US 20130203313A1

(19) United States
(12) Patent Application Publication
Gotoh
(10) Pub. No.: US 2013/0203313 A1
(43) Pub. Date: Aug. 8, 2013

(54) MANUFACTURING METHOD OF LIQUID CRYSTAL DISPLAY DEVICE

(71) Applicant: **Jun Gotoh**, Mobara (JP)

(72) Inventor: **Jun Gotoh**, Mobara (JP)

(21) Appl. No.: **13/798,317**

(22) Filed: **Mar. 13, 2013**

Related U.S. Application Data

(63) Continuation of application No. 13/557,710, filed on Jul. 25, 2012, now Pat. No. 8,421,964, which is a continuation of application No. 12/790,063, filed on May 28, 2010, now Pat. No. 8,233,119.

(30) **Foreign Application Priority Data**

Jun. 3, 2009 (JP) 2009-133752

Publication Classification

(51) **Int. Cl.**
G02F 1/1335 (2006.01)

(52) **U.S. Cl.**
CPC *G02F 1/133516* (2013.01)
USPC **445/24**

(57) **ABSTRACT**

Manufacturing method of a liquid crystal display device having a TFT substrate with a display area in which pixels are arranged, a counter substrate, a sealing material formed in a periphery to bond the TFT and counter substrates, and a liquid crystal layer interposed between an orientation film on the TFT substrate and an orientation film on the counter substrate. The method includes the steps of forming a first color filter, a second color filter, or a third color filter corresponding to each of the pixels in the display area of the TFT substrate, and forming an orientation film stopper by overlapping a portion of the first color filter, the second color filter, or the third color filter, in an area between the display area and the sealing material. A profile of the orientation film formed in the TFT substrate is defined by the orientation film stopper.

