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(54) **TRANSMISSION TYPE LIQUID CRYSTAL
DISPLAY DEVICE**

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(52) **U.S. Cl.** **349/38; 349/43; 438/30**

(58) **Field of Search** **349/38, 43; 438/30**

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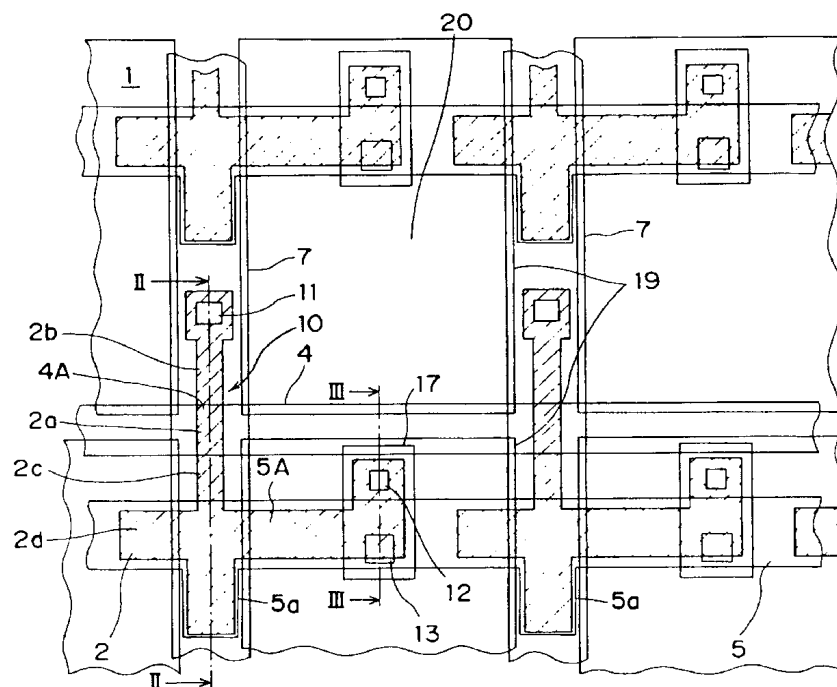
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(57) **ABSTRACT**

In a transmission type liquid crystal display device, a semiconductor thin film is formed for each pixel below a signal wiring, a gate wiring, an auxiliary capacitance wiring and a lead electrode which are made of a light shading material via an insulating film. A region that belongs to the semiconductor thin film and is located below the signal wiring and below the gate wiring is made to serve as a channel region of a TFT. Regions that belong to the semiconductor thin film and are located on both sides of the channel region below the signal wiring are made to serve as a source region and a drain region of the TFT, respectively. Further, a region that belongs to the semiconductor thin film and is located below the auxiliary capacitance wiring is made to serve as an auxiliary capacitance electrode region. The TFT is effectively shaded without impairing the opening ratio of the transmission type liquid crystal display device with a simple construction, and the transmission type liquid crystal display device is fabricated with a high yield at low cost through a short process.

