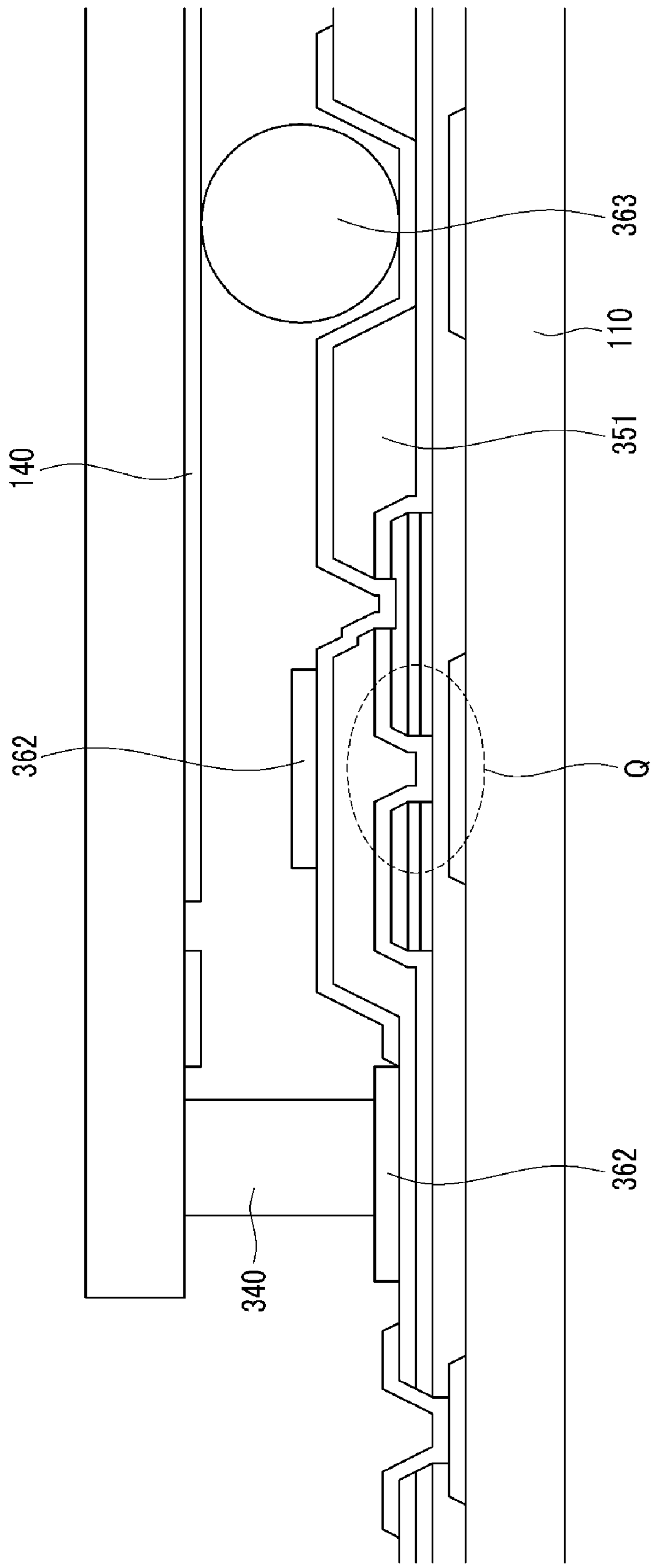


FIG.11

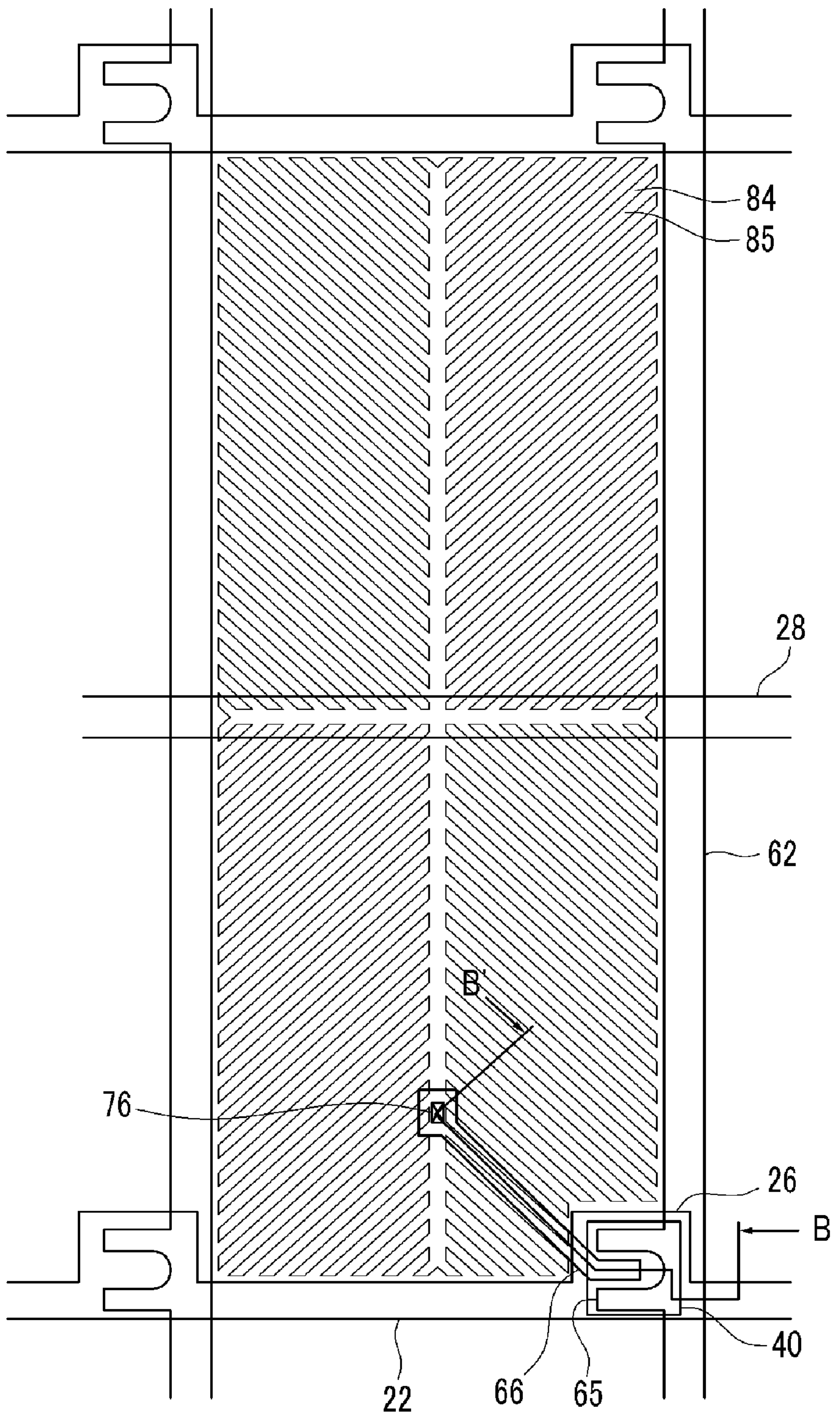
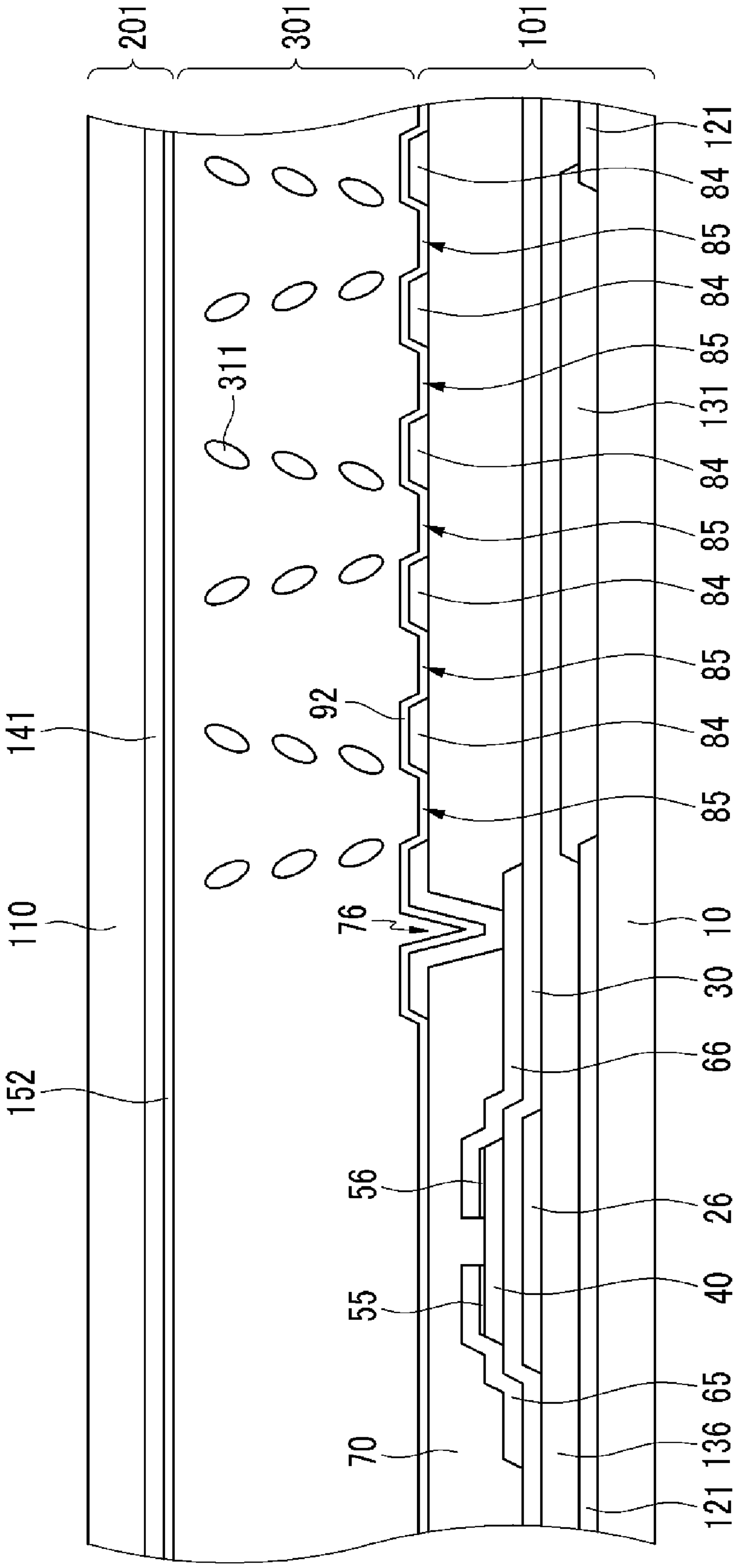