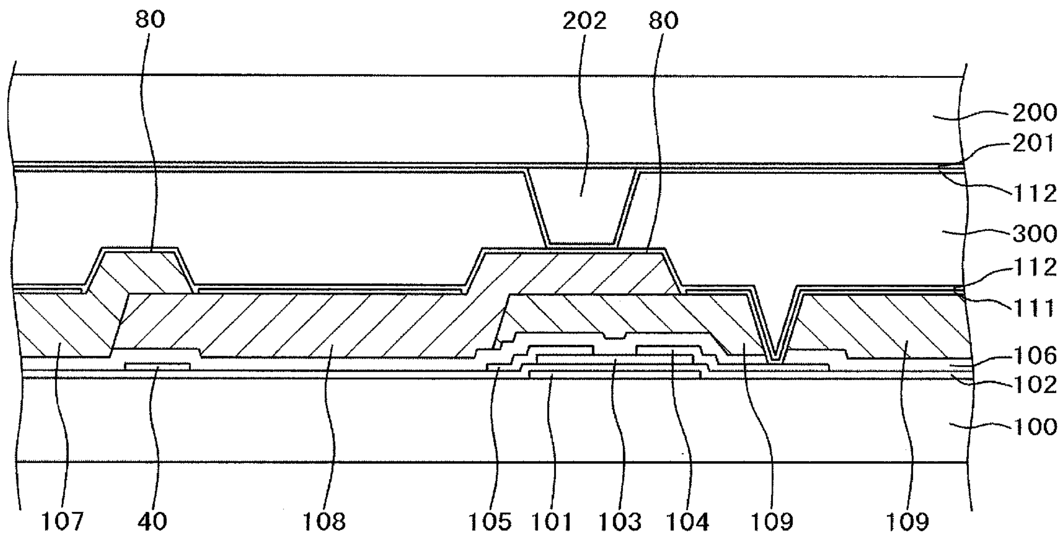


FIG. 1

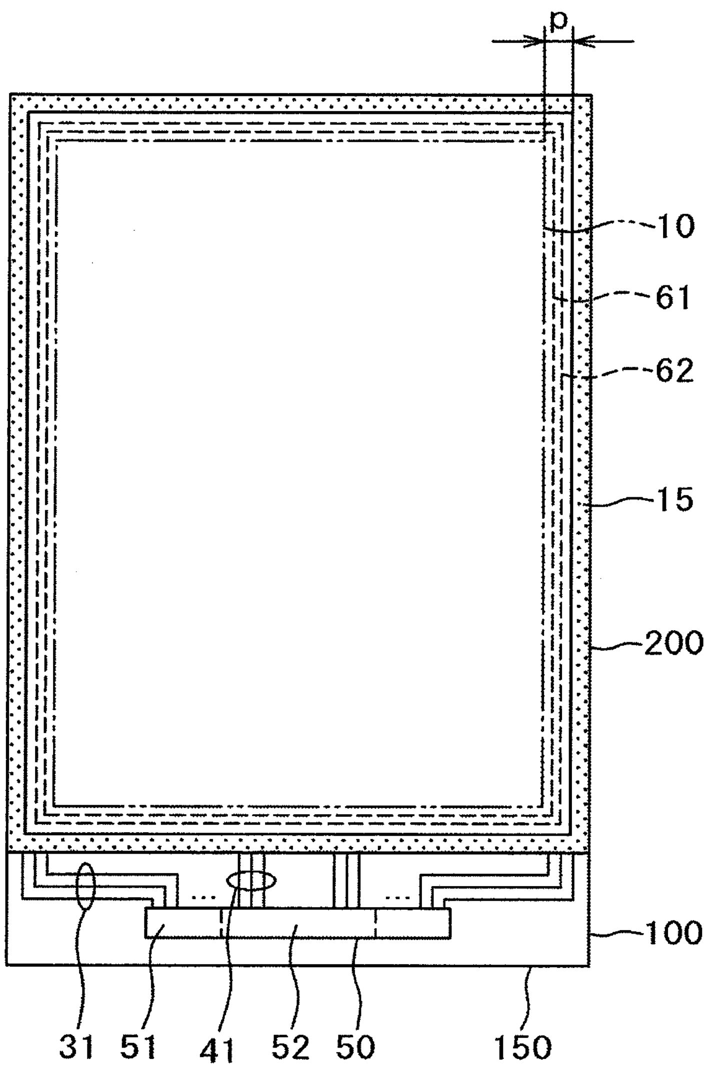


FIG. 2

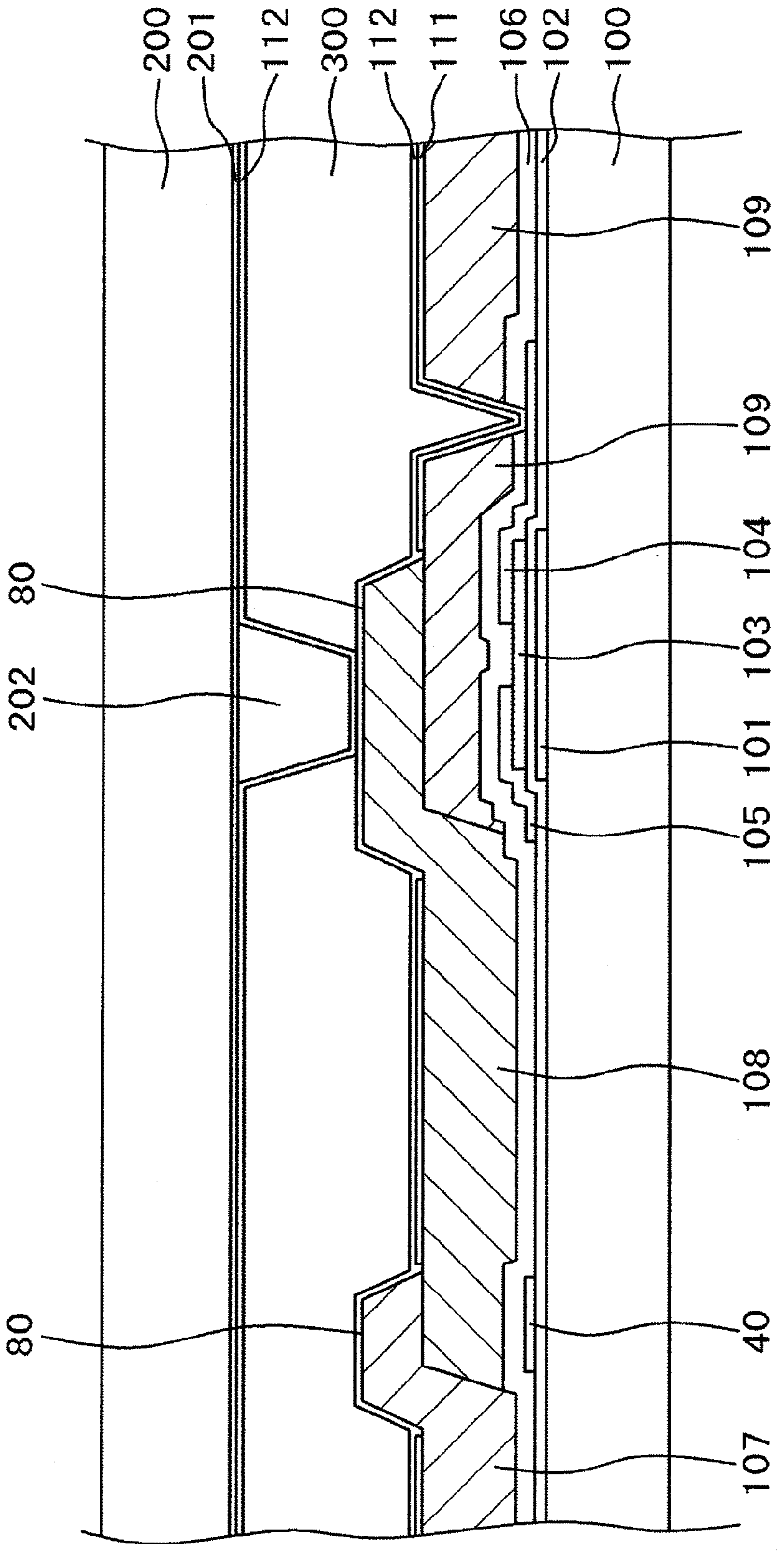

200
201
112
300
112
111
106
102
100
109
109
104
103
101
105
108
40
107
80
202
80

FIG. 3

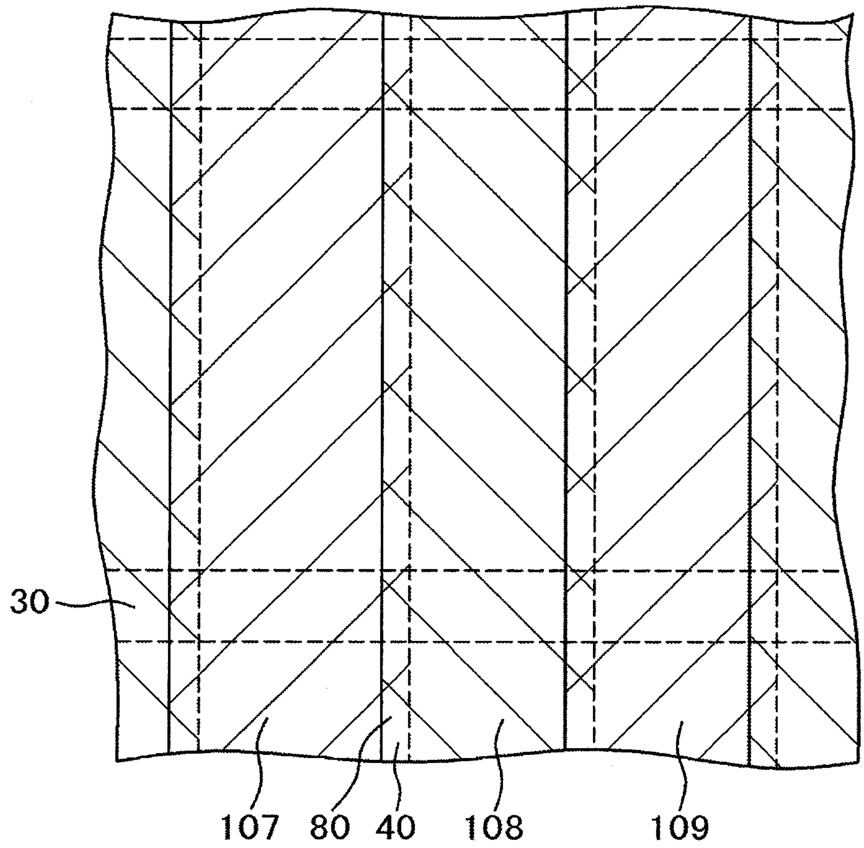


FIG. 4

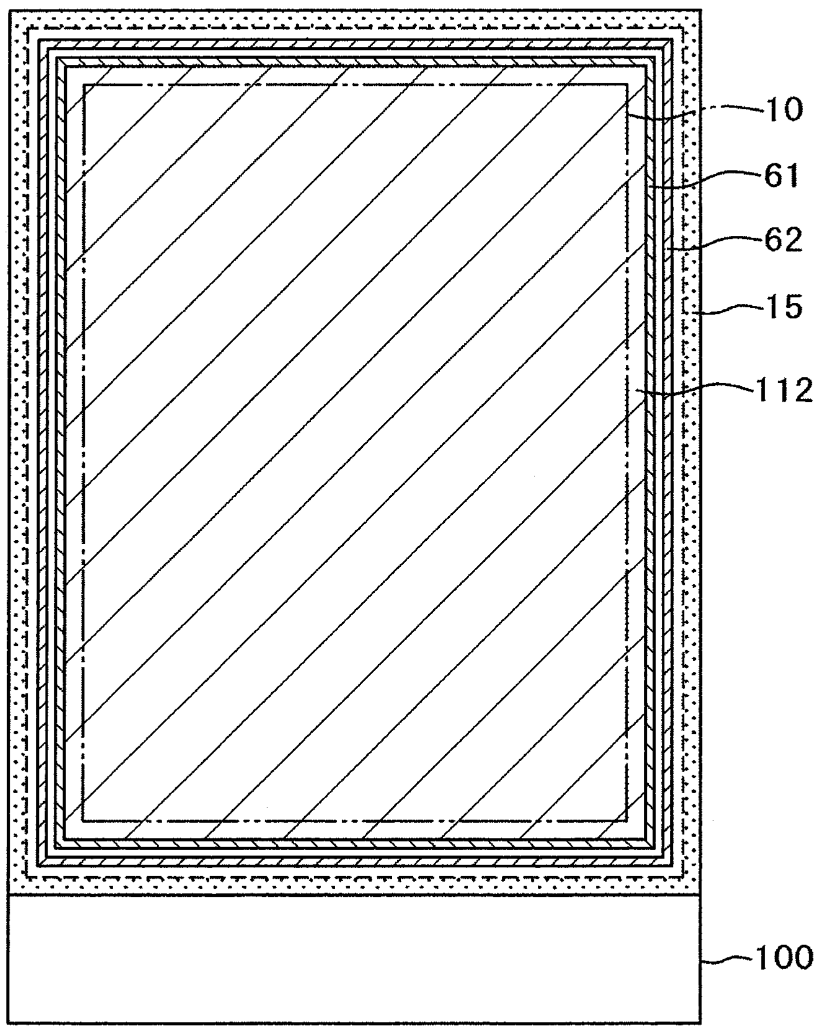


FIG. 5

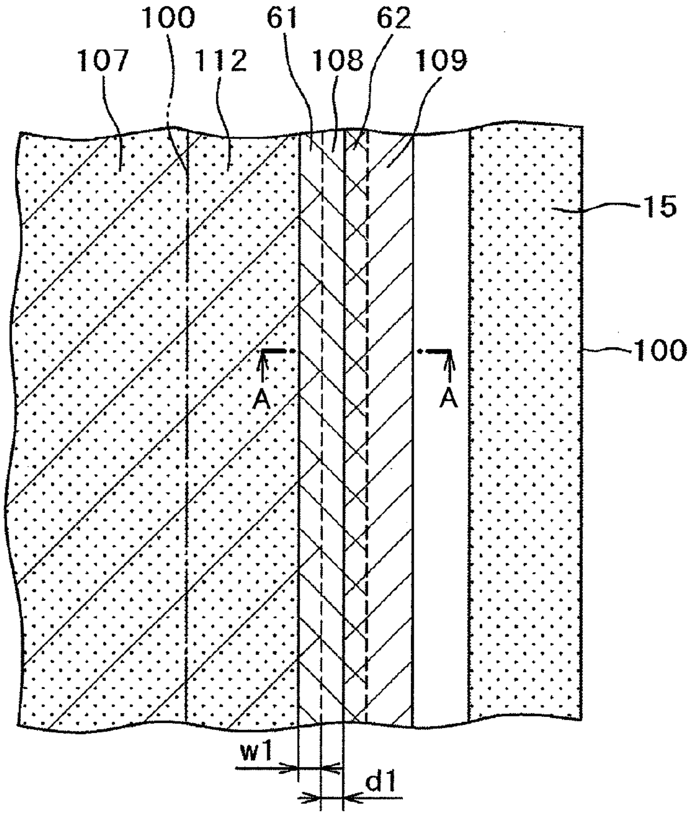

100
61
62
107
112
108
109
15
100
A
A
w1
d1

FIG. 6

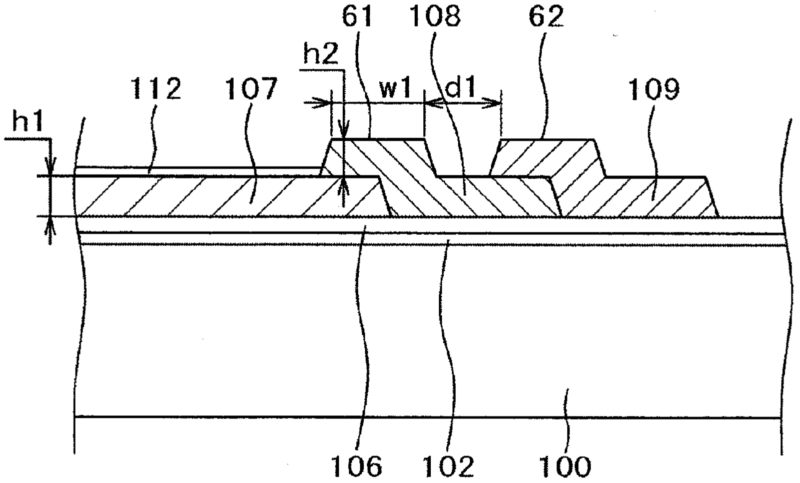

61
108
62
h2
112
107
w1
d1
109
h1
106
102
100

FIG. 7

