



US00752224B2

(12) **United States Patent**
Hwang et al.

(10) **Patent No.:** **US 7,522,224 B2**
(45) **Date of Patent:** **Apr. 21, 2009**

(54) **ARRAY SUBSTRATE OF LIQUID CRYSTAL DISPLAY AND FABRICATING METHOD THEREOF**

(75) Inventors: **Kwang Jo Hwang**, Anyang-shi (KR); **Woo Hyun Kim**, Seoul (KR); **Se Jung Kim**, Seoul (KR)

(73) Assignee: **LG Display Co., Ltd.**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 19 days.

(21) Appl. No.: **11/785,200**

(22) Filed: **Apr. 16, 2007**

(65) **Prior Publication Data**

US 2007/0188671 A1 Aug. 16, 2007

Related U.S. Application Data

(63) Continuation of application No. 10/183,683, filed on Jun. 28, 2002, now Pat. No. 7,256,842.

(30) **Foreign Application Priority Data**

Jul. 7, 2001 (KR) 10-2001-40605

(51) **Int. Cl.**
G02F 1/1343 (2006.01)

(52) **U.S. Cl.** 349/38; 349/147

(58) **Field of Classification Search** 349/38
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,081,315 A	6/2000	Matsuyama et al.
6,100,947 A	8/2000	Katayama
6,137,551 A *	10/2000	Jeong
6,207,480 B1	3/2001	Cha et al.
6,372,535 B1	4/2002	Lyu
6,407,780 B1 *	6/2002	Sung
6,528,357 B2	3/2003	Dojo et al.
6,696,324 B2	2/2004	Hong et al.
6,894,734 B1 *	5/2005	Ihara
		349/38

FOREIGN PATENT DOCUMENTS

KR	2001-001426	1/2001
KR	2001-055982	7/2001

* cited by examiner

Primary Examiner—Richard H Kim

(74) *Attorney, Agent, or Firm*—Birch, Stewart, Kolasch & Birch, LLP

(57) **ABSTRACT**

An array substrate of a liquid crystal device has a plurality of gate lines, data lines, pixel areas, and thin film transistors, wherein the gate lines are formed from a material of a first and second metal layer, and wherein the first metal layer of the gate line is extended on the pixel area. Also, a display device has first and second gate lines and a data line on a substrate, a thin film transistor, a pixel electrode, a first storage electrodes extending from the second gate line and wherein at least one of the first and second gate lines and the data line includes first and second line layers respectively formed of an oxidized metal later and a metal layer.