FIG.12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301
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121
84
85
84
85
131
84
85
84
85
84
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10
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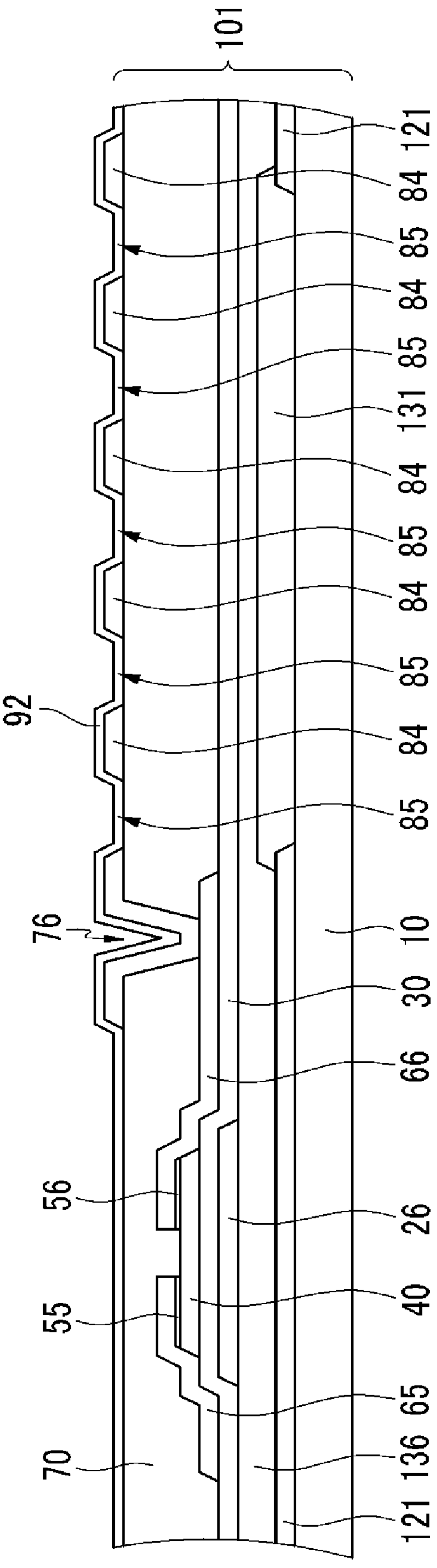
40
65
136
121
311
92
76
56
55
70
141
110
152

FIG.13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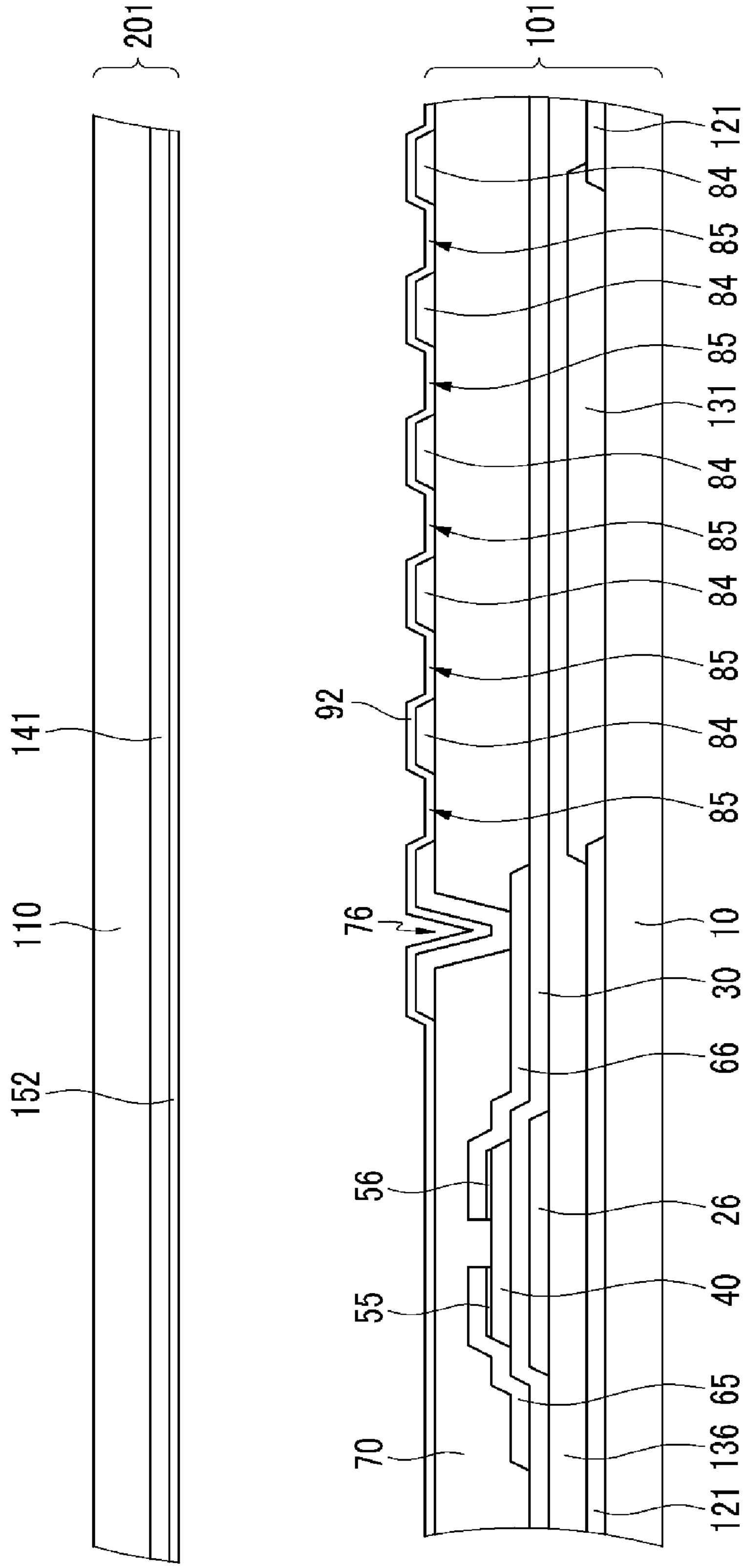
136
121

