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Nishino et al.

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(54) **LIQUID CRYSTAL DISPLAY DEVICE**

(56) **References Cited**

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U.S. PATENT DOCUMENTS

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6,100,954 A *	8/2000	Kim		G02F 1/133345	257/410
6,882,399 B2 *	4/2005	Park		G02F 1/1339	349/106
9,372,364 B2 *	6/2016	Kim		G02F 1/1339	
2007/0211202 A1 *	9/2007	Ishii		G02F 1/1339	349/153
2010/0253658 A1 *	10/2010	Tanaka		G02F 1/1339	345/205

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 9 days.

FOREIGN PATENT DOCUMENTS

JP	2008-191265 A	8/2008
JP	2012-150290 A	8/2012

* cited by examiner

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(21) Appl. No.: **14/817,520**

(22) Filed: **Aug. 4, 2015**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Aug. 6, 2014 (JP) 2014-160415

(51) **Int. Cl.**

G02F 1/1333 (2006.01)

G02F 1/1339 (2006.01)

G02F 1/1368 (2006.01)

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

CPC **G02F 1/1339** (2013.01); **G02F 1/1368** (2013.01); **G02F 1/133345** (2013.01); **G02F 2001/13396** (2013.01); **G02F 2001/133311** (2013.01)

(58) **Field of Classification Search**

CPC G02F 1/133345; G02F 1/1339

See application file for complete search history.

(57) **ABSTRACT**

In order to avoid generation of black unevenness caused by the water intrusion into a liquid crystal display device, there is to provide a liquid crystal display device including a display area and a terminal portion, in which a TFT substrate with an organic passivation film formed and an opposite substrate are adhered to each other by a seal portion and a liquid crystal is enclosed there, wherein in the seal portion of the TFT substrate, a groove-shaped through-hole is formed in the organic passivation film to surround the display area, a water absorption layer formed of the same material in the same process as that of the organic passivation film is formed within the groove-shaped through-hole, and the water absorption layer is not covered with the inorganic insulating film.

