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(54) LIQUID CRYSTAL DISPLAY DEVICE

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(57) **ABSTRACT**

A liquid crystal display device and a fabrica tion method of such a liquid crystal display device which can reduce man-hours for fabrication are provided. The liquid crystal display device is characterized in that, on each pixel region at a liquid-crystal side of one of respective substrates which are arranged in an opposed manner while sandwiching a liquid crystal therebetween a thin film transistor which is driven by scanning signals from a gate signal line, a pixel electrode to which video signals from a drain signal line are supplied through the thin film transistor, and a capacity element which is formed between the pixel electrode and a holding capacity electrode, the capacity element is formed such that a semiconductor layer forming the same layer as a semiconductor layer of the thin film transistor, a first insulation film forming the same layer as a gate insulation film of the thin film transistor, the holding capacity electrode, a second insulation film and a metal layer are sequentially laminated from a substrate side, and the semiconductor layers and the metal layer are connected to each other, and the metal layer is formed as a reflector which occupies a portion of the pixel region.

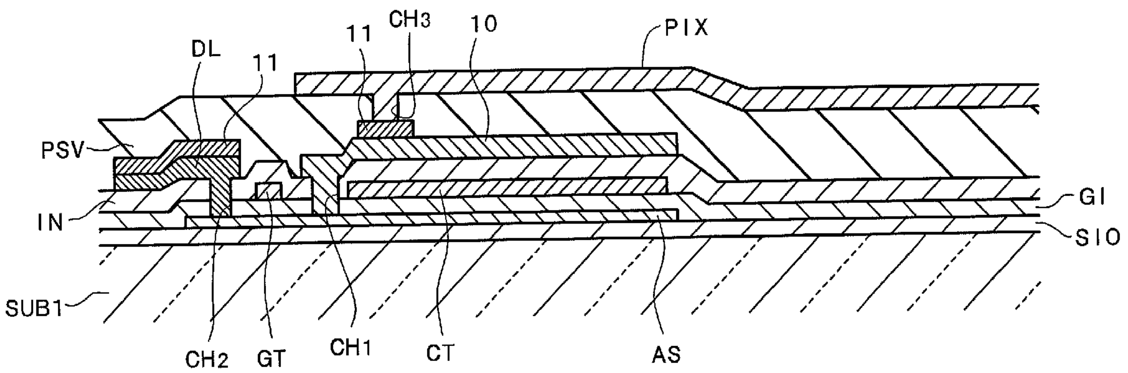


FIG. 1

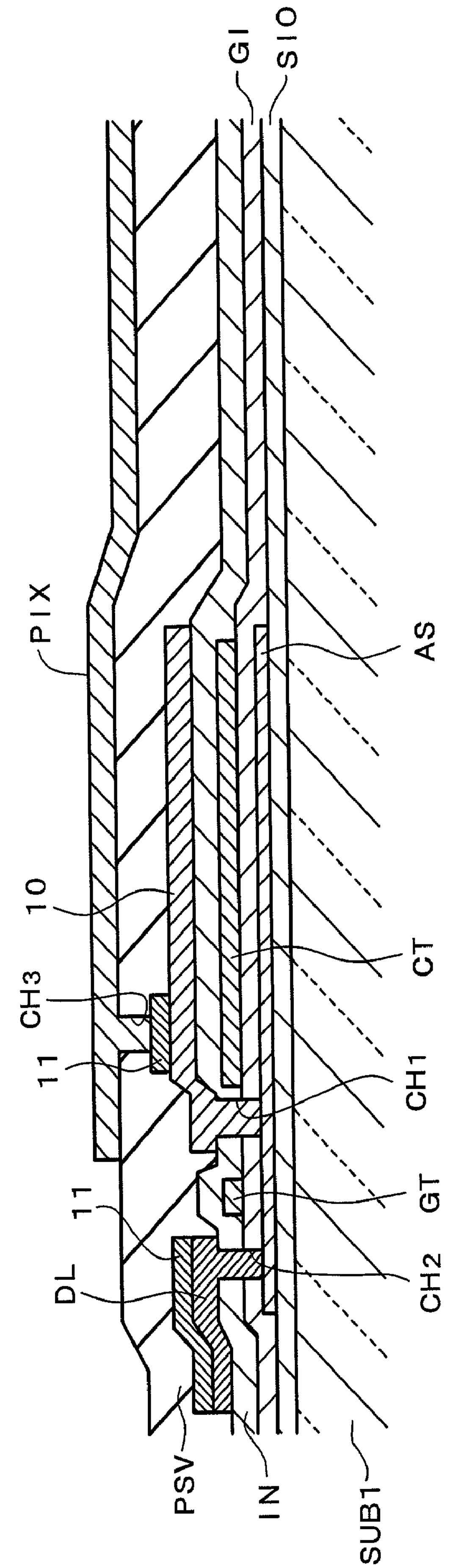


FIG. 2

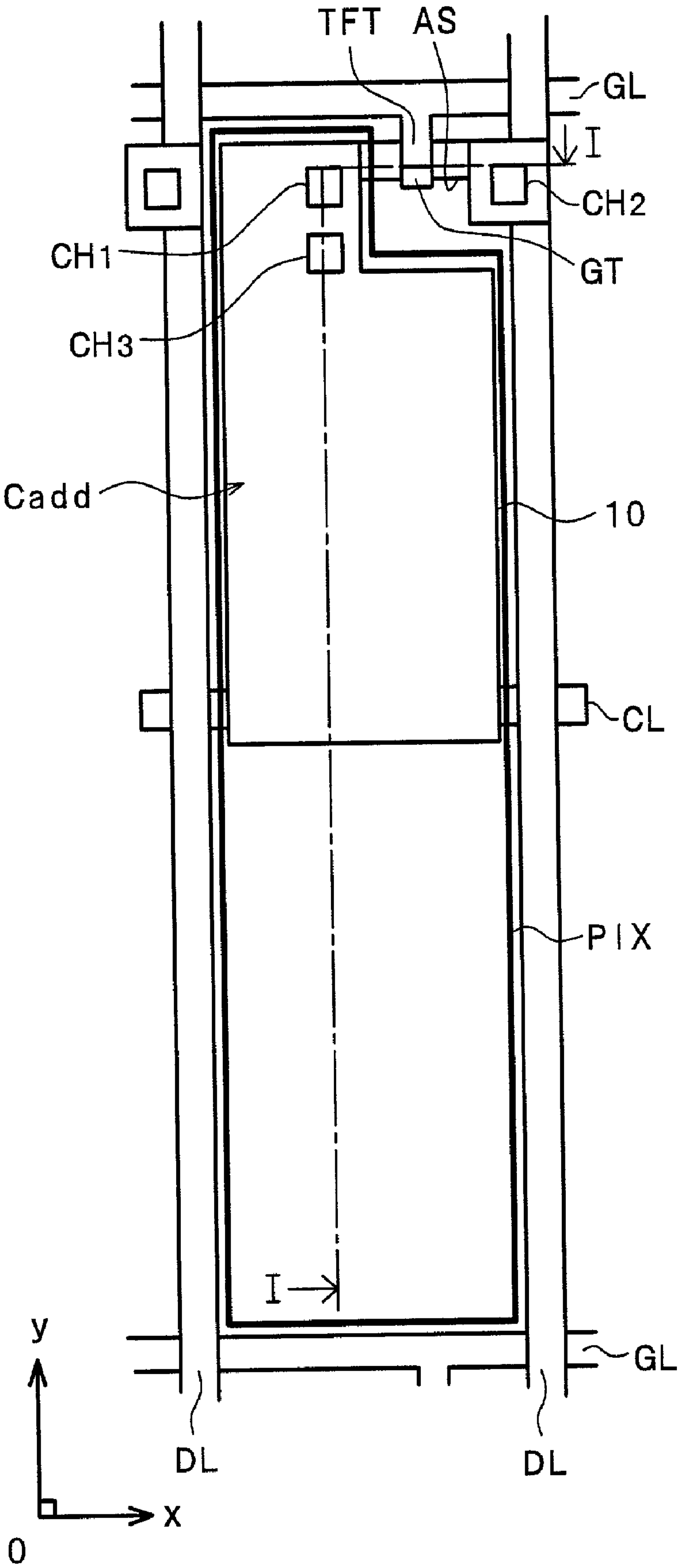


FIG. 3

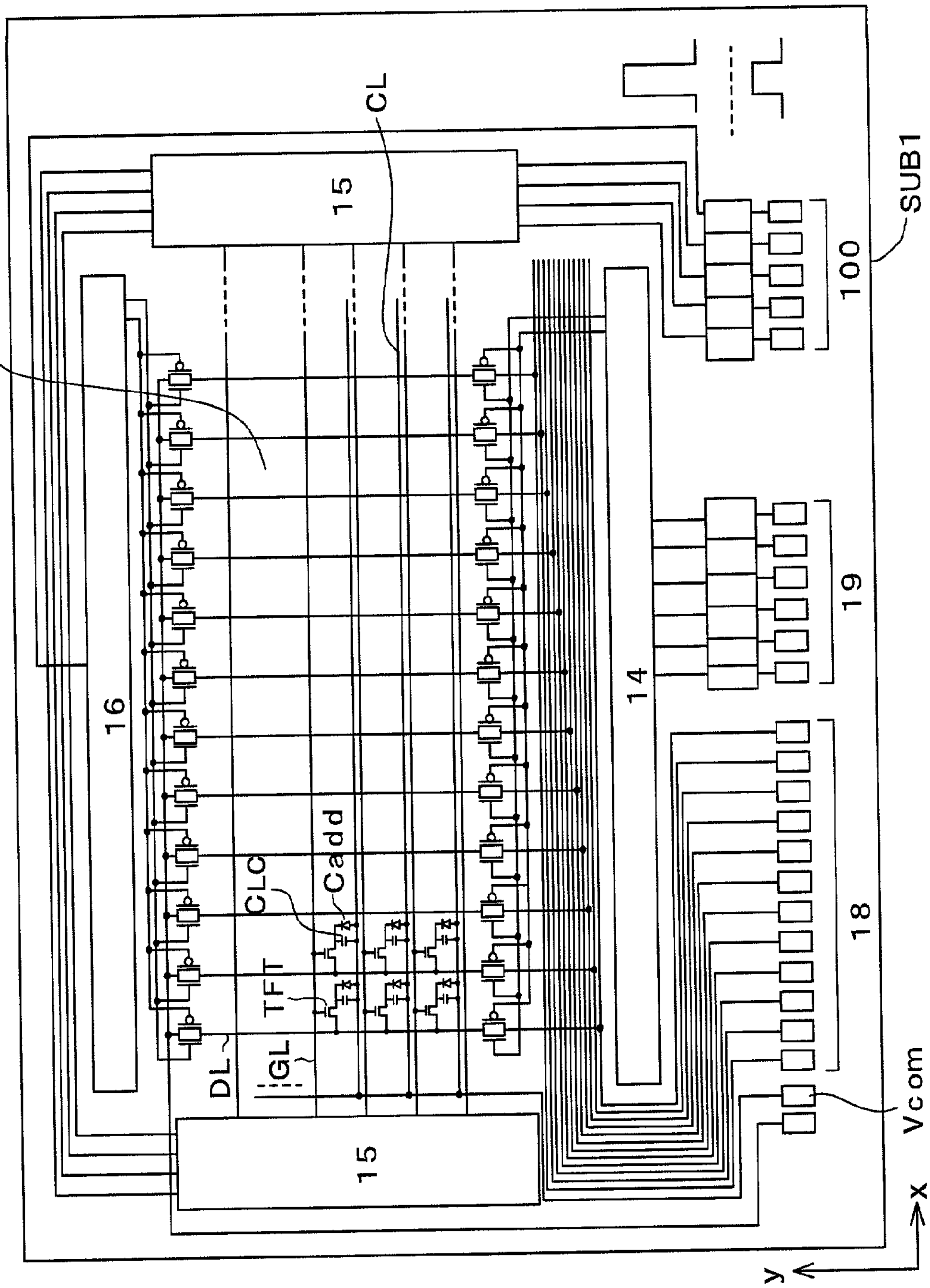


FIG. 4A

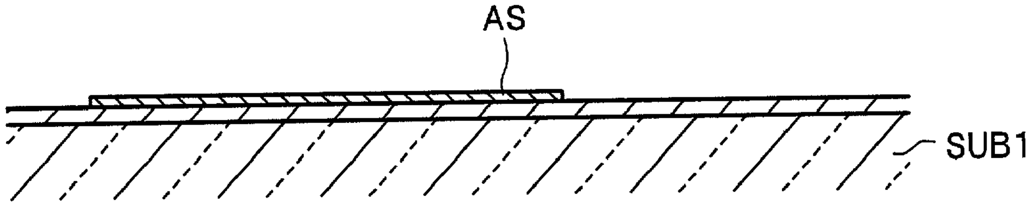


FIG. 4B

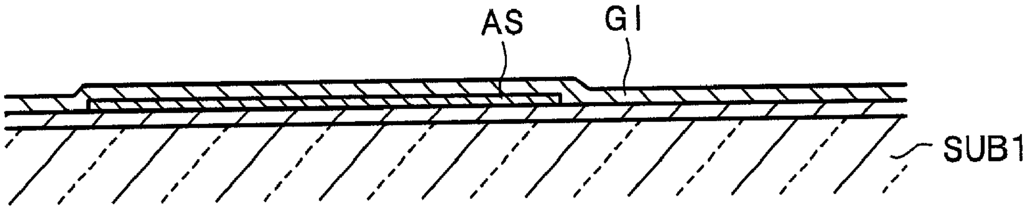


FIG. 4C

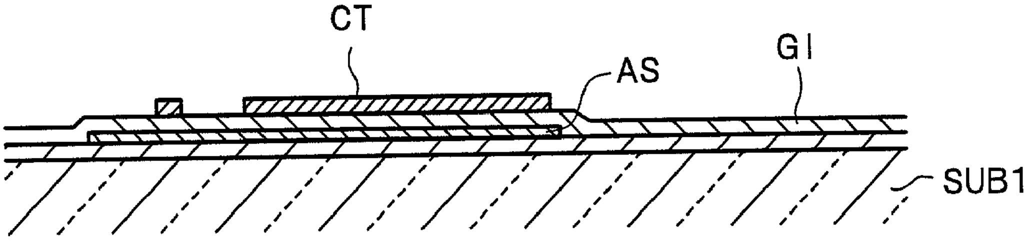


FIG. 5D

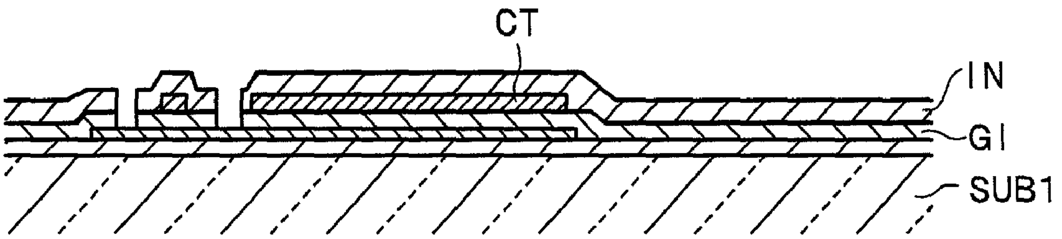


FIG. 5E

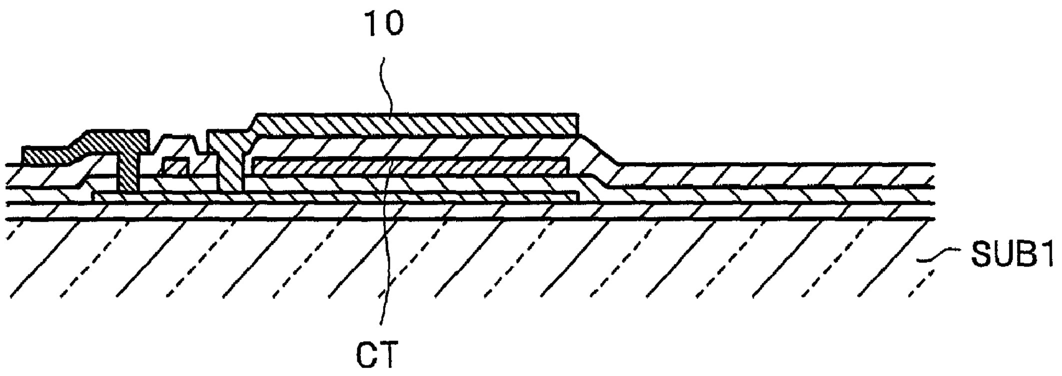


FIG. 5F

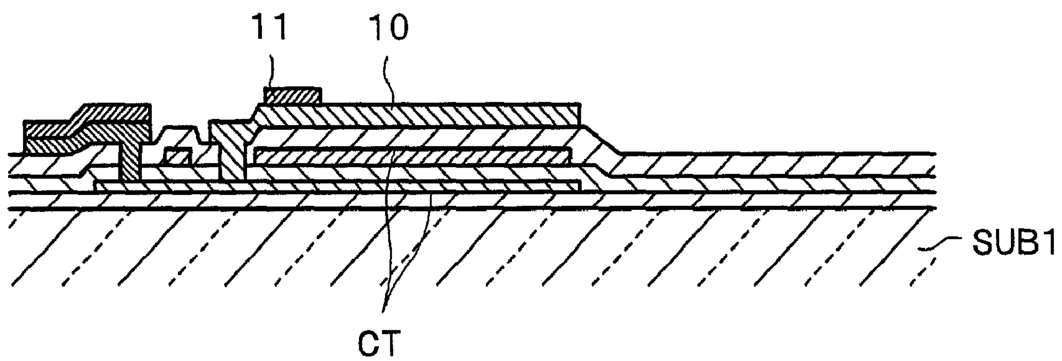


FIG. 6G

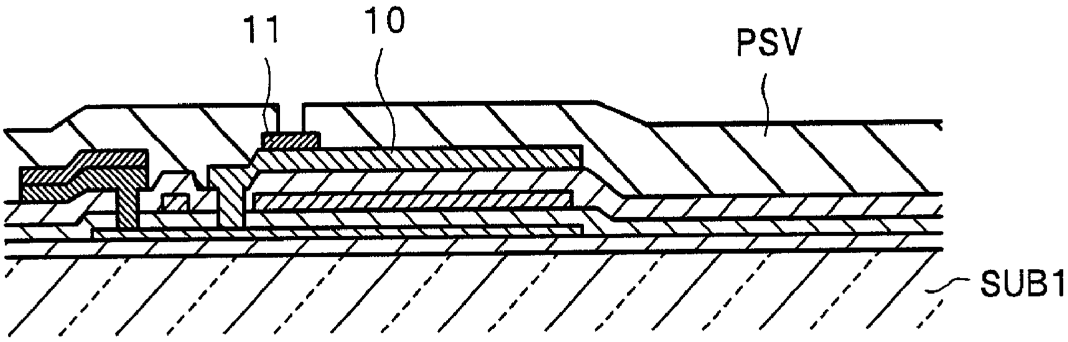


FIG. 6H

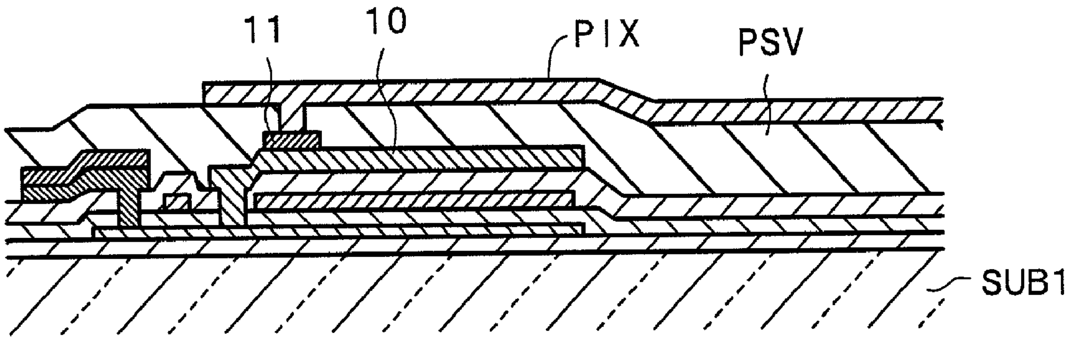


FIG. 7A

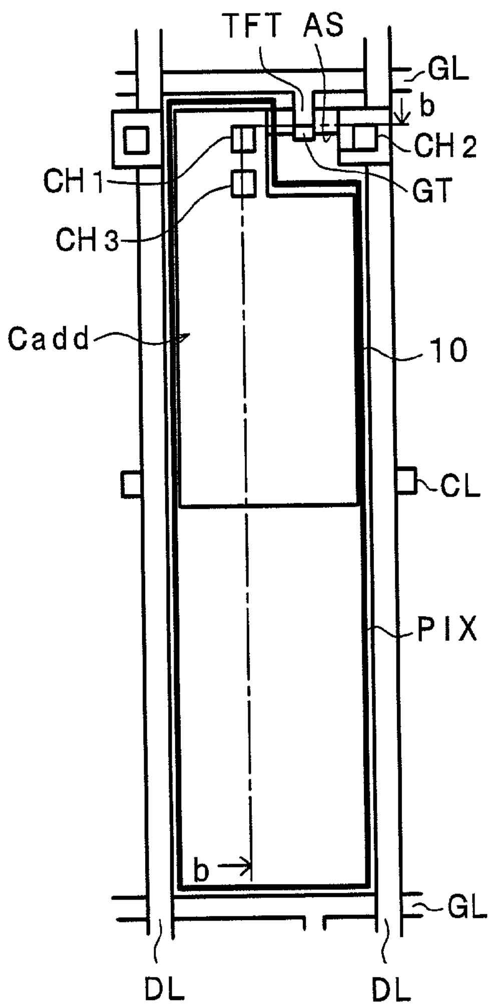

TFT
AS
GL
b
CH 2
CH 1
GT
CH 3
Cadd
10
CL
PIX
b
GL
DL
DL

FIG. 7B

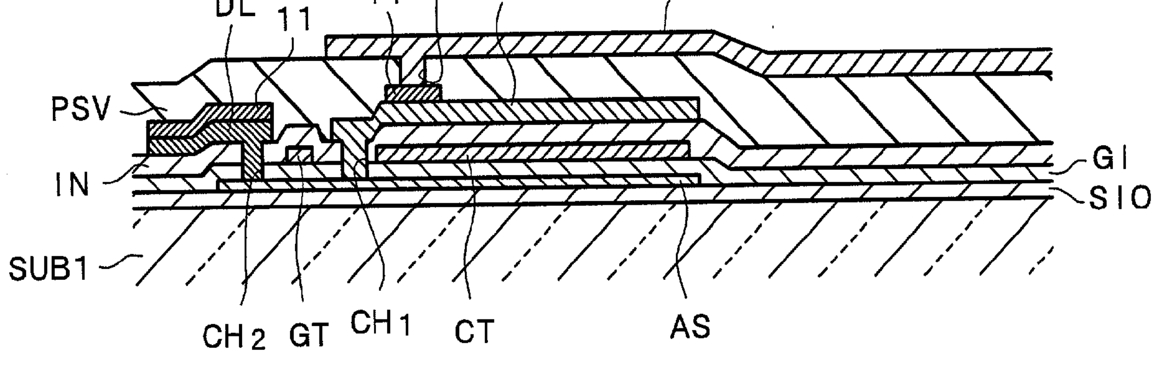

DL
11
11
CH 3
10
PIX
PSV
IN
GI
SIO
SUB1
CH 2
GT
CH 1
CT
AS

FIG. 8A

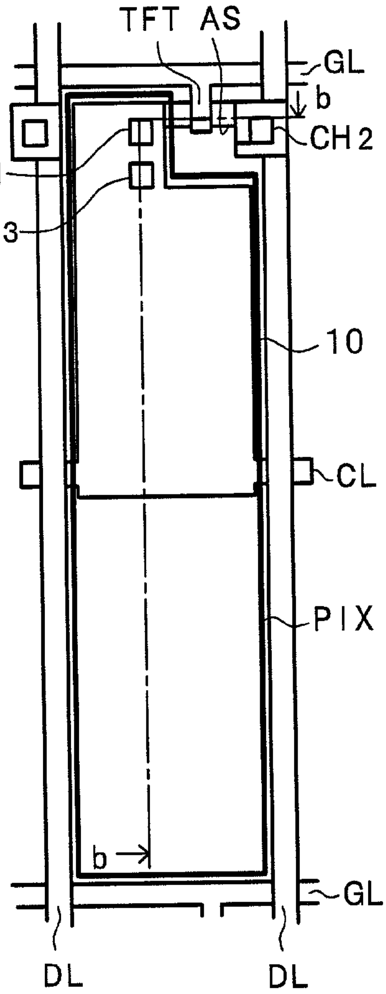
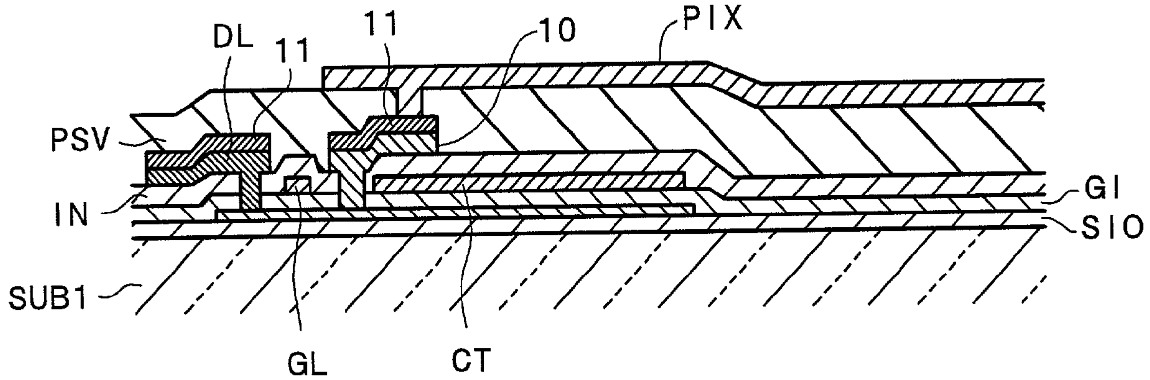

TFT AS
GL
b
CH 2
CH 1
CH 3
10
CL
PIX
b
GL
DL
DL

FIG. 8B


PIX
11
10
DL
11
PSV
GI
IN
SIO
SUB1
GL
CT