20 Claims, 15 Drawing Sheets

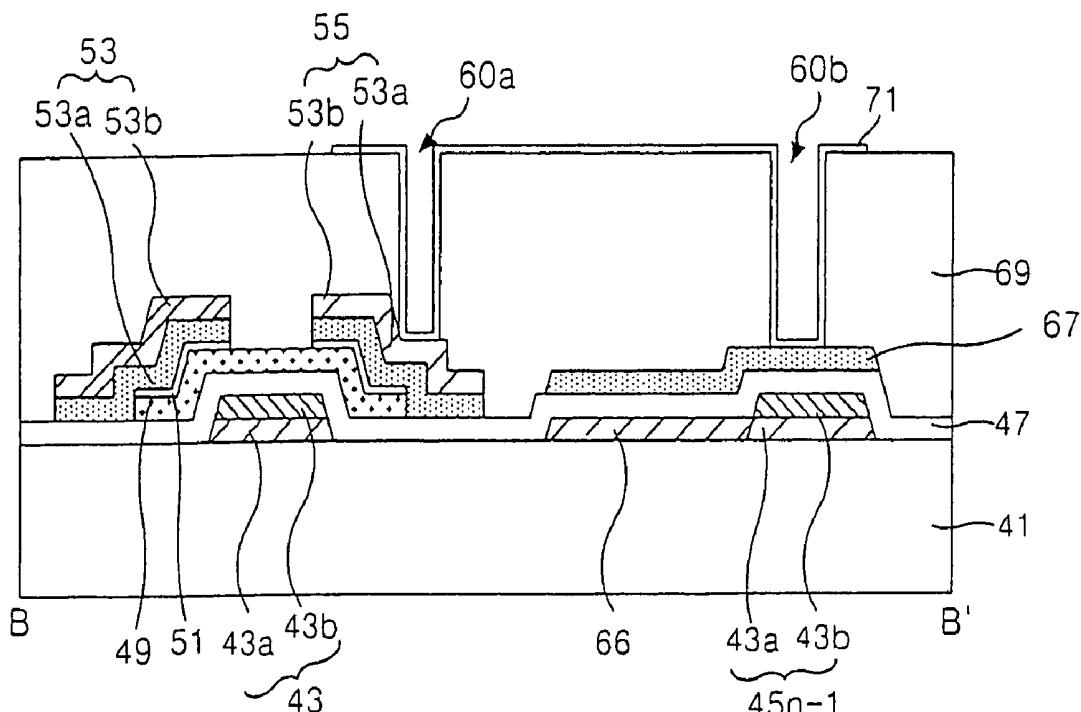


FIG. 1
CONVENTIONAL ART

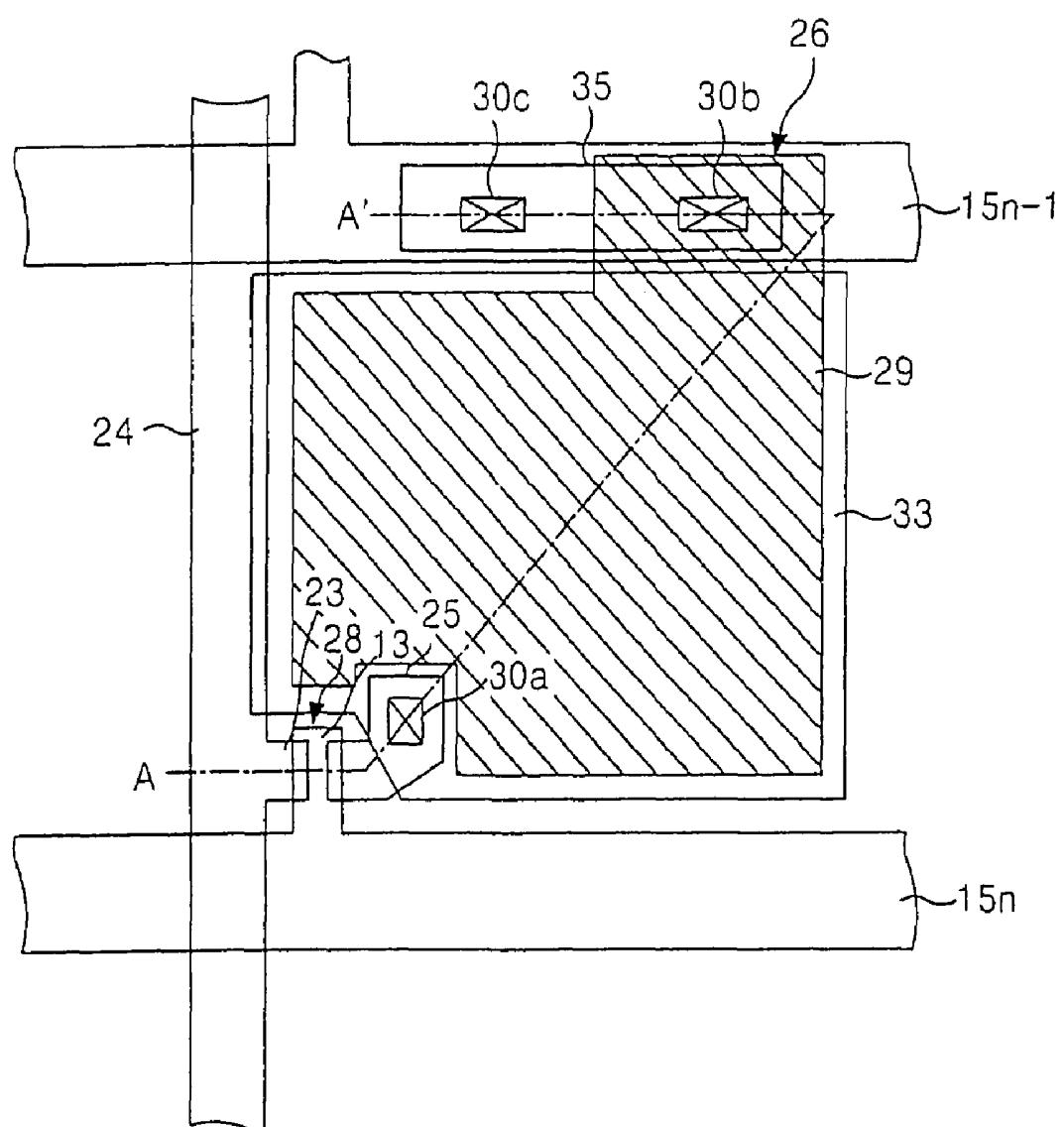


FIG.2 CONVENTIONAL ART

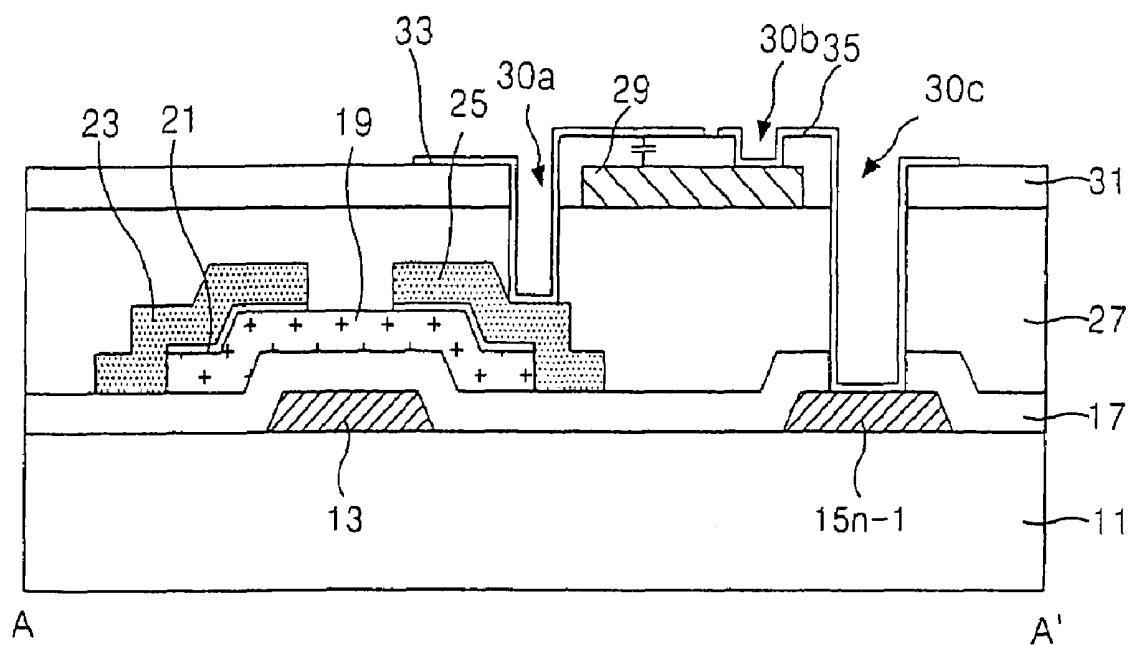


FIG.3
CONVENTIONAL ART

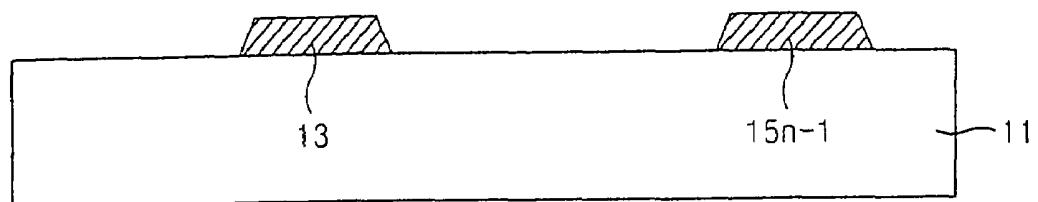


FIG.4
CONVENTIONAL ART

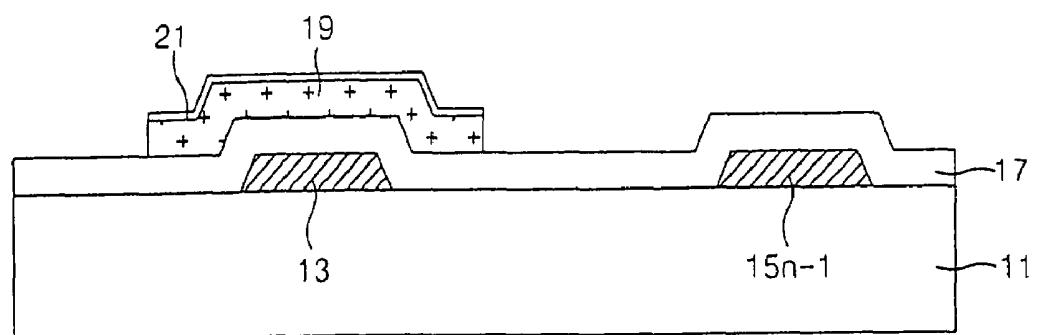


FIG.5
CONVENTIONAL ART

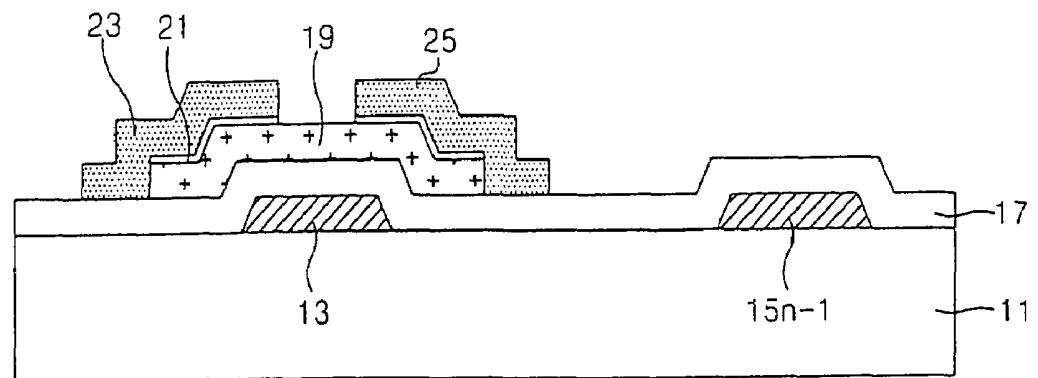