4 Claims, 9 Drawing Sheets

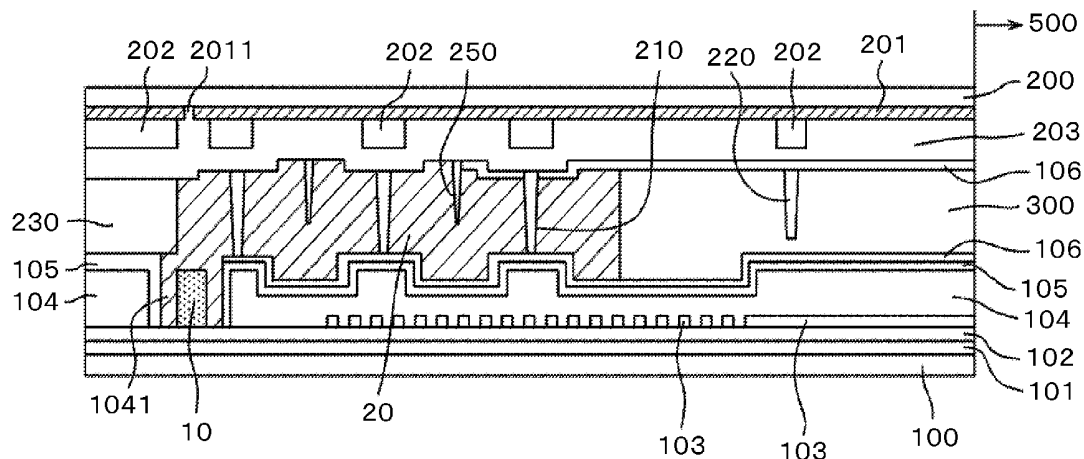


FIG. 1

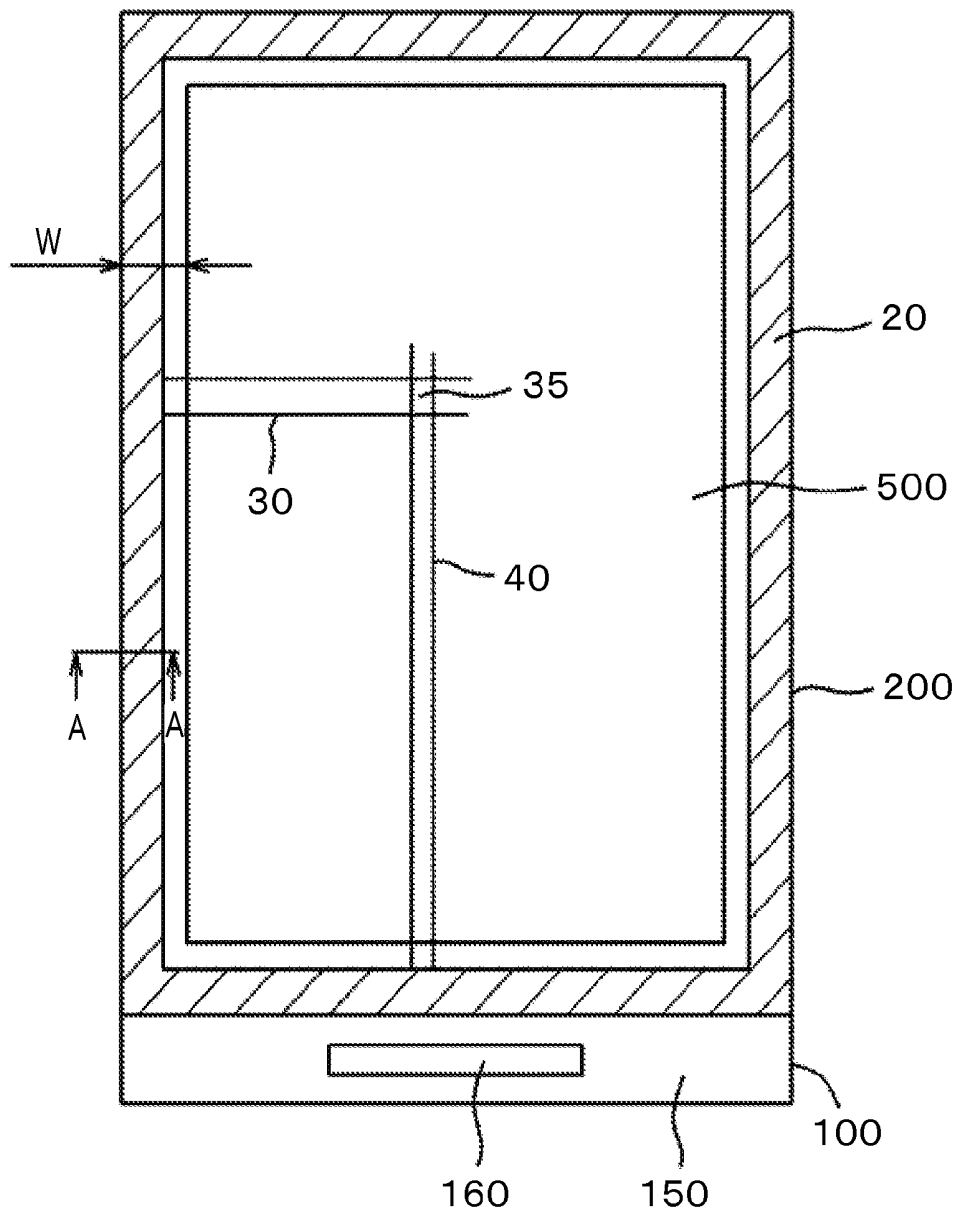