LIQUID CRYSTAL DISPLAY DEVICE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a liquid crystal display device, and more particularly to a so-called partial-transmission type liquid crystal display device.

[0003] 2. Description of the Related Art

[0004] A so-called partial-transmission type liquid crystal display device is used as a small-sized liquid crystal display device for mobile phone and images on a display surface are recognized with the use of a reflection light of sun beam or light of an incorporated backlight when necessary.

[0005] That is, out of respective transparent substrates which are arranged in an opposed manner while sandwiching a liquid crystal therebetween, on a liquid crystal surface side of one transparent substrate, pixel regions are defined by regions which are surrounded by gate signal lines extended in the y direction and arranged in parallel to the x direction and drain signal lines extended in the x direction and arranged in parallel to the y direction, and a thin film transistor which is driven with a supply of a scanning signal from one gate signal line and a pixel electrode to which a video signal is supplied from one drain signal line through the thin film transistor are formed on the respective pixel region

[0006] This pixel electrode is, for example, made of a transparent electrode such as ITO (Indium-Tin-Oxide). On the liquid crystal side of the other transparent substrate, an electric field is generated between the pixel electrode and a counter electrode made of a transparent electrode commonly formed on each pixel region, and the optical transmissivity of the liquid crystal in the pixel regions can be controlled due to the electric field.

[0007] Then, with respect to these respective pixel regions, by providing reflectors made of, for example, metal layers in approximately half of these regions, it becomes possible to give the liquid crystal display device a function which enables a reflection-type display at portions where the reflectors are provided and a function which enables a transmission-type display at portions where the reflectors are not provided.

[0008] The constitution of this type of liquid crystal display device is disclosed in detail in, for example, Japanese Patent Laid-open No. 101992/1999 and Japanese Patent Laid-open No. 242226/1999.

[0009] However, the liquid crystal display device having such a constitution has a complicated structure and requires a large number of man-hours for fabrication and hence, it has been often pointed out that the cost is pushed up.