FIG. 6
CONVENTIONAL ART

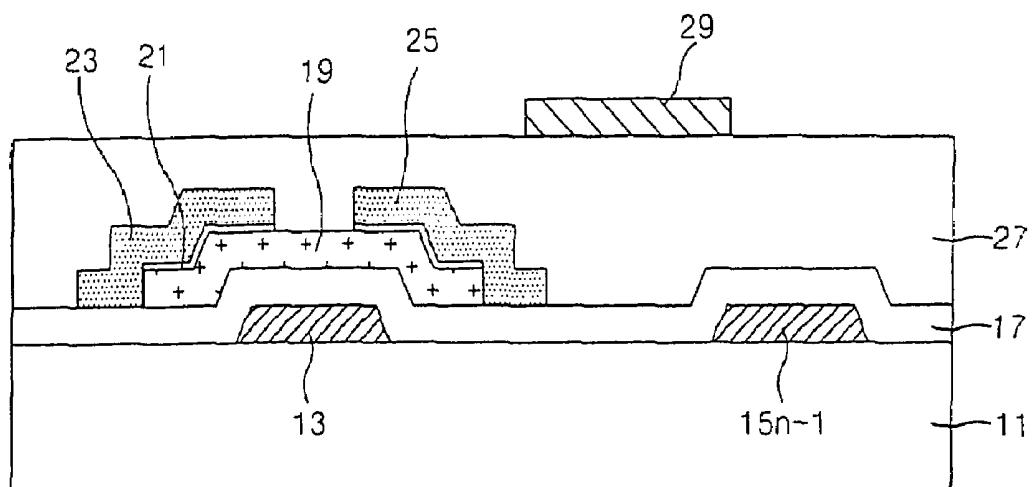


FIG. 7
CONVENTIONAL ART

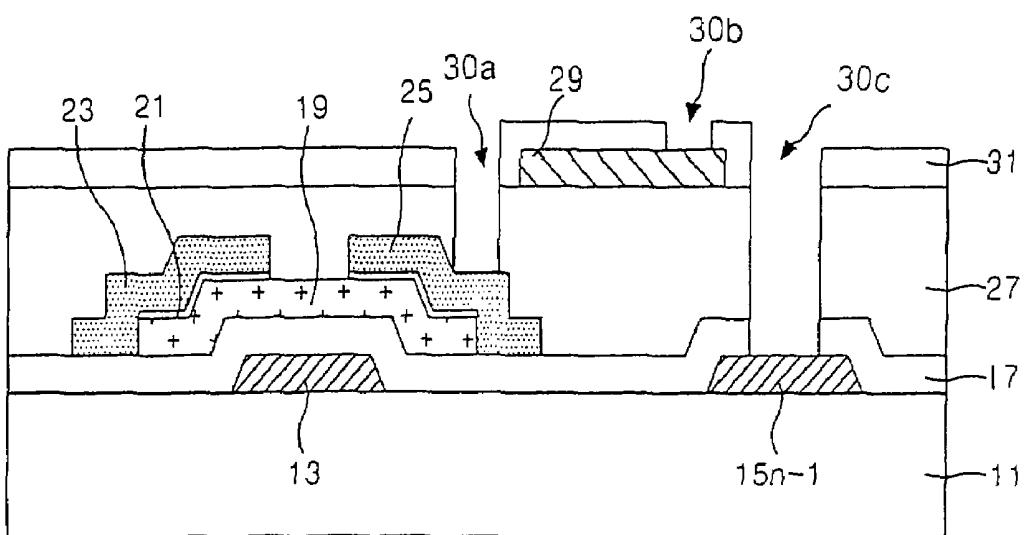


FIG.8
CONVENTIONAL ART

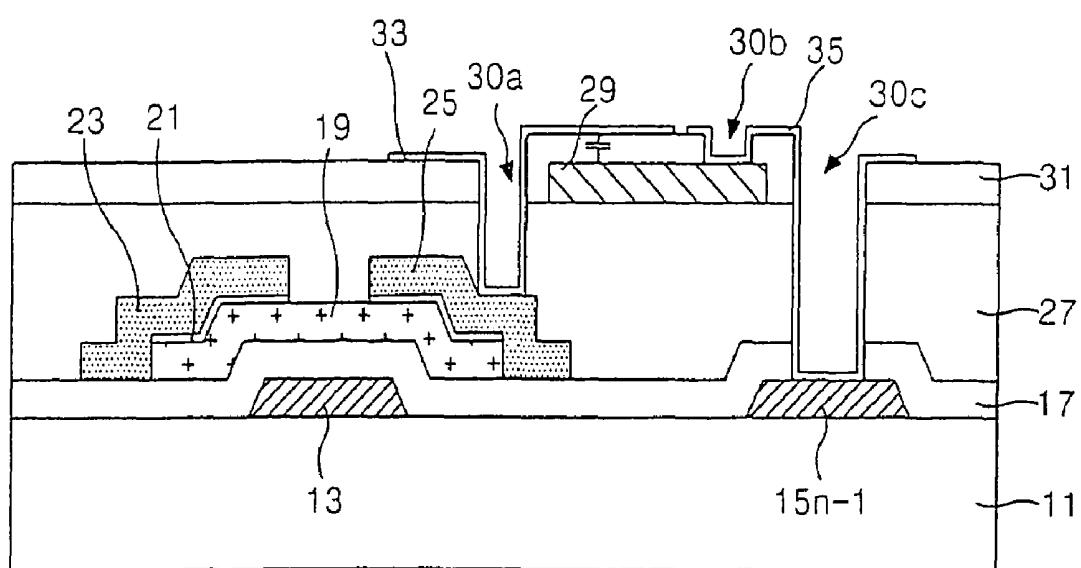


FIG. 9

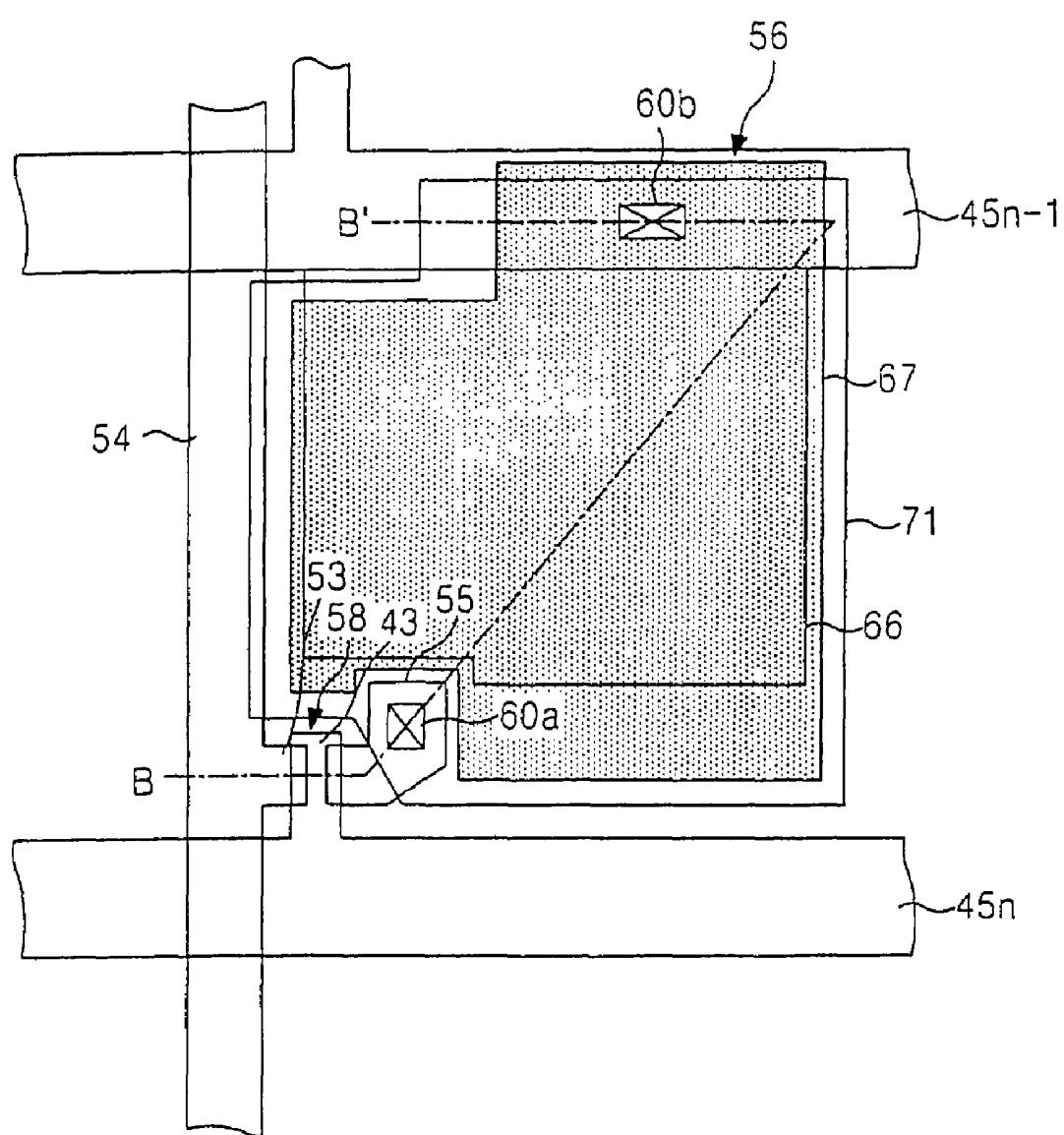


FIG. 10

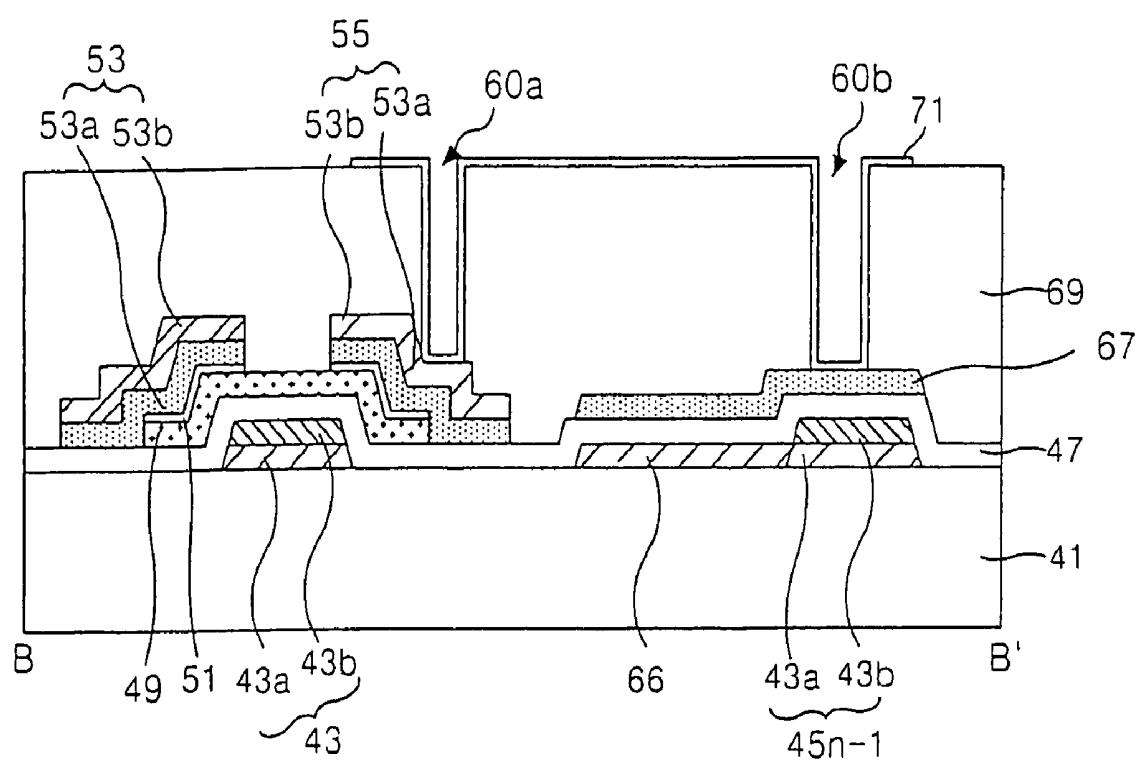


FIG. 11

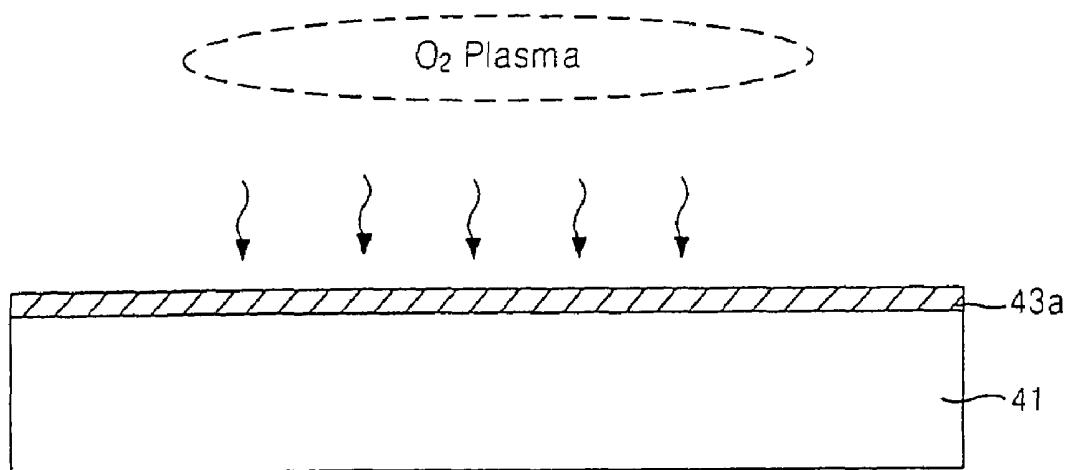


FIG. 12

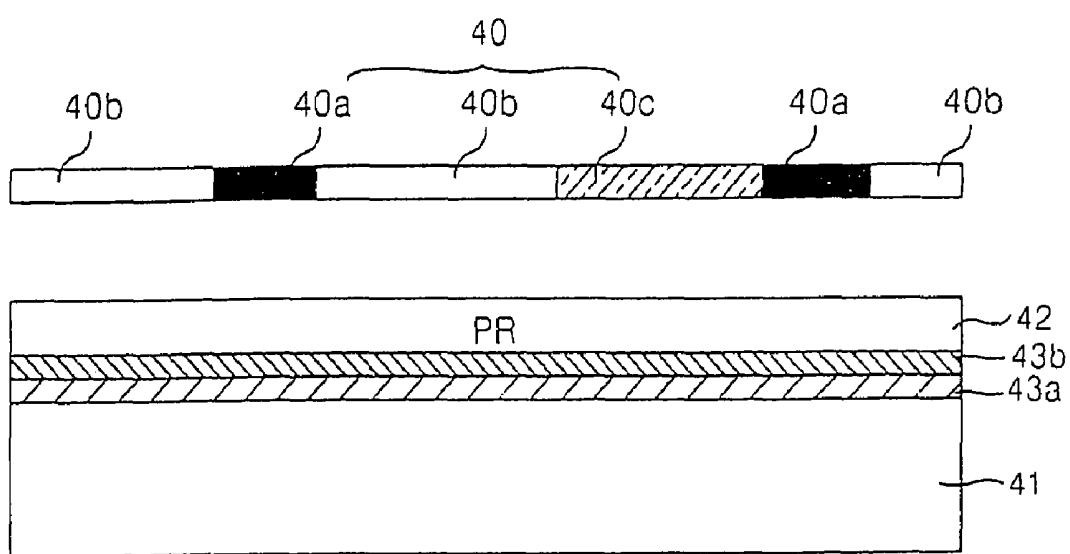