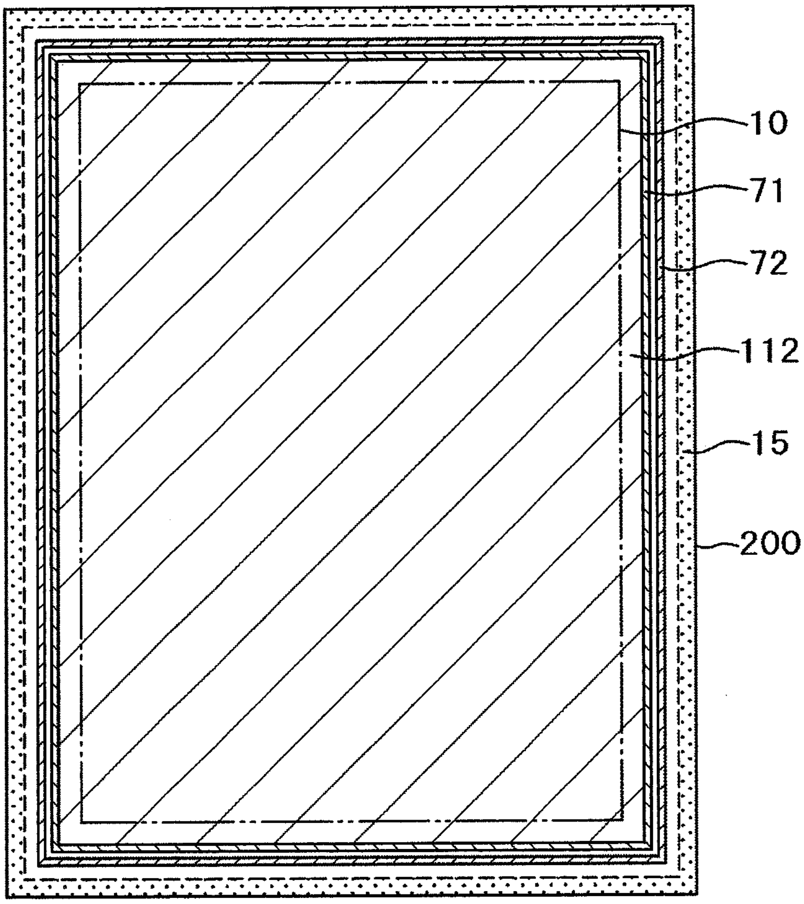


FIG. 8

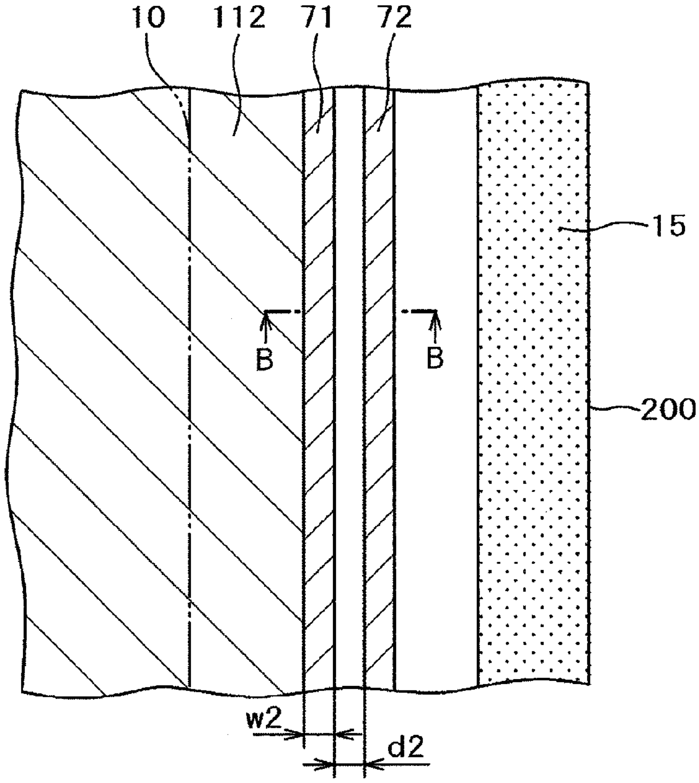


FIG. 9

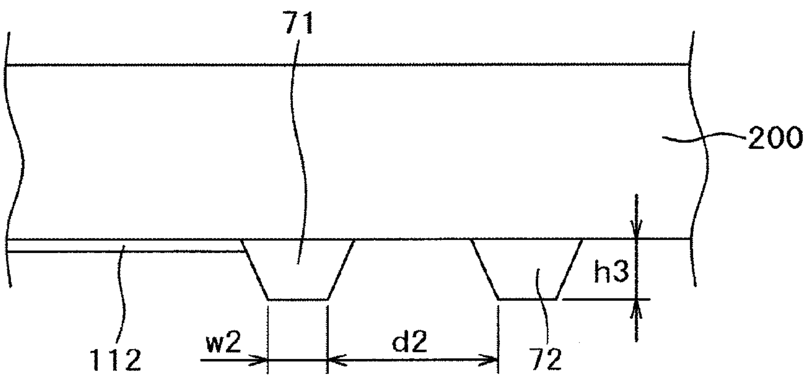


FIG. 10

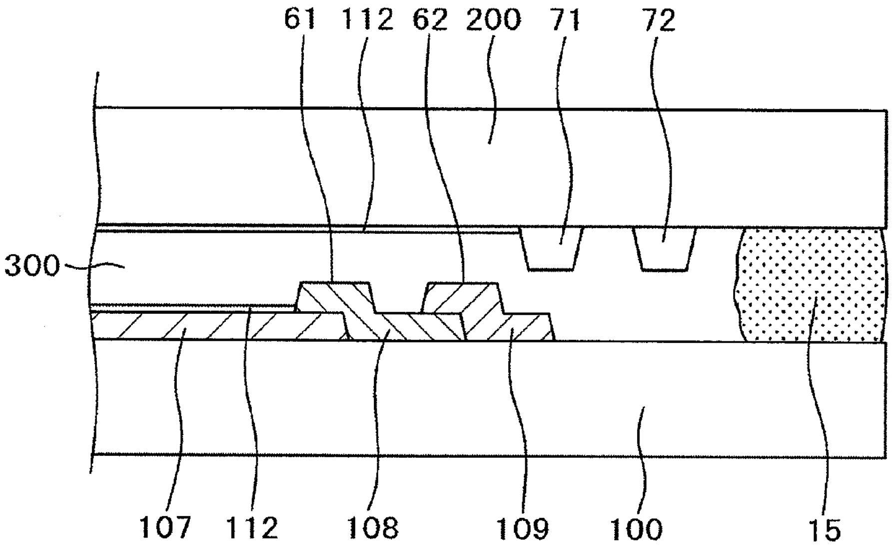

61
112
62
200
71
72
300
107
112
108
109
100
15

FIG. 11

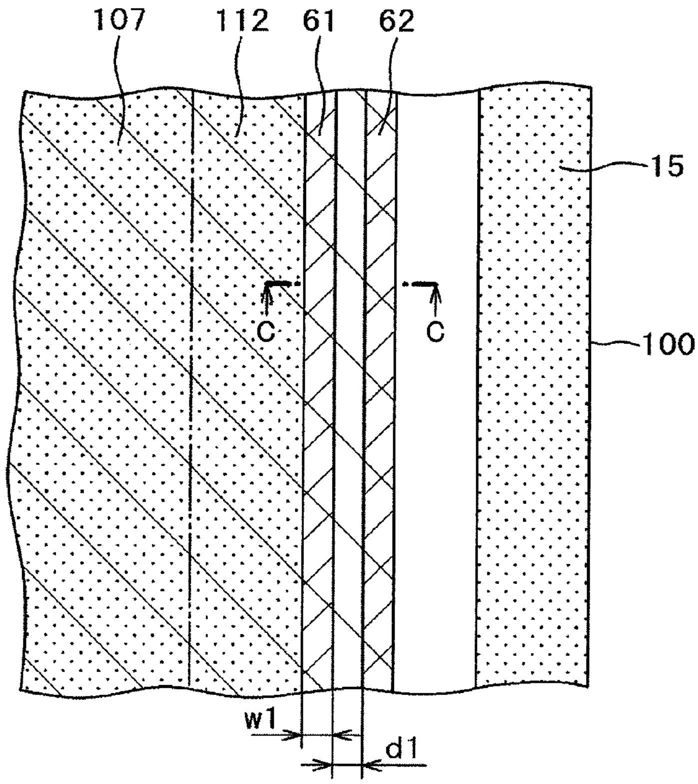

107
112
61
62
15
C
C
100
w1
d1

FIG. 12

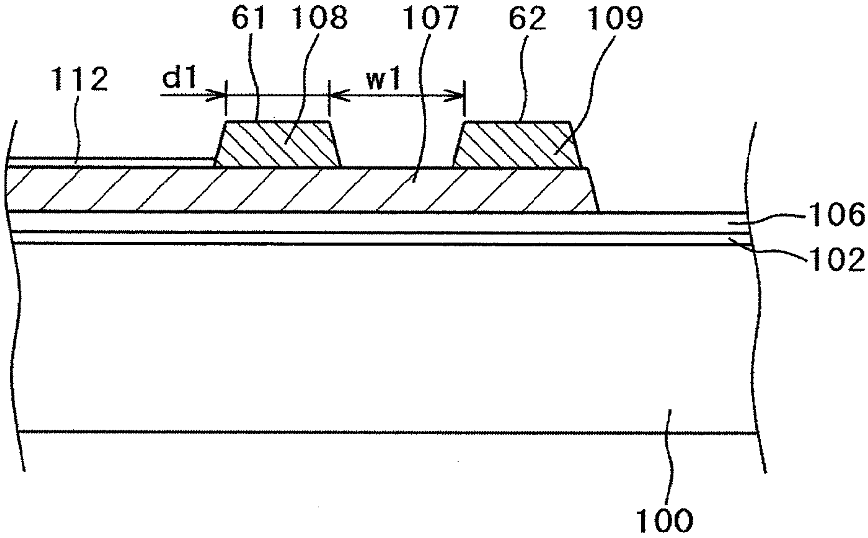

61
108
107
62
109
112
d1
w1
106
102
100

FIG. 13

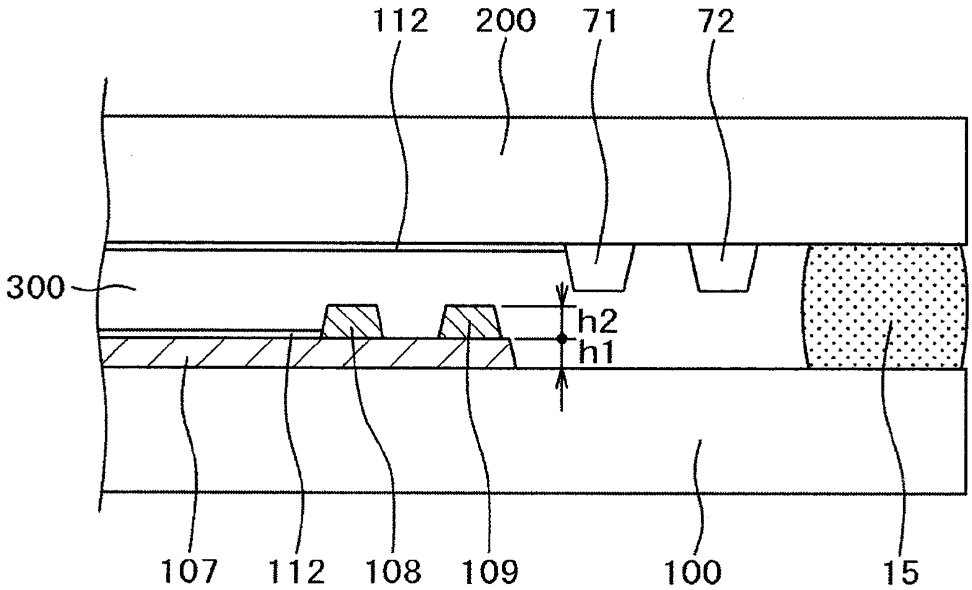
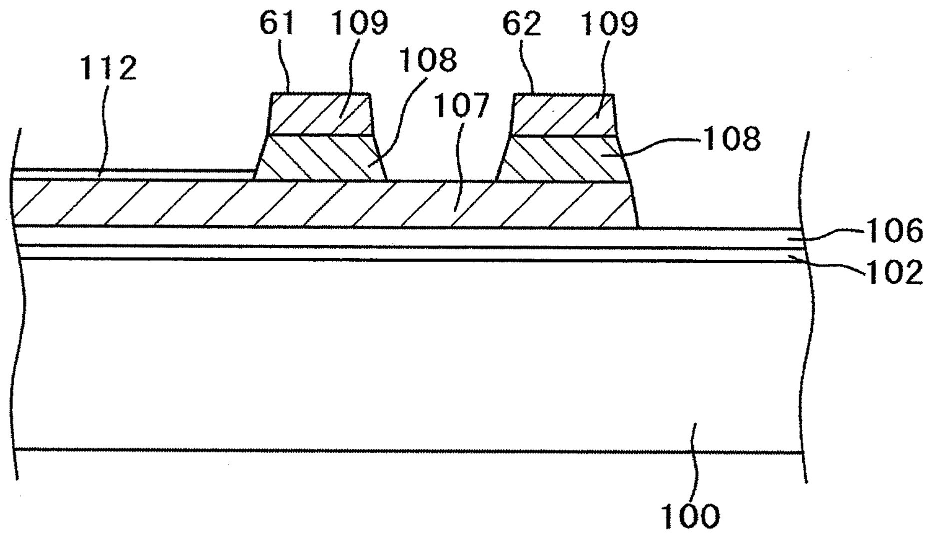

112
200
71
72
300
h2
h1
107
112
108
109
100