SUMMARY OF THE INVENTION

[0010] The present invention has been made in view of the above circumstance and it is an object of the present invention to provide a liquid crystal display device which can reduce the fabrication steps and a fabrication method thereof.

[0011] To simply explain a typical invention among inventions disclosed in the present application, it goes as follows.

[0012] That is, a liquid crystal display device according to the present invention is substantially characterized in that, on each pixel region at a liquid-crystal side of one of respective substrates which are arranged in an opposed manner while sandwiching a liquid crystal therebetween , a thin film transistor which is driven by a scanning signal from a gate signal line, a pixel electrode to which a video signal from a drain signal line is supplied through the thin film transistor, and a capacity element which is formed between the pixel electrode and a holding capacity electrode are provided,

[0013] the capacity element is formed such that a semiconductor layer forming the same layer as a semiconductor layer of the thin film transistor, a first insulation film forming the same layer as a gate insulation film of the thin film transistor, the holding capacity electrode, a second insulation film and a metal layer are sequentially laminated from a substrate side, and the semiconductor layers and the metal layer are connected to each other, and

[0014] the metal layer is formed as a reflector which occupies a portion of the pixel region and, at the same time and is connected to the pixel electrode which is formed above a third insulation film formed in the pixel region such that the third insulation film covers the metal layer.

[0015] In the liquid crystal display device having such a constitution, the reflector is configured as one electrode of the capacity element.

[0016] This means that the reflector is formed in forming one electrode of the capacity element, so that the increase of the man-hours for fabrication can be suppressed or the man-hours can be reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] **FIG. 1** is a cross-sectional view showing one embodiment of a pixel of a liquid crystal display device according to the present invention.

[0018] **FIG. 2** is a plan view showing one embodiment of a pixel of a liquid crystal display device according to the present invention and a cross-sectional view taken along a line **1-1** of **FIG. 2** corresponds to **FIG. 1**.

[0019] **FIG. 3** is an equivalent circuit diagram showing one embodiment of a liquid crystal display device according to the present invention.

[0020] **FIG. 4** is a step view showing one embodiment of a fabrication method of a liquid crystal display device according to the present invention, wherein **FIG. 4** shows one fabrication step together with **FIG. 5** and **FIG. 6**.

[0021] **FIG. 5** is a step view showing one embodiment of a fabrication method of a liquid crystal display device according to the present invention, wherein **FIG. 5** shows one fabrication step together with **FIG. 4** and **FIG. 6**.

[0022] **FIG. 6** is a step view showing one embodiment of a fabrication method of a liquid crystal display device according to the present invention, wherein **FIG. 6** shows one fabrication step together with **FIG. 4** and **FIG. 5**.

[0023] **FIG. 7** is a constitutional view showing another embodiment of a liquid crystal display device according to the present invention.

[0024] **FIG. 8** is a constitutional view showing still another embodiment of a liquid crystal display device according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0025] An embodiment of a liquid crystal display device according to the present invention is explained hereinafter in conjunction with attached drawings.

[0026] <Overall Constitution>

[0027] **FIG. 3** is an equivalent circuit diagram showing one embodiment of a liquid crystal display device according to the present invention. Although the drawing is a circuit diagram, it is drawn corresponding to an actual geometrical arrangement.

[0028] In the drawing, a transparent substrate SUB1 is shown. This transparent substrate SUB1 is arranged such that the substrate SUB1 faces another transparent substrate (not shown in the drawing) in an opposed manner while sandwiching a liquid crystal therebetween.

[0029] On a center portion except for a periphery of a liquid-crystal side surface of the transparent substrate SUB1, gate signal lines GL which are extended in the x direction and are arranged in parallel to the y direction as well as drain signal lines DL which are extended in the y direction and are arranged in parallel to the x direction are formed. Pixel regions are formed of regions which are surrounded by these respective signal lines GL, DL.

[0030] A plurality of these pixel regions are arranged in a matrix array thus constituting a display region **13**.

[0031] Then, between the gate signal line GL and other neighboring gate signal line GL, a holding capacity electrode wiring CL which is extended in the x direction is formed and this holding capacity electrode wiring CL is made to form one capacity holding electrode CT of a capacity element Cadd which will be explained later with respect to each pixel region.

[0032] Each pixel element includes a thin film transistor TFT which is driven by a supply of a scanning signal from one gate signal line GL and a transparent pixel electrode PIX to which a video signal from one drain signal line DL is supplied through the thin film transistor TFT. Further, the holding capacity element Cadd is formed between the pixel electrode PIX and the holding capacity electrode wiring CL.

[0033] Further, each gate signal line GL has both ends (left and right sides in the drawing) thereof connected to a gate signal line drive circuit **15** which is constituted of a semiconductor integrated circuit mounted on the transparent substrate SUB1 so as to enable the sequential supply of scanning signals outputted from the gate signal line drive circuit **15** to respective gate signal lines GL.

[0034] Further, each drain signal line DL has one end (lower-side end in the drawing) thereof connected to a drain signal line drive circuit **14** which is constituted of a semiconductor integrated circuit mounted on the transparent substrate SUB1 so as to enable the supply of video signals matching the timing of the supply of the scanning signal to respective drain signal lines DL.

[0035] Still further, the holding capacity electrode wiring CL has one end (left side in the drawing) thereof connected to a terminal Vcom.

[0036] This terminal Vcom is formed in parallel to input terminals **18**, **19**, **100** formed on the periphery of the transparent substrate SUB1 and is held at the same potential as a transparent counter electrode (not shown in the drawing) common to respective pixel regions on a liquid-crystal side surface of the other transparent substrate which is arranged in an opposed manner to the transparent substrate SUB1.

[0037] In the drawing, numeral **16** indicates a precharge circuit for charging the drain signal lines DL, numeral **17** indicates a level shift circuit which makes digital signals (control signals) inputted to input terminals **19**, **100** have a voltage sufficient to drive the gate signal line drive circuit **15** and the drain signal line drive circuit **14**.

[0038] <Constitution of Pixels>

[0039] **FIG. 2** is a plan view showing one embodiment of the pixel region of the liquid crystal display device according to the present invention and a cross section taken along a line I-I is shown in **FIG. 1**.

[0040] **FIG. 2** shows a constitution of one pixel region out of respective pixel regions which constitutes the display region **13** shown in **FIG. 3**. Accordingly, respective pixel regions which are arranged in the left and right direction as well as in the up and down direction relative to this pixel region also have the same constitution.

[0041] In **FIG. 1** and **FIG. 2**, first of all, on a liquid-crystal side surface of the transparent substrate SUB1, a background layer SIO consisting of a single layer or laminated films made of SiO_2 or SiN is formed. This background layer SIO is formed for preventing ionic impurities contained in the transparent substrate SUB1 from giving adverse effects to a thin film transistor TFT which will be explained later.

[0042] Then, on a surface of this background layer SIO, a semiconductor layer AS made of a polysilicon layer, for example, is formed. This semiconductor layer AS is, for example, made of material formed by polycrystallizing an amorphous Si film which is formed by a plasma CVD apparatus using an excimer laser.

[0043] This semiconductor layer AS consists of a strip-like portion formed adjacent to the gate signal lines GL which will be explained later and a rectangular portion which is integrally formed with the strip-like portion and occupies an approximately half (an upper-side half in the drawing) of the pixel region.