FIG.14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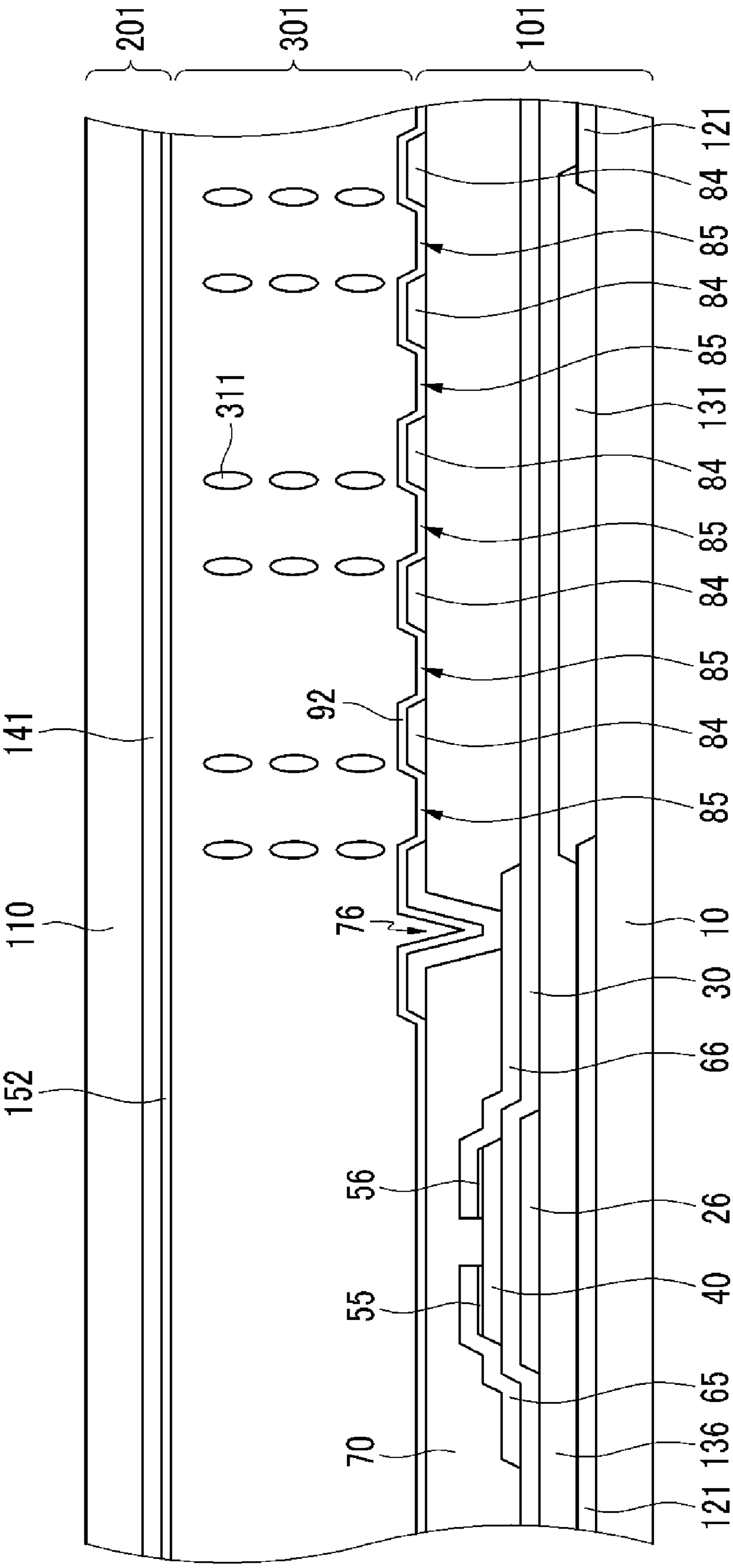
65
70
136
121

FIG.15


201
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10
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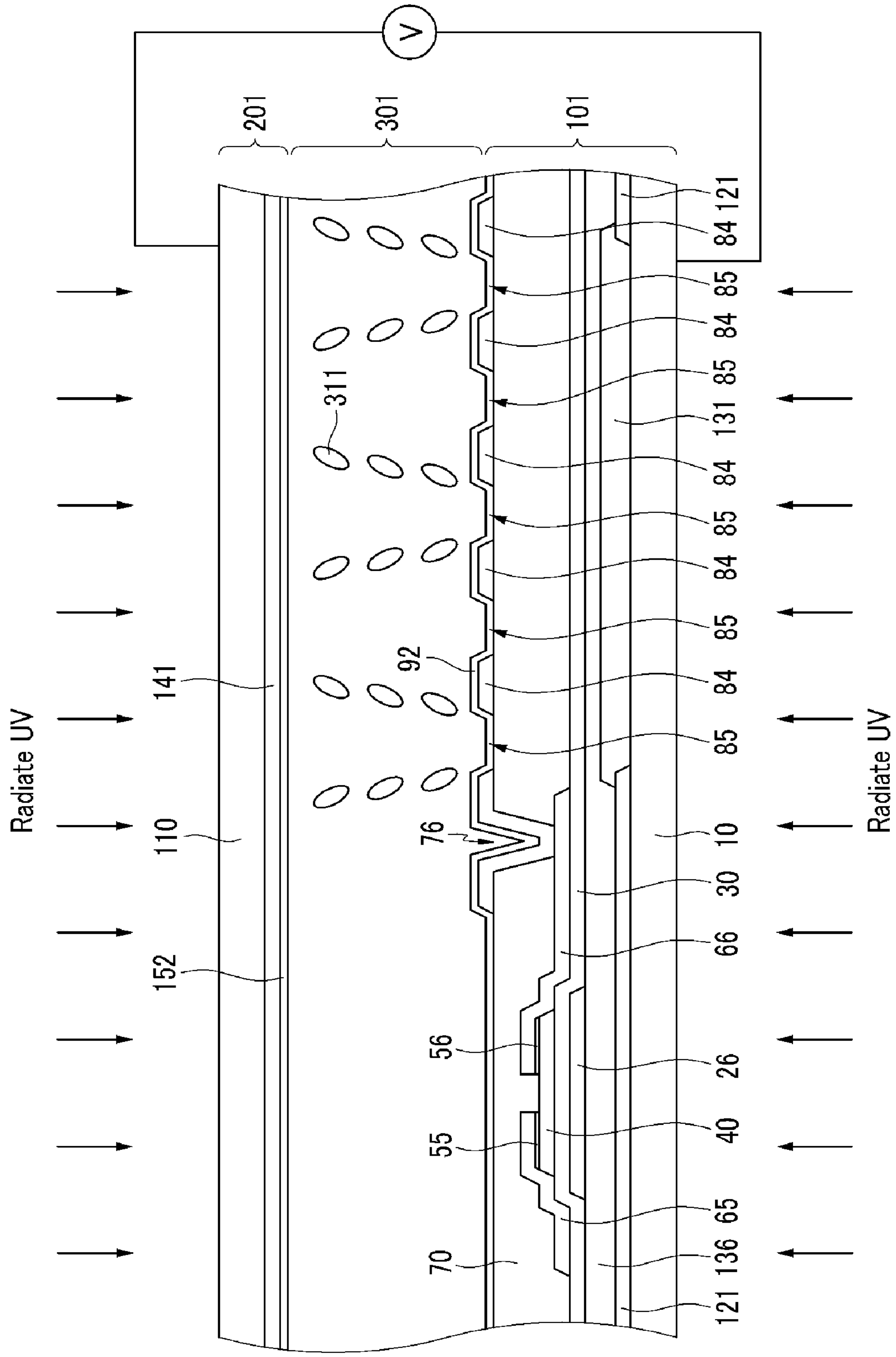
65
136
121
311
92
76
56
55
70
141
110
152

FIG.16


V
201
301
101
Radiate UV
Radiate UV
121
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85
131
311
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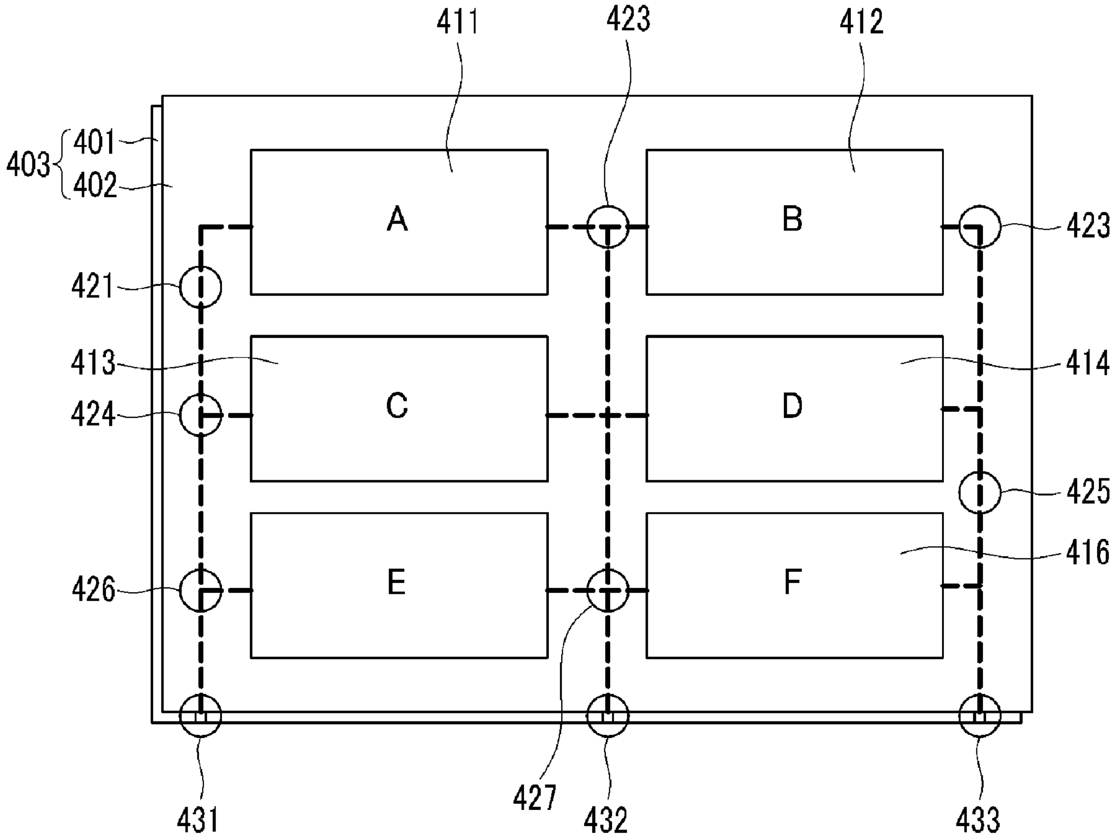
141
110
152
76
10
30
66
26
40
65
136
56
55
70

