



US007425997B2

(12) **United States Patent**  
**Kim**

(10) **Patent No.:** **US 7,425,997 B2**  
(45) **Date of Patent:** **Sep. 16, 2008**

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

(75) Inventor: **Woo Hyun 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 0 days.

(21) Appl. No.: **11/528,591**

(22) Filed: **Sep. 28, 2006**

(65) **Prior Publication Data**

US 2007/0019124 A1 Jan. 25, 2007

**Related U.S. Application Data**

(62) Division of application No. 10/141,848, filed on May  
10, 2002, now Pat. No. 7,133,087.

(30) **Foreign Application Priority Data**

Jun. 5, 2001 (KR) ..... 10-2001-31511

(51) **Int. Cl.**  
**G02F 1/1333** (2006.01)

(52) **U.S. Cl.** ..... 349/39; 349/38

(58) **Field of Classification Search** ..... 349/38-39,  
349/43; 257/59, 72; 345/92

See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

5,905,548 A 5/1999 Shimada

6,326,641 B1 \* 12/2001 Choi ..... 257/57  
6,466,281 B1 10/2002 Huang et al.  
6,610,997 B2 8/2003 Murade  
6,614,083 B1 \* 9/2003 Yamazaki et al. .... 257/412  
6,654,073 B1 \* 11/2003 Maruyama et al. .... 349/38  
2003/0038306 A1 \* 2/2003 Izumi et al. .... 257/222

**FOREIGN PATENT DOCUMENTS**

JP 2001-66633 3/2001  
KR 1994-11988 6/1994  
KR 2000-2804 1/2000  
KR 2001-0026625 4/2001

\* cited by examiner

*Primary Examiner*—David C. Nelms

*Assistant Examiner*—Hoan C Nguyen

(74) *Attorney, Agent, or Firm*—Morgan, Lewis & Bockius  
LLP

(57) **ABSTRACT**

An array substrate of a liquid crystal display includes a gate line, a data line crossing the gate line, a thin film transistor including a gate electrode connected to the gate line, a semiconductor layer having first and second sides, a source electrode contacting the first side of the semiconductor layer and connected to the data line, and a drain electrode contacting the second side of the semiconductor layer, a gate insulating film provided between the gate line and the data line, an organic protective film formed on the gate insulating film, a capacitor common line provided on the organic protective film to overlap the gate line, an upper insulating layer provided on the organic protective film, and a pixel electrode provided on the upper insulating layer partially overlapping the capacitor common line and the data line, the pixel electrode connected to the drain electrode via a contact hole through the upper insulating layer and the organic protective film.

**9 Claims, 32 Drawing Sheets**

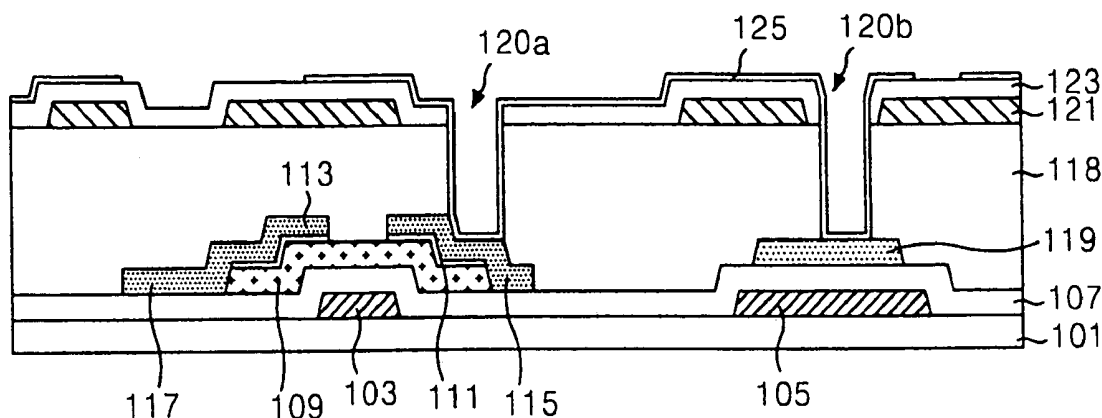
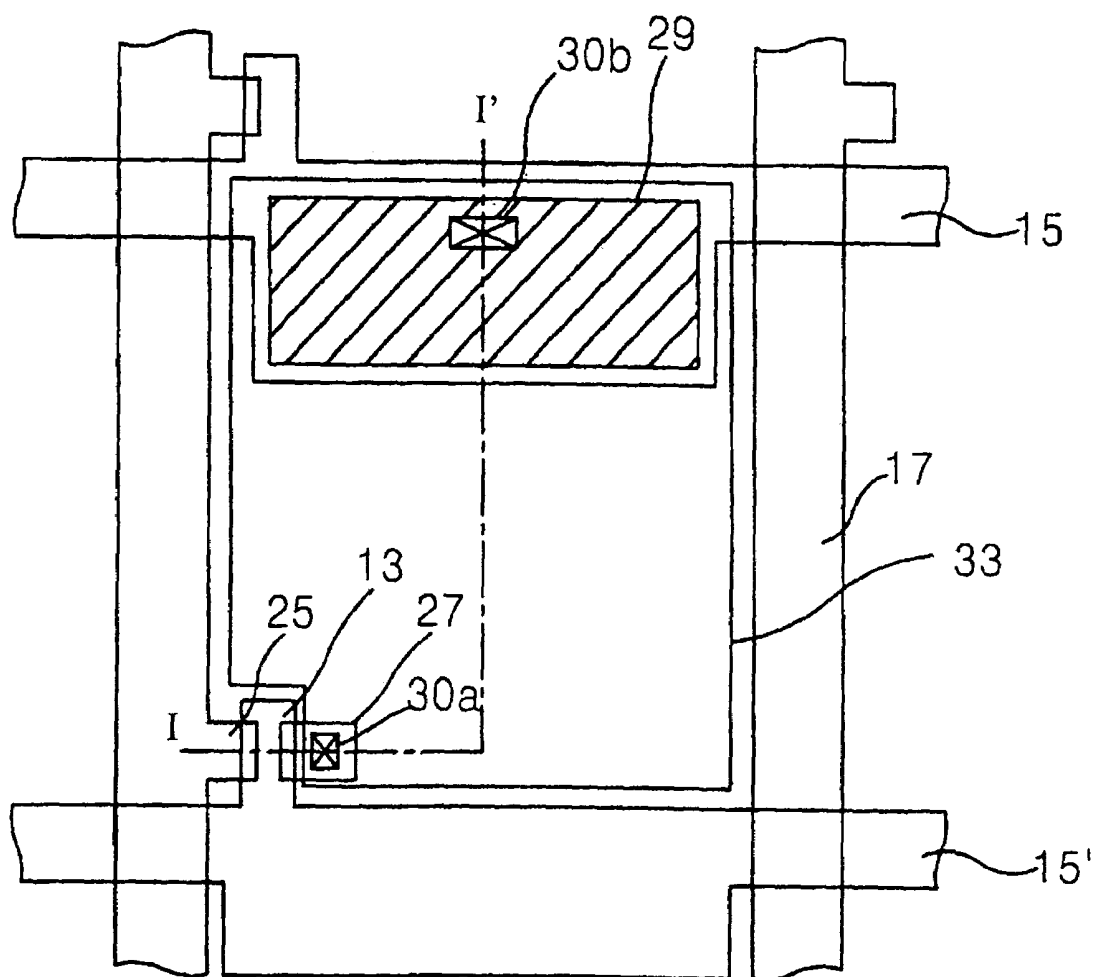