FIG. 3

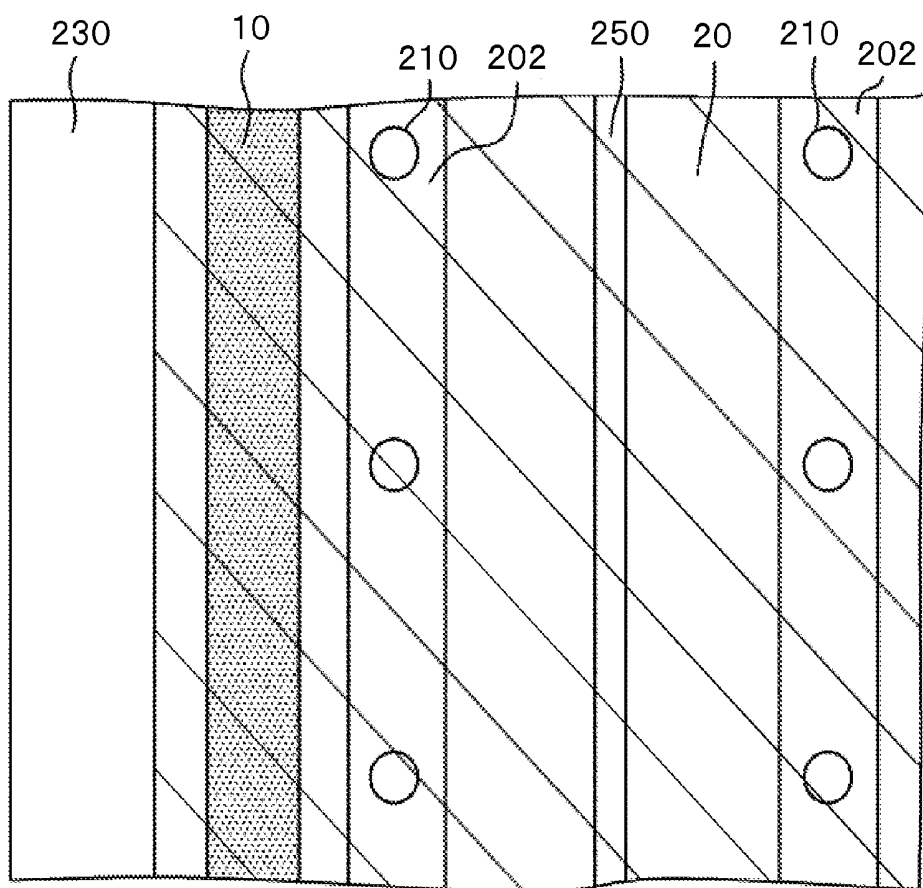


FIG. 4

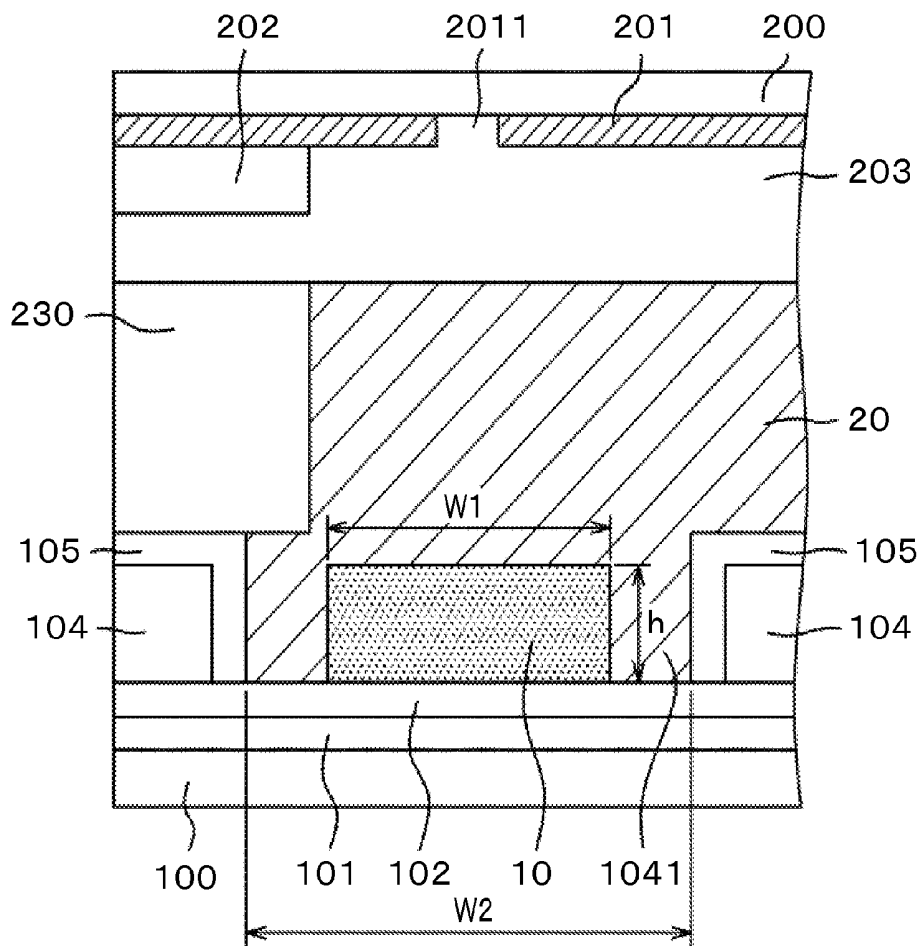