FIG.17


411
423
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401
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A
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413
C
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F
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431
432
433

FIG.18

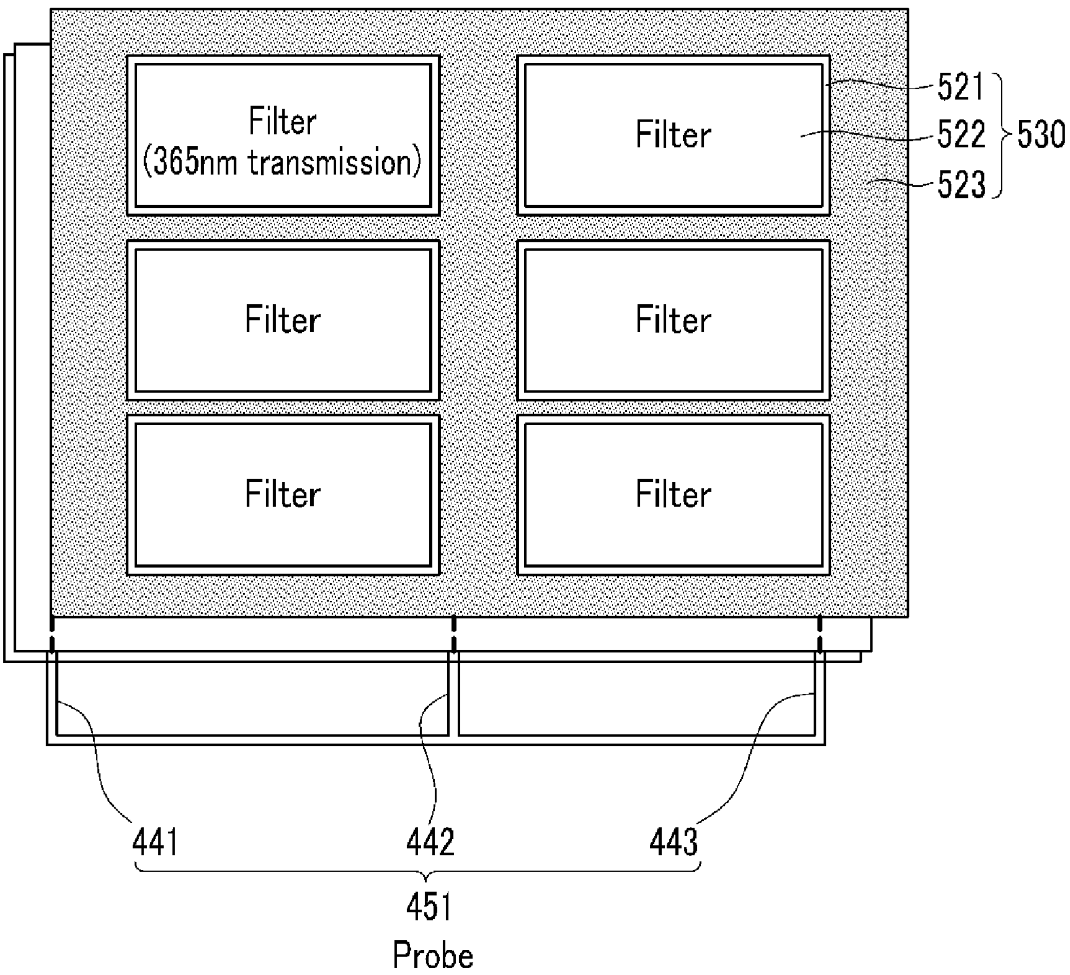
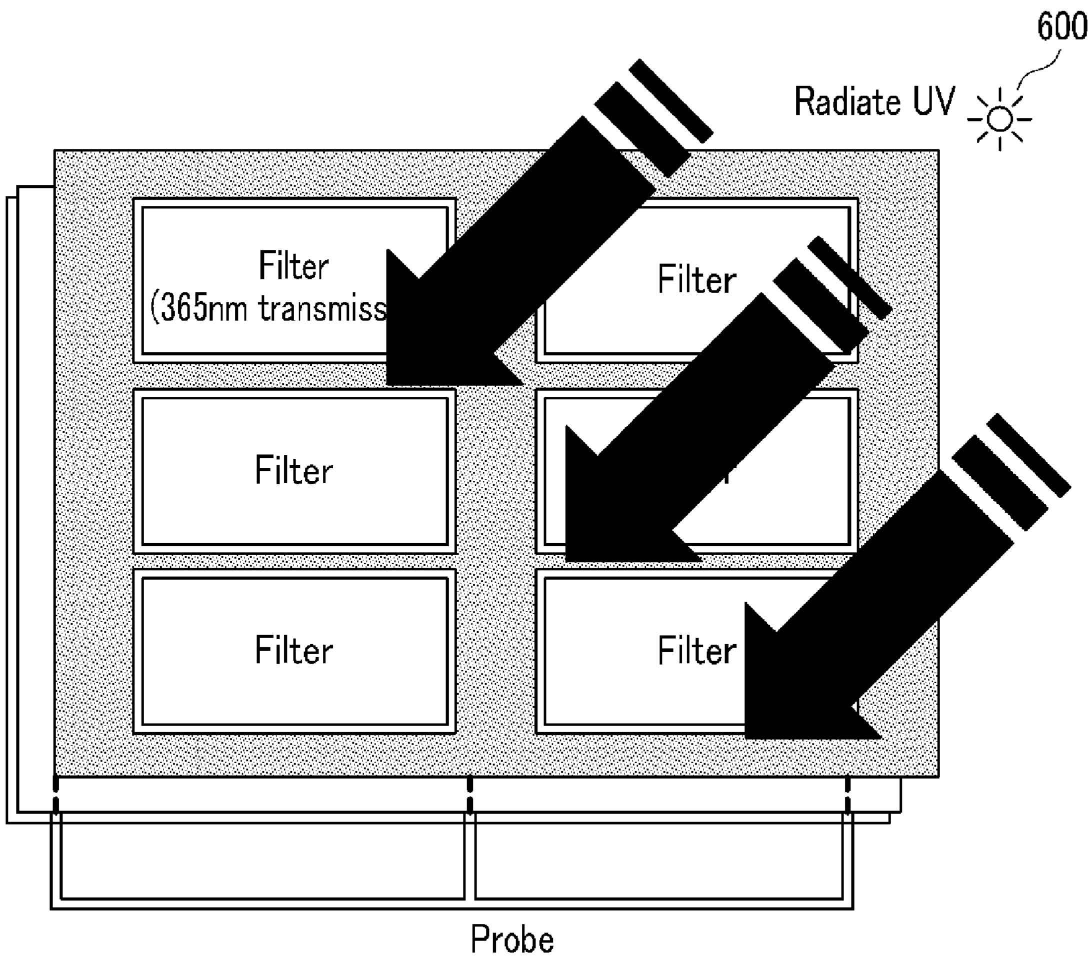

Filter
(365nm transmission)
Filter
Filter
Filter
Filter
Filter
521
522
523
530
441
442
443
451
Probe

FIG.19


600
Radiate UV
Filter
(365nm transmiss
Filter
Filter
Filter
Filter
Probe

METHOD OF MANUFACTURING LIQUID CRYSTAL DISPLAY

This application claims priority to Korean Patent Application No. 10-2008-0037778, filed on Apr. 23, 2008, and all the benefits accruing therefrom under 35 U.S.C. §119, the contents of which are herein incorporated by reference.

BACKGROUND OF THE INVENTION

(a) Field of the Invention

The present invention relates to a method for manufacturing a liquid crystal display.

(b) Description of the Related Art

Liquid crystal displays ("LCDs"), one of the most popular flat panel displays, include a first display panel, a second display panel, and a liquid crystal layer interposed between the first and second display panels. The LCD displays images by generating an electric field at the liquid crystal layer, determining the alignment of liquid crystals of the liquid crystal layer through the generated electric field, and controlling the polarization of incident light thereby.

In a vertical alignment ("VA") mode LCD, a longitudinal axis of liquid crystal is aligned vertically to upper and lower substrates in the absence of an applied electric field. Since the VA mode LCD has a great contrast ratio and a wide reference viewing angle, the VA mode LCD has been receiving increased attention. In order to embody a wide viewing angle in the VA mode LCD, a domain-forming member is formed in a field generating electrode. For example, the domain-forming member may be an aperture or a protrusion on the field generating electrode.

As examples, LCDs having a domain-forming member include a VA mode liquid crystal display having domain-forming members formed at both of the upper and lower substrates, and a patternless VA mode liquid crystal display having miniature patterns formed only at a lower substrate without forming patterns on an upper substrate. A display area is sectored into a plurality of domains by the domain-forming members, and liquid crystals in each domain are inclined in the same direction.