1 Claim, 8 Drawing Sheets



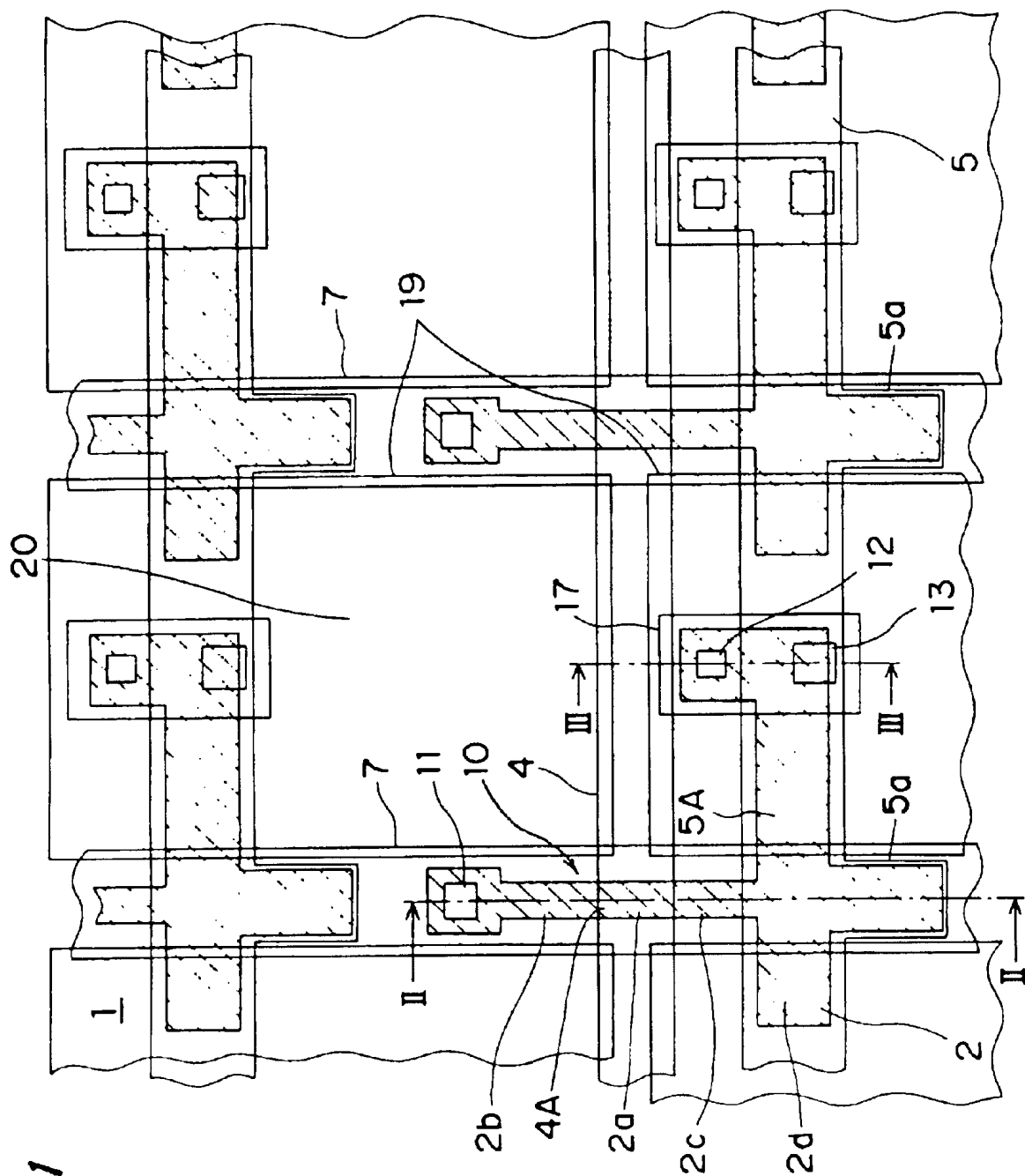


Fig. 1

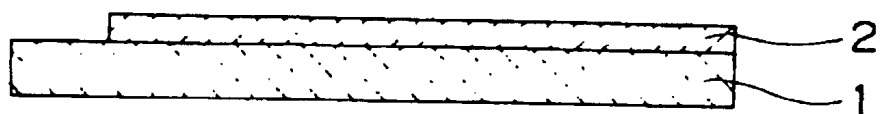
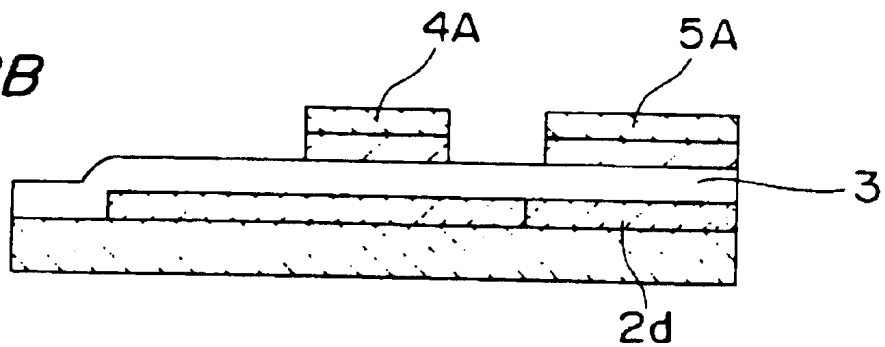
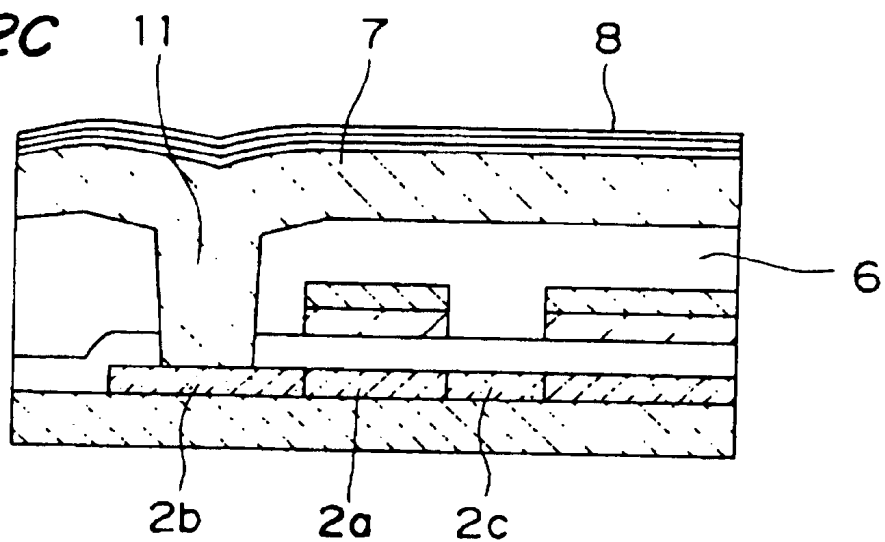
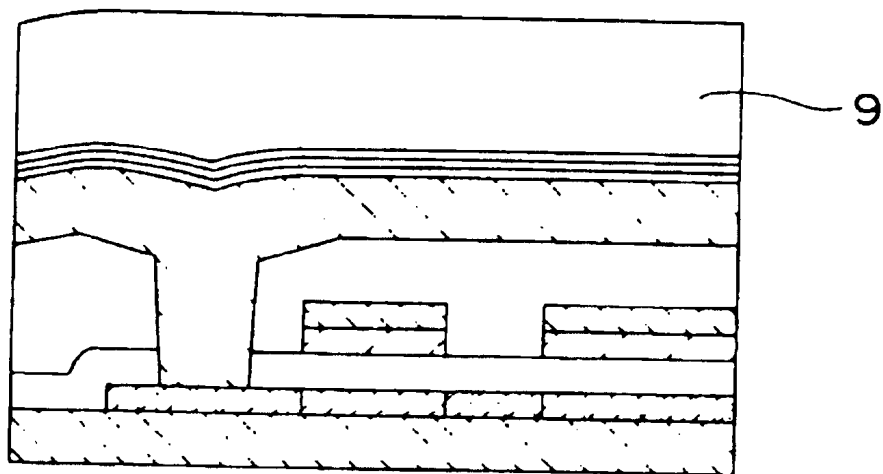
Fig. 2A*Fig. 2B**Fig. 2C**Fig. 2D*

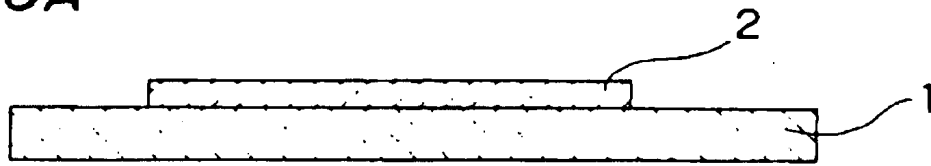
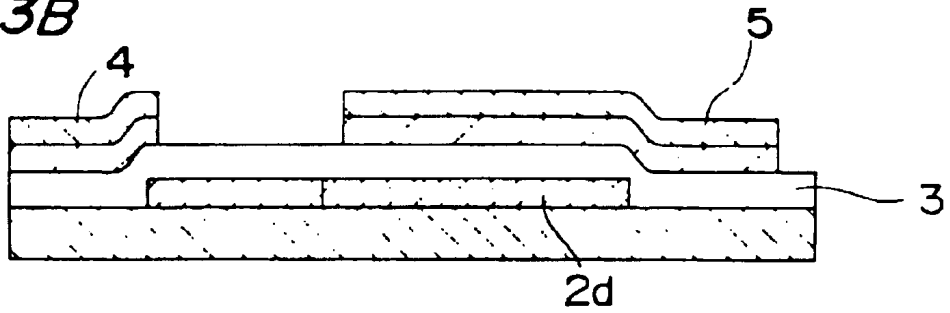
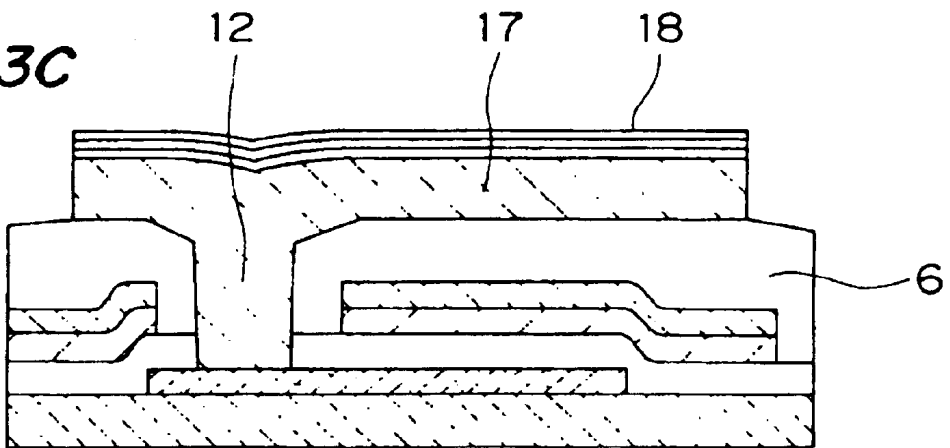
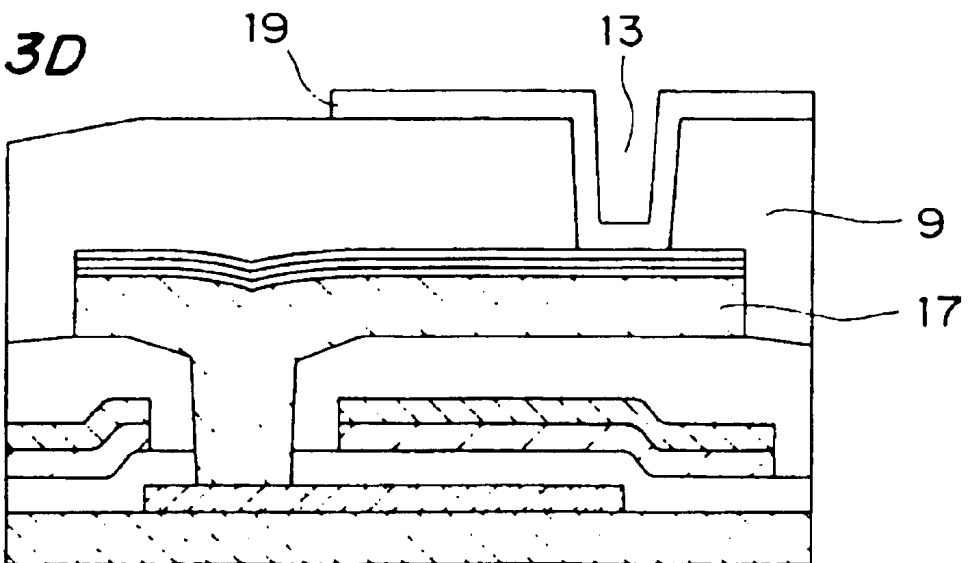
Fig. 3A*Fig. 3B**Fig. 3C**Fig. 3D*