FIG. 6

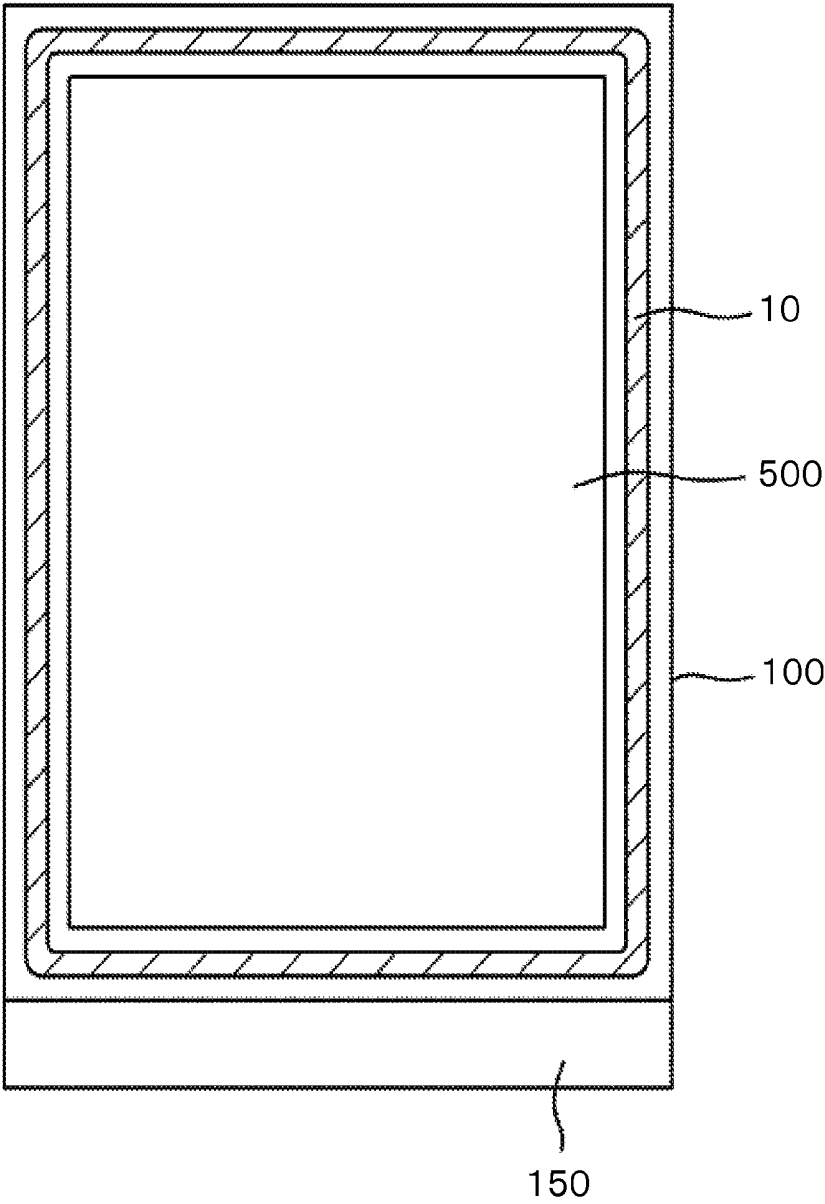
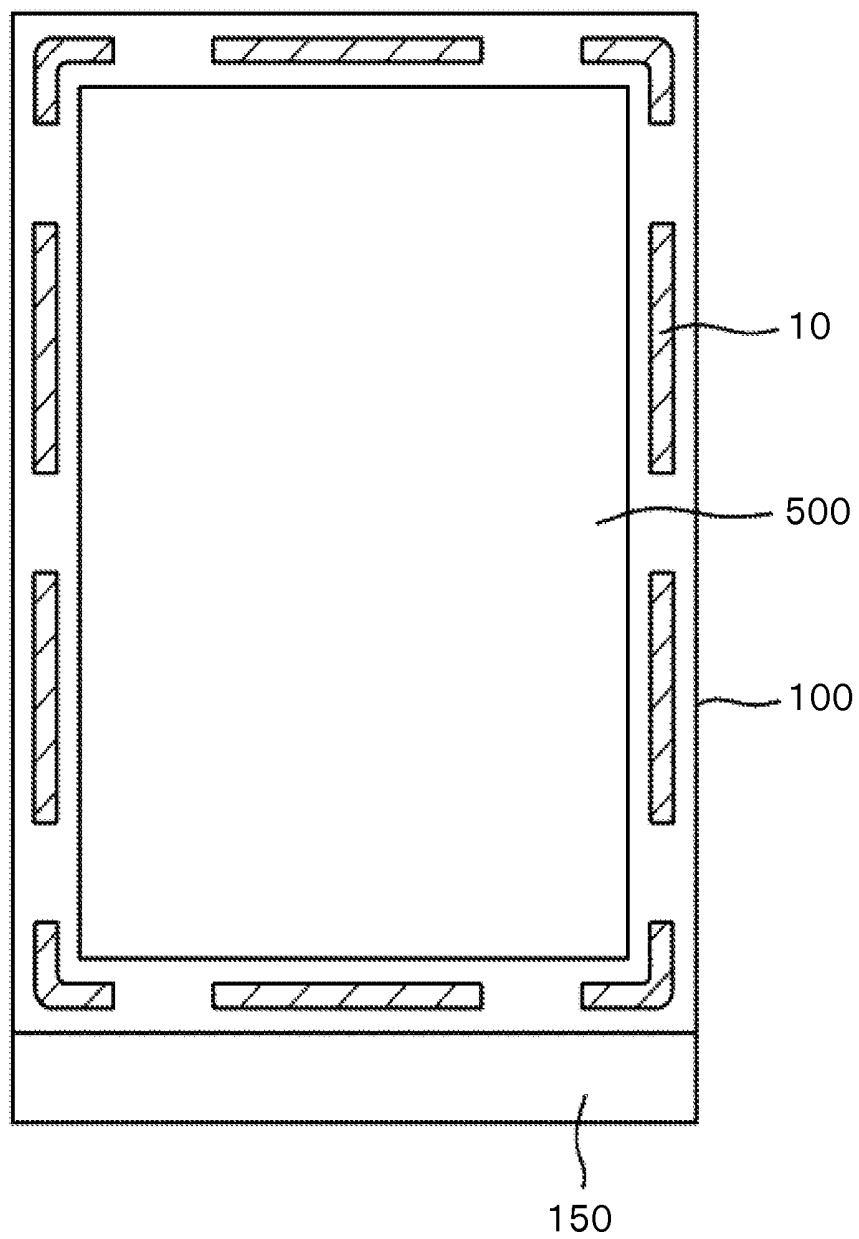