Lately, a technology for pre-tilting liquid crystals at a predetermined angle has been introduced in order to improve response speed. For example, liquid crystals are disposed between first and second display panels, an alignment supplement is added between the first and second display panels to pre-tilt the liquid crystals at a predetermined angle, and the alignment supplement is hardened.

In a process of hardening the alignment supplement and liquid crystals are aligned by applying a voltage in the liquid crystal display, and the alignment supplement among the aligned liquid crystals is hardened with a predetermined pre-tilt angle at a surface of the alignment material.

BRIEF SUMMARY OF THE INVENTION

The present invention relates a method for manufacturing a liquid crystal display. More particularly, the present invention relates to a method for manufacturing a liquid crystal display for reducing afterimages and improving response speed of a liquid crystal.

The present invention provides a method for manufacturing a liquid crystal display in order to reduce overall manufacturing processes by simultaneously hardening an alignment supplement and a sealant for sealing upper and lower substrates of each liquid crystal panel.

The technical objects of the present invention are not limited by the above-described technical objects, and other technical objects not described above may be clearly understood by a person of ordinary skill in the art based on the following description.

An exemplary embodiment of the present invention provides a method of manufacturing a liquid crystal display including; forming a mother substrate assembly by disposing a liquid crystal mixture layer having liquid crystals and a light curable alignment supplement between a first mother substrate and a second mother substrate of a liquid crystal display, and disposing a light curable sealant surrounding the liquid crystal mixture, pretilting liquid crystal molecules of the liquid crystal mixture layer by applying a voltage to the first mother substrate and the second mother substrate, and simultaneously hardening the alignment supplement and the sealant by radiating light to the mother substrate assembly while applying the voltage to the first mother substrate and the second mother substrate.

Details of other exemplary embodiments are included in detailed description and drawings.

As described above, overall manufacturing processes can be reduced and a manufacturing time can be shortened by simultaneously hardening a monomer for pre-tilt and a sealant through radiating ultraviolet rays.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a top plan layout view of an exemplary embodiment of a liquid crystal display ("LCD") manufactured by an exemplary embodiment of a method for manufacturing an LCD in accordance with the present invention.

FIG. **2** is a cross-sectional view of an LCD of FIG. **1** taken along line A-A'.

FIGS. **3-6** are cross-sectional views illustrating an exemplary embodiment of a method for manufacturing an LCD according to the present invention.

FIG. **7**A is a cross-sectional view illustrating monomers of FIG. **6** and movements of liquid crystal molecules according to an applied voltage.

FIG. **7**B is a cross-sectional view illustrating monomers of FIG. **6** and movements of liquid crystal molecules according to an applied voltage.

FIG. **8** is a cross-sectional view illustrating monomers that are hardened after step b) of FIG. **7** and liquid crystal molecules without a voltage being applied.

FIG. **9** and FIG. **10** are cross-sectional views of an exemplary embodiment of an LCD having a color filter and a black matrix disposed on a first substrate in a manufacturing process of the LCD of FIG. **1**.

FIG. **11** is a top plan layout view of another exemplary embodiment of an LCD manufactured by an exemplary embodiment of a method of manufacturing an LCD according to the present invention.

FIG. **12** is a cross-sectional view of the LCD of FIG. **11** taken along line B-B'.

FIGS. **13-16** are cross-sectional views illustrating an exemplary embodiment of a method for manufacturing another exemplary embodiment of an LCD according to the present invention.

FIG. **17** is a schematic diagram illustrating the exemplary embodiment of an LCD of FIG. **1** or FIG. **11** having a plurality of mother substrate assemblies.

FIG. **18** is a schematic diagram illustrating a probe and an ultraviolet mask arranged at the mother substrate assembly of FIG. **17**.

FIG. **19** is a schematic diagram illustrating the mother substrate assembly of FIG. **18** with ultraviolet rays being applied thereto.

DETAILED DESCRIPTION OF THE INVENTION

The invention now will be described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as 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. Like reference numerals refer to like elements throughout.

It will be understood that when an element is referred to as being "on" another element, it can be directly on the other element or intervening elements may be present therebetween. In contrast, when an element is referred to as being "directly on" another element, there are no intervening elements present. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

It will be understood that, although the terms first, second, third etc. may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms are only used to distinguish one element, component, region, layer or section from another element, component, region, layer or section. Thus, a first element, component, region, layer or section discussed below could be termed a second element, component, region, layer or section without departing from the teachings of the present invention.

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," or "includes" and/or "including" when used in this specification, specify the presence of stated features, regions, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, regions, integers, steps, operations, elements, components, and/or groups thereof.

Furthermore, relative terms, such as "lower" or "bottom" and "upper" or "top," may be used herein to describe one element's relationship to another elements as illustrated in the Figures. It will be understood that relative terms are intended to encompass different orientations of the device in addition to the orientation depicted in the Figures. For example, if the device in one of the figures is turned over, elements described as being on the "lower" side of other elements would then be oriented on "upper" sides of the other elements. The exemplary term "lower", can therefore, encompasses both an orientation of "lower" and "upper," depending on the particular orientation of the figure. Similarly, if the device in one of the figures is turned over, elements described as "below" or "beneath" other elements would then be oriented "above" the other elements. The exemplary terms "below" or "beneath" can, therefore, encompass both an orientation of above and below.

Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and the present disclosure, and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

Exemplary embodiments of the present invention are described herein with reference to cross section illustrations that are schematic illustrations of idealized embodiments of the present invention. As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, embodiments of the present invention should not be construed as limited to the particular shapes of regions illustrated herein but are to include deviations in shapes that result, for example, from manufacturing. For example, a region illustrated or described as flat may, typically, have rough and/or nonlinear features. Moreover, sharp angles that are illustrated may be rounded. Thus, the regions illustrated in the figures are schematic in nature and their shapes are not intended to illustrate the precise shape of a region and are not intended to limit the scope of the present invention.

Hereinafter, an exemplary embodiment of an exemplary embodiment of a method for manufacturing an exemplary embodiment of a liquid crystal display ("LCD") in accordance with the present invention will be described with reference to FIG. **1** to FIG. **10** and FIG. **17** to FIG. **19**.

FIG. **1** is a top plan layout view of an exemplary embodiment of an LCD manufactured by an exemplary embodiment of a method for manufacturing an LCD in accordance with the present invention, FIG. **2** is a cross-sectional view of the exemplary embodiment of an LCD of FIG. **1** taken along line A-A', FIGS. **3-6** are cross-sectional views illustrating an exemplary embodiment of a method for manufacturing an exemplary embodiment of an LCD according to the present invention, and FIG. **7** is a cross-sectional view illustrating monomers of FIG. **6** and movements of liquid crystal molecules according to an applied voltage. FIG. **8** is a cross-sectional view illustrating monomers that are hardened after step b) of FIG. **7** and liquid crystal molecules without a voltage being applied, and FIG. **9** and FIG. **10** are cross-sectional views of the exemplary embodiment of an LCD having a color filter and a black matrix disposed on a first substrate in a manufacturing process of the LCD of FIG. **1**. FIG. **17** is a schematic diagram illustrating an LCD of FIG. **1** or FIG. **11** having a plurality of mother substrate assemblies. FIG. **18** is a schematic diagram illustrating a probe and an ultraviolet mask arranged at the mother substrate assembly of FIG. **17**. FIG. **19** is a schematic diagram illustrating the mother substrate assembly of FIG. **18** with ultraviolet rays being applied thereto.

As shown in FIG. **1** and FIG. **2**, the exemplary embodiment of an LCD according to the present invention includes a first display panel **100**, a second display panel **200** and a liquid crystal mixture layer **300** interposed between the first and second display panels **100** and **200**.

As shown in FIG. **3**, the first display panel **100** including a plurality of elements such as a pixel electrode **82** having a domain-forming member **83** is prepared for manufacturing such an LCD. In particular, a metal layer for forming a gate wiring is stacked on an insulation substrate **10**. In one exemplary embodiment, the gate wiring may be formed through sputtering. The gate wiring includes a gate line **22**, a gate electrode **26** and a storage electrode **28**, and is formed by patterning the metal layer.

Then, a gate insulating layer **30**, exemplary embodiments of which are made of silicon nitride SiNx, is formed on the gate wiring. In one exemplary embodiment the gate insulating layer **130** is formed through plasma enhanced chemical vapor deposition ("PCVD").

Hydrogenated amorphous silicon, polysilicon, an n+ hydrogenated amorphous silicon semiconductor layer **40** with an n-type impurity doped at a high concentration, and a conductive layer for forming a data wiring are sequentially deposited on the gate insulating layer **30**. In one exemplary embodiment the amorphous silicon, polysilicon, n+ hydrogenated amorphous silicon semiconductor layer **40**, and data wiring are formed through sputtering. Then, a semiconductor layer **40**, ohmic contact layers **55** and **56**, a data line **62**, a source electrode **65** and a drain electrode **66** are formed by etching the result through photolithography.

Then, a passivation layer **70** is formed on the result. In one exemplary embodiment the passivation layer may be formed through reactivity chemical vapor deposition. A contact hole **76** is formed to expose a predetermined part of the drain electrode **66**.