Fig. 4

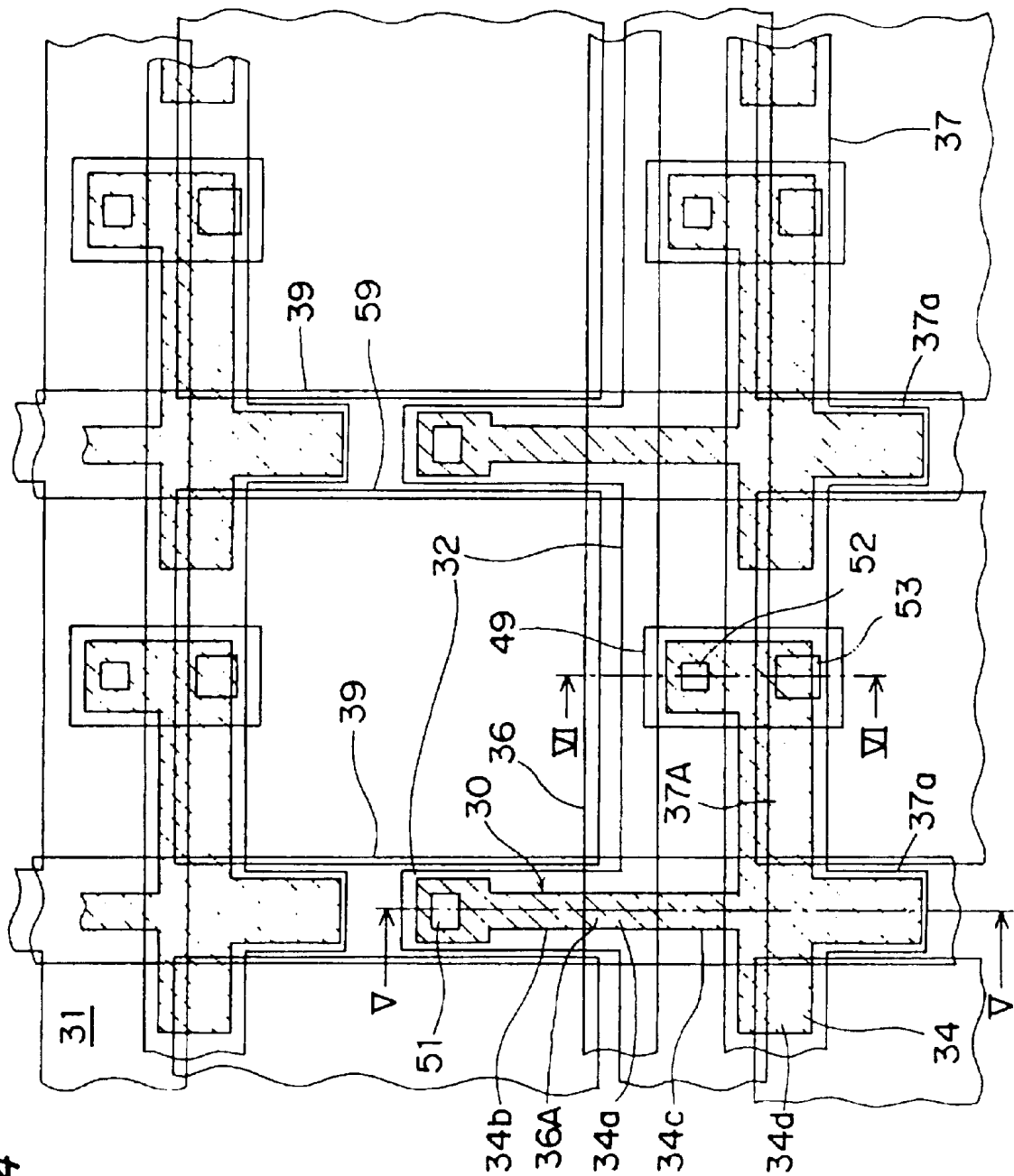


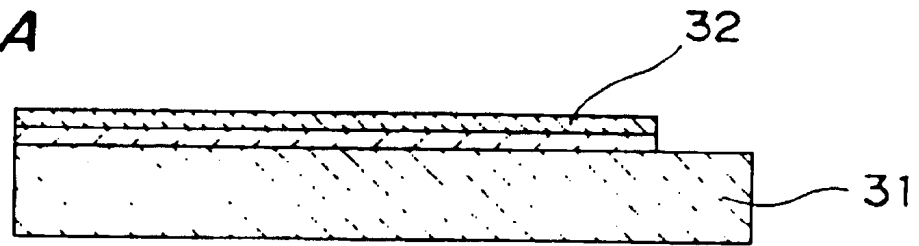
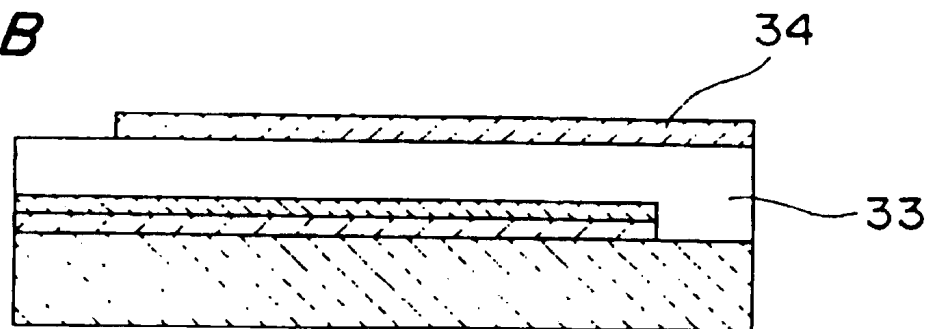
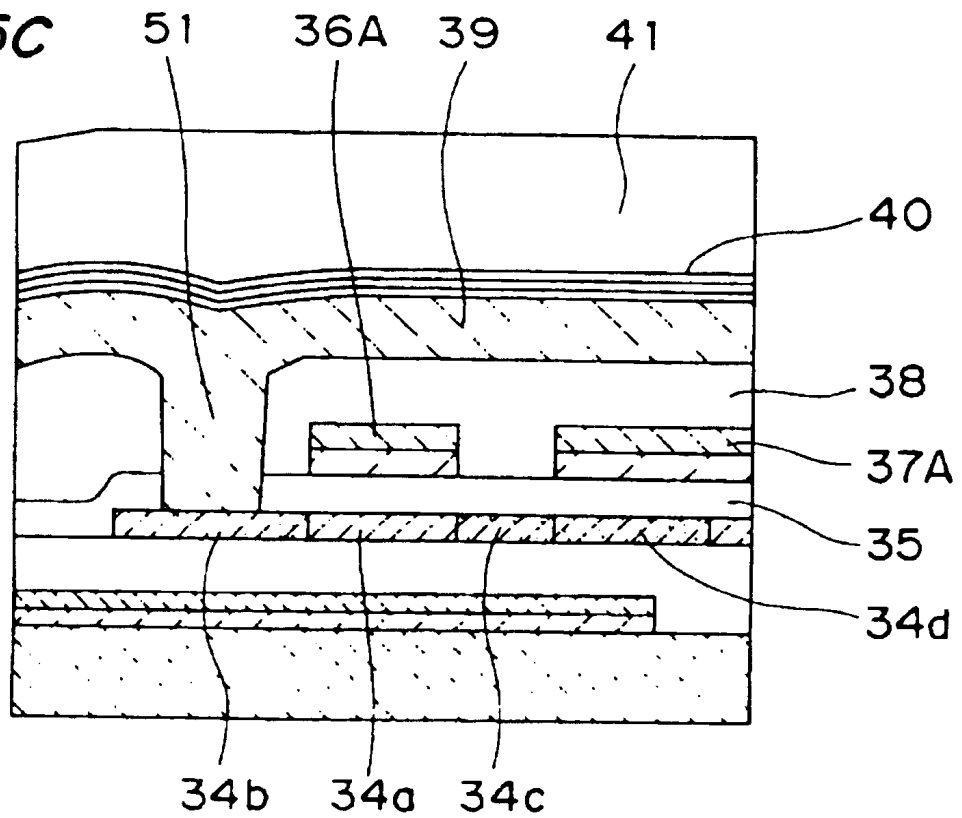
Fig. 5A*Fig. 5B**Fig. 5C*