FIG.1  
CONVENTIONAL ART



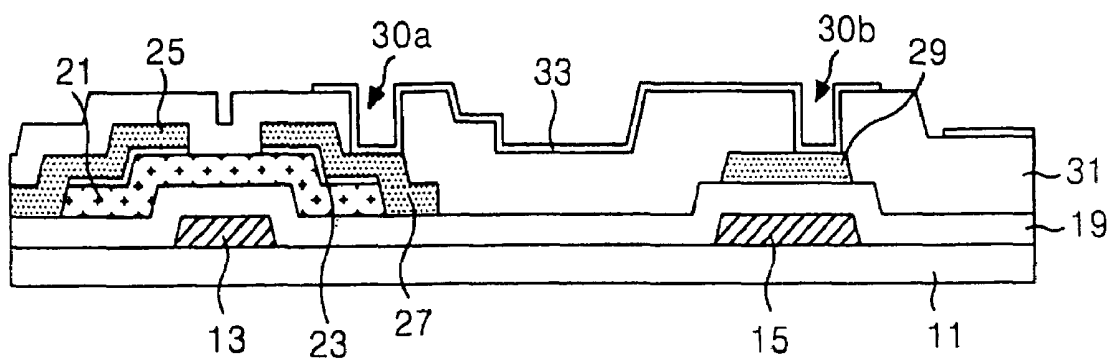


FIG. 3A  
CONVENTIONAL ART

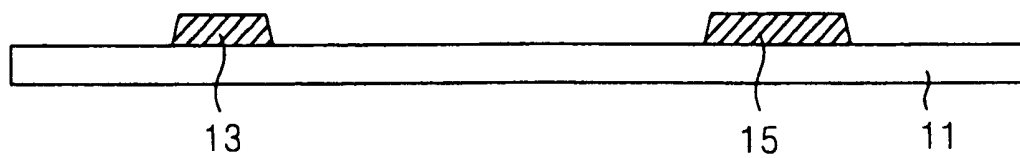


FIG. 3B  
CONVENTIONAL ART

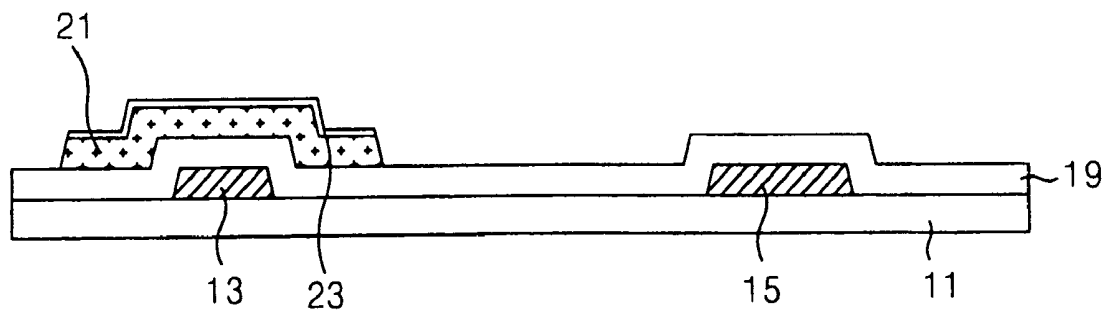


FIG. 3C  
CONVENTIONAL ART