FIG.13

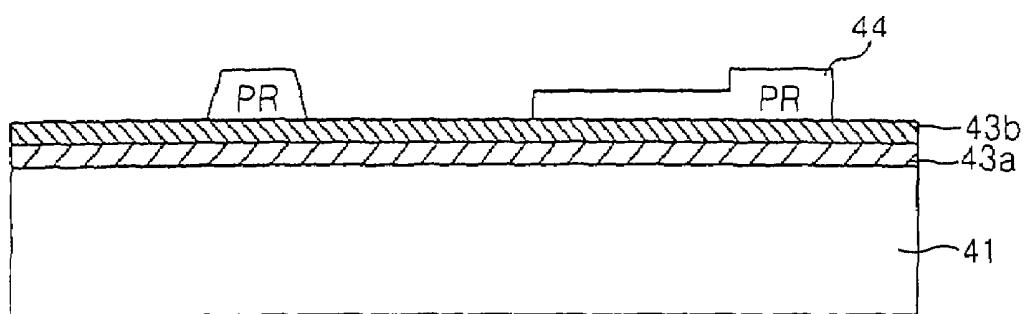


FIG.14

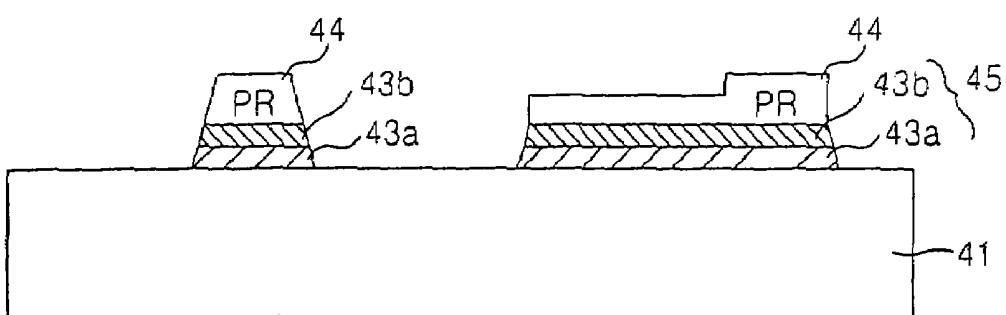


FIG.15

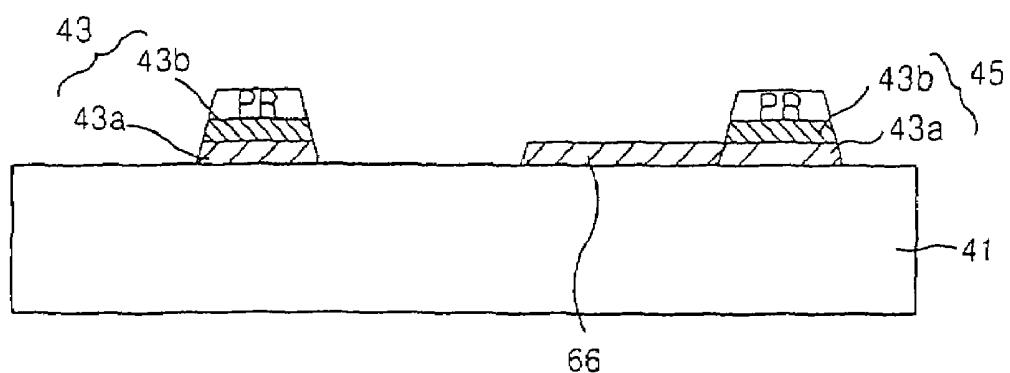


FIG.16

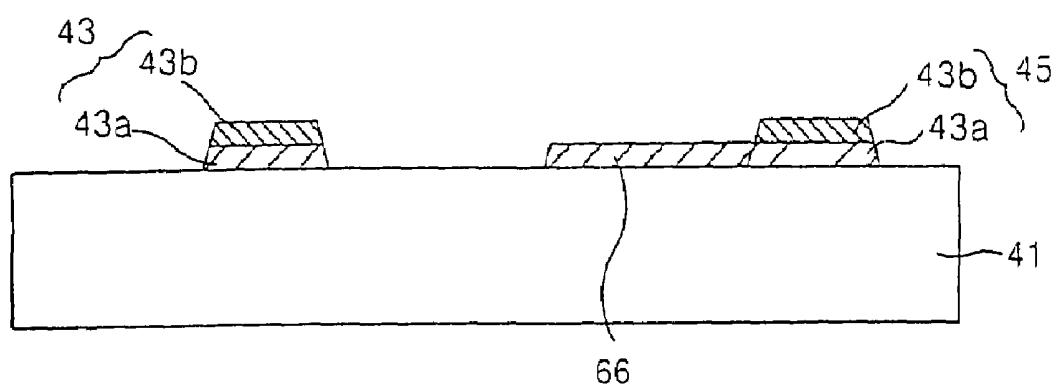


FIG.17

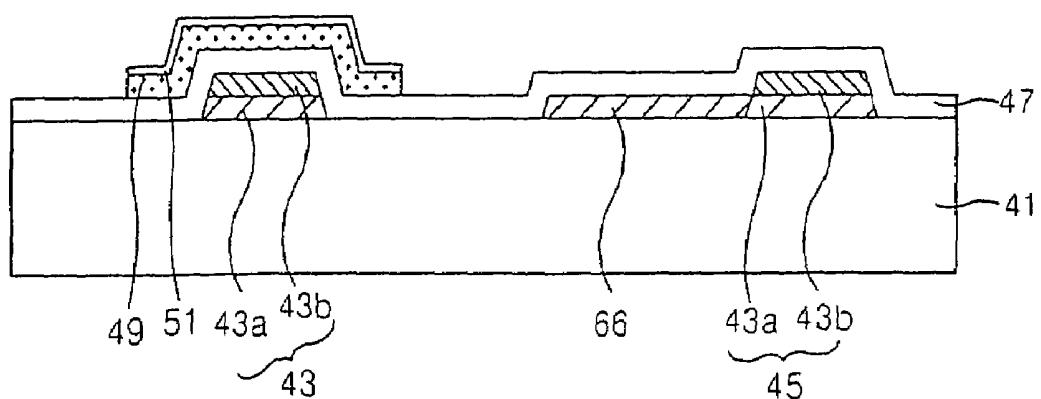


FIG. 18

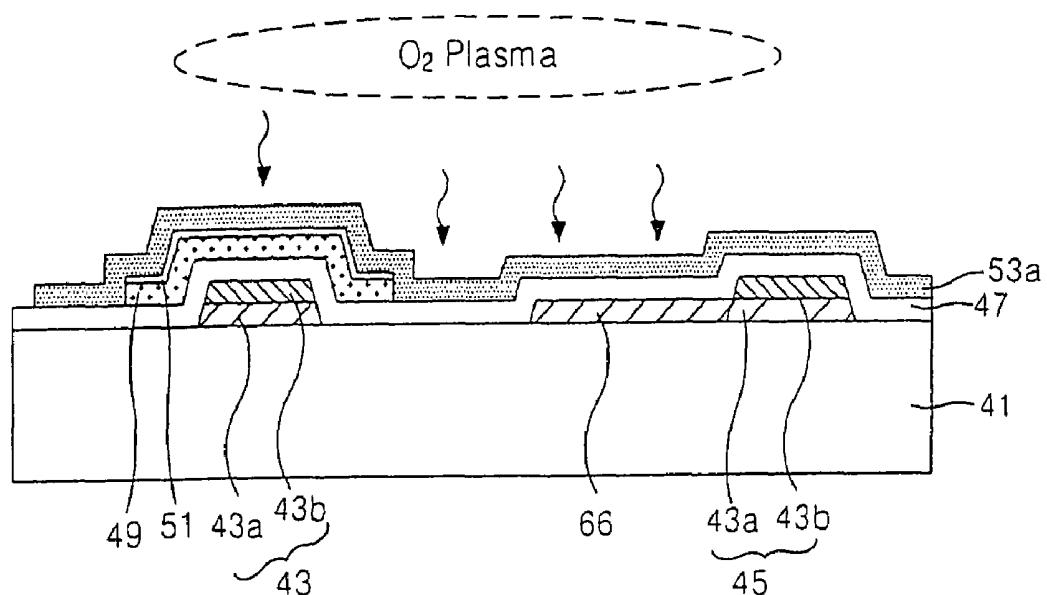


FIG. 19

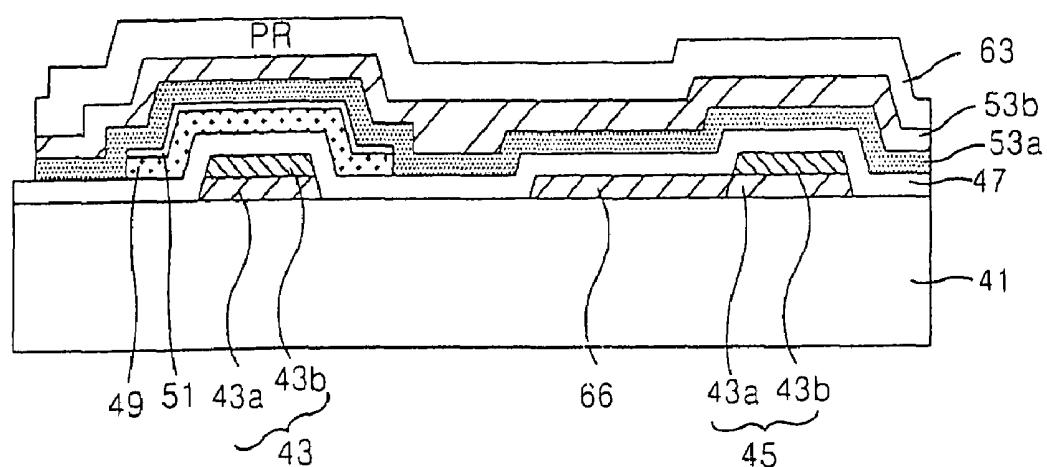
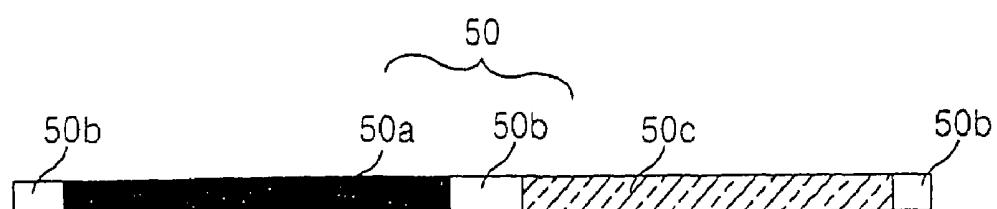