FIG. 7



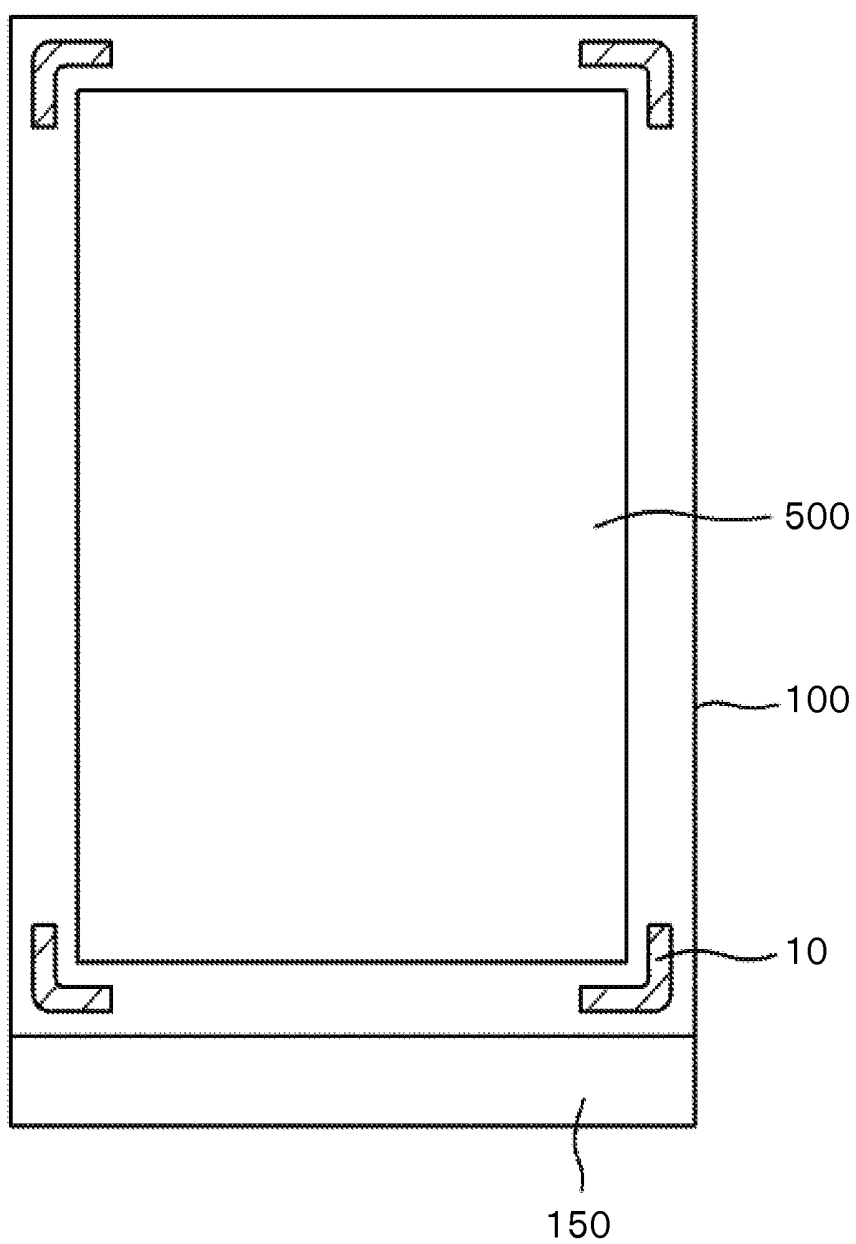
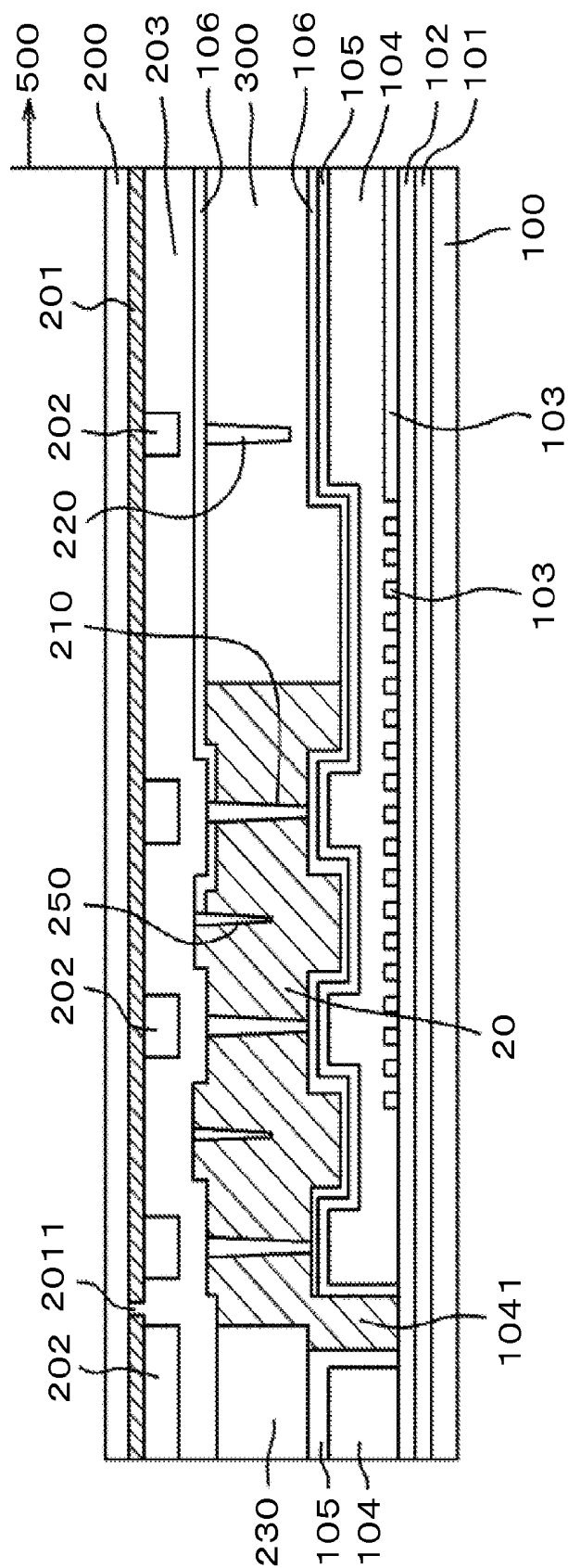


FIG. 9



LIQUID CRYSTAL DISPLAY DEVICE

CLAIM OF PRIORITY

The present application claims priority from Japanese Patent Application JP 2014-160415 filed on Aug. 6, 2014, the content of which is hereby incorporated by reference into this application.

BACKGROUND OF THE INVENTION

(1) Field of the Invention

The invention relates to a display device and particularly, to a liquid crystal display device capable of avoiding black unevenness generated in a display area.

(2) Description of the Related Art

A liquid crystal display device is formed by a TFT substrate with pixels including pixel electrodes and thin film transistors (TFT) formed in a matrix shape, an opposite substrate facing the TFT substrate, and a liquid crystal interposed between the TFT substrate and the opposite substrate. Then, an image is formed by controlling the transmittance of light through liquid crystal molecules in every pixel.

In a liquid crystal display device, there sometimes occurs black unevenness especially in the periphery of a display area. This may be affected by the water entering into the liquid crystal. In order to avoid the water from entering inside, various structures have been developed. On the other hand, there is another way of, even if water enters into the liquid crystal display device, adsorbing the water entered inside in order to suppress the affect on the liquid crystal.

Japanese Patent Publication Laid-Open No. 2008-191265 discloses a structure in which an adsorbent layer for adsorbing the water is arranged in a seal portion for sealing the TFT substrate and the opposite substrate. Japanese Patent Publication Laid-Open No. 2012-150290 discloses a structure in which an adsorbent layer for adsorbing the water is arranged between a display area and a seal portion.

SUMMARY OF THE INVENTION

The both structures described in Japanese Patent Publication Laid-Open No. 2008-191265 and Japanese Patent Publication Laid-Open No. 2012-150290 are to arrange an adsorption layer for adsorbing the water entered inside a liquid crystal display device; then, as the adsorption layer, a material which is not used usually for the liquid crystal display device is used. In other words, something other than the essential material for the operation of the liquid crystal display device is used as another component. This conventional method has the following problems:

(1) The other component is arranged in the different process; therefore, the manufacturing cost is increased according to an increase in the component cost and the process. (2) The material other than the essential material for the operation of the liquid crystal display device is used; therefore, it is necessary to check whether the display performance is affected by the material when the liquid crystal display device is operated for a long time.