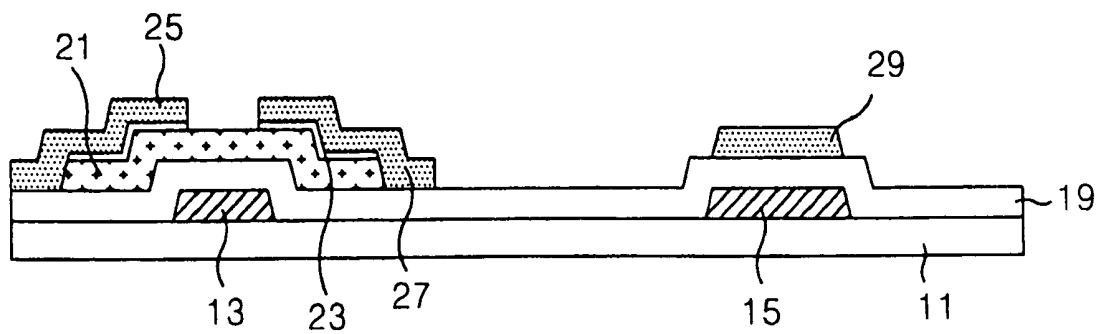


FIG. 3D  
CONVENTIONAL ART

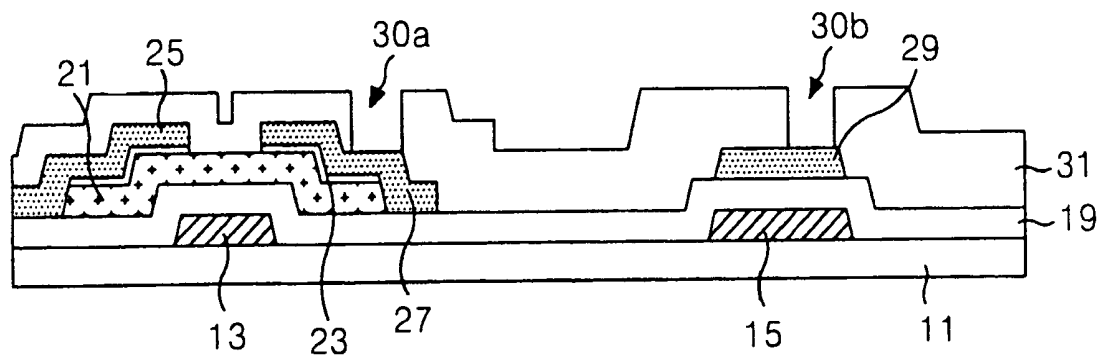


FIG. 3E  
CONVENTIONAL ART

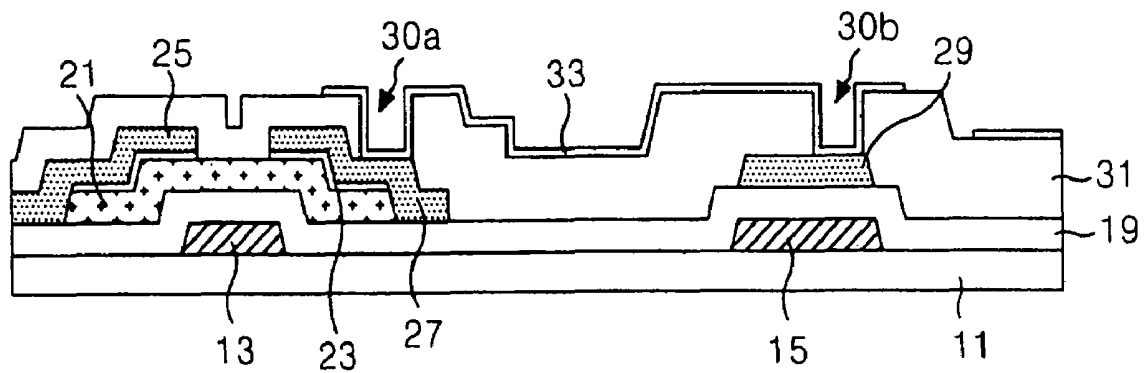


FIG. 4  
CONVENTIONAL ART