FIG.20

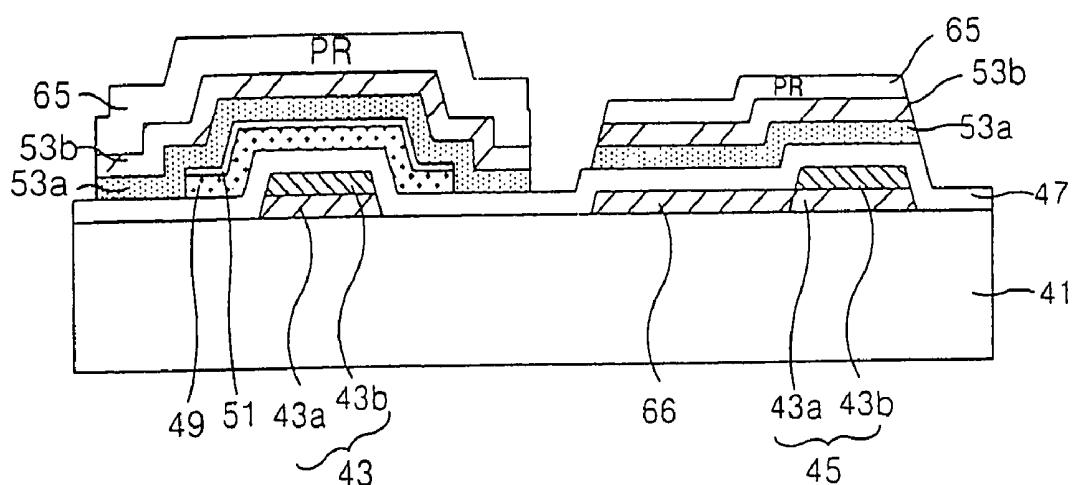


FIG.21

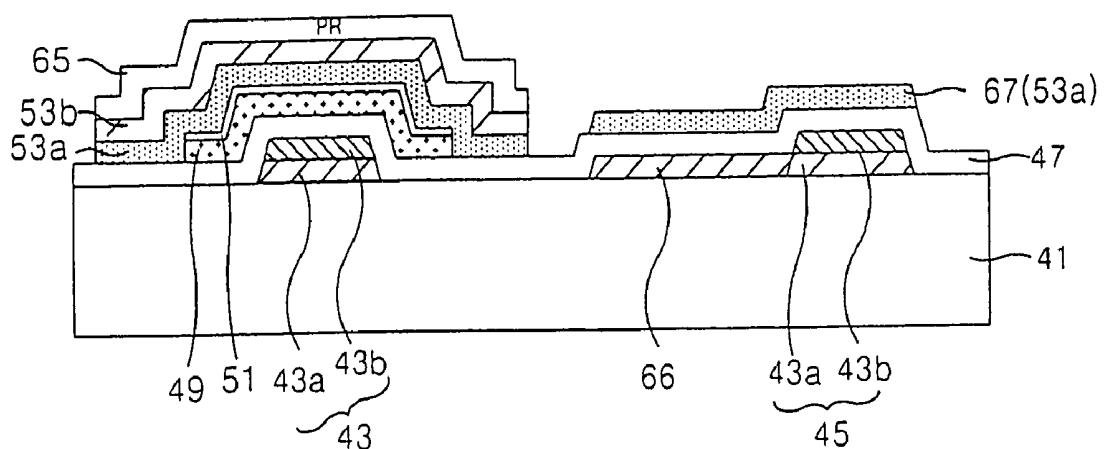


FIG.22

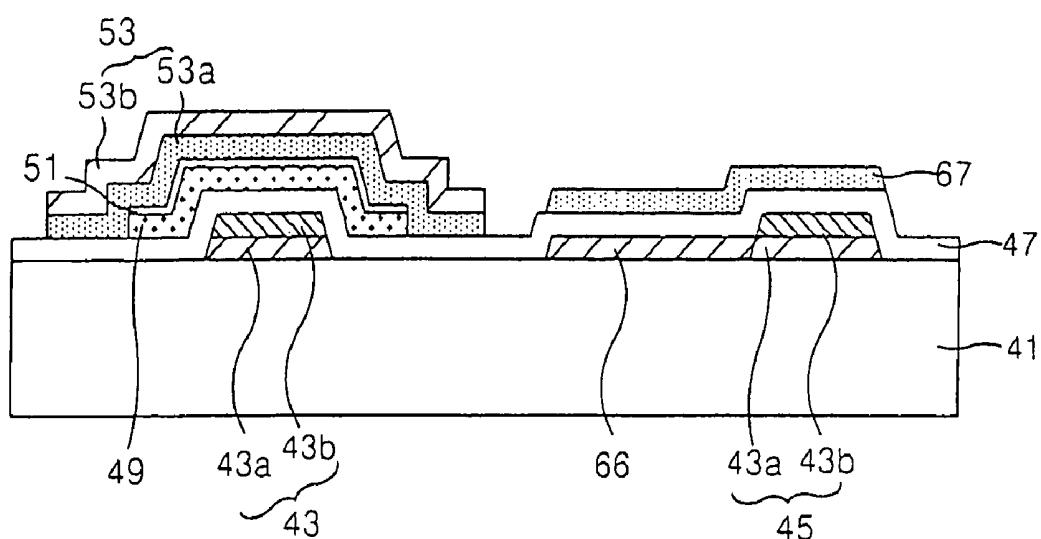


FIG.23

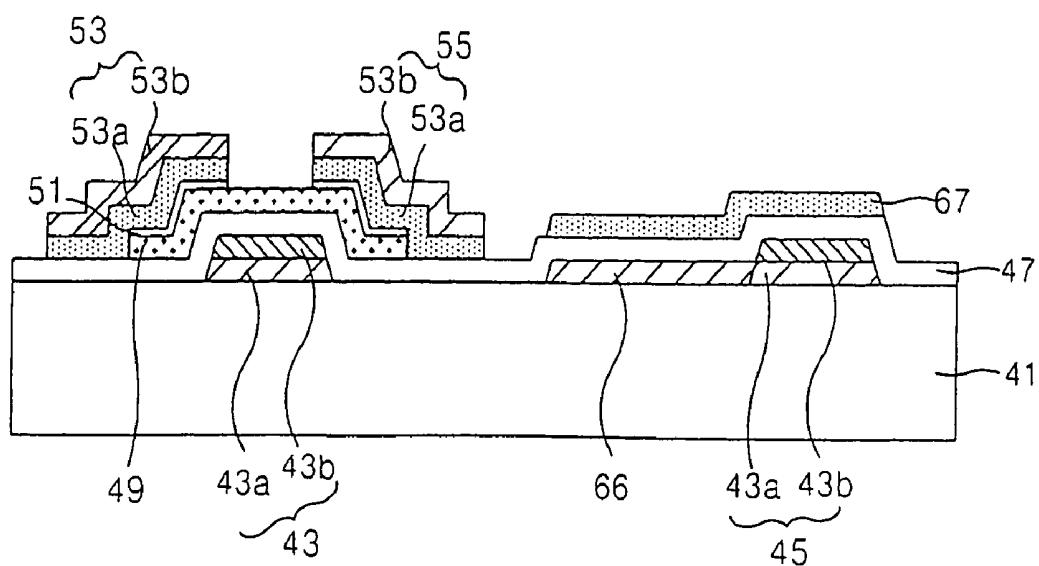


FIG.24

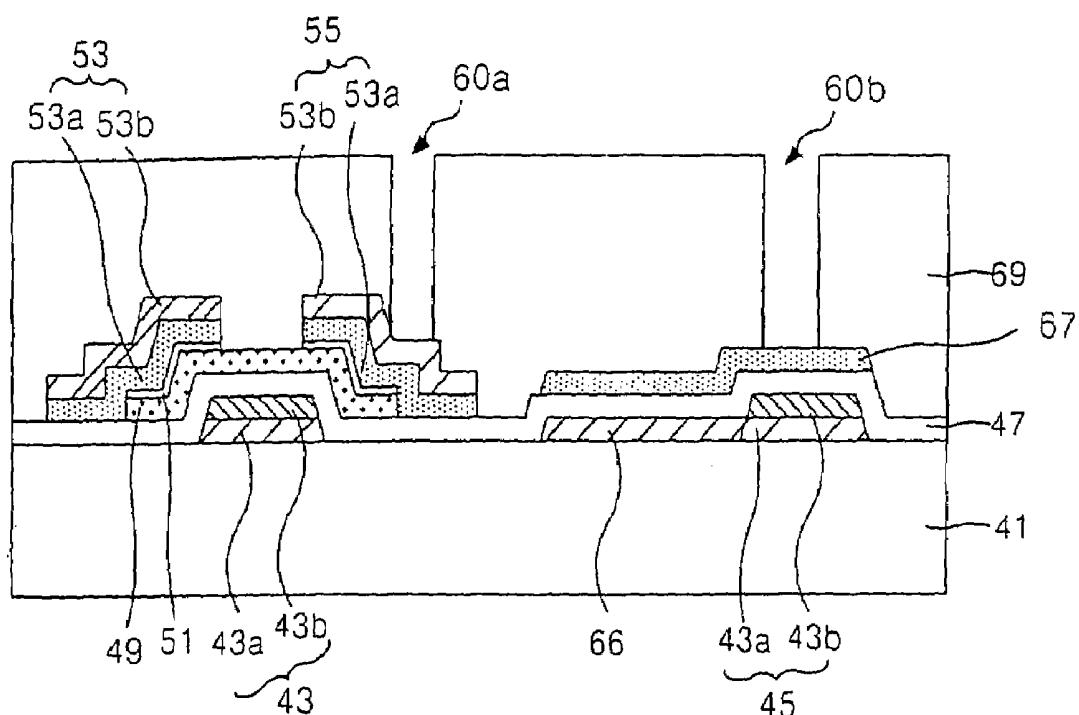


FIG.25

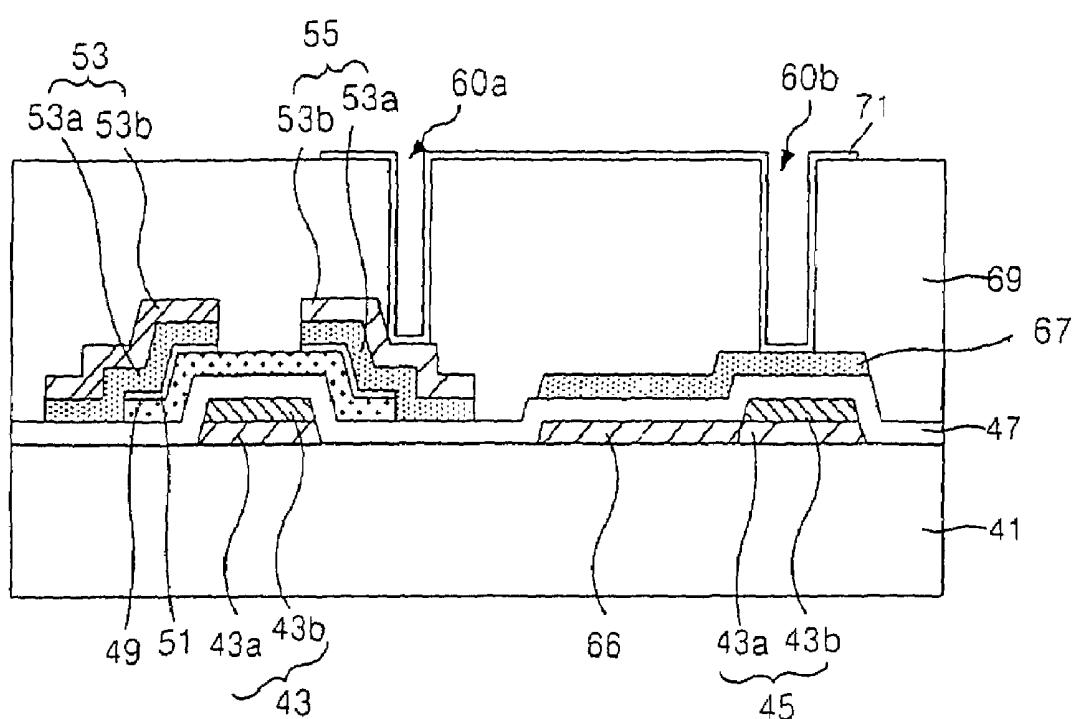
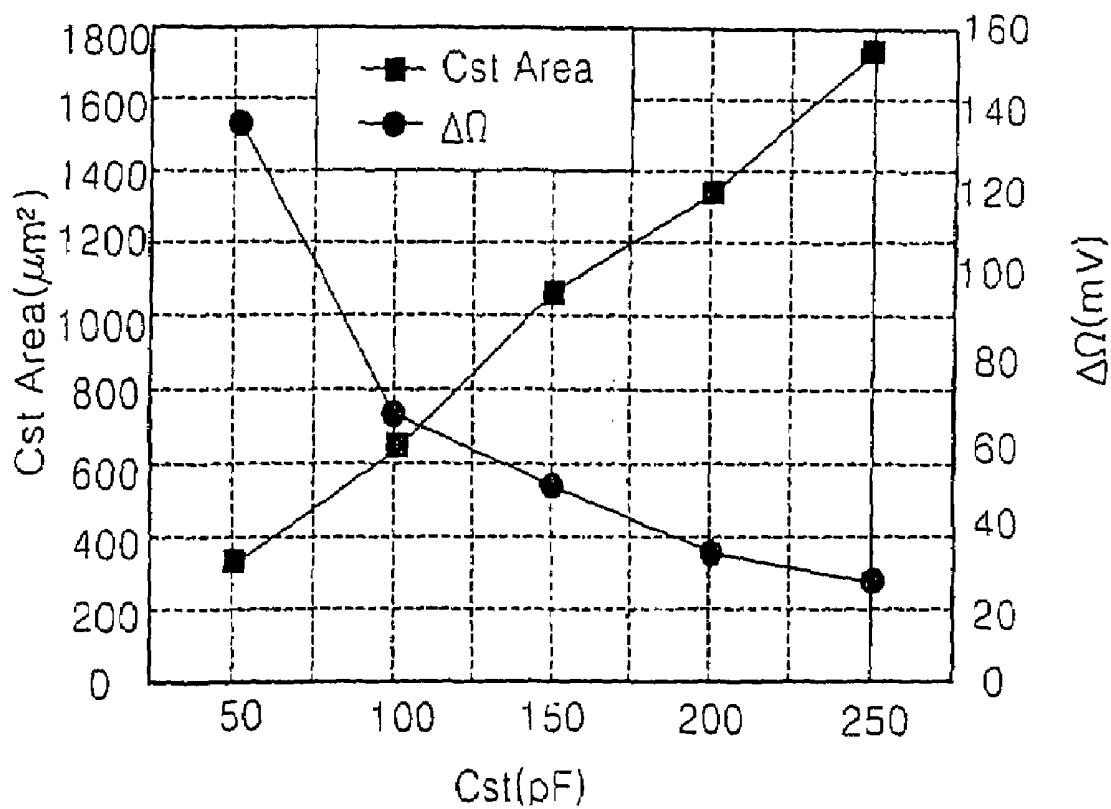


FIG. 26



**ARRAY SUBSTRATE OF LIQUID CRYSTAL
DISPLAY AND FABRICATING METHOD
THEREOF**

**CROSS-REFERENCE TO RELATED
APPLICATION**

The application is a Continuation of application Ser. No. 10/183,683, filed on Jun. 28, 2002, now U.S. Pat. No. 7,256,842 which claims priority to Korean Patent Application No. P2001-40605 filed Jul. 7, 2001, the entire contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to an array substrate of a liquid crystal display and a fabricating method thereof, and more particularly to an array substrate of a liquid crystal display and a fabricating method thereof that is capable of increasing the electrostatic capacitance of a storage capacitor without any decrease of an aperture ratio to reduce flickers and to lessen the number of required processes.