Subsequently, a conductive material is formed on the passivation layer **70**. In one exemplary embodiment the conductive material may be formed through sputtering, and a pixel electrode **82** having the domain-forming member **83** is formed by patterning the conductive material. The pixel electrode **82** may be made of a transparent conductor exemplary embodiments of which include indium tin oxide ("ITO") and indium zinc oxide ("IZO"), and the pixel electrode **82** may be made of an opaque conductor, exemplary embodiments of which include aluminum. Here, the domain-forming member **83** may be an aperture in the pixel electrode **82** or a protrusion (not shown). Hereinafter, the pixel electrode **82** will be described to have an aperture as the domain-forming member **83** in further detail. However, the present invention is not limited thereto.

As shown in FIG. **1**, the pixel electrode **82** is divided into a plurality of domain regions by apertures **83** formed in an incision pattern. Here, the apertures **83** include a horizontal member which extends to a horizontal midpoint of the pixel electrode **82**, and oblique line members which extend in an oblique direction at an upper part and a lower part of the pixel electrode **82**. Here, the oblique line member of the upper part is substantially perpendicular to the oblique line member of the lower part in order to uniformly distribute a horizontal electric field in four directions. Each of the oblique line members includes a part that substantially forms an angle of about 45° from the gate line **22** when seen from a top plan view, and another part that substantially forms an angle of about −45° from the gate line **22** when send from a top plan view. The upper and lower apertures **83** may have a mirror symmetry about the storage electrode **28** which divides the pixel area into two substantially equal upper and lower parts. In one exemplary embodiment, the oblique line member of the aperture **83** may be formed in the upper part of the pixel electrode **82** to substantially form an angle of about 45° from the gate line **22** from a top plan view perspective and another oblique line member of the aperture **83** may be formed in the lower part of the pixel electrode **82** to substantially form an angle of about −45° from the gate line **22** from a top plan view perspective, as shown in FIG. **1**. However, the present invention is not limited thereto. The shape and arrangement of the oblique line members of the apertures **83** may be changed within a range that allows the oblique line member of the aperture **83** to substantially form about 45° or about −45° from the gate line **22**.

Using the aperture **83** of the pixel electrode **82**, the display area of the pixel electrode **82** is divided into a plurality of domains according to alignment directions of the liquid crystal molecules **310** included in a liquid crystal mixture layer **300** when an electric field is applied to liquid crystal molecules **310**. Here, the domain denotes a region formed of liquid crystals, where liquid crystal molecules **310** are grouped and inclined in a predetermined direction by an electric field formed between the pixel electrode **82** and a common electrode **140**.

Then, a first vertical alignment layer **92** is formed on the pixel electrode **82**. In one exemplary embodiment, the first vertical alignment layer **92** may be formed through printing. The first vertical alignment layer **92** vertically aligns the liquid crystal molecules **310** with a second vertical alignment layer **152**. The second vertical alignment layer **152** will be described later.

Meanwhile, a color filter **351** and a light blocking member **362** may be formed at a lower part or a upper part of a thin film transistor Q in the first display panel **100**, as shown in FIG. **9** and FIG. **10**.

Subsequently, as shown in FIG. **4**, the second display panel **200** is disposed to face the first display panel **100**. The second display panel **200** includes a plurality of elements such as a common electrode **140** having a domain-forming member (not shown).

In particular, a black matrix **120** is disposed on an insulation substrate **110**. In one exemplary embodiment, the black matrix **120** may be formed by depositing an opaque material such as chromium on the insulation substrate **110** and patterning the deposited opaque material. The black matrix **120** prevents light leakage and defines a pixel area.

Then, a color filter layer is formed on the black matrix **120** and a top surface of the insulation substrate **110**, which is exposed by the black matrix **120**. In one exemplary embodiment, a photosensitive resist may be coated to form the color filter layer. Red, green, and blue color filters **130** are formed by exposing and developing the color filter layer. Then, an overcoat layer **135** is formed on the black matrix **120** and the color filters **130**.

A common electrode **140** is then formed on the overcoat layer **135**. In one exemplary embodiment, the common electrode **140** may be formed by coating a conductive material on the overcoat layer **135**.

Subsequently, the second vertical alignment layer **152** is formed on the common electrode **140**. In one exemplary embodiment, the second vertical alignment layer **152** may be formed through printing.

Referring to FIG. **9**, a column spacer **361** may be formed at the second display panel **200** to sustain a cell gap, which is a distance between the first display panel **100** and the second display panel **200**. In one exemplary embodiment, the column spacer **361** has a black color so that it operates as a black matrix. In an alternative exemplary embodiment, the column spacer **361** may be formed at the first display panel instead of the second display panel **200**. Referring to FIG. **10**, the cell gap may be sustained by distributing bead spacers **363** at one of the two display panels **100** and **200** instead of, or in combination with, the column spacer **361**. Referring to FIG. **9** and FIG. **10**, a sealant **340** is coated at the circumference of the first display panel **100** or the second display panel **200** in order to seal the liquid crystal mixture **300** between the first and second display panels.

Referring to FIG. **5**, a liquid crystal mixture **300** having liquid crystals and an alignment supplement is coated on one of the first and second display panels **100** and **200**, in one exemplary embodiment they may be coated through a drip process, and the two display panels **100** and **200** are then bonded together. Alternative exemplary embodiments include configurations wherein, the first and second display panels **100** and **200** are bonded together, and the liquid crystal mixture **300** is then interposed between the first display panel **100** and the second display panel **200**, in one exemplary embodiment the interposing may be done using an injection process. In one exemplary embodiment, the liquid crystal may have negative dielectric anisotropy, e.g., the liquid crystal may be nematic liquid crystal. The alignment supplement is a reactive monomer, and in one exemplary embodiment the alignment supplement is an ultraviolet curable monomer. In one exemplary embodiment, the liquid crystal mixture may further include an ultraviolet hardening initiator, e.g., the ultraviolet curable monomer may be an acrylate monomer. The ultraviolet curable monomer is made of a material that can be cured by light having a wavelength in an ultraviolet region of the electromagnetic spectrum. In one exemplary embodiment, the ultraviolet curable monomer may be 2,2-dimethoxy-1,2-diphenyl ethanone. The ultraviolet hardening initiator may be present in a range between about 0 wt % and about 0.05 wt % based on the liquid crystals, and the ultraviolet curable monomer may be present in a range between about 0 wt % and about 1 wt % based on the liquid crystals.

Subsequently, referring to FIG. **6**, the alignment supplement as well as the sealant **340** are hardened after applying a pre-tilt voltage V to the first and second display panels **100** and **200**. If the alignment supplement is the ultraviolet curable monomer, the ultraviolet rays are radiated for hardening the alignment supplement. In one exemplary embodiment, the pre-tilt voltage V may be applied through a visual test pad of the first and second display panels **100** and **200** or an additional voltage applying unit. The pre-tilt voltage V applied through an additional voltage applying unit will be described with reference to FIGS. **17-19**.

Referring to FIG. **17**, wiring lines **421**, **423**, **424**, **425**, **426**, and **427** for applying a voltage and pads **431** to **433** connected thereto are formed on a first mother substrate **401** and a second mother substrate **402**. Here, a plurality of first display panels **100** may be formed on the first mother substrate **401**, and a plurality of second display panels **200** may be formed on the second mother substrate **402**. The wiring lines **421**, **423**, **424**, **425**, **426**, and **427** for applying a voltage and the pads **431** to **433** may be made of substantially the same material and manufactured through the same manufacturing method as the gate wires, the data wires, the pixel electrodes **82**, or the common electrodes **140**. In FIG. **17**, each of reference numerals **411** to **416** denotes a region that becomes one of a plurality of LCDs, and reference numeral **403** denotes a mother substrate assembly including the first mother substrate **401**, the second mother substrate **402**, the liquid crystal mixture layer **300**, and the sealant **340**.

In FIG. **17**, the wiring lines **421**, **423**, **424**, **425**, **426**, and **427** may be formed at both the first and second mother substrates **401** and **402**. Some of the wiring lines **421**, **423**, **424**, **425**, **426**, and **427** may be formed at the first mother substrate **401**, and the others may be formed at the second mother substrate **402**. A voltage may be separately applied to the first and second mother substrates **401** and **402**. Alternative exemplary embodiments include configurations wherein, the voltage may be applied to one of the first and second mother substrates **401** and **402**, and the one receiving the voltage transfers the voltage to the other. In such an alternative exemplary embodiment, it is necessary to have a break point that connects the two mother substrates **401** and **402**.

The two mother substrates **401** and **402** must be slightly unevenly overlapped in order to expose the pads **431** to **433**. Accordingly, regions formed in the first and second mother substrates **401** and **402** must be formed to unevenly overlap each other.

As shown in FIG. **18**, electrodes **441** to **443** of a probe **451** are connected to the pads **431** to **433**, and an ultraviolet mask **530** is aligned with the mother substrate assembly **403**. The ultraviolet mask **530** includes a sealant filter **521**, a display area filter **522**, and a black region **523**. The sealant filter **521** transmits ultraviolet wavelength light. The sealant filter **521** transmits light having a wavelength of less than about 380 nm, and in one exemplary embodiment, the sealant filter **521** transmits a wavelength of less than about 365 nm. The display area filter **522** transmits light having a predetermined wavelength of ultraviolet rays, in one exemplary embodiment the display area filter **522** transmits light having a wavelength of about 365 nm, about 313 nm and about 303 nm. Alternative exemplary embodiments include configurations wherein the display area filter **522** transmits ultraviolet rays having a short wavelength, for example about 370 nm. Here, the black region **532** may be made of a transparent material or an opaque material, excluding the filter units **521** and **522** of the ultraviolet mask **530**. Also, exemplary embodiments include configurations wherein the ultraviolet mask **530** may be similar to, slightly smaller than, or slightly larger than the mother substrate assembly **403** in size. In one exemplary embodiment, the ultraviolet mask **530** may be formed by forming two types of filters **521** and **522** inside a black mask after forming the black mask.