[0044] The semiconductor layer AS of the strip-like portion is formed as a semi conductor layer of the thin film transistor TFT which will be explained later and the semiconductor layer AS of the rectangular portion is formed as one electrode out of a pair of electrodes of the capacity elements Cadd which will be explained later.

[0045] Then, on the surface of the transparent substrate SUB1 on which the semiconductor layer AS is formed, a first insulation film GI which is made of, for example, SiO_2 or SiN and also covers the semiconductor layer AS is formed.

[0046] This first insulation film GI functions as a gate insulation film of the thin film transistor TFT and also functions as one of interlayer insulation films between the gate signal lines GL and the drain signal lines DL which will be explained later and one of dielectric films of the capacity element Cadd which wil be explained later.

[0047] Then, on the surface of the first insulation film GI, the gate signal lines GL which are extended in the x direction and are arranged in parallel to the y direction are formed.

These gate signal lines GL define the rectangular pixel region together with the drain signal lines DL which will be explained later.

[0048] Here, the gate signal lines GL may be made of any conductive film having the heat resistance and, for example, Al, Cr, Ta, TiW and the like can be selected as material of the conductive film. In this embodiment, the gate signal lines GL are made of TiW.

[0049] These gate signal lines GL have respective portions thereof extended into the inside of the pixel region and these portions are superposed on the strip-like semiconductor layer As such that the portion intersect the semiconductor layer As. An extension portion GL of the gate signal line GL is formed as a gate electrode GT of the thin film transistor TFT.

[0050] Here, after forming the gate signal lines GL, ion implantation of impurities is performed through the first insulation film GI so as to make the region of the semiconductor layer AS except for a portion right below the gate electrode GT conductive whereby the source region and the drain region of the thin film transistor TFT can be formed and, at the same time, one electrode out of a pair of electrodes of the above-mentioned capacity element Cadd is formed.

[0051] Further, on the upper surface of the first insulation film GI at the center of the pixel region, a holding capacity electrode wiring CL is formed such that the wiring CL is extended in the x direction in the drawing. This holding capacity electrode wiring CL is integrally formed with a holding capacity electrode CT extending to the upper side region of the pixel region in the drawing. This holding capacity electrode wiring CL (holding capacity electrode CT) is formed as the same layer as the gate signal lines GL and is made of the same material as the gate signal lines GL.

[0052] On the upper surface of the first insulation film GI, a second insulation film IN is formed such that the film IN also covers the above-mentioned gate signal lines GL and the holding capacity electrode wiring CL (holding capacity electrode CT). The second insulation film IN is, for example, made of SiO_2 or SiN.

[0053] Further, on the upper surface of the second insulation film IN, a metal film **10** which is made of aluminum (Al) is formed such that the metal film **10** occupies approximately a half region (an upper-side region in the drawing) of the pixel region.

[0054] This metal film **10** is connected to the semiconductor layer AS through contact hole CH_1 formed in the second insulation film IN and the first insulation film GI at the portion adjacent to the thin film transistor TFT.

[0055] The semiconductor layer AS which is connected with the metal film **10** forms a portion which corresponds to a source region of the thin film transistor TFT. On the other hand, the drain region of the thin film transistor TFT is a region of the semiconductor layer AS opposite to the gate electrode GT while sandwiching a portion which is superposed with the gate electrode GT and is connected with the drain signal lines DL which will be explained later through contact hole CH

[0056] Further, the metal film **10** is approximately extended to the center portion of the pixel such that the metal film **10** is superposed on the holding capacity electrode CT.

[0057] That is, this metal film **10** constitutes a reflector which forms a reflection-type pixel region and also constitutes the other electrode of the capacity element Cadd.

[0058] The capacity element Cadd constitutes a two-staged capacity element in which a first capacity element which uses the holding capacity electrode CT as one electrode, the rectangular semiconductor layer AS as the other electrode and the first insulation film GI as the dielectric film, and a second capacity element which uses the holding capacity electrode CT as one electrode, the metal film **10** as the other electrode and the second insulation film IN as a dielectric film are connected in parallel between the source region and the holding capacity electrode CT of the thin film transistor TFT (see **FIG. 1**).

[0059] Further, on the upper surface of the second insulation layer IN, the drain signal lines DL which are extended in the y direction and are arranged in parallel to the x direction are formed. These drain signal lines DL define the pixel region together with the gate signal lines GL.

[0060] The drain signal lines DL are made of, for example, aluminum, aluminum which uses TiW as a background layer thereof or aluminum which uses MoSi as a background layer thereof. When aluminum directly comes into contact with the polysilicon layer, it may give rise to the poor conductance at a process temperature of not less than 400° C., for example, and hence, it is effective to provide the background layer.

[0061] These drain signal lines DL have portions thereof connected with the drain region of the thin film transistor TFT (the side of the thin film transistor TFT which is connected to the drain signal lines DL is called drain region in this specification) through the contact hole CH_2 formed in the second insulation film IN and the first insulation film GI.

[0062] Then, a third insulation film PSV is formed on the upper surface of the second insulation film IN such that the film PSV also covers the drain signal lines DL and the metal film **10**. The third insulation film PSV is made of, for example, SiO_2 or SiN. However, the third insulation film PSV may be formed by coating an organic film or the like. When the third insulation film PSV is formed by coating the organic film or the like, the surface can be made flattened so that it becomes possible to make the orientation of the liquid crystal have the favorable state.

[0063] A pixel electrode PIX made of ITO (Indium-Tin-Oxide) film, for example is formed on the upper surface of the third insulation film PSV.

[0064] In this case, when the third insulation film PSV is formed of the organic film, the occurrence of pin holes in the film can be largely suppressed and hence, an advantageous effect that damages to the metal film **10** at the time of performing a patterning to form the pixel electrode PIX of the ITO film can be prevented is obtained.

[0065] This pixel electrode PIX is connected with the metal film **10** through the contact hole CH_3 formed in the third insulation film PSV at a portion adjacent to the thin film transistor TFT.

[0066] Due to such a constitution, the pixel electrode PIX is connected with the source region of the thin film transistor TFT through the metal film **10** and when the thin film transistor TFT is turned on, the video signals from the drain signal lines are supplied to the pixel electrode PIX through the thin film transistor TFT.

[0067] Here, on the surface of the metal film **10** at the connecting portion with the pixel electrode PIX, an interposed layer **11** is selectively formed.

[0068] When aluminum (Al) or the like, for example, is used as material of the metal film **10**, the contact between the metal film **10** and the ITO film which constitutes the pixel electrode PIX is not favorable. Accordingly, to improve such a contact, metal such as molybdenum silicon (MoSi), titanium tungsten (TiW) or the like is inserted as the interposed layer **11**.

[0069] In this case, although it is desirable to form the interposed layer **11** on the whole region of the metal film **10** in view of the fabrication steps, the interposed layer **11** is selectively formed in a fixed range centering around the connecting portion thereof with the pixel electrode PIX in this embodiment.

[0070] It is because that since the metal film **10** is made to function as the reflector, assume a case that the interposed layer **11** is formed on the whole region of the metal film **10**, the light reflectance is usually decreased due to the interposed layer **11**.