An object of the invention is to solve the above problems and to avoid black unevenness from occurring in a liquid crystal display device by effectively adsorbing water entered into a liquid crystal display panel, without increasing the manufacturing cost and without deteriorating reliability.

The invention is to solve the above problems and the concrete means are as follows.

(1) A liquid crystal display device including a display area and a terminal portion, in which a TFT substrate with an organic passivation film formed there and an opposite substrate are adhered to each other by a seal portion and a liquid crystal is enclosed there, wherein in the seal portion of the TFT substrate, a groove-shaped through-hole is formed in the organic passivation film to surround the display area, a water absorption layer formed of the same material in the same process as that of the organic passivation film is formed within the groove-shaped through-hole, and the water absorption layer is not covered with the inorganic insulating film.

(2) The device according to the above (1), wherein the water absorption layer is continuously formed along the whole periphery to surround the display area.

(3) The device according to the above (1), wherein the water absorption layer is formed discontinuously to surround the display area.

(4) The device according to the above (1), wherein the water absorption layer is formed only in the corner portions of the display area.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top plan view of a liquid crystal display device according to the invention.

FIG. 2 is a cross-sectional view taken along the line A-A of FIG. 1.

FIG. 3 is an enlarged top plan view corresponding to FIG. 2.

FIG. 4 is an enlarged cross-sectional view of a seal portion of FIG. 2.

FIG. 5 is an enlarged cross-sectional view of another example of the seal portion of FIG. 2.

FIG. 6 is a schematic plan view illustrating the invention.

FIG. 7 is a schematic plan view illustrating another example of the invention.

FIG. 8 is a schematic plan view illustrating further another example of the invention.

FIG. 9 is a cross-sectional view illustrating the structure of the seal portion of the liquid crystal display device used together with the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Before describing the embodiment of the invention, a structure for avoiding water from entering into a liquid crystal layer, which is used together with the invention, will be described. FIG. 9 is a cross-sectional view in the vicinity of a seal portion of a liquid crystal display device. In FIG. 9, a TFT substrate 100 and an opposite substrate 200 are adhered to each other by a sealing material 20. An organic passivation film 4 serving also as a flattening film is formed on the TFT substrate 100. This organic passivation film 104 is formed of acrylate resin; therefore, the above film absorbs water and transmits the water easily. Further, the organic passivation film 104 also serves as the flattening film and formed thick with 1 to 4 μm , generally with 2 to 3 μm ; therefore, the above film easily transmits the water.

The organic passivation film is provided with a groove-shaped through-hole along the end portion of the TFT substrate 100 in a way of surrounding a display area. The water absorbed by the organic passivation film 104, coming from the end portion of the substrate inwardly, is shut out by the groove-shaped through-hole 1041 and does not arrive at a liquid crystal layer 300. In the groove-shaped through-hole

1041, the organic passivation film 104 is covered with the insulating film 105 formed of SiN; therefore, it takes a long time for the entered water to pass the groove-shaped through-hole 1041, hence to prolong a lifetime of the liquid crystal display device as much.

In the structure as illustrated in FIG. 9, however, once the water passes the insulating film 105, the water easily arrives at the liquid crystal layer 300. According to the structure as illustrated in FIG. 9, there is a limit to a long life of the liquid crystal display device.

In the opposite substrate 200 in FIG. 9, a black matrix 201 is formed extensively in the end portion of the substrate. The black matrix 201 is formed of an organic material in many cases. When the black matrix is formed of the organic material, water easily enters from the end portion. In order to shut down the water entered through the black matrix 201, a black matrix groove 2011 is formed. The black matrix is not so thick as the organic passivation film 104 in the TFT substrate 100 and therefore, the entered amount of the water is smaller than that on the side of the TFT substrate. The contents of the invention will be described in detail using the following embodiments.

First Embodiment

FIG. 1 is a top plan view of a liquid crystal display device to which the invention is applied. In FIG. 1, the TFT substrate 100 and the opposite substrate 200 are adhered to each other by the sealing material 20, with the liquid crystal interposed between the TFT substrate 100 and the opposite substrate 200. The TFT substrate 100 is formed larger than the opposite substrate 200, and a portion of only one sheet of the TFT substrate 100 is a terminal portion 150. In the terminal portion 150, an IC driver 160 for driving a liquid crystal display panel and terminals for connecting a flexible wiring substrate for supplying power, video signals, and scanning signals to the liquid crystal display panel are formed.

In FIG. 1, in a display area 500, scanning lines 30 respectively extend in a horizontal direction and are aligned in a vertical direction. Further, video signal lines 40 respectively extend in the vertical direction and are aligned in the horizontal direction. An area surrounded by the scanning line 30 and the video signal line 40 is a pixel 35. In a narrow frame, a distance w between the end portion of the display area 500 and the end portion of the liquid crystal display device is small with about 1 mm. In this case, the width of the sealing material becomes smaller and if so, the outside water gets easily reach the liquid crystal layer in the display area. This easily causes a so-called black unevenness easily, affected by the water.