15

FIG. 14



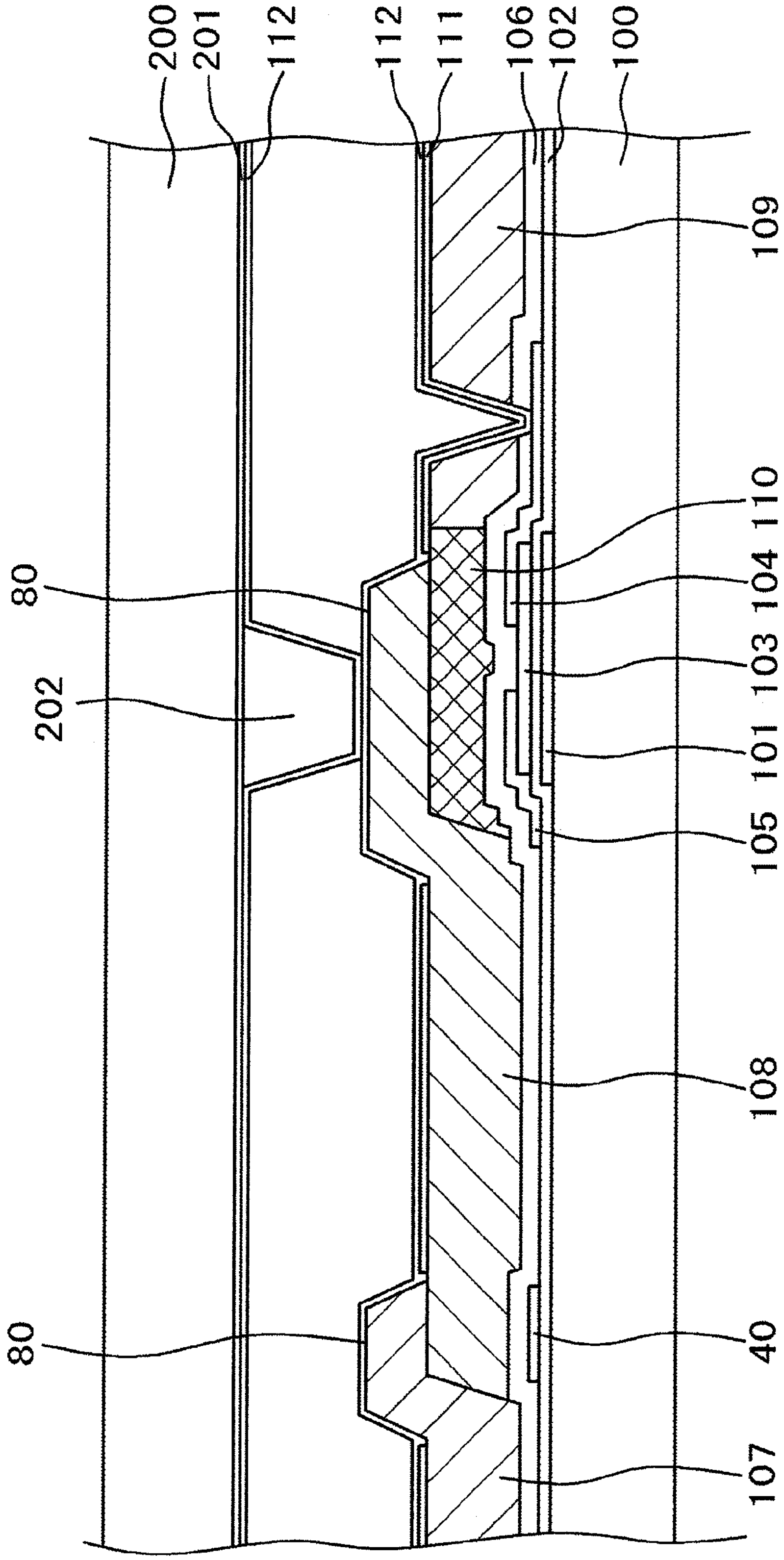
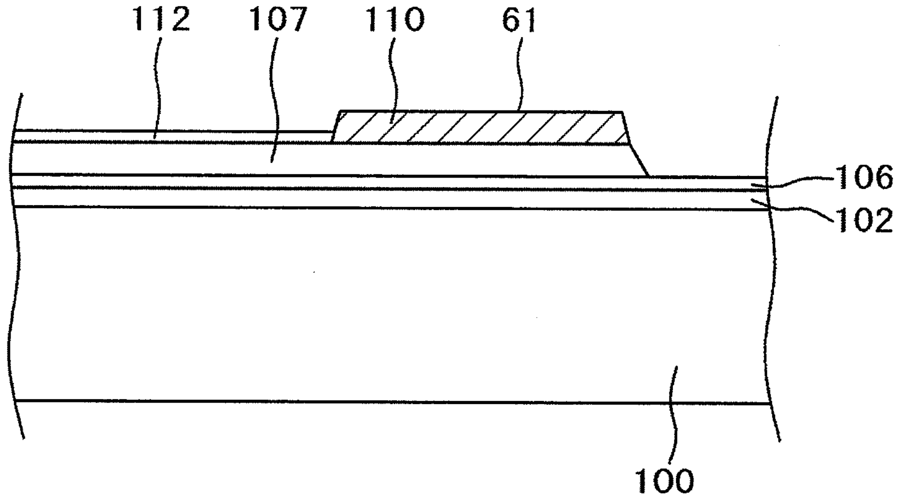

200
201
112
112
111
106
102
100
109
110
104
103
101
105
108
40
107
80
202
80

FIG. 15

FIG. 16



MANUFACTURING METHOD OF LIQUID CRYSTAL DISPLAY DEVICE

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application is a continuation of U.S. application Ser. No. 13/557,710, filed Jul. 25, 2012, which is a continuation of U.S. application Ser. No. 12/790,063, filed May 28, 2010, the contents of which are incorporated herein by reference.