2. Description of the Related Art

Generally, a liquid crystal display LCD controls a light transmittance of a liquid crystal using an electric field to display a picture. To this end, the LCD includes a liquid crystal display panel having liquid crystal pixels arranged in a matrix type, and a driving circuit for driving the liquid crystal display panel.

In the liquid crystal display panel, there are provided a pixel electrode and a common electrode for applying an electric field to each of the liquid crystal pixels. The pixel electrode is formed on a lower substrate by liquid crystal pixels, whereas the common electrode is formed on the entire surface of an upper substrate. Each pixel electrode is connected to a thin film transistor TFT used as a switching device. The pixel electrode together with the common electrode drives the liquid crystal pixel in accordance with data signals supplied through the TFT.

FIG. 1 is a plan view showing an array substrate of a conventional liquid crystal display, FIG. 2 is a sectional view of the array substrate of the liquid crystal display taken along the line "A-A" shown in FIG. 1.

Referring to FIGS. 1 and 2, a lower substrate 11 of a liquid crystal display includes a TFT 28 located at the intersection of a data line 24 and a gate line 15n, a pixel electrode 33 connected to a drain electrode 25 of the TFT 28, and a storage capacitor 26 located at the overlapping area of the pixel electrode 33 and a previous gate line 15n-1.

The TFT 28 includes a gate electrode 13 connected to the gate line 15n, a source electrode 23 connected to the data line 24, and the drain electrode 25 connected to the pixel electrode 33 through a first contact hole 30a. Also, the TFT 28 further includes a gate insulating film 17 for insulating the gate electrode 13 from the source and drain electrode 23 and 25, and semiconductor layers 19 and 21 for defining a channel between the source electrode 23 and the drain electrode 25 by a gate voltage applied to the gate electrode 13. The TFT 28 responds to a gate signal from the gate line 15 to selectively apply a data signal from the data line 24 to the pixel electrode 33.

The pixel electrode 33 is positioned at a cell area divided by the data line 24 and the gate line 15n, and is made of a transparent conductive material having a high light transmissivity, such as indium tin oxide ITO, etc. The pixel electrode 33 is formed on a second protective layer 31 spread on the

entire surface of the lower substrate, is electrically connected to the drain electrode 25 through the first contact hole 30a passing through first and second protective layers 27 and 31. Such a pixel electrode 33 generates a potential difference from a common transparent electrode (not shown) provided at an upper substrate (not shown) by a data signal applied via the TFT. By this potential difference, a liquid crystal positioned between the lower substrate 11 and the upper substrate rotates due to its dielectric anisotropy. In other words, the liquid crystal display changes the molecular arrangement of the liquid crystal cells in accordance with the voltage applied by the pixels, to display images or the like.

FIGS. 3 to 8 are sectional views showing by steps a conventional fabricating method of the liquid crystal display shown in FIG. 2.

Referring to FIG. 3, there are formed the gate electrode 13 and the previous gate line 15n-1 on the lower substrate 11. Aluminum Al or Copper Cu is deposited on the entire surface of the substrate 11 by a known deposition method such as a sputtering method, etc. and is then patterned to form the gate electrode 13 and the previous gate line 15n-1.

Referring to FIG. 4, a gate insulating film 17 is formed over the gate electrode 13 and the previous gate line 15n-1. Then an active layer 19 and an ohmic contact layer 21 are formed on the gate insulating film 17. In this step, an insulating material is entirely deposited to cover the gate electrode 13 and the gate line 15n-1 by a plasma enhanced chemical vapor deposition PECVD method, to form the gate insulating film 17. The active layer 19 and the ohmic contact layer 21 are formed by depositing two semiconductor layers on the gate insulating film 17 and patterning them. Herein, the active layer 19 is formed of amorphous silicon that is not doped with impurities. The ohmic contact layer 21 is formed of amorphous silicon that is extensively doped with impurities of N type or P type.

Referring to FIG. 5, the data line 24 and the source and drain electrodes 23 and 25 are formed on the gate insulating film 17. In this step, a metal is entirely deposited by a CVD technique or sputtering technique and then patterned to form the data line 24 and the source and drain electrodes 23 and 25. The source and drain electrodes 23 and 25 are patterned, and then the area of the ohmic contact layer 21 corresponding to the gate electrode 13 is patterned to expose the active layer 19. The area corresponding to the gate electrode 13 between the source and drain electrodes 23 and 25 in the active layer 19 becomes a channel. The data line 24 and the source and drain electrodes 23 and 25 are formed of chromium Cr or molybdenum Mo.

Referring to FIG. 6, the first protective layer 27 and a storage electrode 29 are formed on the gate insulating film 17. In this step, the first protective layer 27 are formed by depositing an insulating material on the gate insulating layer 17 with the thickness of 1~2 μm to cover the source and drain electrodes 23 and 25. The first protective layer 27 is formed of an organic insulating material with a small dielectric constant such as acrylic organic compound, Teflon, benzocyclobutene BCB, Cytop, or perfluorocyclobutane PFCB.

The storage electrode 29 is formed by depositing a transparent conductive material on the first protective layer 27, and then patterning it. The storage electrode 29 is formed of indium-tin-oxide (ITO), indium-zinc-oxide (IZO), or indium-tin-zinc-oxide (ITZO).

Referring to FIG. 7, the second protective layer 31 is formed on the first protective layer 27 and the storage electrode 29. The first to third contact holes 30a, 30b and 30c are provided through the first and/or second protective layers 27 and 31. In this step, the second protective layer 31 is formed

by depositing an inorganic insulating material such as silicon nitride (SiN_x) or silicon oxide (SiO_x) with the thickness of around 2000~4000 Å. After that, the first to third contact holes **30a**, **30b** and **30c** are formed by selecting removing the first and/or second protective layers **27** and **31** and the gate insulating film **17**.

Referring to FIG. 8, the pixel electrode **33** and a transparent electrode **35** are formed on the second protective layer **31** and in the contact holes **30a**, **30b** and **30c**. In this step, the pixel electrode **33** is formed by depositing a transparent conductive material on the second protective layer **31** and the first contact hole **30a**, and then patterning it. The pixel electrode **33** is electrically in contact with the drain electrode **25** through the first contact hole **30a**. The pixel electrode is formed of any one of ITO, IZO, or ITZO.

The transparent electrode **35** is formed by depositing a transparent conductive material on the second protective layer **31** and the second and third contact holes **30b** and **30c**, and then patterning it. The transparent electrode **35** is electrically in contact with the storage electrode **29** and the previous gate line **15n-1** through the second and the third contact holes **30b** and **30c**.

In the foregoing liquid crystal display, if the TFT turns on, electric charge is accumulated at a storage capacitor and a liquid crystal is driven. The flicker occurring during the operation of the liquid crystal display decreases if the difference (ΔV_p) of a descending voltage upon driving in relation to the accumulated voltage at the storage capacitor is smaller. The fluctuating voltage ΔV_p is decided by the capacitance C_{st} of the storage capacitor, the capacitance Clc of the liquid crystal, a parasitic capacitance C_{gs} between the gate electrode **13** and the source electrode **23** of the TFT, and a voltage difference ΔV_g of the pulse applied to the gate electrode **13**. The fluctuating voltage ΔV_p is defined as follows according to FORMULA (1).

$$\Delta V_p = (C_{gs}/C_{st} + C_{lc} + C_{gs}) * \Delta V_g \quad (1)$$

Herein, C_{st} represents a capacitance of the storage capacitor, Clc represents a capacitance of the liquid crystal, C_{gs} represents a parasitic capacitance between corresponding gate and source electrodes, and ΔV_g represents a difference in the gate voltage.

According to the FORMULA (1) above, to decrease the fluctuating voltage ΔV_p for reducing flickers, the capacitance C_{st} of the storage capacitor should be increased, or the capacitance Clc of the liquid crystal or the parasitic capacitance C_{gs} or the voltage difference ΔV_g of the gate voltage should be decreased. If the capacitance Clc of the liquid crystal, the parasitic capacitance C_{gs} , and the gate voltage difference ΔV_g are invariable, then at least the capacitance C_{st} should be increased. And to increase the capacitance C_{st} of the storage capacitor, the area of the storage electrode needs to be increased. However, an increase of the area of the storage electrode decreases the aperture ratio of the LCD. Particularly, the aperture ratio drops significantly in a ferroelectric LCD that requires a high capacitance C_{st} of the storage capacitor or in an LCD that requires high precision.

Therefore, there is a need to provide an LCD and its fabrication method that overcome these problems of the related art. Further, there is a need to reduce costs associated with the LCD and its fabrication method by eliminating or reducing the use of expensive masks in fabricating processes of the LCD.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a liquid crystal display (LCD) and a fabricating

method thereof that is capable of increasing the electrostatic capacitance of a storage capacitor without decreasing the aperture ratio of the LCD to reduce flickers and lessen the number of fabrication steps.

It is another object of the present invention to provide an LCD and its fabrication method that overcome the problems and disadvantages associated with the related art.

In order to achieve these and other objects of the invention, an array substrate of a liquid crystal display according to an embodiment of the present invention includes a substrate; a plurality of gate lines formed on the substrate; a plurality of data lines formed on the substrate to intersect perpendicularly to the gate lines; pixel areas defined by the gate lines and the data lines; thin film transistors each formed at each intersection of the gate line and the data line; pixel electrodes each formed on each pixel area to be connected to the thin film transistor, wherein the gate lines are formed from a disposed material of a first and second metal layer, and wherein the first metal layer of the gate line is extended on the pixel area.

In the array substrate according to one embodiment, the first metal layer of the gate line is an oxidized metal layer.

In the array substrate according to one embodiment, the first metal layer of the gate line is formed from any one of a titanium oxide and an indium zinc oxide.

In the array substrate according to one embodiment, the first metal layer of the gate line is below 50 Å in the thickness.

In the array substrate according to one embodiment, the second metal layer of the gate line is formed from any one of a copper and an aluminum.

In the array substrate according to one embodiment, the first metal layer of the gate line extended on the pixel area forms a first electrode of a storage capacitor.