[0071] Based on the above, it becomes possible to select the material having the large reflectance as the metal film **10** and to make the metal film **10** obtain the reliable connection with the pixel electrode PIX.

[0072] Further, in this embodiment, a conducive member made of the same material as the interposed layer **11** is formed such that the conductive member is superposed on the drain signal lines DL. However, it is needless to say that the interposed layer **11** is not always necessary.

[0073] Here, the pixel electrode PIX is provided for generating an electric field between the pixel electrode PIX and a transparent counter electrode which is formed on a liquid-crystal side surface of other transparent substrate (not shown in the drawing) common to respective pixel regions which is arranged in an opposed manner to the transparent substrate SUB1 on which the pixel electrode PIX is formed through the liquid crystal and the optical transmissivity of the liquid crystal is controlled by this electric field.

[0074] In the liquid crystal display device having such a constitution, the metal film **10** which functions as the reflector is constituted such that it does not directly come into contact with the liquid crystal and the third insulation film PSV and the pixel electrode PIX made of material which is hardly oxidized are interposed between the metal film **10** and the liquid crystal.

[0075] Accordingly, the liquid crystal display device adopts the constitution which hardly generates the cell action which may be generated when the liquid crystal is interposed between the metal film **10** and the other metal, and hence, an advantageous effect that the deterioration of the liquid crystal derived from the cell action can be prevented can be obtained.

[0076] <Fabrication method>

[0077] An example of the fabrication method of the above-mentioned liquid crystal display device is explained in conjunction with **FIG. 4** to **FIG. 6**.

[0078] Step 1 (**FIG. 4**(*a*))

[0079] The transparent substrate SUB1 having the background layer S**10** formed on a main surface thereof is prepared. The polysilicon layer is formed on the whole region of the surface of the background layer S**10** and the semiconductor layer AS is formed into a given pattern using a selective etching method based on a photolithography technique. In this case, the polysilicon layer is a so-called intrinsic semiconductor layer which is not doped with impurities.

[0080] Step 2. (**FIG. 4**(*b*)) The first insulation film GI made of, for example, SiO_2 is formed on the whole area of the upper surface of the transparent substrate SUB1 such that the first insulation film GI also covers the semiconductor layer AS.

[0081] Step 3. (**FIG. 4**(*c*))

[0082] For example, the TiW layer is formed on the whole area of the upper surface of the transparent substrate SUB1 and is formed into a given pattern using a selective etching method based on a photolithography technique thus forming the gate signal lines GL and the holding capacity electrode wiring GL (holding capacity electrode CL).

[0083] Then, the semiconductor layer AS which forms a layer below the first insulation film GI is doped with impurities, for example, by implanting ions into the surface of the first insulation film GI on which such gate signal lines GL and the like are formed.

[0084] In the semiconductor layer AS, a portion thereof on which the gate electrode GT is formed constitutes a region which is not doped with impurities since the gate electrode GT works as a mask, while other regions are doped with impurities.

[0085] That is, in the semiconductor layer AS, a channel region of the thin film transistor TFT is formed of the portion on which the gate electrode GT is formed and the source region and the drain region are formed at both sides of the channel region. Further, on the other region, one electrode of the holding capacity element Cadd which is connected to the source region of the thin film transistor TFT is formed.

[0086] Step 4. (**FIG. 5**(*d*))

[0087] The second insulation film IN which is made of SiO_2, for example, is formed on the whole area of the upper surface of the transparent substrate SUB1 such that the second insulation film IN also covers the holding capacity electrode CT and the like. Thereafter, the contact hole CH_1 which penetrates the second insulation film IN and the first insulation film GI which forms a layer below the second insulation film IN is formed using a selective etching method based on a photolithography technique.

[0088] Step 5. (**FIG. 5**(*e*))

[0089] On the whole area of the upper surface of the transparent substrate SUB1, for example, aluminum (Al) which uses TiW as the background layer is formed, and is formed into a given pattern using a selective etching method based on a photolithography technique so as to form the drain signal lines DL and the metal film **10**.

[0090] Step 6. (**FIG. 5**(*f*))

[0091] A metal layer made of molybdenum silicon (MoSi), for example, is formed on the whole area of the upper surface of the transparent substrate SUB1 and the interposed layer **11** is selectively formed using a selective etching based on a photolithography technique.

[0092] Step 7. (**FIG. 6**(*g*))

[0093] The third insulation film PSV made of resin material , for example, is formed on the whole area of the upper surface of the transparent substrate SUB1. Thereafter, the contact hole CH_3 which penetrates the third insulation film

PSV is formed by a selective etching method based on a photolithography technique and a portion of the interposed layer **11** is exposed from the contact hole CH_3.

[**0094**] Step 8. (**FIG. 6**(*h*))

[**0095**] The ITO film is formed on the whole area of the upper surface of the transparent substrate SUB1. Thereafter, the ITO film is formed into a given pattern using a selective etching method based on a photolithography technique so as to form the pixel electrode PIX.

[**0096**] This pixel electrode PIX is connected with the interposed layer **11** through the contact hole CH_3.

[**0097**] In the fabrication method of liquid crystal display device having such a constitution, the metal film **10** is arranged to be used as one electrode of the holding capacity element Cadd as well as the reflector.

[**0098**] Accordingly, it is no more necessary to form a metal film used as a reflector and a metal film used as one electrode of the holding capacity element Cadd in separate steps respectively as in the case of the conventional method and hence, an advantageous effect that the man-hours can be reduced is obtained.

[**0099**] Embodiment 2.

[**0100**] **FIG. 7** is a constitutional view showing another embodiment of the liquid crystal display device according to the present invention, wherein **FIG. 7**(*a*) is a plan view corresponding to **FIG. 2** and **FIG. 7**(*b*) is a cross-sectional view taken along a line b-b of **FIG. 7**(*a*).

[**0101**] In **FIG. 7, a** constitution which differs from the constitution shown in **FIG. 2** is that the metal film **10** which also functions as the reflector is formed such that the metal film **10** is slightly extended to the transmission-type pixel region so that the metal film **10** is mounted astride a stepped portion which is apparently formed on the surface of the second insulation film IN by the electrodes (AS, CT) which constitute the holding capacity element Cadd.

[**0102**] The liquid crystal display device formed in this manner is advantageous when the priority is given to the image of a reflection display. Further, it also brings about an advantageous effect that the deterioration of display due to the poor orientation of the liquid crystal at the stepped portion becomes more difficult to recognize with naked eyes in the case that the stepped portion is formed of a light reflection region than in the case that the stepped portion is formed of a light transmission region.

[**0103**] Embodiment 3

[**0104**] **FIG. 8** is a constitutional view showing another embodiment of the liquid crystal display device according to the present invention, wherein **FIG. 8**(*a*) is a plan view corresponding to **FIG. 2** and **FIG. 8**(*b*) is a cross-sectional view taken along a line b-b of **FIG. 8**(*a*).

[**0105**] In **FIG. 7, a** constitution which differs compared with the constitution shown in **FIG. 1** which is the cross-sectional view of **FIG. 2** is that the gate signal lines GL and the holding capacity electrode CT are formed of material having high light reflectance such as aluminum, silver or the like, for example so as to make the holding capacity electrode CT function as the reflector.