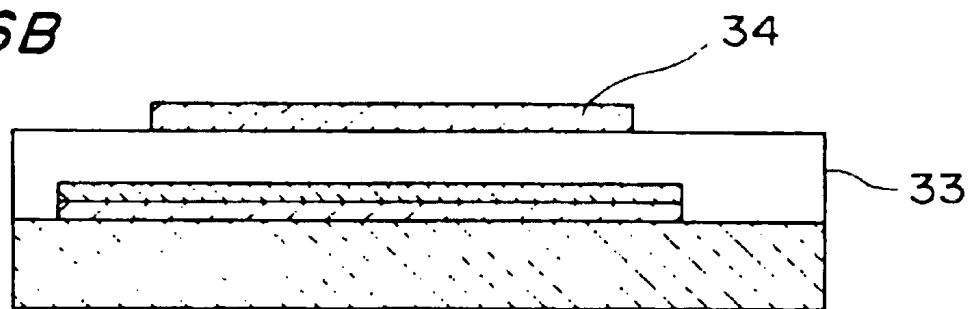
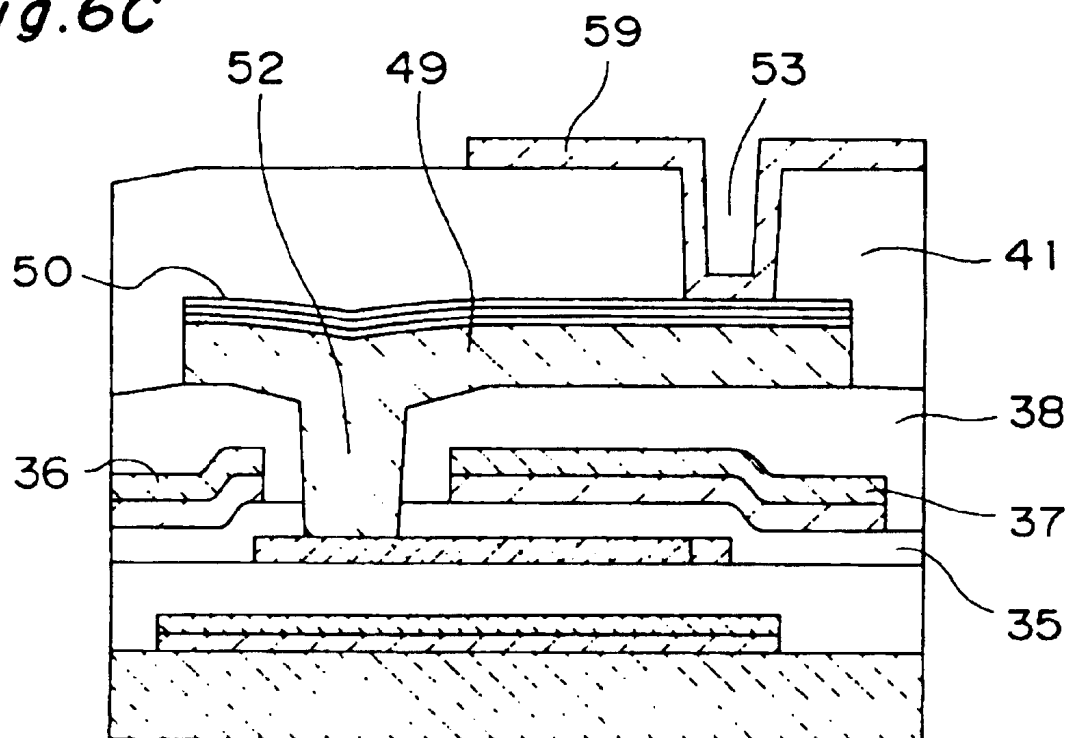
Fig. 6A*Fig. 6B**Fig. 6C*

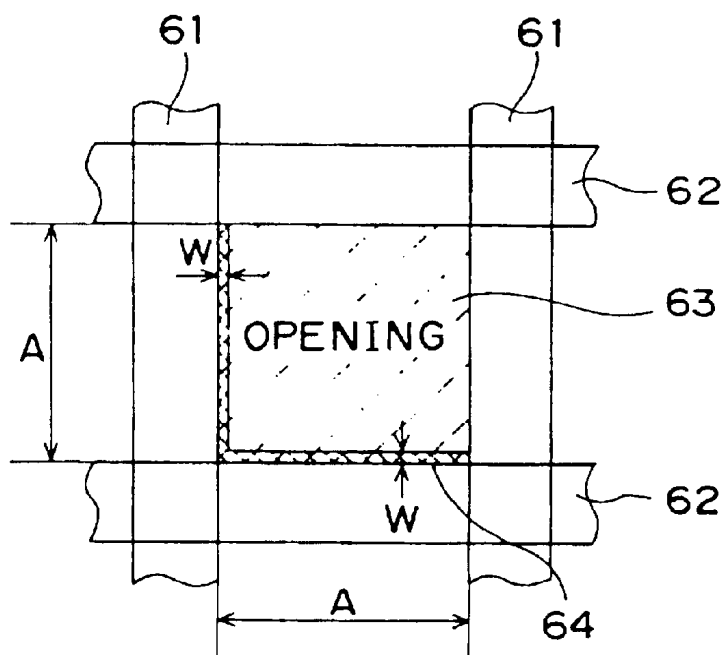
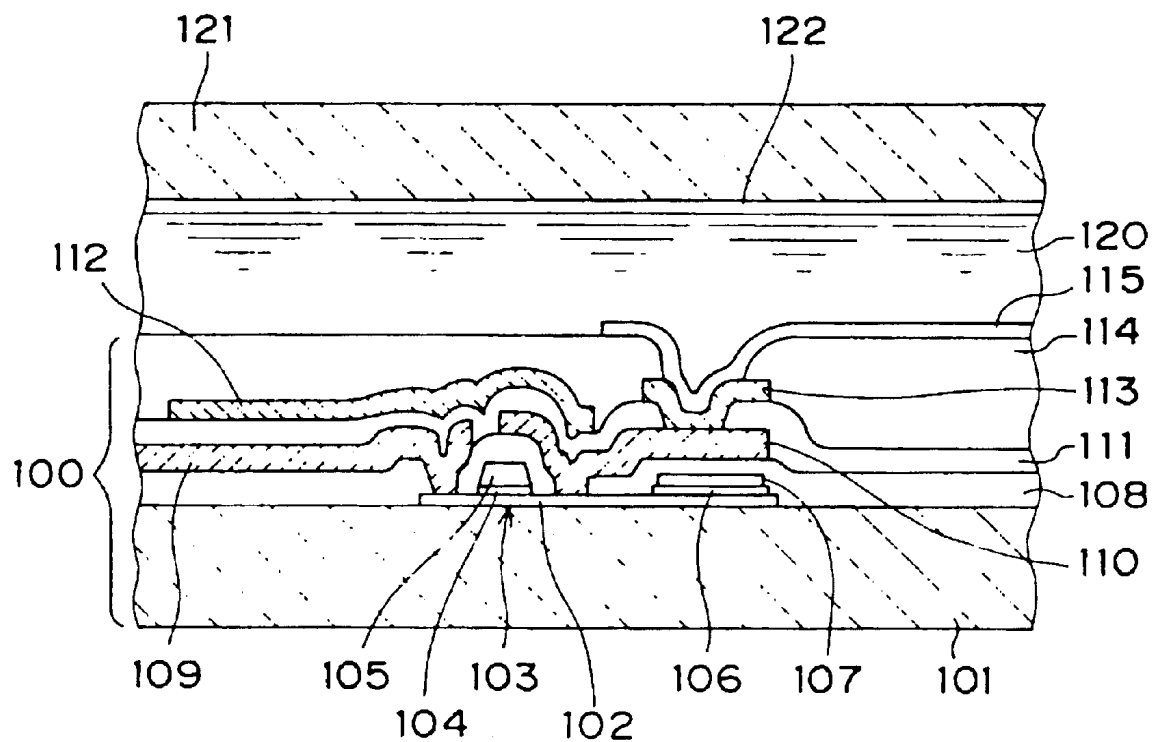
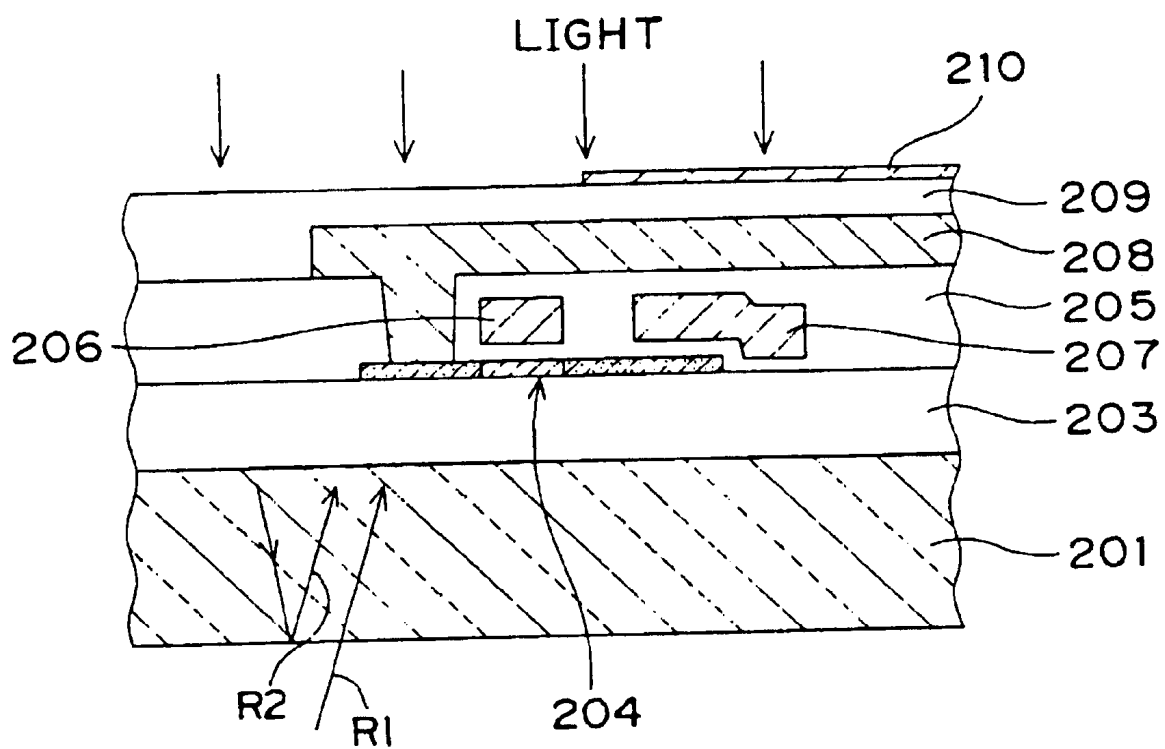
Fig. 7*Fig. 8 PRIOR ART*

Fig. 9 PRIOR ART

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TRANSMISSION TYPE LIQUID CRYSTAL DISPLAY DEVICE

BACKGROUND OF THE INVENTION

The present invention relates to a transmission type liquid crystal display device.