CLAIM OF PRIORITY

[0002] The present application claims priority from Japanese Patent Application JP 2009-133752 filed on Jun. 3, 2009, the content of which is hereby incorporated by reference into this application.

FIELD OF THE INVENTION

[0003] The present invention relates to a display device, and more particularly, to a liquid crystal display device configured to have color filters on the side of a TFT substrate and allow an effective application of an orientation film.

BACKGROUND OF THE INVENTION

[0004] In a conventional liquid crystal display device, there is provided a TFT substrate in which pixel electrodes, thin film transistors (TFTs) and the like are arranged in a matrix form and a counter substrate in which color filters and the like are formed at locations corresponding to the pixel electrodes of the TFT substrate is disposed opposite to the TFT substrate. A liquid crystal is interposed between the TFT substrate and the counter substrate. Then, an image is formed by controlling the transmittance of light of the liquid crystal molecules for each pixel.

[0005] In such a conventional liquid crystal display device, it is necessary to exactly match the pixel electrodes formed in the TFT substrate to the color filters formed in the counter substrate. However, the positioning accuracy of the TFT substrate and the counter substrate is about 3 to 5 μm, which should be taken into account in the allowance of the pattern. As a result, the transmittance of a liquid display panel is reduced.

[0006] On the other hand, when the color filters are formed on the side of the TFT substrate, the TFT substrate and the counter substrate can be roughly positioned to each other. In other words, when the color filters are formed on the side of the TFT substrate, the alignment accuracy of the color filters with respect to the wiring and the TFTs in the TFT substrate can be set in accordance with the mask alignment accuracy in photo processing, and can be set to about 1 μm. JP-A No. 357828/2002 describes a configuration in which color filters are formed on the side of the TFT substrate as described above.

[0007] Liquid crystal display devices have been used in a wide range of applications. Under such circumstances there is a demand to produce liquid display panels of different sizes. In particular, a variety of sizes are expected to be available in small liquid crystal display panels. The liquid crystal display panel uses an orientation film of polyimide or other suitable resin in order to orient liquid crystal. The orientation film has been formed by flexographic printing in the past.

[0008] However, the flexographic printing requires different plates for each type of orientation films to be printed. The production of the plate is a factor of the increase in the production cost of the liquid crystal display panel. In recent years, as a measure to solve this problem, there has been developed a process for applying the orientation film by inkjet printing. However, when the orientation film is formed by inkjet printing, it is necessary to reduce the viscosity of the orientation film when it is applied.

[0009] In this case, it is difficult to keep the orientation film in a predetermined area due to the reduced viscosity of the orientation film. For example, the orientation film flows to a portion of a sealing material for bonding the TFT substrate and the counter substrate together. When the orientation film is formed extending to the portion of the sealing material, the reliability of the sealing portion is reduced.

[0010] In order to prevent this, JP-A No. 145461/2008 describes a configuration in which ITO (Indium Tin Oxide), which is used as a pixel electrode, is formed to surround the display area so that the orientation film is confined to a predetermined range. In this way, the orientation film is prevented from extending to the sealing portion.

[0011] According to JP-A No. 145461/2008, the configuration for confining an orientation film to a predetermined range is as follows. In a frame area between the display area and the sealing portion, a concavo-convex pattern is formed in an insulating film and is coated with ITO constituting a pixel electrode. The concavo-convex pattern formed in the periphery of the display area prevents the orientation film with a low viscosity applied by inkjet printing, from extending beyond the periphery of the display area.

[0012] However, the thickness of the ITO formed in the periphery of the display area is equal to the thickness of the ITO of the pixel electrode, about 70 to 100 nm. It is not sufficient as a stopper for the orientation film whose thickness is about 150 nm. Further, the concavo-convex pattern is formed from an insulator with a thickness of about 300 nm, which is not sufficient to block the low viscosity orientation film.

SUMMARY OF THE INVENTION

[0013] It is desirable to be able to apply the orientation film by inkjet printing, without an increase in the production cost while maintaining the reliability of the sealing portion.

[0014] The present invention overcomes the above problem by the following means.

[0015] (1) There is provided a liquid crystal display device including a TFT substrate having a display area in which pixels each having a pixel electrode and a TFT are arranged in a matrix form, and a counter substrate disposed opposite to the TFT substrate. The TFT substrate and the counter substrate are bonded together by a sealing material formed in the periphery. A liquid crystal layer is interposed between an orientation film formed in the TFT substrate and an orientation film formed in the counter substrate. A first color filter, a second color filter, or a third color filter is formed corresponding to each of the pixels in the display area of the TFT substrate. An orientation film stopper is formed by an overlapping portion of the first color filter, the second color filter, or the third color filter, between the display area of the TFT substrate and the sealing material. A profile of the orientation film formed in the TFT substrate is defined by the orientation film stopper.

[0016] (2) In the liquid crystal display device described in (1), the orientation film stopper is formed of two layers of color filters.

[0017] (3) In the liquid crystal display device described in (1), the orientation film stopper is formed of three layers of color filters.

[0018] (4) There is provided a liquid crystal display device including a TFT substrate having a display area in which pixels each having a pixel electrode and a TFT are arranged in a matrix form, and a counter substrate disposed opposite to the TFT substrate. The TFT substrate and the counter substrate are bonded together by a sealing material formed in the periphery. A liquid crystal layer is interposed between an orientation film formed in the TFT substrate and an orientation film formed in the counter substrate. A distance between the TFT substrate and the counter substrate is defined by a columnar spacer. A first color filter, a second color filter, or a third color filter is formed corresponding to each of the pixels in the display area of the TFT substrate. A first orientation film stopper is formed by an overlapping portion of the first color filter, the second color filter, or the third color filter, between the display area of the TFT substrate and the sealing material. A profile of the orientation film formed in the TFT substrate is defined by the first orientation film stopper. A second orientation film stopper is formed by the same process of the columnar spacer on the outside of the display area of the counter substrate. A profile of the orientation film formed in the counter substrate is defined by the second orientation film stopper.

[0019] (5) There is provided a liquid crystal display device including a TFT substrate having a display area in which pixels each having a pixel electrode and a TFT are arranged in a matrix form, and a counter substrate disposed opposite to the TFT substrate. The TFT substrate and the counter substrate are bonded together by a sealing material formed in the periphery. A liquid crystal layer is interposed between an orientation film formed in the TFT substrate and an orientation film formed in the counter substrate. A first color filter, a second color filter, or a third color filter is formed corresponding to each of the pixels in the display area of the TFT substrate. A light shielding film is formed by the overlapping of the first color filter, the second color filter, or the third color filter. An orientation film stopper is formed by an overlapping portion of the first color filter, the second color filter, or the third color filter, between the display area of the TFT substrate and the sealing material. A profile of the orientation film formed in the TFT substrate is defined by the orientation film stopper. A height of the orientation film stopper is greater than a height of the light shielding film formed in the display area of the TFT substrate.

[0020] (6) There is provided a liquid crystal display device including a TFT substrate having a display area in which pixels each having a pixel electrode and a TFT are arranged in a matrix form, and a counter substrate disposed opposite to the TFT substrate. The TFT substrate and the counter substrate are bonded together by a sealing material formed in the periphery. A liquid crystal layer is interposed between an orientation film formed in the TFT substrate and an orientation film formed in the counter substrate. A first color filter, a second color filter, or a third color filter is formed corresponding to each of the pixels in the display area of the TFT substrate. A light shielding film is formed on the TFT, in addition to the first color filter, the second color filter, or the third color filter. An orientation film stopper is formed by an overlapping portion of the first color filter, the second color filter, or the third color filter, between the display area of the TFT substrate and the sealing material. A profile of the orientation film formed in the TFT substrate is defined by the orientation film stopper.

[0021] (7) There is provided a liquid crystal display device including a TFT substrate having a display area in which pixels each having a pixel electrode and a TFT are arranged in a matrix form, and a counter substrate disposed opposite to the TFT substrate. The TFT substrate and the counter substrate are bonded together by a sealing material formed in the periphery. A liquid crystal layer is interposed between an orientation film formed in the TFT substrate and an orientation film formed in the counter substrate. A first color filter, a second color filter, or a third color filter is formed corresponding to each of the pixels in the display area of the TFT substrate. A light shielding film is formed on the TFT, in addition to the first color filter, the second color filter, or the third color filter. An orientation film stopper is formed by an overlapping portion of the light shielding film and the first color filter, the second color filter, or the third color filter, between the display area of the TFT substrate and the sealing material. A profile of the orientation film formed in the TFT substrate is defined by the orientation film stopper.

[0022] According to the present invention, it is possible to apply the orientation film by inkjet printing, without reducing the reliability of the sealing portion and without a need to have an additional production process. As a result, the production cost of the liquid crystal display device can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] FIG. **1** is a top view of a liquid crystal display device to which the present invention is applied;

[0024] FIG. **2** is a cross-sectional view of a display area of the liquid crystal display device according to a first embodiment;

[0025] FIG. **3** is a top view of the arrangement of color filters in a TFT substrate;

[0026] FIG. **4** is a top view of the TFT substrate according to the first embodiment;

[0027] FIG. **5** is a top view of the periphery of the TFT substrate according to the first embodiment;

[0028] FIG. **6** is a cross-sectional view taken along line A-A of FIG. **5**;

[0029] FIG. **7** is a top view of a counter substrate according to the first embodiment;

[0030] FIG. **8** is a top view of the periphery of the counter substrate according to the first embodiment;

[0031] FIG. **9** is a cross-sectional view taken along line B-B of FIG. **8**;

[0032] FIG. **10** is a cross-sectional view of the periphery of the liquid crystal display device according to the first embodiment;

[0033] FIG. **11** is a top view of the periphery of the TFT substrate according to a second embodiment;

[0034] FIG. **12** is a cross-sectional view taken along line C-C of FIG. **11**;

[0035] FIG. **13** is a cross-sectional view of the periphery of the liquid crystal display device according to the second embodiment;

[0036] FIG. **14** is a cross-sectional view of the periphery of the TFT substrate according to a third embodiment;

[0037] FIG. **15** is a cross-sectional view of the display area of the liquid crystal display device according to a fourth embodiment; and

[0038] FIG. **16** is a cross-sectional view of the periphery of the TFT substrate according to the fourth embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0039] Preferred embodiments of the present invention will be described in detail below.