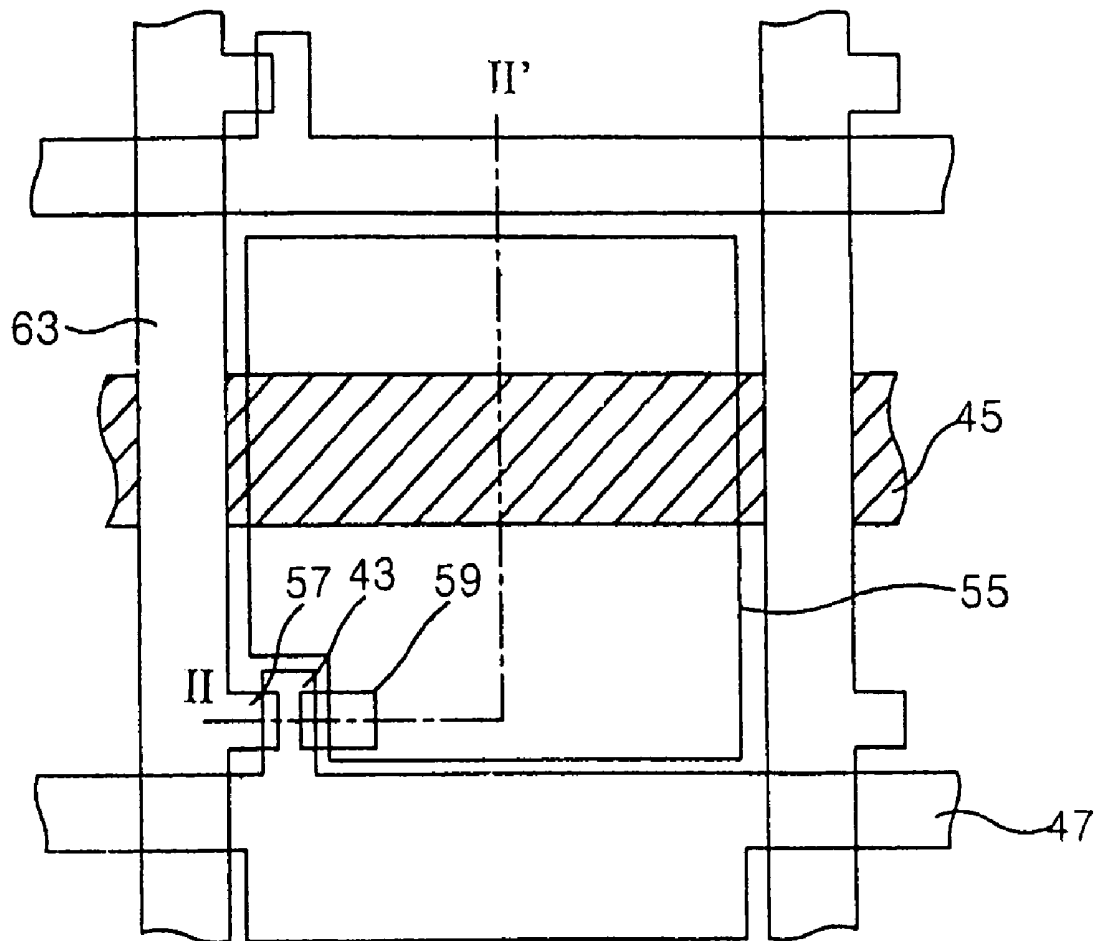


FIG. 5  
CONVENTIONAL ART

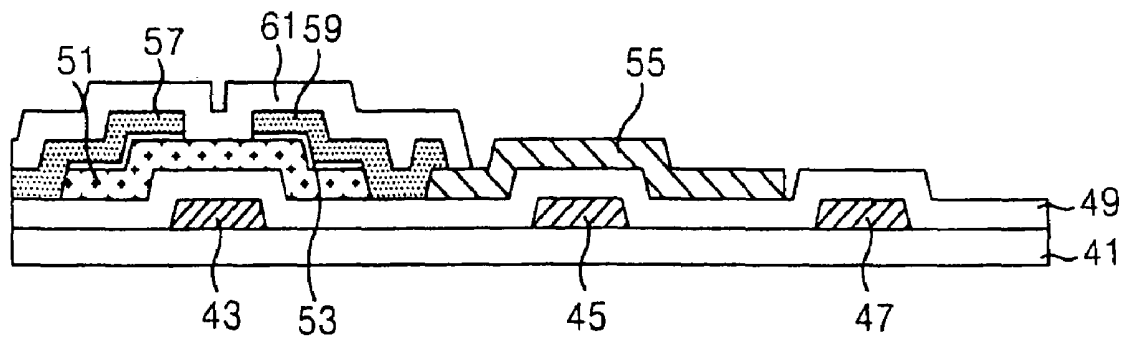




FIG. 6A  
CONVENTIONAL ART

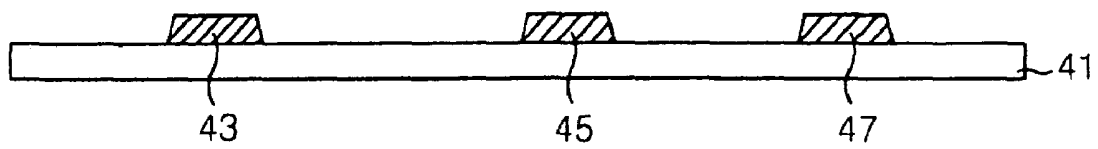


FIG. 6B  
CONVENTIONAL ART

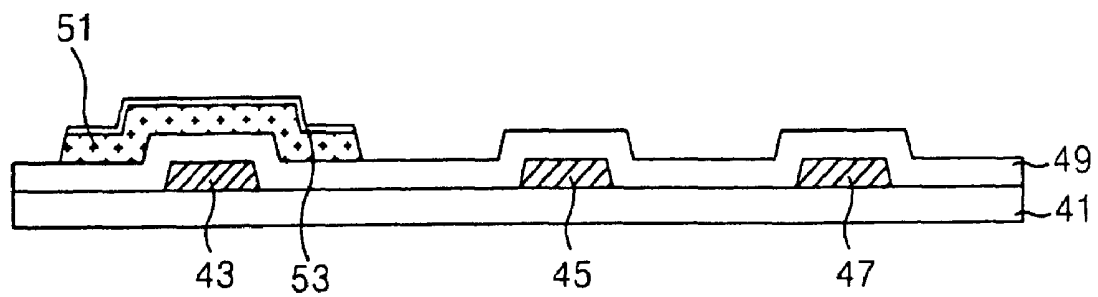