Conventionally, in accordance with improvement in resolution of the transmission type liquid crystal display device, there have been proposed a variety of structures for effectively shading light without impairing an opening ratio of the liquid crystal display device in order to prevent a reduction in contrast due to malfunction ascribed to a photoelectric current and leak of light from the semiconductor layer of a thin film transistor that serves as a switching element.

As a typical transmission type liquid crystal display device, there is the one shown in FIG. 8 (Japanese Patent Laid-Open Publication No. HEI 9-43639). As shown in FIG. 8, this transmission type liquid crystal display device is constructed of a transparent drive substrate **101** and an opposite substrate **121** that are bonded to each other with interposition of a specified gap, and liquid crystals **120** are held in this gap.

The opposite substrate **121** is located on the incident side of the liquid crystal display device, and an opposite electrode **122** is provided on the drive substrate **101** side. The drive substrate **101** is located on the radiating side and includes a group of pixels each constructed of a pixel electrode **115** and a switching element **103** on the drive substrate **101** and a black matrix for shading an unopened portion of individual pixels from light incident on the incident side. The black matrix is constructed of two layers of a mask light shading pattern **112** and a pad light shading pattern **113**, which are patterned to overlap each other to complementarily shade incident light. For example, an upper layer is made of titanium (Ti), while the lower layer is made of aluminum (Al).

The drive substrate **101** is constructed of an upper layer, an intermediate layer and a lower layer. The upper layer includes the pixel electrode **115**. The lower layer includes the switching element **103** for driving each pixel electrode **115**, a gate wiring (not shown) for scanning the rows of the switching elements **103** and a signal wiring (not shown) for supplying a specified image signal to the switching elements **103** of each column.

The switching element **103** is constructed of a thin film transistor (referred to as TFT hereinafter) that has a semiconductor thin film **102** made of polycrystal silicon or the like as an active layer. A gate electrode **105** is formed on the transistor via a gate insulating film **104**. The gate electrode **105** leads to the gate wiring. The TFT that serves as the switching element **103** is provided with a source region and a drain region on both sides of the gate electrode **105**. One lead electrode **109** is connected to the source region of the semiconductor thin film **102**, and the lead electrode **109** leads to a signal wiring (not shown). The other lead electrode **110** is connected to the drain region of the semiconductor thin film **102**.

Further, the semiconductor thin film **102** is also provided with an auxiliary capacitance. This auxiliary capacitance includes the semiconductor thin film **102** that serves as one electrode and an auxiliary capacitance wiring **107** that serves as the other electrode via an insulating film **106**. The gate electrode **105**, the gate wiring and the auxiliary capacitance wiring **107** are constructed of a same layer and insulated

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from the lead electrodes **109**, **110** by a first interlayer insulating film **108**.

Then, bisected light shading patterns **112**, **113** exist in the intermediate layer. One light shading pattern **112** is continuously patterned along the direction of row of the pixels and at least partially shades light to the switching element **103** while being vertically held by a second interlayer insulating film **111** and a flattening film **114** so as to be insulated from the lower layer and the upper layer. The other light shading pattern **113** is discretely patterned to be interposed between the pixel electrode **115** and the lead electrode **110**, so that the light shading pattern **113** is for good electrical connection between both the electrodes as well as light shading. The lead electrode **110** is formed of a layer identical to that of the signal wiring and electrically connected to the drain region of the semiconductor thin film **102**.

In the above-mentioned transmission type liquid crystal display device, no light shading is needed if a metal or silicide is used for the gate wiring, gate electrode **105**, auxiliary capacitance wiring **107**, signal wiring and lead electrodes **109**, **110**. However, the semiconductor layer of the TFT formed of the semiconductor thin film **102** is required to be completely shaded from light due to the light transmission of the semiconductor layer. Therefore, in order to completely shade the region to be shaded from light in the lower layer by the light shading patterns **112**, **113**, the light shading patterns are required to be formed jutting out of the region (semiconductor layer of TFT) to be shaded from light taking variations in alignment and line width through the patterning process into consideration. The opening ratio is reduced by an area of the jut region, and this causes a problem that brightness of the liquid crystal display device is reduced.

Furthermore, due to the necessity of the film formation of the light shading patterns, the process is prolonged and the structure becomes complicated, disadvantageously leading to a factor of yield reduction and cost increase. Specifically, there are needed the processes of forming the interlayer insulating films, light shading patterns and contact holes.

FIG. 9 shows a sectional view of the essential part of another conventional transmission type liquid crystal display device, in which a lower layer insulating film **203**, a TFT **204**, a first interlayer insulating film **205**, a gate electrode **206**, an auxiliary capacitance wiring **207**, a signal wiring **208**, a second interlayer insulating film **209** and a pixel electrode **210** are successively formed on a transparent substrate **201**. With regard to the above transmission type liquid crystal display device, light comes from the above and goes out downward in FIG. 9. A reflected light **R1** from an optical system on the radiating side may be incident on the TFT **204**, and a reflected light **R2** caused by reflection of a transmitted light on the lower surface of the transparent substrate **201** may be incident on the TFT **204**. This leads to a problem that the reflected lights **R1** and **R2** are incident on the TFT to cause an optical leak current when the TFT is turned off in accordance with the dimensional reduction of pixels in company with the improvement in resolution.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a transmission type liquid crystal display device that can cope with an improvement in resolution by effectively shading light without impairing an opening ratio and by shading a rear surface reflection light, the device being able to be fabricated with a simple construction and high yield at low cost through a short process.

In order to achieve the above-mentioned object, the present invention provides a transmission type liquid crystal display device including on a transparent substrate a gate wiring; a signal wiring perpendicular to the gate wiring, an auxiliary capacitance wiring that is generally parallel to the gate wiring and perpendicular to the signal wiring, a thin film transistor having either one of a source region and a drain region connected to the signal wiring, and a pixel electrode to which the other one of the source region and the drain region of the thin film transistor is connected via a lead electrode, wherein the signal wiring, the gate wiring, the auxiliary capacitance wiring and the lead electrode are made of a light shading material, a semiconductor thin film is formed for each pixel electrode below the signal wiring, the gate wiring, the auxiliary capacitance wiring and the lead electrode via an insulating film, a region that belongs to the semiconductor thin film and is located below the signal wiring and below the gate wiring is made to serve as a channel region of the thin film transistor, regions that belong to the semiconductor thin film and are located on both sides of the channel region below the signal wiring are made to serve as a source region and a drain region of the thin film transistor respectively, and a region that belongs to the semiconductor thin film and is located below the auxiliary capacitance wiring is made to serve as an auxiliary capacitance electrode region.

According to the transmission type liquid crystal display device of the present invention, the gate wiring, the signal wiring, the auxiliary capacitance wiring and the lead electrode are formed of a light shading material. Therefore, the channel region of the TFT, which is located below the signal wiring and below the gate wiring, is shaded from incident light. The source region and the drain region of the TFT, which are located on both sides of the channel region below the signal wiring, are also shaded from incident light. Accordingly, the TFT is entirely shaded from incident light. Since the gate wiring, the signal wiring, the auxiliary capacitance wiring and the lead electrode are made of the light shading material, it is not necessary to form a light shading film for shading the TFT. This allows the transmission type liquid crystal display device to be fabricated at low cost and with high yield. Light shading of the TFT is effectively achieved with a simple construction without impairing the opening ratio of a liquid crystal display.

In an embodiment of the invention, a jut region of the semiconductor thin film in which juts from the signal wiring, the gate wiring, the auxiliary capacitance wiring and the lead electrode has an areal ratio of 0.1 or less with respect to an area of an opening through which light is transmitted.