[**0106**] In this case, since the metal film **10** which is made to perform a function as the reflector in **FIG. 1** has only the function as a relay layer for enabling the connection between the semiconductor layer AS and the pixel electrode PIX so that the metal film **10** is not extended to the center portion of the pixel region and is merely formed in the periphery of the contact hole CH_1.

[**0107**] Different from the cases of the above-mentioned respective embodiments, the holding capacity element Cadd does not have a multiple-stage constitution and adopts a single stage constitution where the first insulation film GI is formed as the diel ectric film, one electrode is formed as the semiconductor layer AS, and the other electrode is formed as the holding capacity electrode CT.

[**0108**] Further, in this embodiment, the metal film **10** has an area small enough to prevent the large intrusion into the inside of the pixel region, so that the interposed layer **11** which enhances the connection between the metal film **10** and the pixel electrode PIX is formed on the whole area of the metal film **10** and is superposed on the drain signal lines DL with the same pattern.

[**0109**] Accordingly, respective material layers formed in two layers can be formed by adopting a selective etching method based on a photolithography technique once so that the increase of fabrication man-hours can be obviated.

[**0110**] As can be clearly understood from the above explanation, according to the liquid crystal display device of the present invention, since the reflector can be simultaneously formed with one electrode of the capacity element, the fabrication steps can be decreased.

[**0111**] Further, since the liquid crystal display device is constituted such that the connection between the reflector and the pixel electrode is performed through the interposed layer which is selectively provided, material having the large reflectance can be selected as the reflector and at the same time the reliability of the connection between the reflector and the pixel electrode can be enhanced.

[**0112**] Still further, since the liquid crystal display device is constituted such that the reflector is formed as a layer disposed below the insulation film which is covered with the pixel electrode, it becomes possible to provide the constitution which hardly generates the cell action between the reflector and other metal so that the deterioration of the liquid crystal derived from the cell action can be suppressed.

What is claimed is

1. A liquid crystal display device being characterized in that

a thin film transistor which is driven by scanning signals from a gate signal line, a pixel electrode to which video signals from a drain signal line are supplied through the thin film transistor, and a capacity element which is formed between the pixel electrode and a holding capacity electrode are provided to each pixel region at a liquid-crystal side of one of respective substrates which are arranged in an opposed manner while sandwiching a liquid crystal therebetween,

the capacity element is formed such that a semiconductor layer forming the same layer as a semiconductor layer of the thin film transistor, a first insulation film forming the same layer as a gate insulation film of the thin film transistor, the holding capacity electrode, a second insulation film and a metal layer are sequentially laminated from a substrate side, and the semiconductor layers and the metal layer are connected to each other, and

the metal layer is formed as a reflector which occupies a portion of the pixel region.

2. A liquid crystal display device being characterized in that

a thin film transistor which is driven by scanning signals from a gate signal line, a pixel electrode to which video signals from a drain signal line are supplied through the thin film transistor, and a capacity element which is formed between the pixel electrode and a holding capacity electrode are provided to each pixel region at a liquid-crystal side of one of respective substrates which are arranged in an opposed manner while sandwiching a liquid crystal therebetween,

the capacity element is formed such that a semiconductor layer forming the same layer as a semiconductor layer of the thin film transistor, a first insulation film forming the same layer as a gate insulation film of the thin film transistor, the holding capacity electrode, a second insulation film and a metal layer are sequentially laminated from a substrate side, and the semiconductor layers and the metal layer are connected to each other, and

the metal layer is formed as a reflector which occupies a portion of the pixel region and, at the same time, is connected to the pixel electrode which is formed above a third insulation film formed in the pixel region such that the third insulation film covers the metal layer.

3. A liquid crystal display device according to claim 2, wherein the metal layer is connected with the pixel electrode through a contact hole formed in the third insulation film, and the connection between the metal layer and the pixel electrode is performed through a conductive layer which is selectively formed on the metal layer.

4. A liquid crystal display device according to any one of claim 1 and claim 2, wherein the pixel region is defined by a region which is surrounded by a plurality of gate signal lines which are extended in one direction and are arranged in the direction which intersects the one direction and a plurality of drain signal lines which intersect the gate signal lines and are arranged parallel to each other, and the holding capacity electrode is formed as the same layer as the gate signal lines.

5. A fabrication method of a liquid crystal display device in which a capacity element and a reflector are formed on a portion in the inside of a pixel region at a liquid crystal side of one substrate out of respective substrates which are arranged in an opposed manner while sandwiching a liquid crystal therebetween, the fabrication method comprising steps of:

a step for forming a semiconductor layer on the one substrate, a step for forming a first insulation film which also covers the semiconductor layer, a step for forming a holding capacity electrode on the first insulation film such that the holding capacity electrode is superposed on at least a portion of the semiconductor layer, a step for forming a second insulation film such that the second insulation film also covers the holding capacity electrode, and a step for forming a metal layer on the second insulation film such that the metal layer is connected to the semiconductor layer while being superposed on at least the holding capacity electrode,

wherein the metal layer is formed as a reflector.

6. A fabrication method of the liquid crystal display device according to claim 5, wherein a thin film transistor is formed in the inside of the pixel region at the liquid crystal side of one substrate and the semiconductor layer is formed as the same layer as a semiconductor layer which constitutes the thin film transistor.

7. A liquid crystal display device being characterized in that

a thin film transistor which is driven by scanning signals from a gate signal line, a pixel electrode to which video signals from a drain signal line are supplied through the thin film transistor, and a capacity element which is formed between the pixel electrode and a holding capacity electrode are provided to each pixel region at a liquid-crystal side of one of respective substrates which are arranged in an opposed manner while sandwiching a liquid crystal therebetween,

the capacity element is formed such that a semiconductor layer forming the same layer as a semiconductor layer of the thin film transistor, a first insulation film forming the same layer as a gate insulation film of the thin film transistor, and

the holding capacity electrode are sequentially laminated from a substrate side, and the holding capacity electrode is formed as a reflector which occupies a portion of the pixel region.

8. A liquid crystal display device characterized in that a light reflection type region and a light transmission type region are provided respectively to each pixel region at a liquid crystal side of one substrate out of respective substrates which are arranged in an opposed manner through a liquid crystal,

said each pixel region includes a thin film transistor driven by scanning signals from a gate signal line and a pixel electrode to which video signals from a drain signal line are supplied through the thin film transistor, and

the connection between the pixel electrode and the thin film transistor is performed in the inside of the light reflection type region.

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摘要(译)

本发明提供一种能够减少制造工时的液晶显示装置和这种液晶显示装置的制造方法。该液晶显示装置的特征在于，在以相对的方式排列的各个基板之一的液晶侧的每个像素区域上，同时将液晶夹在其间的薄膜晶体管中，该薄膜晶体管由来自扫描信号的扫描信号驱动。栅极信号线，通过薄膜晶体管向漏极信号线提供视频信号的像素电极，以及在像素电极和保持电容电极之间形成的电容元件，电容元件形成为半导体形成与薄膜晶体管的半导体层相同的层的层，形成与薄膜晶体管的栅极绝缘膜相同的层的第一绝缘膜，保持电容电极，第二绝缘膜和金属层依次层叠从基板侧开始，半导体层和金属层相互连接，形成金属层a s是占据像素区域的一部分的反射器。