First Embodiment

[0040] FIG. **1** is a top view of a liquid crystal display device used for electronic devices such as mobile phones, which is an example of the liquid crystal display device in which the present invention is used. In FIG. **1**, a counter substrate **200** is disposed above a TFT substrate **100**. A liquid crystal layer is interposed between the TFT substrate **100** and the counter substrate **200**. The TFT substrate **100** and the counter substrate **200** are bonded together by a sealing material **15** formed in the periphery.

[0041] In FIG. **1**, the liquid crystal display device is sealed by dropping liquid crystal into the liquid crystal display device. Thus, no sealing hole of the liquid crystal is formed in the liquid crystal display device. The TFT substrate **100** is made greater than the counter substrate **200**. A terminal portion **150** is formed in a portion of the TFT substrate **100** extending beyond the counter substrate **200**. The liquid crystal display panel is supplied with power, image signals, scan signals, and the like, from the terminal portion **150**.

[0042] Further, an IC driver **50** is formed in the terminal portion **150** to drive scan lines, image signal lines, and the like. The IC driver **50** is divided into three areas. In the center area of the three areas, an image signal driving circuit **52** is provided. A scan signal driving circuit **51** is provided in the two areas on both sides of the center area.

[0043] In the display area **10** of FIG. **1**, scan lines, not shown, extend in the lateral direction and are arranged in the vertical direction. Further, image signal lines, not shown, extend in the vertical direction and are arranged in the lateral direction. The scan lines are connected by leaders **31** to the scan signal driving circuit **51** of the IC driver **50**. In FIG. **1**, the scan line leaders **31** is provided on both sides of the display area, in order to provide the display area **10** in the central portion of the liquid crystal display device. For this reason, the scan signal driving circuit **51** is provided on both sides of the IC driver **50**. While the image signal lines are connected to the IC diver **50** by image signal leaders **41** extending together to the lower side of the display. The image signal line leaders **41** are connected to the image signal driving circuit **52** provided in the center area of the IC driver **50**.

[0044] The space from the boundary of the display area **10** to the end of the counter substrate is called a frame area. The frame area is expected to be reduced, in particular in the small liquid crystal display device. In FIG. **1**, a distance p from the boundary of the display area **10** to the sealing material **15** is about 1 mm in the small liquid crystal display device.

[0045] An orientation film stopper, which will be described below, is formed between the boundary of the display area **10** and the sealing material **15**. The orientation film stopper is formed both in the TFT substrate **100** and in the counter substrate **200**. In FIG. **1**, only first and second orientation film stoppers **61** and **62** are formed in the TFT substrate **100**, which are shown by the dotted lines. In this embodiment, as shown in FIG. **1**, the orientation film stopper has a two-stage structure of the first and second orientation film stoppers. However, a one-stage structure or a three- or more-stage structure can also be used.

[0046] FIG. **2** is a cross-sectional view of the configuration of the display area **10** of FIG. **1**. FIG. **2** shows a cross section of the liquid crystal display device of the so-called TN (Twisted Nematic) type. It is to be understood that the present invention is not limited to this type. The present invention can also be applied to liquid crystal display devices of IPS (In Plane Switching) type, VA (Vertical Alignment) type, or other types.

[0047] In FIG. **2**, a TFT is formed on the TFT substrate **100**. A gate electrode **101** of Al or other metal is formed on the TFT substrate **100**. Then, a gate insulating film **102** of, for example, SiN is formed to cover the gate electrode **101** on the TFT substrate **100**. A semiconductor layer **103** of, for example, a-Si is formed on the gate insulating film **102**. The thickness of a-Si is, for example, 150 nm. In this embodiment, the semiconductor layer **103** uses a-Si. However, poly-Si can also be used for the semiconductor layer **103**. The thickness of the semiconductor layer **103** of poly-Si is about 50 nm. The present invention can also be applied to the semiconductor layer **103** of poly-Si, although the configuration of TFT is different in the use of poly-Si.

[0048] A drain electrode **105** and a source electrode **104** of, for example, Al are formed on both sides of the semiconductor layer **103**. An n+Si layer not shown for an ohmic contact is formed between the semiconductor layer **103**, and the drain electrode **105** and the source electrode **104**. The thickness of the n+Si layer is, for example, about 50 nm. The drain electrode **105** is connected to an image signal line **40**. The source electrode **104** is connected to a pixel electrode **111**. The TFT is formed by the process described above. Further, in FIG. **2**, the image signal line, which is formed in the same layer of the drain electrode **105**, is formed on the gate insulating film **102**.

[0049] An inorganic passivation film **106** is formed to cover the TFT and the image signal line. The inorganic passivation film **106** has a role to protect the TFT from impurity. The inorganic passivation film **106** is formed, for example, from SiN with a thickness of about 400 nm.

[0050] Color filters are formed on the inorganic passivation film **106**. The color filters are formed by photo processing from a photosensitive resin in which a pigment is dispersed. The color filters of each pixel are provided with different colors. In FIG. **2**, a blue color filter **109** is formed in the pixel including the TFT on the right side. A green color filter **108** is formed in the pixel in the center. A red color filter **107** is formed in the pixel on the left side. In FIG. **2**, the TFT is shown only in the pixel of the blue color filter **109**, but actually is formed in all the pixels.

[0051] In FIG. **2**, the color filters overlap to form a boundary portion of each pixel. When the color filters are formed to overlap with each other, it is found to have characteristics of light shielding film. In this embodiment, the color filters are formed to overlap with each other in the boundary of each pixel in order to obtain the necessary light shielding effect, without separately forming a black matrix on the TFT substrate **100**. As a result, it is possible to omit the additional process for forming the black matrix.

[0052] FIG. **3** is a top view of only the image signal lines, the scan lines, and the red, green, blue color filters in the display area **10**. In FIG. **3**, the scan lines extend in the lateral direction and are arranged in the vertical direction. Further, the image signal lines extend in the vertical direction and are arranged in the lateral direction. The areas surrounded by the scan lines and the image lines are pixels.

[0053] The color filters are formed in a strip shape to cover the image signal lines on both sides of each pixel. Thus, two color filters are formed to overlap with each other on the image signal line. A light shielding film **80** is formed in the overlapping portion of the two color filters. Although not shown in FIG. **3**, the light shielding film **80** with the same configuration is also formed on the TFT. The color filters are formed by photo processing to leave each color filter in the desired location. In this way, it is possible to form the overlapping portion of the color filters, or the light shielding film **80**, in any location.

[0054] Returning to FIG. **2**, the pixel electrode **111** is formed on the color filter in the pixel area. The pixel electrode **111** is connected to the source electrode **104** by a through hole formed in the color filter and the inorganic passivation film **106**. The pixel electrode **111** is formed from ITO with a thickness of, for example, 70 μm. An orientation film **112** for orienting the liquid crystal is formed to cover the pixel electrode **111**. In this embodiment, the orientation film **112** is applied by inkjet printing, and then is burned and solidified.

[0055] In FIG. **2**, the counter substrate **200** is disposed opposite to the TFT substrate **100**. In the counter substrate **200**, a counter electrode **201** is formed from ITO. A columnar spacer **202** is formed on the counter substrate **200** to define the distance between the TFT substrate **100** and the counter substrate **200**. The columnar spacer **202** comes into contact with the color filters constituting the light shielding film **80** to define the distance between the TFT substrate **100** and the counter substrate **200**.

[0056] The orientation film **112** is formed to cover the counter electrode **201** and the columnar spacer **202**. In this embodiment, the orientation film **112** on the side of the counter electrode **201** is also applied by inkjet printing, and then is burned and solidified. A liquid crystal layer **300** is interposed between the TFT substrate **100** and the counter substrate **200**. The liquid crystal layer **300** is sealed by the sealing material **15** as shown in FIG. **1**.

[0057] FIG. **4** is a top view of the side of the TFT substrate **100**. In FIG. **4**, the sealing material **15** is formed in the portion of the TFT substrate **100** to which the counter substrate **200** is bonded. The orientation film stopper is formed between the outer periphery of the display area **10** and the sealing material **15**. The orientation film stopper has a two-stage structure of the first orientation film stopper **61** and the second orientation film stopper **62**.

[0058] In order to apply the orientation film **112** by inkjet printing, it is necessary to reduce the viscosity of the orientation film **112**. When the viscosity of the orientation film **112** is reduced, the orientation film **112** flows. This makes it difficult to define the area of the orientation film **112**, in particular, on the outside of the display area **10**. When the orientation film **112** flows to the portion in which the sealing material **15** is formed, the adhesive force of the sealing material **15** is reduced. This leads to a problem with the reliability of the sealing portion.

[0059] In the present invention, as shown in FIG. **4**, the orientation film stopper is formed to define the area to which the orientation film **112** should be applied. The orientation film stopper has the two-stage structure. In this way, when the orientation film **112** flows beyond the first orientation film stopper **61**, the second orientation film stopper **62** can prevent the orientation film **112** from flowing to the outside of the display area **10**. Here, when one stage of orientation film stopper can prevent the flow of the orientation film **112**, a one-stage structure can be used. It is also possible to use a three- or more-stage structure when two stages of orientation film stopper are not sufficient to prevent the outflow of the orientation film **112**.