According to the transmission type liquid crystal display device of the above embodiment, it is preferred that the semiconductor thin film be completely covered. However, even if the semiconductor thin film juts over the opening through which light is transmitted, the jut region of the semiconductor thin film cannot be visually distinguished by human beings so long as the jut region has an area of not greater than 10% of the total area of the opening.

In an embodiment of the invention, the transmission type liquid crystal display device further comprises a lower layer light shading film formed below the semiconductor thin film and on the transparent substrate so as to cover a region that includes at least the channel region of the thin film transistor of the semiconductor thin film.

According to the transmission type liquid crystal display device of the above embodiment, the rear surface reflection light to the TFT is obstructed by forming the lower layer

light shading film below at least the channel region, the source region and the drain region of the TFT in the semiconductor thin film via the insulating film.

In an embodiment of the invention, the lower layer light shading film is formed on the transparent substrate so as to cover a region located between the gate wiring and the auxiliary capacitance wiring.

According to the transmission type liquid crystal display device of the above embodiment, the region between the gate wiring and the auxiliary capacitance wiring is shaded by the lower layer light shading film.

In an embodiment of the invention, the transmission type liquid crystal display device further comprises a first contact hole for connecting either one of the source region and the drain region of the semiconductor thin film to the signal wiring, a second contact hole for connecting the other one of the source region and the drain region of the semiconductor thin film to the lead electrode, and a third contact hole for connecting the lead electrode to the pixel electrode,

the signal wiring being electrically connected to the pixel electrode via the first contact hole, the source region, the channel region, the drain region, and the auxiliary capacitance electrode region of the semiconductor thin film, the second contact hole, the lead electrode and the third contact hole.

According to the transmission type liquid crystal display device of the above embodiment, if the above-mentioned TFT is turned on, then the potential of the signal wiring is applied to the pixel electrode via the first contact hole, the source region, the channel region, the drain region and the auxiliary capacitance electrode region of the semiconductor thin film, the second contact hole, the lead electrode and the third contact hole. Then, the potential of the pixel electrode is retained in the capacitance formed by holding liquid crystals between the pixel electrode and the opposite electrode (located on the opposite substrate side), and the potential of the pixel electrode is retained in the auxiliary capacitance formed by holding the insulating film that serves as a dielectric film between the auxiliary capacitance wiring and the auxiliary capacitance electrode region of the semiconductor thin film.

In an embodiment of the invention, the gate electrode and the auxiliary capacitance wiring are made of a same material.

According to the transmission type liquid crystal display device of the above embodiment, the gate wiring and the auxiliary capacitance wiring of the same material is formed, so there can be obtained a simple construction in which the gate wiring and the auxiliary capacitance wiring can be formed in a same layer through a same process.

In an embodiment of the invention, the signal wiring and the lead electrode are made of a same material.

According to the transmission type liquid crystal display device of the above embodiment, the signal wiring and the lead electrode of the same material is formed, so there can be obtained a simple construction in which the signal wiring and the lead electrode can be formed in a same layer through a same process.

In an embodiment of the invention, the lead electrode is a thin film whose a principal component is Al, and a film layer which contains at least one substance selected from among Ir, Ru, Cr, Co, Ta, Ti, W, Mo, TiW alloy, WN, TiN and a silicide of Ir, Cr, Co, Ta, Ti, W and Mo is laminated on the lead electrode

According to the transmission type liquid crystal display device of the above embodiment, the film layer containing at least one substance selected from among Ir, Ru, Cr, Co,

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Ta, Ti, W, Mo, TiW alloy, WN, TiN and the silicide of Ir, Cr, Co, Ta, Ti, W and Mo is laminated on the lead electrode whose a principal component is Al. Therefore, the pixel electrode which is made of a transparent oxide such as ITO (indium-tin-oxide) does not directly contacts the Al thin film of the lead electrode, and thereby Al oxide is not formed at an interface between the lead electrode and the pixel electrode, allowing good electrical connection between the lead electrode and the pixel electrode to be obtained.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

FIG. 1 is a schematic plan view of an essential part of a transmission type liquid crystal display device according to a first embodiment of the present invention;

FIGS. 2A through 2D are views showing fabricating processes of a cross-sectional portion taken along line II—II of FIG. 1;

FIGS. 3A through 3D are views showing the fabricating processes of a cross-sectional portion taken along line III—III of FIG. 1;

FIG. 4 is a schematic plan view of the essential part of a transmission type liquid crystal display device according to a second embodiment of the present invention;

FIGS. 5A through 5C are views showing fabricating processes of a cross-sectional portion taken along line V—V of FIG. 4;

FIGS. 6A through 6C are views showing the fabricating processes of a cross-sectional portion taken along line VI—VI of FIG. 4;

FIG. 7 is a view for explaining an opening and a jut region;

FIG. 8 is a schematic sectional view of an essential part of a conventional transmission type liquid crystal display device; and

FIG. 9 is a schematic sectional view of an essential part of another conventional transmission type liquid crystal display device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A transmission type liquid crystal display device of the present invention will be described in detail below on the basis of embodiments thereof shown in the drawings.

FIG. 1 is a schematic plan view of an essential part of a transmission type liquid crystal display device according to a first embodiment of the present invention. As shown in FIG. 1, this transmission type liquid crystal display device includes a plurality of gate wiring lines 4 (only one is shown in FIG. 1) arranged generally parallel to one another, a plurality of signal wiring lines 7 that are arranged generally parallel to one another so as to be perpendicular to the gate wiring lines 4, a plurality of auxiliary capacitance wiring lines 5 arranged generally parallel to the gate wiring lines 4 between the gate wiring lines 4, a plurality of TFT's 10 whose source regions 2b are connected to the signal wiring lines 7 and a plurality of pixel electrodes 19 connected to the drain regions 2c of the TFT's 10 via lead electrodes 17, the elements being formed on a transparent substrate 1. The auxiliary capacitance wiring 5 has a region 5a that extends downward along the signal wiring 7 in FIG. 1.

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The signal wiring lines 7, gate wiring lines 4, auxiliary capacitance wiring lines 5, and lead electrodes 17 are made of a light shading material. A plurality of polycrystal silicon films 2 that serve as semiconductor thin films are formed on the transparent substrate 1 for each pixel so as to be below the signal wiring 7, gate wiring 4, auxiliary capacitance wiring 5, and lead electrode 17. Then, a region that belongs to the polycrystal silicon film 2 and is located below the signal wiring 7 and below the gate wiring 4 is made to serve as a channel region 2a of the TFT 19. Regions that belong to the polycrystal silicon film 2 and are located on both sides of the channel region 2a are made to serve as a source region 2b and a drain region 2c of the TFT 10. Further, a region that belongs to the polycrystal silicon film 2 and is located below the auxiliary capacitance wiring 5 is made to serve as an auxiliary capacitance electrode region 2d. The channel region 2a, source region 2b and drain region 2c of the polycrystal silicon film 2 are shaded from light by the signal wiring 7 and the gate wiring 4, while the auxiliary capacitance electrode region 2d of the polycrystal silicon film 2 is shaded from light by the auxiliary capacitance wiring 5 and the signal wiring 7.

The signal wiring 7 and the source region 2b are connected to each other via a first contact hole 11. The auxiliary capacitance electrode region 2d led to the drain region 2c and the lead electrode 17 are connected to each other via a second contact hole 12. A pixel electrode 19 and the lead electrode 17 are connected to each other via a third contact hole 13.

FIGS. 2A through 2D are views showing fabricating processes of a cross-sectional portion taken along line II—II of FIG. 1, while FIGS. 3A through 3D are views showing the fabricating processes of a cross-sectional portion taken along line III—III of FIG. 1. A fabricating method of the aforementioned transmission type liquid crystal display device will be described with reference to FIGS. 2A to and FIG. 3.

First of all, as shown in FIGS. 2A to 2D and FIGS. 3A to 3D, amorphous silicon is deposited to a thickness of about 75 nm on the transparent substrate 1 made of glass or quartz by the low pressure CVD (chemical vapor deposition) method. Then, the deposited silicon is subjected to a heating process at a temperature of 600° C. for 24 hours in an N₂ atmosphere so as to be crystallized into polycrystal silicon and thereafter patterned into an island-like shape, forming a polycrystal silicon film 2.