FIG. 6C  
CONVENTIONAL ART

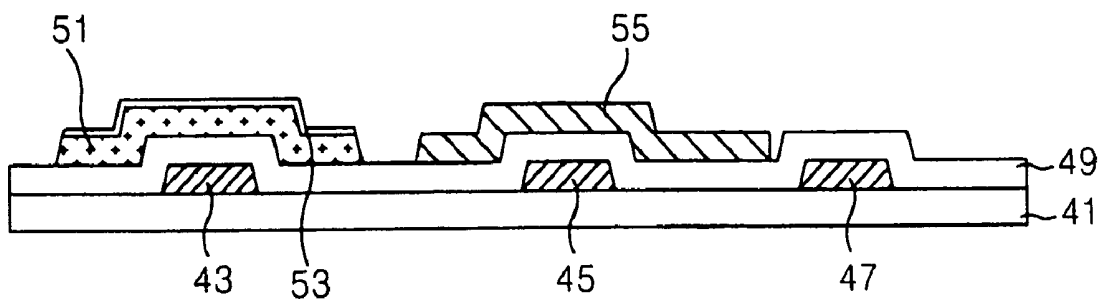


FIG. 6D  
CONVENTIONAL ART

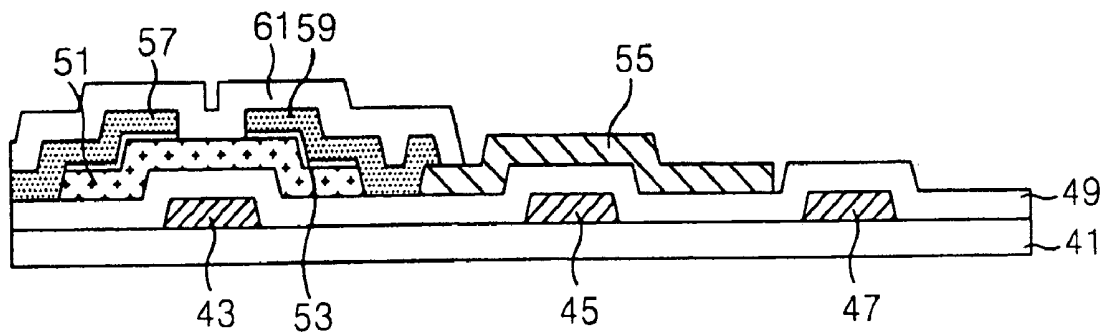


FIG. 7

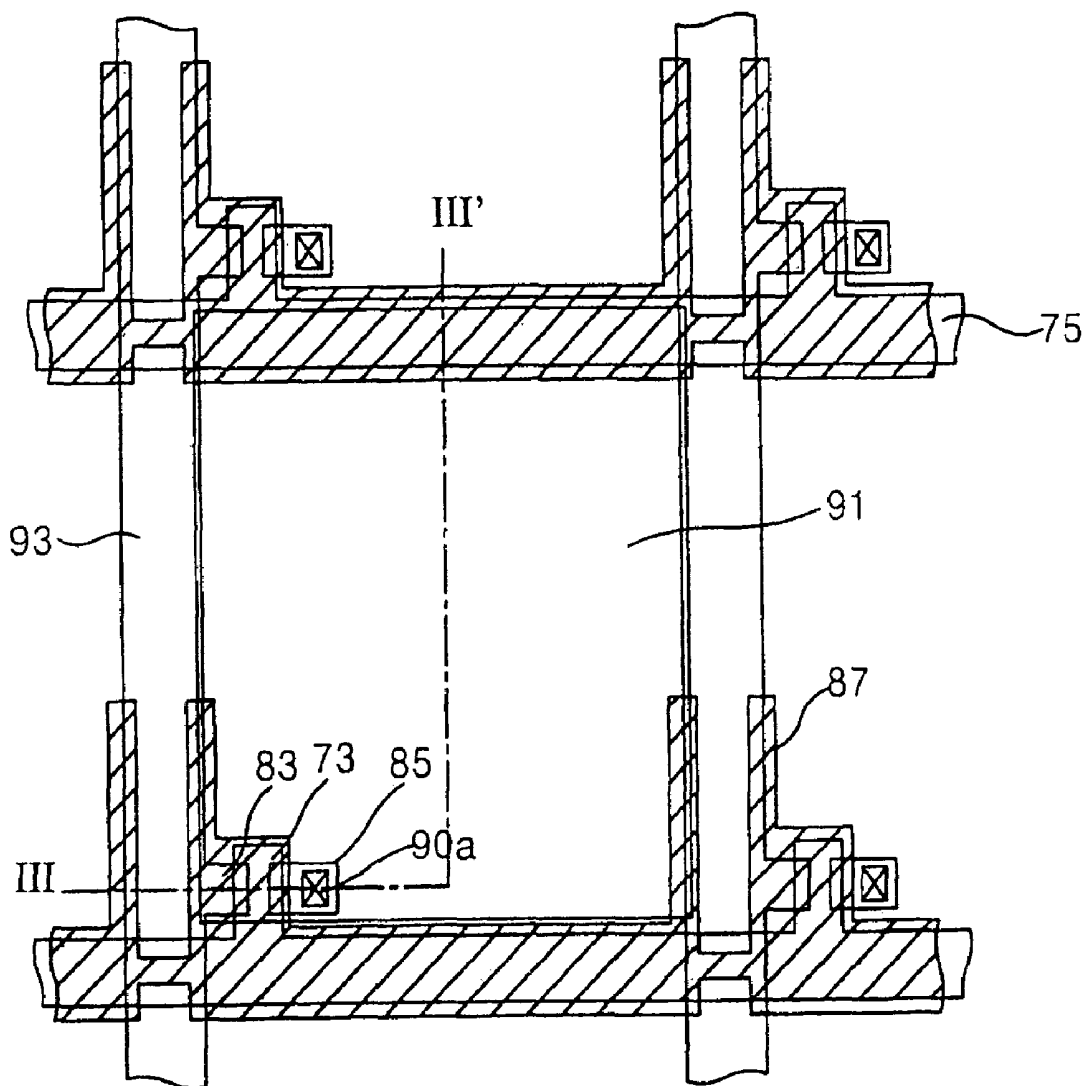


FIG. 8

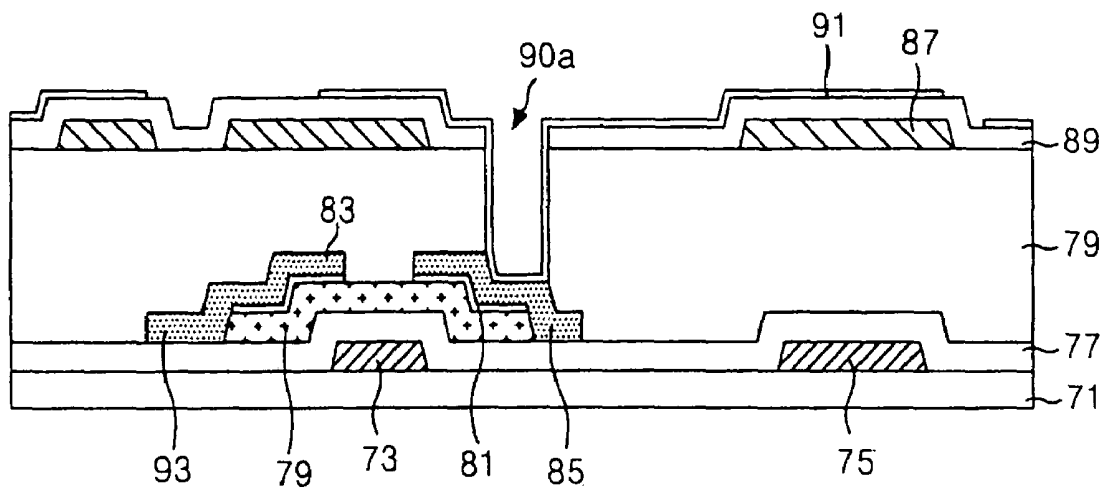