[0060] FIG. **5** is a detailed top view of the periphery of FIG. **4**. FIG. **6** is a cross-sectional view taken along line A-A of FIG. **5**. In FIG. **5**, the sealing material **15** is formed in the end portion of the TFT substrate **100**. The first and second orientation film stoppers **61** and **62** are formed by color filters between the end portion of the display area **10** and the sealing material **15**. The orientation film **112** is defined by the first orientation film stopper **61**.

[0061] FIG. **6** is a cross-sectional view taken along line A-A of FIG. **5**, showing the configuration of the orientation film stopper. In FIG. **6**, the gate insulating film **102** and the inorganic passivation film **106** are formed on the TFT substrate **100**, on which the color filters are formed. In FIG. **6**, the pixel in the outermost periphery is the red pixel, so that the red color filter **107** extends to the periphery.

[0062] The green color filter **108** is formed to partially overlap the end of the read color filter **107**. The red color filter **107** and the green color filter **108** overlap with each other to form the first orientation film stopper **61**. The blue color filter **109** is formed to partially overlap the end of the green color filter **108**. The green color filter **108** and the blue color filter **109** overlap with each other to form the second orientation film stopper **62**.

[0063] In FIG. **6**, the outer periphery of the orientation film **112** applied by inkjet printing is defined by the first orientation film stopper **61**. Thus, when the viscosity of the orientation film **112** is small, the orientation film **112** does not flow to the outside of the first orientation film stopper **61**. However, if any defect is present in the first orientation film stopper **61**, the orientation film **112** may flow to the outside of the first orientation film stopper **61**. In this case, the outflow of the orientation film **112** can be prevented by the second orientation film stopper **62**.

[0064] In FIG. **6**, a width w**1** of the first and second orientation film stoppers **61** and **62** is about 10 μm. Also, a distance d**1** between the first and second orientation film stoppers **61** and **62** is about 10 μm. However, w**1** and d**1** can be set to an arbitrary value.

[0065] In FIG. **6**, a thickness h**2** of the upper color filter and a thickness h**1** of the lower color filter are substantially equal to each other, about 2 μm. However, the thickness h**2** of the upper color filter is often slightly smaller than the thickness h**1** of the lower color filter. This is due to the leveling effect in the application of the color filter. The upper color filter with a thickness of about 1 μm is sufficient to prevent the outflow of the orientation film **112**.

[0066] In the display area **10** shown in FIG. **2**, the light shielding film **80** is formed by the overlapping portion of the two color filters, in which the thickness of the upper color filter may be made much smaller than the thickness of the lower color filter. This is because the presence of a large step between the color filters may have effect on the orientation of the liquid crystal. In such a case, the upper color filter, which is formed as the orientation film stopper in the periphery, should have a greater thickness than the thickness of the upper color filter formed as the light shielding film **80** of the display area **10**.

[0067] Such a configuration can be provided, for example, by increasing the amount of overlap between the lower and upper color filters in the periphery. In other words, the greater the amount of overlap between the lower and upper color filters, the smaller the reduction in the film thickness of the upper color filter due to the leveling effect.

[0068] Another method of reducing the thickness of the upper color filter more within the display area **10** than in the periphery of the display area **10** is to pattern the upper color filter by half exposure in the overlapping portion in the display area **10**. The cross-linking reaction in the half exposed portion does not progress further than in the fully exposed portion. Thus, the color filter is formed thin in the half exposed portion after it is developed.

[0069] As described above, it is possible to arbitrarily set the shape of the light shielding film **80** formed by the overlapping of the color filters in the display area **10**, as well as the shape of the orientation film stopper formed by the overlapping of the color filters in the outside of the display area **10**. Further, the light shielding film **80** in the display area **10** and the orientation film stopper in the outside of the display area **10** can be formed at the same time. Thus, the number of processes remains unchanged.

[0070] The above description focuses on the configuration in which the orientation film **112** is formed by inkjet printing on the side of the TFT substrate **100**. The orientation film **112** should be formed also on the side of the counter substrate **200**. In the case of forming the orientation film **112** on the side of the counter substrate **200**, the use of inkjet printing is advantageous in terms of the production cost.

[0071] FIG. **7** is a top view of the side of the counter substrate **200**. In FIG. **7**, the sealing material **15** is formed in a portion of the counter substrate **200** to which the TFT substrate **100** is bonded. The orientation film stopper is formed between the outer periphery of the display area **10** and the sealing material **15**. The orientation film stopper has a two-stage structure of a third orientation film stopper **71** and a fourth orientation film stopper **72**.

[0072] In order to apply the orientation film **112** by inkjet printing, it is necessary to reduce the viscosity of the orientation film **112** when it is applied. However, the orientation film **112** having a low viscosity flows, making it difficult to define the area of the orientation film **112**, in particular, on the outside of the display area **10**. This is the same as the case of the TFT substrate **100**. When the orientation film **112** flows to the portion in which the sealing material **15** is formed, the adhesive force of the sealing material **15** is reduced. This leads to a problem with the reliability of the sealing portion.

[0073] In this embodiment, as shown in FIG. **7**, the orientation film stopper is formed to define the area to which the orientation film **112** should be applied. In the counter substrate **200**, the orientation film stopper is formed from the same material of the columnar spacer **202** at the same time. Thus, also in the counter substrate **200**, there is no additional process in the formation of the orientation film stopper. The orientation film stopper has the two-stage structure. In this way, when the orientation film **112** flows beyond the third orientation film stopper **71**, the fourth orientation film stopper **72** can prevent the flow of the orientation film **112** to the outside. This is the same as the case of the TFT substrate **100**. Of course, when one stage of orientation film stopper can prevent the flow of the orientation film **112**, a one-stage structure can be used. It is also possible to use a three- or more-stage structure when two stages of orientation film stopper are not sufficient to prevent the outflow of the orientation film **112**.

[0074] FIG. **8** is a detailed top view of the periphery of FIG. **7**. FIG. **9** is a cross-sectional view taken along line B-B of FIG. **8**. In FIG. **8**, the sealing material **15** is formed in the end portion of the counter substrate **200**. The third orientation film stopper **71** and the fourth orientation film stopper **72** are formed from the same material and process of the columnar spacer **202**, between the end of the display area **10** and the sealing material **15**. The orientation film **112** is defined by the end of the third orientation film stopper **71**.

[0075] FIG. **9** is a cross-sectional view taken along line B-B of FIG. **8**, showing the state of the orientation film stopper in the counter substrate **200**. In FIG. **9**, the third orientation film stopper **71** and the fourth orientation film stopper **72** are formed on the counter substrate **200**, by the same process of the columnar spacer **202**. The width of the orientation film stopper is, for example, 10 μm. A distance d2 between the orientation film stoppers **72** and **71** is, for example, 10 μm. The orientation film stoppers of the counter substrate **200** are formed in the same manner as the columnar spacer **202**, having a height h**3** of, for example, about 3 to 5 μm.

[0076] In FIG. **9**, the profile of the orientation film **112** is defined by the third orientation film stopper **71**. In this way, in the counter substrate **200**, the use of the third orientation film stopper **71** defines the profile of the orientation film **112**, ensuring that the orientation film **112** remains without flowing to the sealing portion. As a result, the reliability of the sealing portion is not reduced. Further, the orientation film stopper of the counter substrate **200** is formed by the same process of the columnar spacer **202**, in which there is no increase in the production cost.

[0077] FIG. **10** is a cross-sectional view of the periphery of the liquid crystal display panel, in which the TFT substrate **100** and the counter substrate **200** are formed as described above and bonded together. In FIG. **10**, the TFT substrate **100** and the counter substrate **200** are bonded together by the sealing material **15** formed in the periphery. The liquid crystal layer **300** is interposed between the TFT substrate **100** and the counter substrate **200**.

[0078] In the TFT substrate **100**, the red color filter **107** extends from the display area **10**. The green color filter **108** is formed to overlap the end of the red color filter **107**, forming the first orientation film stopper **61**. Further, the blue color filter **109** is formed to overlap the end of the green color filter **108**, forming the second orientation film stopper **62**. The profile of the orientation film **112** of the TFT substrate **100** is defined by the first orientation film stopper **61**.

[0079] In the counter substrate **200** of FIG. **10**, the third orientation film stopper **71** and the fourth orientation film stopper **72** are formed by the same process of the columnar spacer **202**. The profile of the orientation film **112** of the counter substrate **200** is defined by the third orientation film stopper **71**. The first and second orientation film stoppers **61** and **62** formed in the TFT substrate **100**, and the third and fourth orientation film stoppers **71** and **72** formed in the counter substrate **200**, are arranged at positions shifted from each other. In this way, the color filters in the display area **10** as well as the columnar spacer **202** are allowed to define the distance between the TFT substrate **100** and the counter substrate **200** in the liquid crystal display panel.

[0080] In FIG. **10**, the third and fourth orientation film stoppers **71** and **72** in the counter substrate **200** are formed on the outside of the first and second orientation film stoppers **61** and **62** in the TFT substrate **100**. However, the reverse arrangement is also possible. In other words, the first and second orientation film stoppers **61** and **62** of the TFT substrate **100** can be formed on the outside of the third and fourth orientation film stoppers **71** and **72** of the counter substrate **200**.