FIG. 2 is a detailed cross-sectional view of a seal portion corresponding to the cross section taken along the line A-A of FIG. 1. In the seal portion illustrated in FIG. 2, the TFT substrate 100 and the opposite substrate 200 are adhered to each other by the sealing material 20. In FIG. 2, the liquid crystal 300 is charged inside the sealing material 20. In FIG. 2, a first insulating film 101 is formed on the TFT substrate 100 formed of glass. The first insulating film 101 can be occasionally an undercoat film formed to prevent the impurities generated from the glass from contaminating the TFT semiconductor layer. A second insulating film 102 is formed on the first insulating film 101. The second insulating film 102 can be occasionally a gate insulating film in the TFT. A scanning-line lead line 103 is formed on the second insulating film 102. The scanning-line lead line 103 shown in a

rectangular shape in FIG. 2 is a cross section of the scanning-line lead line 103, which is connected to the scanning line 30 in FIG. 1.

An organic passivation film 104 is formed to cover the scanning-line lead lines 103. The organic passivation film 104 is formed thick with 2 to 3 μm , also serving as a flattening film. The organic passivation film 104 is formed of photosensitive resin, which does not need photoresist for patterning.

In the display area, it is necessary to connect a pixel electrode or a common electrode formed on the organic passivation film 104 to a source electrode of the TFT, which connection is performed through the through-hole formed on the organic passivation film 104. The organic passivation film 104 is formed of resin such as acrylic resin. This film easily absorbs water and when the pixel electrode or the common electrode is formed directly on the organic passivation film 104, the pixel electrode or the common electrode is exfoliated especially in the through-hole portion, due to the water absorbed by the organic passivation film 104. In order to avoid this phenomenon, the conventional art has been designed in that the diameter of the through-hole is enlarged so that the inorganic insulating film 105 may cover the organic passivation film assuredly, also in the through-hole. In other words, in the conventional art, it has been essential that the organic passivation film 104 is covered with the inorganic insulating film 105.

In FIG. 2, an interlayer insulating film 105 made of SiN is formed on the organic passivation film 104. This interlayer insulating film 105 is an insulating film between a lower layer electrode formed flat and an upper layer electrode having a slit in the display area of the liquid crystal display device of the IPS method. In some cases, the lower electrode may be the common electrode and the upper layer electrode may be the pixel electrode and in other cases, it may be reversed; the lower layer electrode and the upper layer electrode are both formed of transparent oxide conductive film represented by Indium Tin Oxide (ITO).

Since the organic passivation film 104 easily transmits the water, as described in FIG. 9, the groove-shaped through-hole 1041 is formed in the organic passivation film 104 in order to shut out the water coming from the end portion through the organic passivation film 104. The groove-shaped through-hole 1041 is formed around the whole periphery of the TFT substrate 100 to surround the display area within the seal portion.

The characteristic of the invention is that a water absorption layer 10 formed by the organic passivation film is formed in a shape of wall within the groove-shaped through-hole 1041, not covered with the inorganic insulating material. This water absorption layer 10 is to absorb the water when water transmitted from the end portion of the TFT substrate 100 through the organic passivation film 104 further intends to pass the groove 1041 of the organic passivation film 104. According to this, a time from the intrusion of the water into the liquid crystal display panel to the arrival at the liquid crystal layer 300 can be prolonged. As the result, a lifetime of the liquid crystal display device can be prolonged.

In FIG. 2, an alignment film 106 is formed on the interlayer insulating film 105. The alignment film 106 is formed by applying an alignment film material that is originally liquid according to the flexography or inkjet, and three concave portions are formed on the organic passivation film 104 as a stopper so that the alignment film material does not arrive at the outer end portion of the seal portion. Further, the groove-shaped through-hole 1041 formed fur-

ther outside of the concave portions also serves as the stopper against the alignment film material. In FIG. 2, the alignment film material passes over the three concave portions and stops in the final convex portion.

In FIG. 2, a black matrix **201** is formed on the side of the opposite substrate **200**. The black matrix **201** in FIG. 2 is provided in order to avoid light from leaking from the seal portion. The black matrix **201** is formed of resin and a black matrix groove **2011** is formed in order to shut down the water transmitted through the resin. A color filter **202** is formed on the black matrix **201** in a stripe shape in a direction vertical to the paper surface. The color filter **202** is formed correspondingly to a first column spacer **210** formed on an overcoat film **203**.

The overcoat film **203** is formed on the color filter **202**. The overcoat film **203** is provided with a convex portion in correspondence with the portion of the color filter **202**. This convex portion is to avoid the alignment film material from spreading outside of the substrate when applying the alignment film material. The first spacer **210** is formed in the convex portion of the overcoat film **203**. The column spacer **210** is to define the space between the opposite substrate **200** and the TFT substrate **100** in the seal portion.

In FIG. 2, a second column spacer **220** lower than the first column spacer **210** is formed nearer to the side of the display area than the first column spacer **210**. When a pressure is applied to the opposite substrate **200** from the outside, the second column spacer **220** is to avoid the space between the TFT substrate **100** and the opposite substrate **200** from narrowing excessively.

A wall spacer **250** is formed outside of the first column spacer. This wall spacer becomes the stopper against the alignment film. The wall spacer **250** is formed in two stages. The alignment film **106** is formed to cover the overcoat film **203**. The outer shape of this alignment film is partitioned by the wall spacer **250**.

A bank-shaped spacer **230** is formed in the end portion of the seal portion. Production of the individual liquid crystal display panels is inefficient; therefore, a plurality of liquid crystal display panels are formed on a mother substrate to produce the liquid crystal display panels at once. In the mother substrate with the plural liquid crystal display panels formed there, the bank-shaped spacer **230** is arranged in the boundary of the liquid crystal display panels, scribing is performed along the center of the bank-shaped spacer **230**, and then, the substrate is cut into individual pieces of liquid crystal display panels. When there is no bank-shaped spacer **230**, this portion is the sealing material **20** and when the sealing material **20** exists, even if scribing is performed, it cannot be cut.