FIG. 9A

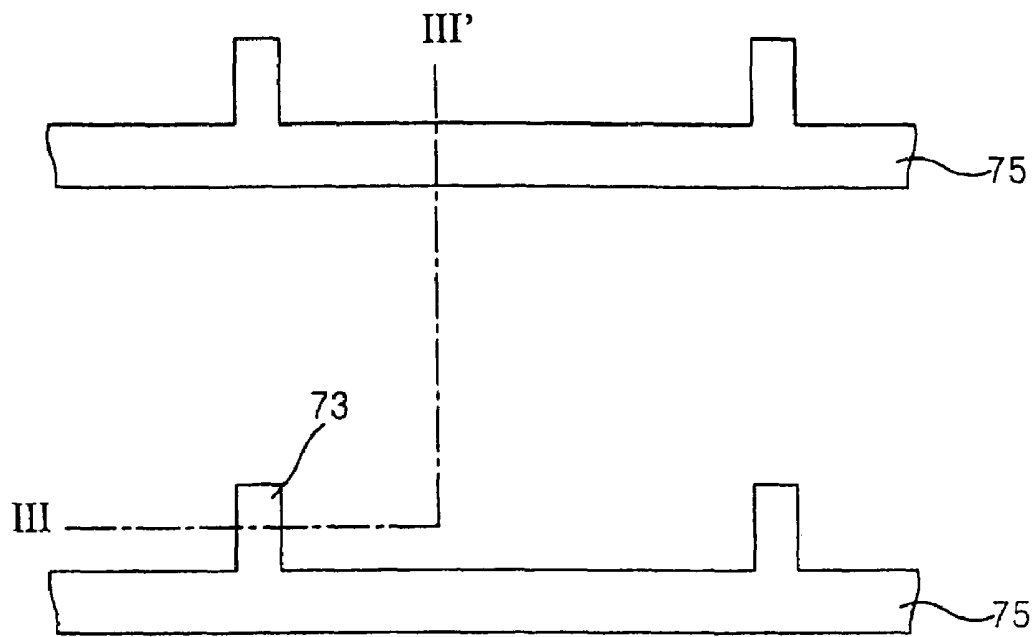


FIG. 9B

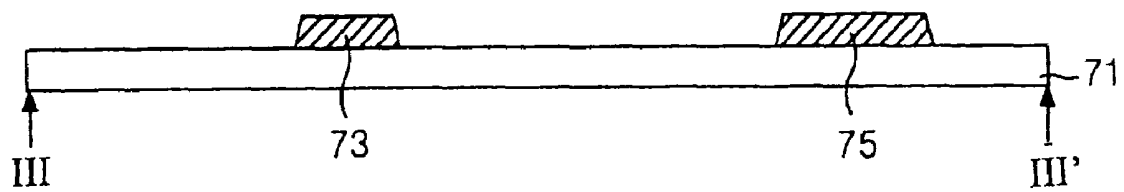


FIG.10

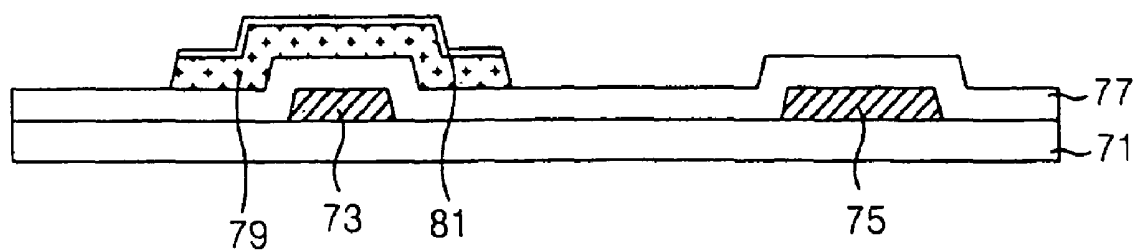


FIG. 11A

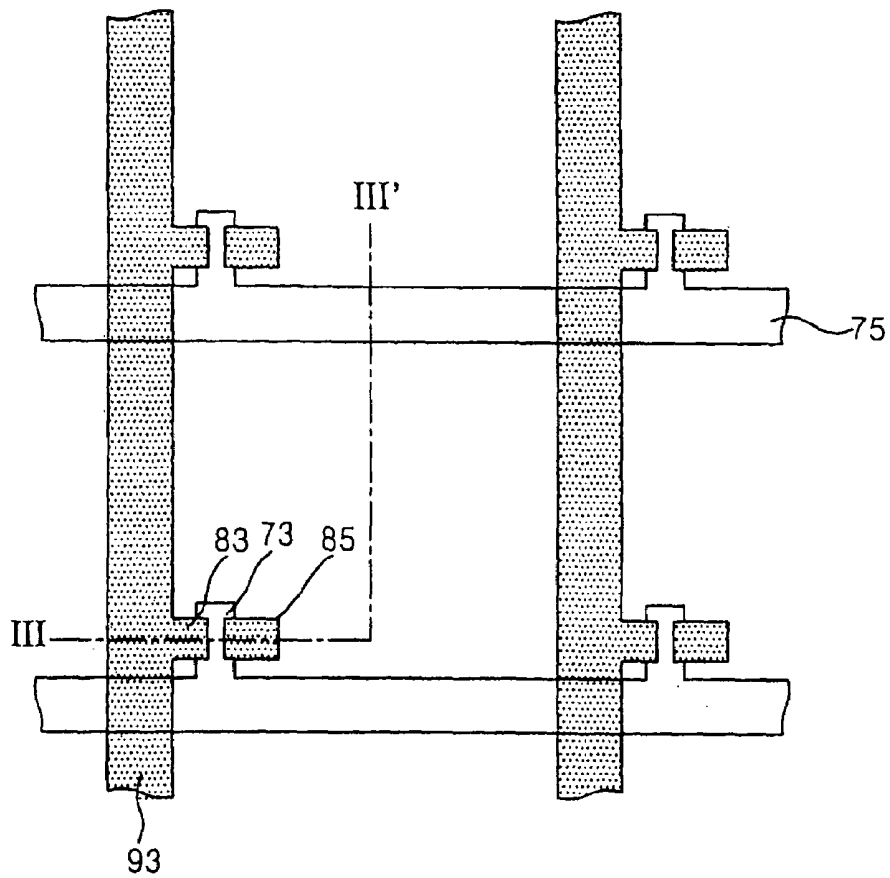


FIG. 11B