In the array substrate according to one embodiment, the thin film transistor includes: a gate electrode connected to the gate line; an active layer formed on a gate insulating film over the gate electrode; a source electrode formed on the active layer and connected to the data line; and a drain electrode formed on the active layer with a constant distance from the source electrode and connected to the pixel electrode, wherein the data line, the source electrode and the drain electrode are formed from a disposed material of a third metal layer and a fourth metal layer.

In the array substrate according to one embodiment, the third metal layer is an oxidized metal layer.

In the array substrate according to one embodiment, the third metal layer is any one of a titanium oxide and an indium zinc oxide.

In the array substrate according to one embodiment, the third metal layer is below 50 Å in the thickness.

In the array substrate according to one embodiment, the third metal layer has an extending part on the pixel, the extending part overlapping the extending part of the first metal layer with the gate insulating film therebetween and forming a second electrode of the storage capacitor.

In the array substrate according to one embodiment, further comprises an insulating film between the second electrode of the storage capacitor and the pixel electrode, wherein the second electrode of the storage capacitor are electrically connected to the pixel electrode through a contact hole formed in the insulating film over the gate line.

In the array substrate according to one embodiment, the storage capacitor formed by the extending parts of the first and third metal layers has the capacitance of above 100 times in opposition to a parasitic capacitor between the gate electrode and the source electrode of the thin film transistor.

A method of fabricating a array substrate of a liquid crystal display according to another aspect of the present invention

includes steps of depositing a first metal layer on a substrate; forming an oxidized metal layer by oxidizing the first metal layer; depositing a second metal layer on the oxidized metal layer; forming a photo-resist layer on the second metal layer; patterning the photo-resist layer into a first region with the photo-resist of a first thickness, a second region with the photo-resist of a second thickness and a third region without the photo-resist; etching simultaneously the oxidized metal layer and the second metal layer in the third region; etching the second metal layer in the first region to produce a first metal portion of the oxidized metal layer and a second metal portion having the oxidized and the second metal layers.

In the array substrate according to one embodiment, the oxidized metal layer includes any one of a titanium oxide and an indium zinc oxide.

In the array substrate according to one embodiment, the oxidized metal layer is below 50 Å in the thickness.

In the array substrate according to one embodiment, the second metal layer includes at least one of a copper and an aluminum.

In the array substrate according to one embodiment, the second metal portion is used for a gate line and a gate electrode.

In the array substrate according to one embodiment, the first metal portion is used for an electrode of a storage capacitor.

In the array substrate according to one embodiment, the second metal portion is used for a data line, a source electrode and a drain electrode.

In the array substrate according to one embodiment, the patterning of the photo-resist layer into the first to third regions employs a diffractive mask.

In the array substrate according to one embodiment, the photo-resist layer of the first region corresponds to a thickness of 10~50% in opposition to that of the second region.

In the array substrate according to one embodiment, further comprises an ashing for removing the photo-resist resident on the first region after the etching of the oxidized metal layer and the second metal layer.

In the array substrate according to one embodiment, the forming of the oxidized metal layer includes a exposing of the first metal layer to an O₂ plasma.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects of the invention will be apparent from the following detailed description of the embodiments of the present invention with reference to the accompanying drawings, in which:

FIG. 1 is a plan view of an array substrate of a liquid crystal display according to a conventional technique;

FIG. 2 is a sectional view of the array substrate of the liquid crystal display taken along the line "A-A" shown in FIG. 1;

FIGS. 3 to 8 are sectional views representing by steps a conventional fabricating method of the array substrate of the liquid crystal display shown in FIG. 2;

FIG. 9 is a plan view of an array substrate of a liquid crystal display according to an embodiment of the present invention;

FIG. 10 is a sectional view of the array substrate of the liquid crystal display taken along the line "B-B" shown in FIG. 9;

FIGS. 11 to 25 are sectional views representing processing steps of a fabricating method of the array substrate of the liquid crystal display shown in FIG. 10 according to an embodiment of the present invention; and

FIG. 26 is a graph showing an example of the relation of capacitance of a capacitor and $\Delta\Omega$ according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to FIGS. 9 to 26, preferred embodiments of the present invention are explained as follows.

Referring to FIGS. 9 and 10, a lower substrate 41 of a liquid crystal display according to an embodiment of the present invention includes a TFT 58 located at the intersection of a data line 54 and a gate line 45n, a pixel electrode 71 connected to a drain electrode 55 of the TFT 58, and a storage capacitor 56 located at the overlapping area of the pixel electrode 71 and a previous gate line 45n1.

The TFT 58 includes a gate electrode 43 connected to a gate line 45n, a source electrode 53 connected to the data line 54, and a drain electrode 55 connected to the pixel electrode 71 through a first contact hole 60a. The TFT 58 further includes a gate insulating film 47 for insulating the gate electrode 43 from the source and drain electrodes 53 and 55, and semiconductor layers 49 and 51 for defining a channel between the source electrode 53 and the drain electrode 55 by a gate voltage applied to the gate electrode 43. The TFT 58 responds to a gate signal from the gate line 45n to selectively apply a data signal from the data line 54 to the pixel electrode 71.

The pixel electrode 71 is positioned at a cell area divided by the data line 54 and the gate line 45n and is made of, e.g., a transparent conductive material having a high light transmissivity such as indium tin oxide ITO, etc. The pixel electrode 71 is formed on an organic insulating film 69 spread on the entire surface of the lower substrate 41, is electrically connected to the drain electrode 55 through the first contact hole 60a which is formed through the organic insulating film 69, and is electrically connected to a second storage electrode 67 through a second contact hole 60b. Such a pixel electrode 71 generates a potential difference from a common transparent electrode (not shown) provided at an upper substrate (not shown) by a data signal applied via the TFT 58. By this potential difference, a liquid crystal positioned between the lower substrate 41 and the upper substrate rotates due to its dielectric anisotropy. In other words, the liquid crystal display changes the molecular arrangement of the liquid crystal by pixels in accordance with the voltage applied by the pixels, to display pictures, images or any other displayable entity.

FIGS. 11 to 25 are sectional views representing processing steps of a fabricating method of a liquid crystal display shown in FIG. 10 according to an embodiment of the present invention.

Referring to FIG. 11, a first oxidized metal layer 43a is formed on the substrate 41. In this step, the first oxidized metal layer 43a is formed by depositing titanium Ti or the like with the thickness of around 50 Å using a deposition method such as a sputtering method, etc., and then making it react with oxygen O₂ in a plasma state. As a result, the first oxidized metal layer 43a made of a transparent conductive material such as titanium oxide TiO_x, ITO, etc. is produced.

Referring to FIG. 12, a first metal layer 43b and a photoresist 42 are formed on the first oxidized metal layer 43a. A diffractive mask 40 having a shielding part 40a, a transmission part 40b and a diffraction part 40c is arranged over the upper part of the photoresist 42.

Particularly, copper Cu, aluminum Al, or any other suitable metal material is deposited on the first oxidized metal layer 43a by a deposition method such as sputtering, etc. to form the first metal layer 43b. The shielding parts 40a of the dif-

fractive mask 40 correspond respectively to the gate electrode 43 of the TFT 58 and the gate line 45 being a part of the storage capacitor to be defined later. The diffraction part 40c corresponds to the area where a first storage electrode 66 is to be formed. The transmission part 40b corresponds to the other areas. The shielding part 40a of the diffractive mask 40 shuts off UV light, the transmission part 40b transmits the UV light, and the diffractive part 40c transmits around 10-50% of the UV light.

Subsequently, a photoresist pattern 44 is formed on the first metal layer 43b as shown in FIG. 13. The photoresist pattern 44 is formed by developing the photoresist 42 with a developing solution such as alkaline aqueous solution, etc. In the step, the photoresist pattern 44 with its original thickness (before patterning) is formed at an area corresponding to the shielding part 40a of the diffractive mask 40. The photoresist pattern 44 with the thickness of around 10-50% of its original thickness, is formed at an area corresponding to the diffraction part 40c of the mask 40. The photoresist pattern 44 is eliminated at an area corresponding to the transmission part 40b of the mask 40 to expose portions of the first metal layer 43b.

Then, the first metal layer 43b and the first oxidized metal layer 43a on the substrate 41 are patterned as shown in FIG. 14. Portions of the first oxidized metal layer 43a and the first metal layer 43b corresponding to the photoresist pattern 44 remain by a wet etching process. As a result, a gate electrode 43 and a gate line corresponding to the shield parts 40a of the mask 40 are defined.

Referring to FIG. 15, the portion of the photoresist pattern 44 with the thickness of around 10-50% of its original thickness is removed by an ashing process or any other suitable process. Then, the exposed portion of the first metal layer 43b is selectively etched. Accordingly, the portion of the first oxidized metal layer 43a corresponding to the diffraction part 40c of the diffractive mask 40 extends or is connected to the gate line 45, and is exposed. As discussed above, portions of the first oxidized metal layer 43a and the first metal layer 43b become the gate electrode 43 of the TFT 58. The portion of the first oxidized metal layer 43a extended to the pixel area becomes the first storage electrode 66. Then, all the photoresist pattern 44 on the gate electrode 43 and the gate line 45 is eliminated as illustrated in FIG. 16.

Referring to FIG. 17, a gate insulating film 47, an active layer 49 and an ohmic contact layer 51 are formed on the gate electrode 43 and the gate line 45. This step can be implemented as follows.

Silicon nitride SiO_x or silicon oxide SiO_x is entirely deposited by a PECVD technique in the manner of covering the gate electrode 43 and the gate line 45 to form the gate insulating film 47. Two semiconductor layers are deposited on the gate insulating film 47 and then patterned to form the active layer 49 and the ohmic contact layer 51. Herein, the active layer 49 is formed of amorphous silicon that is not doped with impurities. The ohmic contact layer 51 is formed of amorphous silicon that is extensively doped with impurities of N type or P type.

Referring to FIG. 18, a second oxidized metal layer 53a is formed on the gate insulating film 47 and the ohmic contact layer 51. The second oxidized metal layer 53a is formed by a deposition method such as sputtering, etc. Particularly, the second oxidized metal layer 53a is formed by depositing titanium Ti with the thickness of around 50 Å, and then making it react with oxygen O_2 in a plasma state. As a result, the second oxidized metal layer 53a made of a transparent conductive material such as titanium oxide TiO_x or ITO is produced.

Referring to FIG. 19, a second metal layer 53b and a photoresist 63 are formed on the second oxidized metal layer 53a. A diffractive mask 50 having a shielding part 50a, a transmission part 50b and a diffraction part 50c is arranged over the upper part of the photoresist 63.

More specifically, copper Cu, aluminum Al or any other suitable metal material is deposited by a deposition method such as sputtering, etc. to form the second metal layer 53b on the second oxidized metal layer 53a. The photoresist 63 is formed after entirely depositing the second metal layer 53b on the second oxidized metal layer 53a. The shielding part 50a of the diffractive mask 50 is formed at an area corresponding to the source electrode 53 and the drain electrode 55 of the TFT to be defined later. The diffraction part 50c is formed at an area where a second storage electrode 67 is to be formed. The transmission parts 50b are formed at all the other areas. The shielding part 50a of the diffractive mask 50 shuts off UV light, the transmission part 50b transmits the UV light, and the diffractive part 50c transmits around 10-50% of the UV light.