Next, as shown in FIG. 2B and FIG. 3B, phosphorus ions are implanted into the auxiliary capacitance electrode region 2d on the polycrystal silicon film 2. Next, an SiO₂ film of a thickness of about 80 nm is formed by the low pressure CVD method, forming a gate insulating film 3. Next, a gate wiring 4 (including a gate electrode portion 4A) and an auxiliary capacitance wiring 5 (including an auxiliary capacitance electrode portion 5A) are concurrently formed on the gate insulating film 3. The gate wiring 4 and the auxiliary capacitance wiring 5 are constructed of a laminate of a polycrystal silicon film and a WSi layer. The polycrystal silicon film has a thickness of about 150 nm and is doped with an impurity, and the WSi layer has a thickness of about 150 nm laminated on the polycrystal silicon film. In place of the laminate structure of WSi and polycrystal silicon, it is acceptable to employ a metal film of Cr, W, Mo, Ta, Ti or the like or a silicide film of the metal or a laminate structure (the so-called polycide) having polycrystal silicon below the metal film or the silicide film. If impurity activating annealing described later is performed at low temperature or locally by means of laser or the like, a material having a

principal component of Al (AlSi, AlCu, AlSiCu or the like) can be employed.

Next, as shown in FIG. 2C and FIG. 3C, phosphorus ions are implanted into the source region 2b and the drain region 2c of the polycrystal silicon film 2. Next, BPSG (boro-
phospho silicate glass) is deposited to a thickness of about 600 nm by the normal pressure CVD method, forming a first interlayer insulating film 6. After a heating process (950° C., 30 minutes) for activating the implanted impurity ions, contact holes 11, 12 that reach the polycrystal silicon film 2 are each formed. Next, TiN and Al having thicknesses of 150 nm and 400 nm, respectively, are deposited by the sputtering method and thereafter patterned to form a signal wiring 7 and a lead electrode 17. In this case, the signal wiring 7 and the lead electrode 17 have a principal component of Al exemplified by AlSi, AlCu, AlSiCu or the like. In place of Al, it is acceptable to employ a metal film of Cu, Cr, W, Mo, Ta, Ti or the like capable of shading light, a silicide film of the metal or a laminate structure having polycrystal silicon below the layers of the metal film or the silicide film. A barrier metal 18 (laminated with Al) located between pixel electrode 19 of ITO (indium-tin-oxide) and a lead electrode 17 of Al may be formed by laminating a layer made of at least one substance selected from among Ir, Ru, Cr, Co, Ta, Ti, W, Mo, TiW alloy, WN, TiN and a silicide of Ir, Cr, Co, Ta, Ti, W and Mo. An SiO₂ film having a thickness of about 600 nm is formed on the laminate by the plasma CVD method, forming a second interlayer insulating film 9. Then, a contact hole 13 that reaches the lead electrode 17 is opened on the second interlayer insulating film 9. Next, ITO is deposited to a thickness of 150 nm by the sputtering method and thereafter patterned to form the pixel electrode 19.

As described above, light shading can be effectively achieved with a simple construction without impairing the opening ratio by employing the gate wiring 4, signal wiring 7, auxiliary capacitance wiring 5 and lead electrode 17 which are formed of a light shading material, as the light shading film. Furthermore, this can eliminate the process for separately forming a light shading film and simplify the fabricating processes, therefore allowing a transmission type liquid crystal display device to be fabricated with high yield at low cost.

If the TFT 10 is turned on, then a potential of the signal wiring 7 is applied to the pixel electrode 19 via the first contact hole 11, the source region 2b, the channel region 2a, the drain region 2c and the auxiliary capacitance electrode region 2d of the semiconductor thin film 2, the second contact hole 12, the lead electrode 17 and the third contact hole 13. Consequently, the potential of the pixel electrode 19 is retained in the capacitance formed by holding liquid crystals between the pixel electrode 19 and an opposite electrode (not shown) located on the opposite substrate side, and the potential of the pixel electrode 19 is retained in the auxiliary capacitance formed by holding the gate insulating film 3 that serves as a dielectric film between the auxiliary capacitance wiring 5 and the auxiliary capacitance electrode region 2d of the semiconductor thin film 2.

By forming the gate wiring 4 and the auxiliary capacitance wiring 5 of a same material, there can be obtained a simple construction in which the gate wiring 4 and the auxiliary capacitance wiring 5 can be formed in a same layer through a same process.

By forming the signal wiring 7 and the lead electrode 17 of a same material, there can be obtained a simple construction in which the signal wiring 7 and the lead electrode 17 can be formed in a same layer through a same process.

By laminating a layer containing at least one substance selected from among Ir, Ru, Cr, Co, Ta, Ti, W, Mo, TiW alloy, WN, TiN and a silicide of Ir, Cr, Co, Ta, Ti, W and Mo on the lead electrode 17 that has a principal component of Al, Al oxide is not formed at an interface between the lead electrode 17 and the pixel electrode 19. Therefore, good electrical connection can be obtained between the lead electrode 17 and the pixel electrode 19.

FIG. 4 is a schematic plan view of an essential part of a transmission type liquid crystal display device according to a second embodiment of the present invention. As shown in FIG. 4, on a transparent substrate 31, this transmission type liquid crystal display device includes a plurality of gate wiring lines 36 (only one is shown in FIG. 4) arranged generally parallel to one another, a plurality of signal wiring lines 39 that are arranged generally parallel to one another so as to be perpendicular to the gate wiring lines 36, a plurality of auxiliary capacitance wiring lines 37 arranged generally parallel to the gate wiring lines 36 between the gate wiring lines 36, a plurality of TFT's 30 whose source regions 34b are connected to the signal wiring lines 39 and a plurality of pixel electrodes 59 connected to the drain regions 34c of the TFT's 30 via lead electrodes 49. The auxiliary capacitance wiring 37 has a region 37a that extends downward along the signal wiring 39 in FIG. 4.

The signal wiring 39, gate wiring 36, auxiliary capacitance wiring 37 and lead electrode 49 are made of a light shading material. A plurality of polycrystal silicon films 34 that serve as semiconductor thin films are formed for each pixel below the signal wiring 39, gate wiring 36, auxiliary capacitance wiring 37 and lead electrode 49 on the transparent substrate 31. Then, a region that belongs to the polycrystal silicon film 34 and is located below the signal wiring 39 and below the gate wiring 36 is made to serve as a channel region 34a of the TFT 30, regions that belong to the polycrystal silicon film 34 and are located on both sides of the channel region are made to serve as a source region 34b and a drain region 34c of the TFT 30. A region that belongs to the polycrystal silicon film 34 and is located below the auxiliary capacitance wiring 37 is made to serve as an auxiliary capacitance electrode region 34d. The channel region 34a, source region 34b and drain region 34c of the polycrystal silicon film 34 are shaded from light by the signal wiring 39 and the gate wiring 36, while the auxiliary capacitance electrode region 34d of the polycrystal silicon film 34 is shaded from the light by the auxiliary capacitance wiring 37 and the signal wiring 39.

The signal wiring 39 and the source region 34b are connected to each other via a first contact hole 51. The auxiliary capacitance electrode region 34d led to a drain region 34c and the lead electrode 49 are connected to each other via a second contact hole 52. A pixel electrode 59 and the lead electrode 49 are connected to each other via a third contact hole 53. Then, a lower layer light shading film 32 including a region below each TFT 30 and a lower region between the gate wiring 36 and the auxiliary capacitance wiring 37 is formed.

FIGS. 5A through 5C are views showing fabricating processes of a cross-sectional portion taken along line V—V of FIG. 4, while FIGS. 6A through 6C are views showing the fabricating processes of a cross-sectional portion taken along line VI—VI of FIG. 4. A fabricating method of the aforementioned transmission type liquid crystal display device will be described with reference to FIGS. 5A to 5C and FIGS. 6A to 6C. It is to be noted that the fabricating method of this transmission type liquid crystal display device is similar to the fabricating method of the first

embodiment except for the lower layer light shading film **32** and the insulating film **33**.

First of all, as shown in FIG. **5A** and FIG. **6A**, a polycrystal silicon film is deposited to a thickness of about 100 nm on the transparent substrate **31** made of glass or quartz by the low pressure CVD method. Subsequently, WSi is deposited to a thickness of about 100 nm and thereafter patterned to form the lower layer light shading film **32**. In this second embodiment, a laminate structure of the polycrystal silicon film and WSi is provided for the lower layer light shading film **32**. However, it is acceptable to employ a metal film of Cr, W, Mo, Ta, Ti or the like or a silicide film of the metal or a laminate structure (the so-called polycide) having polycrystal silicon below the metal film or the silicide film.

Next, as shown in FIG. **5B** and FIG. **6B**, SiO₂ is deposited to a thickness of about 500 nm on the entire surface of the transparent substrate **31** on which the lower layer light shading film **32** has been formed, consequently forming the insulating film **33**.

Next, as shown in FIG. **5B** and FIG. **6B**, amorphous silicon is deposited to a thickness of about 75 nm on the insulating film **33** by the low pressure CVD method. Then, the silicon is subjected to a heating process at a temperature of 600° C. for 24 hours in an N₂ atmosphere so as to be crystallized into polycrystal silicon and thereafter patterned into an island-like shape, forming the polycrystal silicon film **34**.