Second Embodiment

[0081] In the first embodiment, the overlapping portion of the red color filter **107** and the green color filter **108** forms the first orientation film stopper **61** on the side of the TFT substrate **100**. Similarly, the overlapping portion of the green color filter **108** and the blue color filter **109** forms the second orientation film stopper **62** on the side of the TFT substrate **100**. However, the method of forming the orientation film stopper is not limited to the above example, and other various configurations can also be used.

[0082] FIG. **11** is a top view of another method of forming the orientation film stopper on the side of the TFT substrate **100**. FIG. **12** is a cross-sectional view taken along line C-C of FIG. **11**. In FIG. **11**, the sealing material **15** is formed in the end portion of the TFT substrate **100**. The first orientation film stopper **61** and the second orientation film stopper **62** are formed by the color filters between the end of the display area **10** and the sealing material **15**. The orientation film **112** is defined by the first orientation film stopper **61**. FIG. **11** is different from FIG. **5** of the first embodiment in the method of forming the orientation film stopper.

[0083] FIG. **12** is a cross-sectional view taken along line C-C of FIG. **11**, showing the configuration of the orientation film stopper. FIG. **12** is the same as FIG. **6** except for the method of forming the orientation film stopper, so that the description of the same configuration will be omitted. In FIG. **12**, the red color filter **107** extends to under the blue color filter **109** constituting the second orientation film stopper **62**.

[0084] The first orientation film stopper **61** is formed by placing the green color filter **108** on the red color filter **107**. Further, the second orientation film stopper **62** is formed by placing the blue color filter **109** on the red color filter **107**. In this embodiment, the orientation film stopper can be formed without forming a step between the color filters. In FIG. **13**, the thickness h1 of the lower color filter and the thickness h2 of the upper color filter are substantially equal to each other. Also in this embodiment, the thickness h2 of the upper color filter can be adjusted by the leveling effect.

[0085] FIG. **13** is a cross-sectional view of the periphery of the liquid crystal display panel using the TFT substrate **100** according to this embodiment. FIG. **13** is the same as FIG. **10** except for the method of forming the first and second orientation film stoppers **61** and **62** formed in the TFT substrate **100**. The effect of the second embodiment is the same as the effect of the first embodiment.

Third Embodiment

[0086] A third embodiment addresses the case in which the height of the orientation film stopper is not sufficient in the formation of the orientation film stopper by the overlapping of the color filters on the TFT substrate **100**. FIG. **14** is a cross-sectional view of the periphery of the TFT substrate **100** in this embodiment. The cross-sectional view corresponds to FIG. **12** in the second embodiment.

[0087] In FIG. **14**, the red color filter **107** extends to the second orientation film stopper **62**. The first orientation film stopper **61** is formed by placing the green color filter **108** on the red color filter **107**. Then, the blue color filter **109** is further placed on the green color filter **108**. The first orientation film stopper **61** is formed by the overlapping of the three color filters. Thus, the height of the orientation film stopper can be made large, even to 4 μm or more. This configuration ensures to prevent the orientation film **112** from flowing to the outside of the display area **10**.

[0088] The second orientation film stopper **62** has the very same configuration as that of the first orientation film stopper **61**, and can be formed by the same process of the first orientation film stopper **61**. The third embodiment is the same as the second embodiment in the cross section of the periphery of the liquid crystal display panel formed in such a way that the TFT substrate **100** and the counter substrate **200** are bonded together, except that the first and second orientation film stoppers **61** and **62** have the three-layer structure. Thus, the repeated description will be omitted here.

Fourth Embodiment

[0089] In the above embodiments, the overlapping of the color filters is used as the light shielding film **80** in the display area **10**. However, the light shielding film **80** formed by the overlapping of the color filters may not be sufficient to shield, in particular, the TFT from the light. FIG. **15** is a cross-sectional view of the configuration that solves this problem.

[0090] In FIG. **15**, a black matrix **110** is formed on the TFT substrate **100**, in addition to the color filters. The black matrix **110** is formed from a photosensitive resin with titanium black, carbon black, and the like, dispersed therein, having an excellent light shielding property. Also the black matrix **110** is formed by photo processing. In this embodiment, the number of processes is increased by the use of the photo processing. However, the OFF current of the TFT can be reduced, so that the image quality can be increased.

[0091] Even in the configuration shown in FIG. **15**, the present invention can also be applied in the same manner as described in the first to third embodiments. Further, instead of using the color filter, the black matrix **110** can be placed on the upper layer as an orientation film stopper in the periphery. In this case, the black matrix **110** can function as a stopper of the orientation film **112**, and can function as means for preventing the reduction in the contrast due to the external light reflection in the periphery. FIG. **16** is a cross-sectional view of the TFT substrate **100** in this state.

[0092] In FIG. **16**, the red color filter **107** extends to the periphery. The black matrix **110** is formed on the red color filter **107**. In this embodiment, the black matrix **110** has only one stage. In other words, the orientation film stopper includes only the first orientation film stopper **61**. In FIG. **16**, the black matrix **110** is formed wider than the upper fluorescent layer of the first to third embodiments. The wide width of the black matrix **110** prevents the reflection of external light in the periphery. As a result, the contrast can be increased in the periphery of the display.

[0093] The above embodiments have been described assuming that the red, green, and blue color filters are formed in this order. However, the order of the formation of the color filters is not limited to this example, and can be set arbitrarily.

What is claimed is:

1. Manufacturing method of a liquid crystal display device comprising:

a TFT substrate including a display area in which pixels each having a pixel electrode and a TFT are arranged in a matrix form;

a counter substrate disposed opposite to the TFT substrate;

a sealing material formed in a periphery to bond the TFT substrate and the counter substrate together; and

a liquid crystal layer interposed between an orientation film formed in the TFT substrate and an orientation film formed on the counter substrate;

the manufacturing method comprising the steps of:

forming a first color filter, a second color filter, or a third color filter corresponding to each of the pixels in the display area of the TFT substrate; and

forming an orientation film stopper by overlapping a portion of the first color filter, the second color filter, or the third color filter, in an area between the display area and the sealing material;

wherein a profile of the orientation film formed in the TFT substrate is defined by the orientation film stopper.

2. Manufacturing method of the liquid crystal display device according to claim **1**, wherein the orientation film stopper is formed by overlapping a portion of two layers of color filters.

3. Manufacturing method of the liquid crystal display device according to claim **1**, wherein the orientation film stopper is formed by overlapping a portion of three layers of color filters.

4. Manufacturing method of a liquid crystal display device comprising:

a TFT substrate including a display area in which pixels each having a pixel electrode and a TFT are arranged in a matrix form;

a counter substrate disposed opposite to the TFT substrate;

a sealing material formed in a periphery to bond the TFT substrate and the counter substrate together; and

a liquid crystal layer interposed between an orientation film formed on the TFT substrate and an orientation film formed in the counter substrate;

the manufacturing method comprising the steps of:

forming a columnar spacer for defining a distance between the TFT substrate and the counter substrate;

forming a first color filter, a second color filter, or a third color filter corresponding to each of the pixels in the display area of the TFT substrate;

forming a first orientation film stopper by overlapping a portion of the first color filter, the second color filter, or the third color filter, in an area between the display area of the TFT substrate and the sealing material;

wherein a profile of the orientation film formed in the TFT substrate is defined by the first orientation film stopper; and

forming a second orientation film stopper by the same process of the columnar spacer in an area between the display area of the counter substrate and the sealing material;

wherein a profile of the orientation film formed in the counter substrate is defined by the second orientation film stopper.

5. Manufacturing method of a liquid crystal display device comprising:

a TFT substrate including a display area in which pixels each having a pixel electrode and a TFT are arranged in a matrix form;

a counter substrate disposed opposite to the TFT substrate;

a sealing material formed in a periphery to bond the TFT substrate and the counter substrate together; and

a liquid crystal layer interposed between an orientation film formed in the TFT substrate and an orientation film formed in the counter substrate;

the manufacturing method comprising the steps of:

forming a first color filter, a second color filter, or a third color filter corresponding to each of the pixels in the display area of the TFT substrate;

forming a light shielding film on the TFT, in addition to the first color filter, the second color filter, or the third color filter; and

forming an orientation film stopper by overlapping a portion of the light shielding film and the first color filter, the second color filter, or the third color filter, in an area between the display area of the TFT substrate and the sealing material;

wherein a profile of the orientation film formed in the TFT substrate is defined by the orientation film stopper.

* * * * *

专利名称(译)	液晶显示装置的制造方法		
公开(公告)号	US20130203313A1	公开(公告)日	2013-08-08
申请号	US13/798317	申请日	2013-03-13
[标]申请(专利权)人(译)	GOTOH JUN		
申请(专利权)人(译)	GOTOH，JUN		
当前申请(专利权)人(译)	GOTOH，JUN		
[标]发明人	GOTOH JUN		
发明人	GOTOH, JUN		
IPC分类号	G02F1/1335		
CPC分类号	G02F1/133514 G02F2001/133388 G02F1/1337 G02F1/133516 G02F2001/133519		
优先权	2009133752 2009-06-03 JP		
其他公开文献	US8823906		
外部链接	Espacenet USPTO		

摘要(译)

液晶显示装置的制造方法，具有：TFT基板，其具有配置有像素的显示区域;对置基板;形成于周边的密封材料，用于接合TFT和对置基板;以及液晶层，其介于取向之间TFT基板上的膜和相对基板上的取向膜。该方法包括以下步骤：形成对应于TFT基板的显示区域中的每个像素的第一滤色器，第二滤色器或第三滤色器，以及通过重叠第一滤光器的一部分来形成取向膜止动器滤色器，第二滤色器或第三滤色器，位于显示区域和密封材料之间的区域中。形成在TFT基板中的取向膜的轮廓由取向膜阻挡件限定。