FIG. 3 is a top plan view corresponding to the portion of FIG. 2. In FIG. 3, the sealing material **20** is formed inside the bank-shaped spacer **230**. In FIG. 3, the color filter **202** is formed in a stripe shape and the first column spacer **210** is arranged in the portion corresponding to the color filter **202**. In FIG. 3, the color filter **202** and the first column spacer **210** are shown, by way of example, for two lines. The wall spacer **250** is arranged between the first column spacer **210** and the first column spacer **210**. The sealing material **20** is formed extensively in the end portion of the bank-shaped spacer **230**. In FIG. 3, the water absorption layer **10** is formed between the bank-shaped spacer **230** and the color filter **202** on the side of the TFT substrate.

FIG. 4 is a cross-sectional view enlarging the portion of the water absorption layer **10** in FIG. 2. In FIG. 4, the water absorption layer **10** is formed in the portion of the groove-shaped through-hole **1041** of the organic passivation film

104. This water absorption layer **10** is formed of the same material in the same process as that of the organic passivation film **104**; as the result, there needs no additional material cost and process in order to form the water absorption layer.

The water absorption layer **10** is not covered with the inorganic insulating film **105**, differently from the organic passivation film **104** in the other portion. Therefore, after completion of the liquid crystal display device, it can absorb the water transmitted through the sealing material **20**. In FIG. 4, the width **w1** of the water absorption layer **10** is, for example, 30 μm and the height **h** is 2 to 3 μm . On the other hand, the width of the groove-shaped through-hole **1041** formed in the organic passivation film **104** is about 70 μm . Here, these numeric values can be adjusted according to the water absorption effect expected by the water absorption layer. FIG. 5 is a cross-sectional view when the cross section of the water absorption layer **10** is trapezoid; when the water absorption layer **10** is in this shape, the width **w** of the water absorption layer **10** can be measured only by the bottom of the trapezoid. Here, in the embodiment, the water absorption layer is not covered with the inorganic insulating film, but apart thereof may be covered with the inorganic insulating film to expose the part from the inorganic insulating film. Further, according to the water entering amount, in a plan view, the area of the portion exposed from the inorganic insulating film may be partially various.

FIG. 6 is a top plan view only showing the shape of the water absorption layer **10** in the TFT substrate. As illustrated in FIG. 6, the water absorption layer **10** is generally formed in the whole periphery to surround the display area **500**. However, when the water absorption layer **10** cannot be formed continuously in the periphery with regard to the layer of the wiring, the above layer **10** may be formed discontinuously, as illustrated in FIG. 7. Especially, in the screen corners, when black unevenness occurs on the screen, the water absorption layer **10** may be formed only around the corners, as illustrated in FIG. 8. Further, in FIGS. 6 to 8, the water absorption layer **10** is formed in a linear shape in a plan view; however, it is not restricted to this but may be formed in a wave shape or a zigzag.

As mentioned above, according to the invention, the water absorption layer **10** can be formed in the same material in the same process as that of the organic passivation film **104**; therefore, the black unevenness generated on the screen due to the water can be avoided without an increase in the manufacturing cost.

What is claimed is:

1. A liquid crystal display device including a display area and a terminal portion, in which a TFT substrate with an organic passivation film and an inorganic insulating film formed on the organic passivation film formed there and an opposite substrate are adhered to each other by a seal portion and a liquid crystal is enclosed there,

wherein in the seal portion of the TFT substrate, a groove-shaped through-hole is formed in the organic passivation film to surround the display area, a water absorption layer formed of the same material in the same process as that of the organic passivation film is formed within the groove-shaped through-hole, and the water absorption layer is exposed from the inorganic insulating film.

2. The device according to claim 1, wherein the water absorption layer is continuously formed along a whole periphery to surround the display area.

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3. The device according to claim 1, wherein the water absorption layer is formed discontinuously to surround the display area.

4. The device according to claim 1, wherein the water absorption layer is formed only in a corner portion of the display area.

* * * * *

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专利名称(译)	液晶显示装置		
公开(公告)号	US9696592	公开(公告)日	2017-07-04
申请号	US14/817520	申请日	2015-08-04
[标]申请(专利权)人(译)	株式会社日本显示器		
申请(专利权)人(译)	日本展示INC.		
当前申请(专利权)人(译)	日本展示INC.		
[标]发明人	NISHINO TOMONORI SHIMURA MASATO ISHIKAWA TOMOKAZU KURAMOTO YUKI HASHIMOTO SATOSHI		
发明人	NISHINO, TOMONORI SHIMURA, MASATO ISHIKAWA, TOMOKAZU KURAMOTO, YUKI HASHIMOTO, SATOSHI		
IPC分类号	G02F1/1333 G02F1/1339 G02F1/1368		
CPC分类号	G02F1/1339 G02F1/1368 G02F1/133345 G02F2001/13396 G02F2001/133311		
优先权	2014160415 2014-08-06 JP		
其他公开文献	US20160041413A1		
外部链接	Espacenet USPTO		

摘要(译)

为了避免由于水侵入液晶显示装置而产生黑色不均匀，提供一种包括显示区域和端子部分的液晶显示装置，其中形成有有机钝化膜的TFT基板 and 通过密封部分将相对的基板彼此粘合，并在其中封入液晶，其中在TFT基板的密封部分中，在有机钝化膜中形成槽形通孔以围绕显示区域，在槽形通孔内形成由与有机钝化膜相同的工艺中由相同材料形成的吸水层，并且吸水层未被无机绝缘膜覆盖。