Referring to FIG. 20, a photoresist pattern 65 is formed on the second metal layer 53b. The photoresist pattern 65 is formed by developing the photoresist 63 with a developing solution such as an alkaline aqueous solution, etc. The photoresist pattern 65 having its original thickness (before patterning), is formed at an area corresponding to the shielding part 50a of the diffractive mask 50. The photoresist pattern 65 that has the thickness of 10-50% of its original thickness, is formed at an area corresponding to the diffraction part 50c. The photoresist pattern 65 is eliminated at areas corresponding to the transmission parts 50b to expose parts of the gate insulating film 47.

Then, the second metal layer 53b and the second oxidized metal layer 53a on the ohmic contact layer 51 and the gate insulating film 47 are patterned such that portions of the gate insulating film are exposed. The second oxidized metal layer 53a and the second metal layer 53b only remain at the area corresponding to the photoresist pattern 65 by a wet etching process.

Thereafter, the portion of the photoresist pattern 65 with the thickness of 10-50% of its original thickness is eliminated by an ashing process or any other suitable process. Then, the exposed portion of the second metal layer 53b is selectively etched to expose the portion of the second oxidized metal layer 53a corresponding to the diffraction part 50c of the diffractive mask 50. Herein, this part of the second oxidized metal layer 53a becomes the second storage electrode 67.

Subsequently, the photoresist pattern 65 on the second metal layer 53b is eliminated as illustrated in FIG. 22.

Then there are formed the source electrode 53 and the drain electrode 55 as shown in FIG. 23. In this step, the second oxidized metal layer 53a and the second metal layer 53b of the TFT 58 over the gate electrode 43 are patterned to form the source electrode 53 and the drain electrode 55. The ohmic contact layer 51 at an area corresponding to the gate electrode 43 is patterned to expose a part of the active layer 49. The area corresponding to the gate electrode 43 between the source electrode 53 and the drain electrode 55 becomes a channel in the active layer 49.

Referring to FIG. 24, an organic insulating film 69 is formed and the first contact hole 60a and the second contact hole 60b are formed through the organic insulating film 69. Particularly, the organic insulating film 69 is formed by depositing an insulating material in the manner of covering the source electrode 53, the drain electrode 55 and the second storage electrode 67. The insulating material is deposited and

then patterned to form the first contact hole **60a** and the second contact hole **60b** through the organic insulating film **69**. The organic insulating film **69** is formed of an organic insulating material with a small dielectric constant such as acrylic organic compound, Teflon, benzocyclobutene BCB, Cytop, perfluorocyclobutane PFCB, etc.

After that, a pixel electrode **71** is formed on the organic insulating film **69** and in the first and second contact holes **60a** and **60b** as shown in FIG. 25. Particularly, the pixel electrode **71** is formed by depositing a transparent conductive material on the organic insulating film **69** and then patterning it. The pixel electrode **71** is electrically in contact with the drain electrode **55** through the first contact hole **60a**. The pixel electrode is formed of any one of ITO, IZO or ITZO.

FIG. 26 is a graph showing the relation of a capacitance C_{st} of a storage capacitor (e.g., formed by the organic insulating film **69** and the first and second storage electrodes **66** and **67**) and a fluctuating voltage difference $\Delta\Omega$ according to an embodiment of the present invention.

The fluctuating voltage difference $\Delta\Omega$ is defined by the following FORMULA (2).

$$\Delta\Omega = \Delta V_{p_{(max)}} - \Delta V_{p_{(min)}} \quad (2)$$

Herein, $\Delta\Omega$ is defined as the difference between the maximum value and the minimum value of the fluctuating voltage ΔV_p which is the difference of the voltage decreased upon its driving in relation to the voltage accumulated to the storage capacitor.

Referring to the graph shown in FIG. 26, if the area of the storage capacitor gets bigger, the capacitance C_{st} of the storage capacitor increases. Also, if the value of $\Delta\Omega$ gets smaller, the capacitance C_{st} of the storage capacitor increases. In one example, when the value of $\Delta\Omega$ is about 40 mV in the LCD of the present invention, the capacitance C_{st} of the storage capacitor is around 200 pF. In this case, the process deviation is 1 μ m, the parasitic capacitance C_{gs} is 2.03 pF, the area of the aperture region is 2005 μ m², and the capacitance C_{st} of the storage capacitor is larger than 100 times the deviation value of the parasitic capacitance C_{gs} .

In the present invention, if the value of $\Delta\Omega$ gets bigger, residual images occur on a screen because the difference of the maximum value and the minimum value of the fluctuating voltage is increased. To prevent displaying of the residual images, in accordance with one embodiment the value of $\Delta\Omega$ should be made less than 50 mV. Thus, in the present invention, the area of the storage capacitor is made to be big or the value of $\Delta\Omega$ is made smaller for increasing the capacitance C_{st} of the storage capacitor.

As described above, the liquid crystal display and the fabricating method according to the present invention is capable of increasing the capacitance of the storage capacitor without decreasing an aperture ratio of the LCD, whereby flickers are reduced or eliminated. Also, because the number of masks being used is reduced or is not increased, the fabrication cost can be reduced when compared with a conventional fabrication method of a liquid crystal display.

Although the present invention has been explained by the embodiments shown in the drawings described above, it should be understood to the ordinary skilled person in the art that the invention is not limited to the embodiments, but rather that various changes or modifications thereof are possible without departing from the spirit of the invention. Accordingly, the scope of the invention shall be determined only by the appended claims and their equivalents.

What is claimed is:

1. An array substrate of a liquid crystal display, comprising: a substrate; a plurality of gate lines formed on the substrate, wherein the gate lines include a first metal layer on the substrate and a second metal layer on the first metal layer; a plurality of data lines formed on the substrate to intersect perpendicularly to the gate lines; pixel areas defined by the gate lines and the data lines; thin film transistors each formed at each intersection of the gate line and the data line; pixel electrodes each formed on each pixel area to be connected to the thin film transistor; and a plurality of storage capacitors including a first storage electrode extending from the first metal layer and a second storage electrode connected to the pixel electrode.
2. The array substrate according to claim 1, wherein the first metal layer of the gate line is an oxidized metal layer.
3. The array substrate according to claim 1, wherein the first metal layer of the gate line is formed from any one of a titanium oxide and an indium zinc oxide.
4. The array substrate according to claim 1, wherein the first metal layer of the gate line is below 50 \AA in the thickness.
5. The array substrate according to claim 1, wherein the second metal layer of the gate line is formed from any one of a copper and an aluminum.
6. The array substrate according to claim 1, wherein the thin film transistor includes:
 - 30 a gate electrode connected to the gate line;
 - an active layer formed on a gate insulating film over the gate electrode;
 - a source electrode formed on the active layer and connected to the data line; and
 - 35 a drain electrode formed on the active layer with a constant distance from the source electrode and connected to the pixel electrode,
 - wherein the data line, the source electrode and the drain electrode are formed from a disposed material of a third metal layer and a fourth metal layer.
7. The array substrate according to claim 6, wherein the third metal layer is an oxidized metal layer.
8. The array substrate according to claim 6, wherein the third metal layer is any one of a titanium oxide and an indium zinc oxide.
9. The array substrate according to claim 6, wherein the third metal layer is below 50 \AA in the thickness.
10. The array substrate according to claim 1, further comprising an insulating film between the second electrode of the storage capacitor and the pixel electrode, wherein the second electrode of the storage capacitor are electrically connected to the pixel electrode through a contact hole formed in the insulating film over the gate line.
11. The array substrate according to claim 1, wherein the storage capacitor has the capacitance of above 100 times in opposition to a parasitic capacitor between the gate electrode and the source electrode of the thin film transistor.
12. The array substrate according to claim 1, wherein the storage capacitors further include a insulator film between the first storage electrode and the second storage electrode.
13. An array substrate of a display device, comprising:
 - 60 a gate line having a first gate line layer on a substrate and a second gate line layer on the first gate line layer, wherein the first and second gate line layers are formed respectively of a first oxidized metal layer and a first metal layer;

11

a first storage electrode extending from the first gate line layer;
 a second storage electrode over the gate line and the first storage electrode;
 a TFT (thin film transistor) and a data line on the substrate; and
 a pixel electrode in electrical contact with the second storage electrode.

14. The array substrate according to claim **13**, wherein the data line includes first and second data line layers respectively formed of a second oxidized metal layer and a second metal layer.

15. The array substrate according to claim **13**, wherein the TFT includes;

a gate electrode extending from another gate line adjacent to the gate line having the first and second gate line layers;
 a source electrode extending from the data line; and
 a drain electrode in electrical contact with the pixel electrode.

16. The array substrate according to claim **15**, wherein the gate electrode includes first and second gate electrode layers respectively formed of the first oxidized metal layer and the first metal layer.

17. The array substrate according to claim **15**, wherein at least one of the source and drain electrodes includes first and

12

second electrode layers respectively formed of a second oxidized metal layer and a second metal layer.

18. A display device comprising:

a first gate line on a substrate, a second gate line on the first gate line and a data line crossing the first and second gate lines;

a TFT (thin film transistor) at an intersection area of the first gate line and the data line;

a pixel electrode connected to the TFT; and

a first storage electrode extending from the first gate line, wherein the first and second gate lines include first and second line layers respectively formed of an oxidized metal layer and a metal layer.

19. The display device according to claim **18**, wherein the TFT include:

a gate electrode extending from the first gate line;
 a source electrode extending from the data line; and
 a drain electrode in contact with the pixel electrode,
 wherein at least one of the gate, source and drain electrodes includes first and second electrode layers respectively formed of an oxidized metal layer and a metal layer.

20. The display device according to claim **18**, further comprising:

a second storage electrode over the second gate line and the first storage electrode, and in contact with the pixel electrode.

* * * * *

专利名称(译)	液晶显示器的阵列基板及其制造方法		
公开(公告)号	US7522224	公开(公告)日	2009-04-21
申请号	US11/785200	申请日	2007-04-16
[标]申请(专利权)人(译)	HWANG KWANG J 金宇^ h KIM SE J		
申请(专利权)人(译)	HWANG KWANG J 金宇^ h KIM SE J		
当前申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
[标]发明人	HWANG KWANG JO KIM WOO HYUN KIM SE JUNG		
发明人	HWANG, KWANG JO KIM, WOO HYUN KIM, SE JUNG		
IPC分类号	G02F1/1343 G02F1/1362		
CPC分类号	G02F1/136213 G02F2001/13629		
审查员(译)	KIM , RICHARD H		
优先权	1020010040605 2001-07-07 KR		
其他公开文献	US20070188671A1		
外部链接	Espacenet USPTO		

摘要(译)

液晶器件的阵列基板具有多条栅极线，数据线，像素区和薄膜晶体管，其中栅极线由第一和第二金属层的材料形成，并且其中第一金属层栅极线在像素区域上延伸。此外，显示装置在基板上具有第一和第二栅极线和数据线，薄膜晶体管，像素电极，从第二栅极线延伸的第一存储电极，并且其中第一和第二栅极线中的至少一个数据线包括分别由氧化金属和金属层形成的第一和第二线层。