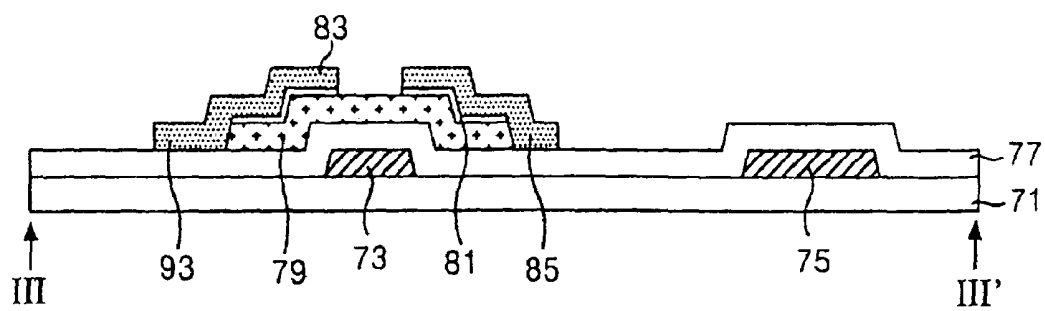


FIG. 12A

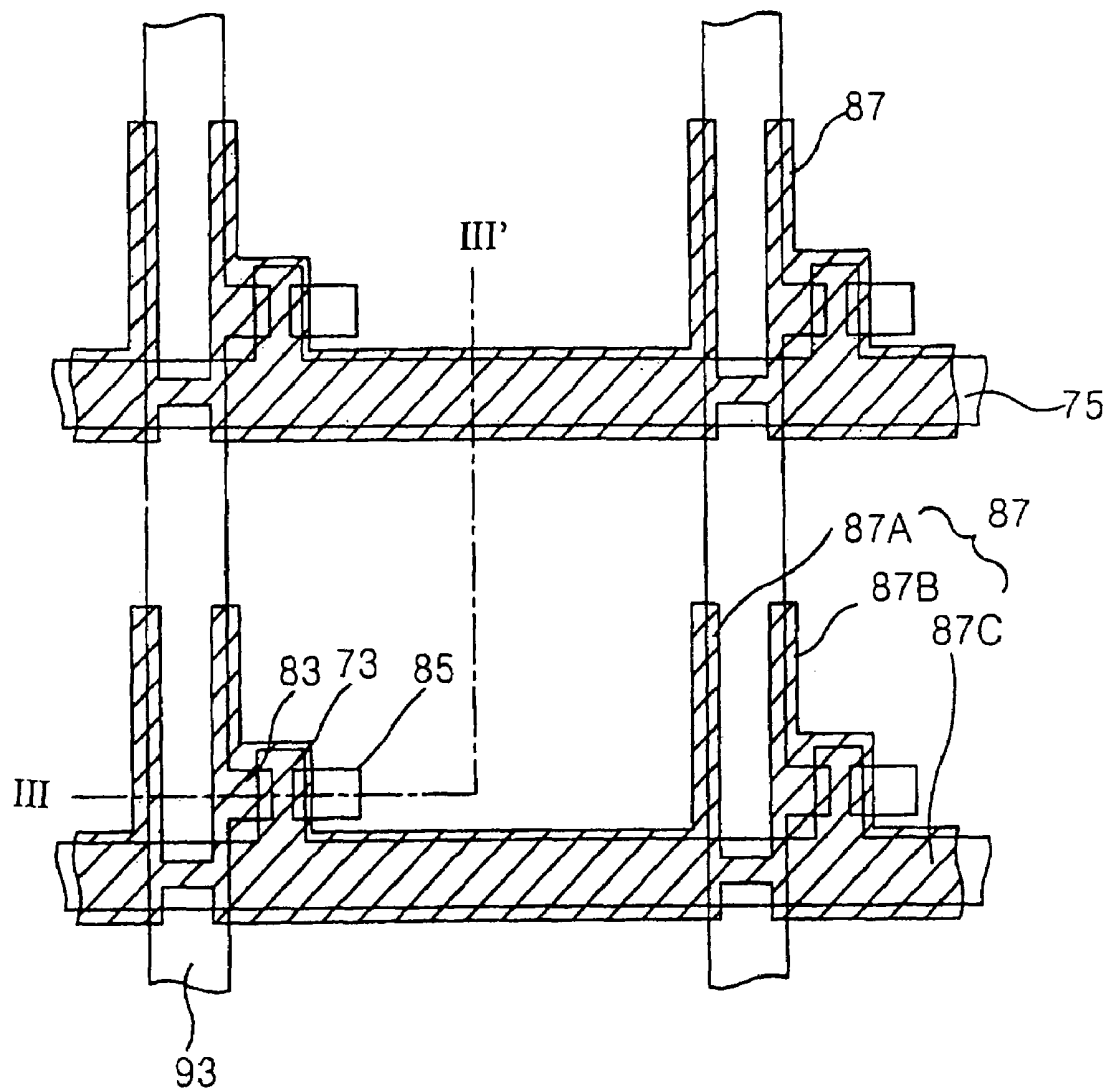




FIG. 12B

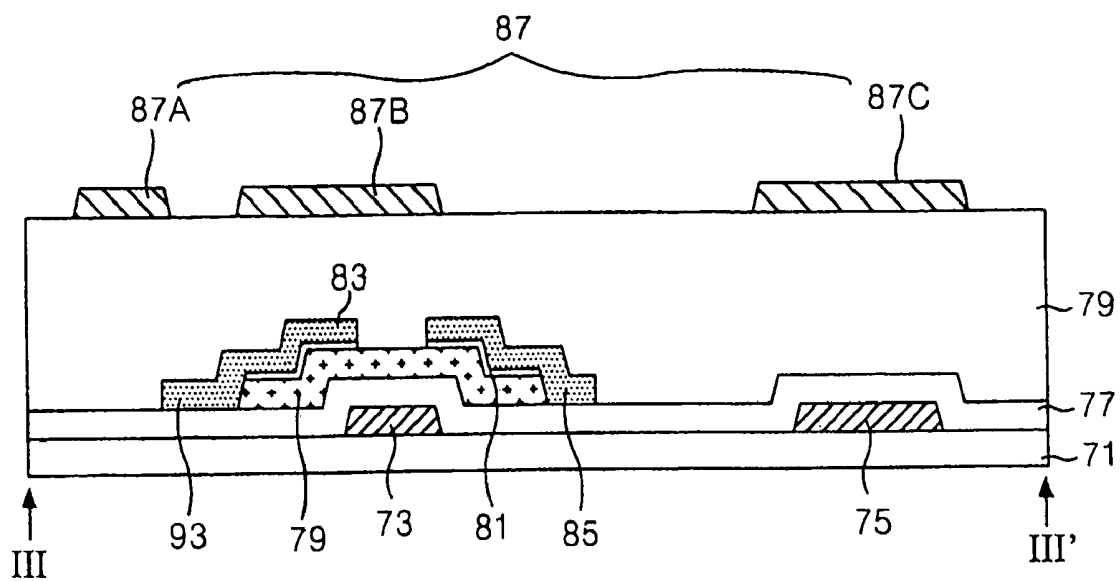


FIG. 13A

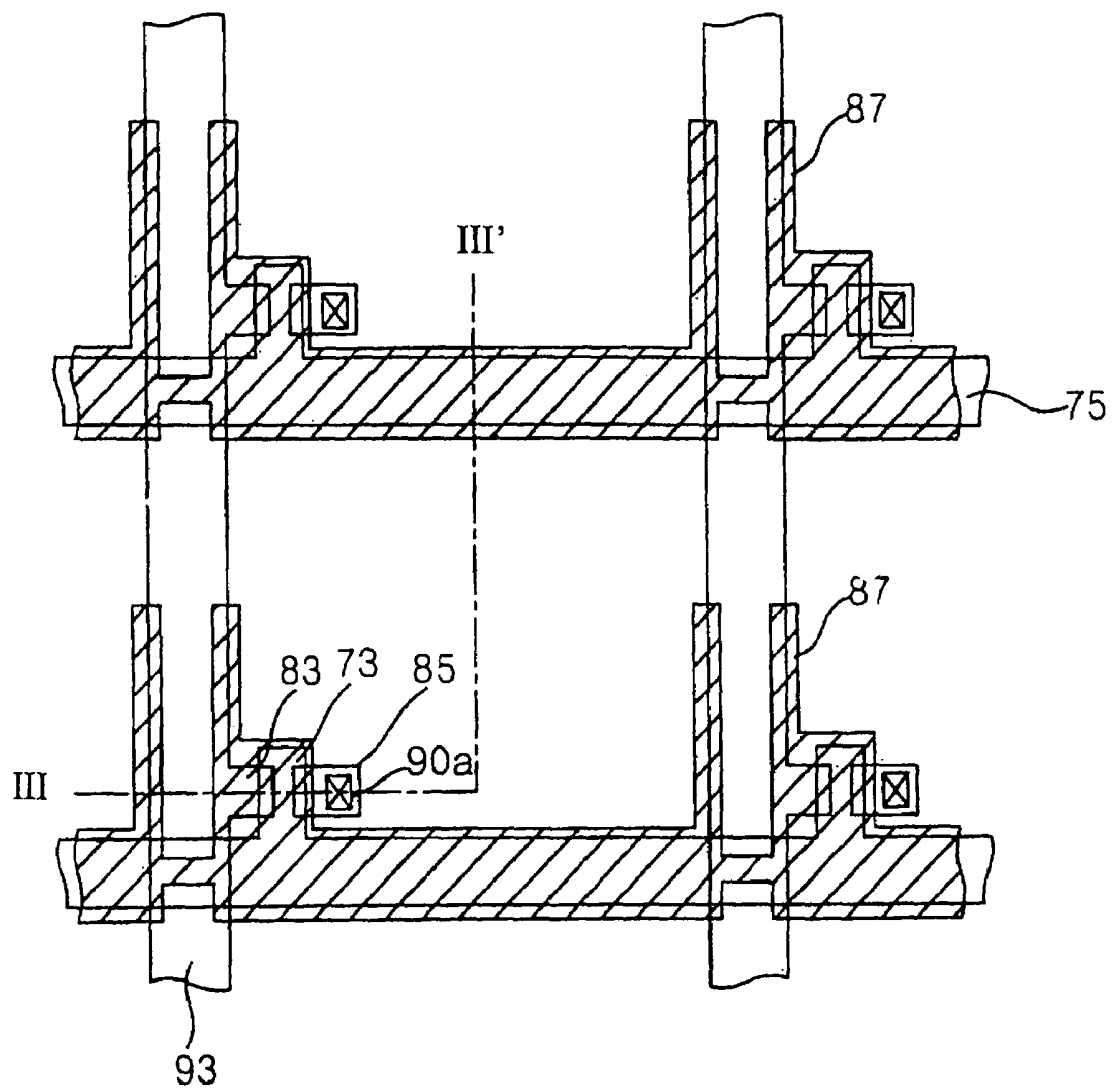


FIG. 13B

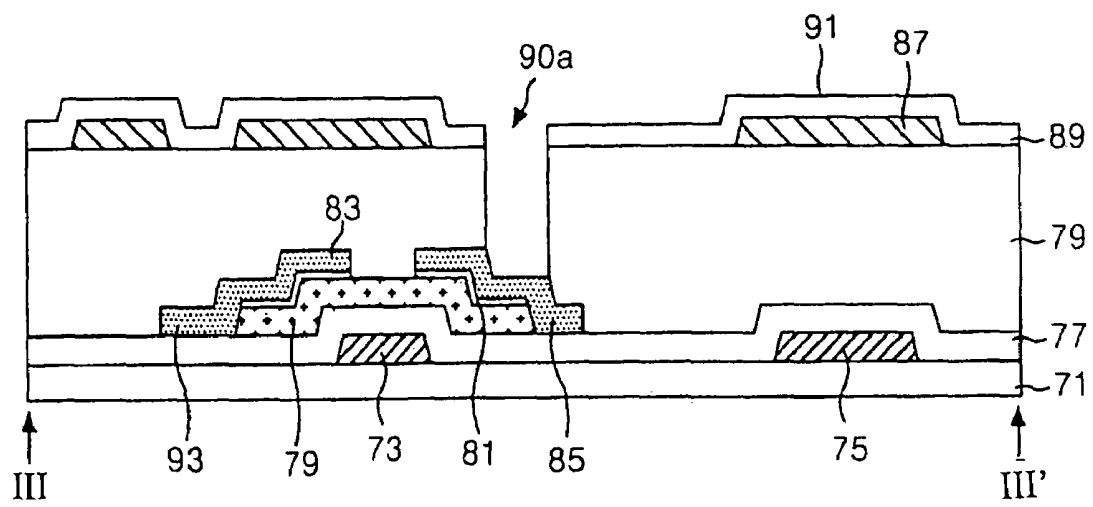