Next, as shown in FIG. **5C** and FIG. **6C**, phosphorus ions are implanted into the auxiliary capacitance electrode region **34d** on the polycrystal silicon film **34** using a resist pattern as a mask. Next, an SiO₂ film is formed to a thickness of about 80 nm by the low pressure CVD method, forming the gate insulating film **35**. Next, a gate wiring **36** (including a gate electrode portion **36A**) and an auxiliary capacitance wiring **37** (including an auxiliary capacitance electrode portion, **37A**) are concurrently formed on the gate insulating film **35**. For the gate wiring **36** and the auxiliary capacitance wiring **37**, there is used a laminate of a polycrystal silicon film that has a thickness of about 150 nm and is doped with an impurity and a WSi layer having a thickness of about 150 nm laminated on the polycrystal silicon film. It is acceptable to employ a metal film of Cr, W, Mo, Ta, Ti or the like or a silicide film of the metal or a laminate structure (the so-called polycide) having polycrystal silicon below the metal film or the silicide film in place of the laminate structure of WSi and polycrystal silicon. If impurity activating annealing described later is performed at low temperature or locally by means of laser or the like, a material having a principal component of Al (AlSi, AlCu, AlSiCu or the like) can be employed.

Next, phosphorus ions are implanted into the source region **34b** and the drain region **34c** of the polycrystal silicon film **34**. Next, BPSG (boro-phospho silicate glass) is deposited to a thickness of about 600 nm by the normal pressure CVD method, forming a first interlayer insulating film **38**. Then, after a heating process (950° C., 30 minutes) for activating the implanted impurity ions, contact holes **51**, **52** that reach the polycrystal silicon film **34** are each formed. Next, TiN and Al having thicknesses of 150 nm and 400 nm, respectively, are deposited by the sputtering method and thereafter patterned to form a signal wiring **39** and a lead electrode **49**. In this case, the signal wiring **39** and the lead electrode **49** have a principal component of Al exemplified by AlSi, AlCu, AlSiCu or the like. It is acceptable to employ a metal film of Cu, Cr, W, Mo, Ta, Ti or the like capable of

shading light, a silicide film of the metal or a laminate of polycrystal silicon below the layers of the metal film or the silicide film in place of Al. For a barrier metal **50** (laminated with Al) located between ITO (pixel electrode **59**) and Al (lead electrode **49**), there may be a laminate containing at least one substance selected from among Ir, Ru, Cr, Co, Ta, Ti, W, Mo, TiW alloy, WN, TiN and a silicide of Ir, Cr, Co, Ta, Ti, W and Mo. An SiO₂ film having a thickness of about 600 is formed on the laminate by the plasma CVD method, forming a second interlayer insulating film **41**. Then, a contact hole **53** that reaches the lead electrode **49** is opened on the second interlayer insulating film **41**. Next, ITO is deposited to a thickness of 150 nm by the sputtering method and thereafter patterned to form the pixel electrode **59**.

The transmission type liquid crystal display device of this second embodiment has effects similar to those of the transmission type liquid crystal display device of the first embodiment. By forming the lower layer light shading film **32** in the layer below the channel region **34a**, source region **34b** and drain region **34c** of the TFT **30** of the semiconductor thin film **34** via the insulating film **33**, there can be provided a transmission type liquid crystal display device capable of shading the rear surface reflection light and coping with an improvement in resolution.

In the aforementioned first and second embodiments, the polycrystal silicon film **2,34** is completely covered with the signal wiring **7,39**, the gate wiring **4,36**, the auxiliary capacitance wiring **5,37** and the lead electrode **17,49**. However, the jut regions of the semiconductor thin film **30** jutting from the signal wiring, gate wiring, auxiliary capacitance wiring and lead electrode may have an areal ratio of 0.1 or less to the respective openings with respect to the area of the each opening through which light is transmitted. In this case, it is impossible for human beings to visually distinguish whether or not the semiconductor thin film is jutting.

As shown in FIG. **7**, assuming that the region of an opening **63** surrounded by a signal wiring **61** and a gate wiring **62** is a square (area $S=A^2$) having a side of A and there is a jut region **64** of a width W of the semiconductor thin film on two sides of the four sides, then the area of the jut region **64** of the semiconductor thin film becomes $2AW$. If this area is not greater than 10% of the area S of the opening **63** through which light is transmitted, then there holds the expression of:

$$2AW/S=2W/\sqrt{S}\leq 0.1 (=10\%)$$

and accordingly, the tolerated jut width W can be expressed by the expression of:

$$W\leq 0.05\sqrt{S}.$$

By setting the jut width W of the jut region **64** of the semiconductor thin film so as to satisfy this condition, it is impossible for human beings to visually distinguish whether or not the semiconductor thin film is jutting.

Although the aforementioned first and second embodiments have described the transmission type liquid crystal display device employing the TFT's **10, 30**, it is acceptable to employ a TFT of LDD (lightly doped drain) type that has a lightly doped impurity region on both sides of a region corresponding to the gate electrode of the polycrystal silicon film and is able to reduce the OFF-state current. Furthermore, the present invention is not substantially changed even if a TFT having another structure capable of reducing the OFF-state current is employed.

As is apparent from the above, according to the transmission type liquid crystal display device of the present

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invention, there can be provided a liquid crystal display device capable of effectively shading light with a simple construction without impairing the opening ratio, allowing a transmission type liquid crystal display device to be fabricated with high yield at low cost through a short process. Furthermore, there can be provided a transmission type liquid crystal display device that can shade the rear surface reflection light without influencing the opening ratio, assuring sufficient brightness even with an improvement in resolution.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

What is claimed is:

1. A transmission type liquid crystal display device comprising on a transparent substrate a gate wiring, a signal wiring perpendicular to the gate wiring, an auxiliary capacitance wiring that is generally parallel to the gate wiring and perpendicular to the signal wiring, a thin film transistor having either one of a source region and a drain region electrically connected to the signal wiring, and a pixel electrode to which the other one of the source region and the drain region of the thin film transistor is electrically connected via a lead electrode, wherein

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the signal wiring, the gate wiring, the auxiliary capacitance wiring and the lead electrode are made of light shading material(s),

a semiconductor thin film is formed for a pixel electrode below and so as to be entirely covered by respective parts of the signal wiring, the gate wiring, the auxiliary capacitance wiring and the lead electrode,

a region of the semiconductor thin film located below and entirely covered by the signal wiring and below and at least partially covered by the gate wiring serves as a channel region of the thin film transistor, regions of the semiconductor thin film located on both sides of the channel region below the signal wiring serve as a source region and a drain region of the thin film transistor respectively, and a region of the semiconductor thin film located below the auxiliary capacitance wiring serves as an auxiliary capacitance electrode region; and

a first contact hole for electrically connecting either one of the source region and the drain region of the semiconductor thin film to the signal wiring, a second contact hole for electrically connecting the other one of the source region and drain region of the semiconductor thin film to the lead electrode, and a third contact hole for electrically connecting the lead electrode to the pixel electrode.

* * * * *

专利名称(译)	透射型液晶显示装置		
公开(公告)号	US6714266	公开(公告)日	2004-03-30
申请号	US09/631964	申请日	2000-08-03
[标]申请(专利权)人(译)	夏普株式会社		
申请(专利权)人(译)	夏普株式会社		
当前申请(专利权)人(译)	夏普株式会社		
[标]发明人	UEDA TOHRU HIGAMI YOSHINORI		
发明人	UEDA, TOHRU HIGAMI, YOSHINORI		
IPC分类号	G02F1/13 G02F1/1362 G02F1/1368 G09F9/30 G02F1/136 H01L29/786 G02F1/1343		
CPC分类号	G02F1/136209 G02F1/1368		
审查员(译)	KIM, 罗伯特H.		
优先权	1999221055 1999-08-04 JP		
外部链接	Espacenet USPTO		

摘要(译)

在透射型液晶显示装置中，为信号布线下方的每个像素形成半导体薄膜，栅极布线，辅助电容布线和引线电极，它们通过绝缘膜由遮光材料制成。将属于半导体薄膜并位于信号布线下方的区域用作TFT的沟道区域。将属于半导体薄膜并位于信号布线下方的沟道区域两侧的区域分别用作TFT的源区和漏区。此外，使属于半导体薄膜并位于辅助电容布线下方的区域用作辅助电容电极区域。通过简单的结构，TFT在不损害透射型液晶显示装置的开口率的情况下被有效地遮蔽，并且通过短的工艺以低成本高产率地制造透射型液晶显示装置。