In one exemplary embodiment the mother substrate assembly **403** is separated from the ultraviolet mask **530** by about 20 cm to about 1 m. In one exemplary embodiment, the power of a lamp producing the ultraviolet rays is greater than 0.1 mW, and the ultraviolet rays are radiated for about one second. Under some circumstances, the power may be greater or smaller than 0.1 mW, and the radiation time thereof may be longer or shorter than one second, as would be apparent to one of ordinary skill in the art.

Referring to FIG. **7**A and **7**B, if ultraviolet rays **600** are radiated while applying a pre-tilt voltage **610**, liquid crystal molecules become pre-tilted molecules **310***a*. Therefore, response speed is improved when an LCD is driven. Also, afterimages are reduced when an LCD displays a black screen in a normally black mode when power is not applied to the LCD.

In particular, it is determined that the response speed is improved and the afterimages are reduced because of the following reasons. When the ultraviolet rays **600** are radiated, hardening begins from ultraviolet curable monomers **321***a* and **321***b* that are adjacent to the first and second alignment layers **92** and **152**. If the magnitude of the pre-tilt voltage **610** increases, the liquid crystal molecules **310** are tilted by an electric field that is induced according to the aperture of the pixel electrode **82**. Accordingly, the ultraviolet curable monomers **321***a* and **321***b* are also tilted and hardened in an orientation similar to the liquid crystal molecules **310***a*. In one exemplary embodiment, the ultraviolet curable monomers adjacent to the first and second alignment layers **92** and **152** may be vertically hardened. In such an exemplary embodiment, the ultraviolet curable monomers may be tilted and hardened in an orientation similar to the liquid crystal molecules **310** as the ultraviolet curable monomers recede from the first and second alignment layers **92** and **152**.

Since the liquid crystal molecules **310** can maintain the pre-tilt because of the ultraviolet curable monomers **321***a* and **321***b* even when no electric field is applied after completely manufacturing the LCD, the liquid crystal molecules **310** can be quickly tilted in a predetermined direction when the electric field is applied to the liquid crystal mixture layer **300**. Therefore, response speed of the LCD is improved, and afterimages are reduced.

After performing the ultraviolet ray hardening process as described above, each of the LCDs is cut from the mother substrate assembly **403**. Then, the manufacturing of each LCD is completed by disposing a backlight assembly having a lamp at a lower part of the liquid crystal panel. However, in another exemplary embodiment, the pixel electrode **82** of the first display panel **100** according to the present exemplary embodiment may be constituted as a plurality of miniature electrodes which form a plurality of miniature slits.

Hereinafter, an exemplary embodiment of a method of manufacturing an LCD according to another exemplary embodiment will be described with reference to FIGS. **11-19**.

FIG. **11** is a top plan layout view of another exemplary embodiment of an LCD manufactured by an exemplary embodiment of a manufacturing method of an LCD according to the present invention. FIG. **12** is a cross-sectional view of an LCD of FIG. **11** taken along line B-B', and FIGS. **13-16** are cross-sectional views illustrating a manufacturing method of an LCD according to the current exemplary embodiment of the present invention.

Referring to FIG. **12**, unlike the previous exemplary embodiment shown in FIGS. **1-6**, in the current exemplary embodiment a color filter **131** and a pixel electrode **84** are formed on a first display panel **101**. The LCD manufactured by the manufacturing method according to the present exemplary embodiment has an Array On Color filter ("AOC") structure or a Color filter On Array ("COA") structure. In the AOC structure, a thin film transistor array including a gate wiring is formed on the color filter **131**. In the COA structure, the color filter **131** is formed on the thin film transistor array. Hereinafter, exemplary embodiments of the LCD will be described as having the AOC structure. Here, the location of sealant will be described with reference to FIG. **9** and FIG. **10**.

Initially, the first display panel **101** having a black matrix **121**, a color filter **131**, and a plurality of miniature and interconnected electrodes **84** is prepared as shown in FIG. **11** and FIG. **12**. The miniature electrodes **84** are disposed at regular intervals so as to form a plurality of miniature slits **85**.

In particular, a black matrix **121** is formed by depositing an opaque material, exemplary embodiments of which include chromium, on the insulation substrate **10** and patterning the deposited opaque material. Subsequently, red, green, and blue color filters **131** are formed by coating a photosensitive resist on the black matrix **121** and a front surface of an insulation substrate **10**, which is exposed by the black matrix **121**, and exposing and developing the photosensitive resist. Then, an overcoat layer **136** is formed on the black matrix **121** and the color filters **131**.

Thereafter, a gate wiring and a data wiring are formed on the overcoat layer **136** using substantially the same process as in the previous exemplary embodiment of a manufacturing method. The gate wiring includes a gate line **22**, a gate electrode **26**, and a storage electrode **28**, and the data wiring includes a gate insulating layer **30**, a semiconductor layer **40**, a data line **62**, a source electrode **65**, and a drain electrode **66**. Then, a passivation layer **70** having a contact hole **76** is formed on the result.

A conductive layer (not shown) for forming a pixel electrode is then formed on the passivation layer **70** and a pixel electrode formed of a plurality of miniature electrodes **84** is formed by patterning the conductive layer. In one exemplary embodiment, the conductive layer may be formed through sputtering. A main backbone structure is formed in a cross shape which divides the pixel electrode in four parts, and a plurality of miniature electrodes **84** extend in an oblique line direction from the main backbone structure by patterning the conductive material for a pixel electrode. Here, a plurality of miniature slits **85** is formed among the plurality of miniature electrodes **84**. In such an exemplary embodiment, a plurality of miniature electrodes **84** have an angle of about 45° from a transmissive axis of a polarizer and extend from the main backbone structure in four directions. Exemplary embodiments include configurations wherein a width of one end of the miniature electrode **84**, which is connected to the main backbone structure, may be identical to or different from a width of the other end. If the width of the miniature electrodes **84** is uniform, the width of the miniature electrodes **84** may be identical to or different from the width of the miniature slits **85**. In one exemplary embodiment, the width may be narrower than about 5 μm. In one exemplary embodiment, a width of one end of the miniature electrodes **84**, which are connected to the main backbone structure, may be wider than a width of the other end thereof.

A first vertical alignment layer **92** is formed above the pixel electrode to complete formation of the first display panel **101**.

Referring to FIG. **14**, a second display panel **201** having a common electrode **141** is provided to face the first display panel **101**. In particular, a conductive material for a common electrode is deposited on an insulation substrate **10**. In one exemplary embodiment, the conductive material may be formed through sputtering. Exemplary embodiments of the conductive material may be made of ITO. Since the common electrode according to the present exemplary embodiment is not patterned, the deposited conductive material for the common electrode may be used as the common electrode **141**. Since the conductive material for the common electrode is not patterned in the present exemplary embodiment, the manufacturing process time may be shortened. Also, the defect rate of the LCD may be reduced because there is no error alignment problem between domains of the first and second display panels **101** and **201**.

Then, a second vertical alignment layer **152** is formed on the common electrode **141**. In one exemplary embodiment, the second vertical alignment layer **152** may be formed through printing. The disposition of the second vertical alignment layer **152** completes the formation of the second display panel **201**.

Referring to FIG. **15**, in one exemplary embodiment a spacer and a sealant are formed on one of the two display panels **101** and **201**, the two display panels **101** and **201** are bonded together, and a liquid crystal mixture is injected therebetween in a vacuum state. Alternative exemplary embodiments include configurations wherein, a liquid crystal mixture is dripped on one of the two display panels **101** and **201**, and the two display panels **101** and **201** are bonded together. The liquid crystal mixture includes liquid crystal and an alignment supplement. The alignment supplement may include an ultraviolet curable monomer as described above. The liquid crystal mixture may further include an ultraviolet hardening initiator. Also, the liquid crystal mixture may include a dopant for controlling a pitch of the liquid crystal. Here, the dopant may be a chiral dopant, and improves a response speed of the LCD by shortening a pitch of a liquid crystal. In FIG. **15**, reference numeral **311** denotes a liquid crystal molecule, and reference numeral **301** denotes a liquid crystal mixture layer.

Referring to FIG. **16**, a pre-tilt voltage V is applied to the first and second display panels **101** and **201**. While applying the pre-tilt voltage V, ultraviolet rays are radiated to the display panel assembly having the first and second display panels **101** and **201** and the liquid crystal mixture layer **301**. In one exemplary embodiment, an ultraviolet radiating process is performed immediately after injecting the liquid crystal mixture.

If the ultraviolet curable monomer is not hardened because the color filter **131** absorbs ultraviolet rays, afterimages may be generated. Therefore, the ultraviolet rays may be radiated toward the second display panel **201** from the upper part of the second display panel **201** in order to minimize the absorption of the ultraviolet rays by the color filter **131**. However, the ultraviolet rays are radiated from both sides of the first and second display panels **101** and **102** according to the present exemplary embodiment.

If the ultraviolet rays are radiated to the LCD, the ultraviolet curable monomer and sealant are simultaneously hardened. Since an electric field is induced at the liquid crystal mixture layer **301** according to the miniature slits **85** of the pixel electrode when the voltage is applied to the first and second display panels **101** and **102**, the liquid crystal molecules **311** are tilted, and accordingly the ultraviolet curable monomers are also tilted. If the ultraviolet rays are radiated, the tilted ultraviolet curable monomers are hardened. Therefore, the tilted state of the liquid crystal molecules **311** is fixed. Since the liquid crystal molecules **311** can maintain the pre-tilt because of the ultraviolet curable monomers even when no electric field is applied after completely manufacturing the LCD, the liquid crystal molecules **311** can be quickly tilted in a predetermined direction when the electric field is applied to the liquid crystal mixture layer **301**. Therefore, response speed of the LCD is improved, and afterimages are reduced. Processes following those explicitly discussed herein may progress substantially identically to the previous exemplary embodiment.

As described above, the overall manufacturing processes can be reduced and manufacturing time can be shortened by simultaneously hardening a monomer for pre-tilt and a sealant through radiating ultraviolet rays.

While this invention 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. Therefore, it should be understood that the above-described exemplary embodiments are only examples, and the present invention is not limited thereto.

What is claimed is:

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

forming a mother substrate assembly by disposing a liquid crystal mixture layer having liquid crystals and a light curable alignment supplement between a first mother substrate and a second mother substrate of a liquid crystal display, and disposing a light curable sealant surrounding the liquid crystal mixture layer;

pre-tilting liquid crystal molecules of the liquid crystal mixture layer by applying a voltage to the first mother substrate and the second mother substrate; and

simultaneously hardening the light curable alignment supplement and the light curable sealant by radiating light to the mother substrate assembly while applying the voltage to the first mother substrate and the second mother substrate,

wherein the radiating light to the mother substrate assembly includes the light curable sealant receiving the light having a wavelength in a first range, while the light curable alignment supplement receives the light having a different wavelength in a second range shorter than the first range.

2. The method of claim **1**, wherein the light includes ultraviolet rays.

3. The method of claim **2**, wherein the mother substrate assembly includes a plurality of liquid crystal display regions, and

the mother substrate assembly further includes voltage-applying wiring which connects the liquid crystal display regions.

4. The method of claim **3**, wherein the simultaneously hardening includes aligning the mother substrate assembly and an ultraviolet mask.

5. The method of claim **4**, wherein the ultraviolet mask includes:

a first filter which transmits ultraviolet rays having a wavelength of the first range and wherein the first filter is disposed corresponding to the light curable sealant; and

a second filter which transmits ultraviolet rays having a wavelength of the second range and wherein the second filter corresponds to a display area surrounded by the light curable sealant.

6. The method of claim **5**, wherein the second filter transmits ultraviolet rays having a wavelength of about 365 nm.

7. The method of claim **2**, further comprising:

disposing a thin film transistor on the first mother substrate; and

disposing a color filter on or below the thin film transistor.

8. The method of claim **7**, further comprising:

disposing a pixel electrode on the first mother substrate;

disposing a first alignment layer on the pixel electrode;

disposing a common electrode on the second mother substrate; and

disposing a second alignment layer on the common electrode.

9. The method of claim **2**, wherein the alignment supplement includes an ultraviolet curable monomer.

10. The method of claim **9**, wherein a content of the ultraviolet curable monomer in the alignment supplement is equal to or greater than about 0 weight % and smaller than about 1 weight % based on the liquid crystals.

11. The method of claim **1**, wherein the pixel electrode includes a plurality of miniature electrodes that form a plurality of miniature slits.

12. A mask for ultraviolet rays, comprising:

a first filter which transmits light having a wavelength of about 320 nm to about 380 nm;

a second filter which surrounds the first filter and transmits light having a wavelength shorter than about 380 nm; and

one of a transparent and opaque region disposed outside the first and second filters.

13. A method for manufacturing a mask for ultraviolet rays, comprising:

forming a black mask;

disposing a first filter inside the black mask for transmitting light having a wavelength of about 320 nm to about 380 nm; and

disposing a second filter at the circumference of the first filter for transmitting light having a wavelength shorter than about 380 nm.

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

forming a first mother substrate;

disposing a second mother substrate facing the first mother substrate;

disposing a liquid crystal mixture layer having liquid crystals and an alignment supplement between the first and second mother substrates

surrounding the liquid crystal mixture layer with a sealant;

bonding the first and second mother substrates together using the sealant;

applying a pre-tilt voltage to the first and second mother substrates;

aligning a display panel assembly including the first and second mother substrates, the liquid crystal mixture layer, the sealant, and an ultraviolet mask having at least two types of ultraviolet filters each having a substantially different transmissive wavelength range; and

simultaneously hardening the alignment supplement and the sealant by radiating ultraviolet rays through the ultraviolet mask.

15. The method of claim **14**, wherein the mother substrate assembly includes a plurality of liquid crystal display regions, and

the mother substrate assembly further includes voltage-applying wiring which connects the liquid crystal display regions.

16. The method of claim **15**, wherein the bonding of the first and second mother substrates includes exposing a pad of the voltage-applying wiring via the alignment of the first and second mother substrates.

17. The method of claim **15**, wherein the radiating of the ultraviolet rays includes separating the display panel assembly from the ultraviolet mask by about 20 cm to about 1 m.

18. The method of claim **15**, wherein the ultraviolet mask is about the same size as the first and second mother substrates.

19. The method of claim **14**, wherein the ultraviolet mask includes:

a first filter which transmits ultraviolet rays having a wavelength in a first range corresponding to the sealant; and

a second filter which transmits ultraviolet rays having a wavelength in a second range shorter than the transmission wavelength of the first filter and wherein the second filter corresponds to a display area surrounded by the sealant.

20. The method of claim **19**, wherein the second filter transmits light having a wavelength of about 300 nm to about 380 nm.

21. The method of claim **20**, wherein the first filter transmits light having a wavelength shorter than about 365 nm.

22. The method of claim **21**, wherein the ultraviolet mask is disposed outside the first and second filters and further includes a region that is one of transparent, semitransparent and opaque.

* * * * *

专利名称(译)	制造液晶显示器的方法		
公开(公告)号	US8237908	公开(公告)日	2012-08-07
申请号	US12/260518	申请日	2008-10-29
[标]申请(专利权)人(译)	三星电子株式会社		
申请(专利权)人(译)	SAMSUNG ELECTRONICS CO., LTD.		
当前申请(专利权)人(译)	三星DISPLAY CO., LTD.		
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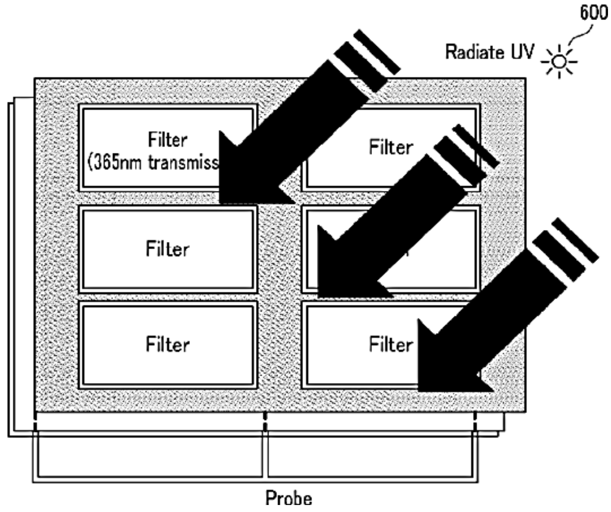
发明人	SEOK, MIN-GOO LYU, JAE-JIN PARK, SEUNG-BEOM SON, JONG-HO SOHN, JI-WON KYE, MYEONG-HA KIM, HOON NA, JUN-HEE		
IPC分类号	G02F1/1337 G02F1/13 G02F1/141 G02F1/1339		
CPC分类号	G02F1/1339 G02F1/133351 G02F1/134363 G03F1/14 G02F2001/133742 G02F2001/13775 G02F2001/133738		
代理机构(译)	康托科尔伯恩LLP		
优先权	1020080037778 2008-04-23 KR		
其他公开文献	US20090270007A1		
外部链接	Espacenet USPTO		

摘要(译)

一种制造液晶显示器的方法，包括：通过在液晶显示器的第一母基板和第二母基板之间设置具有液晶和光固化取向补充剂的液晶混合物层，并在液晶混合物层周围设置光固化密封剂，形成母基板组件，通过向第一母基板和第二母基板施加电压来预倾斜液晶混合物层的液晶分子，同时通过向母基板组件照射光并同时将电压施加到母基板组件来硬化对准补充剂和密封剂。第一母基板和第二母基板。


600
Radiate UV
Filter
(365nm transmiss
Filter
Filter
Filter
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Probe