FIG. 14A

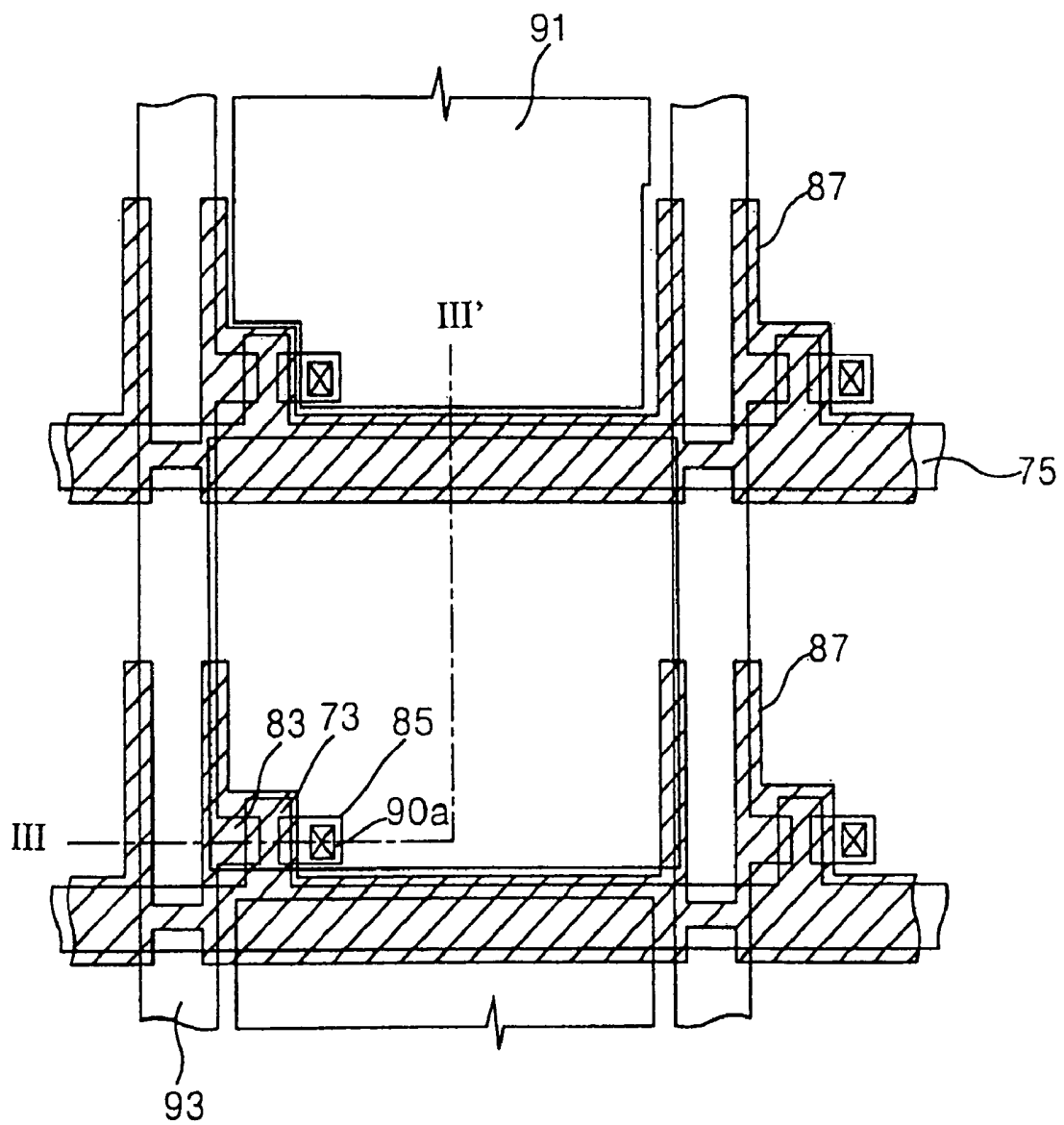


FIG. 14B

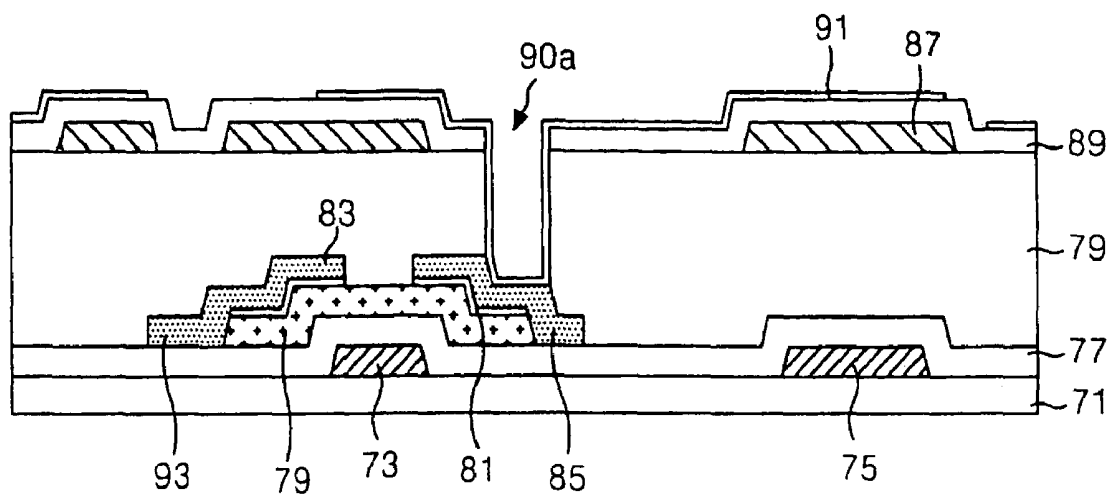


FIG. 15

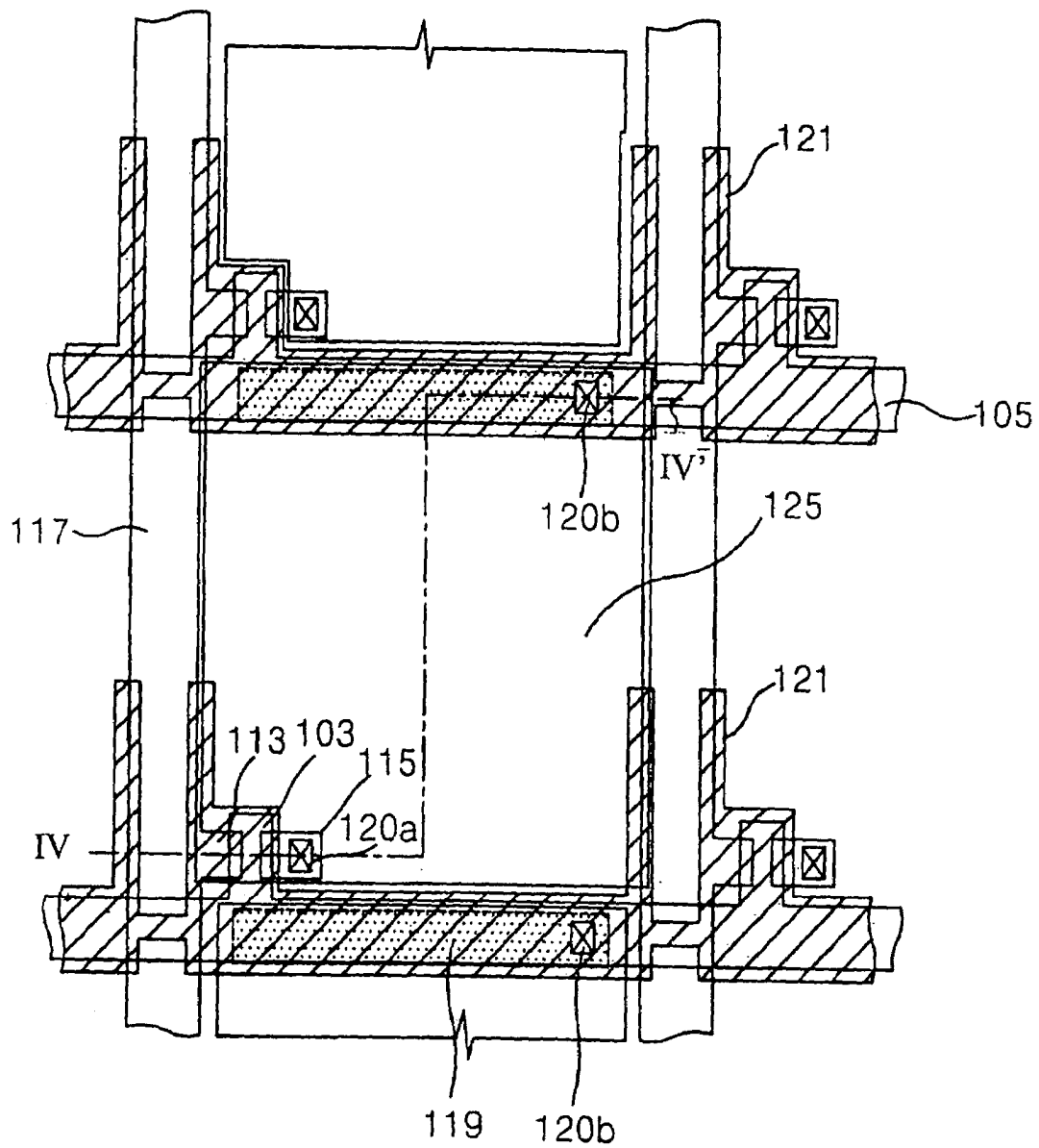


FIG. 16

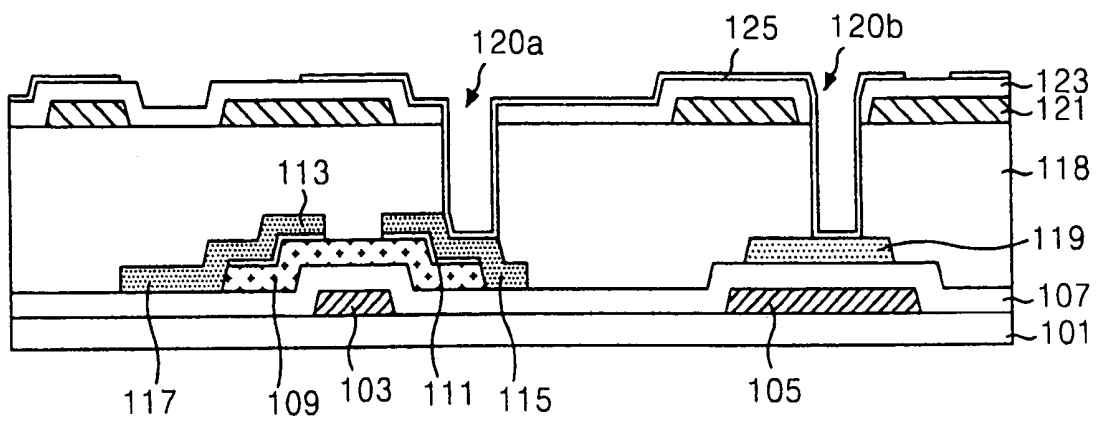


FIG. 17A

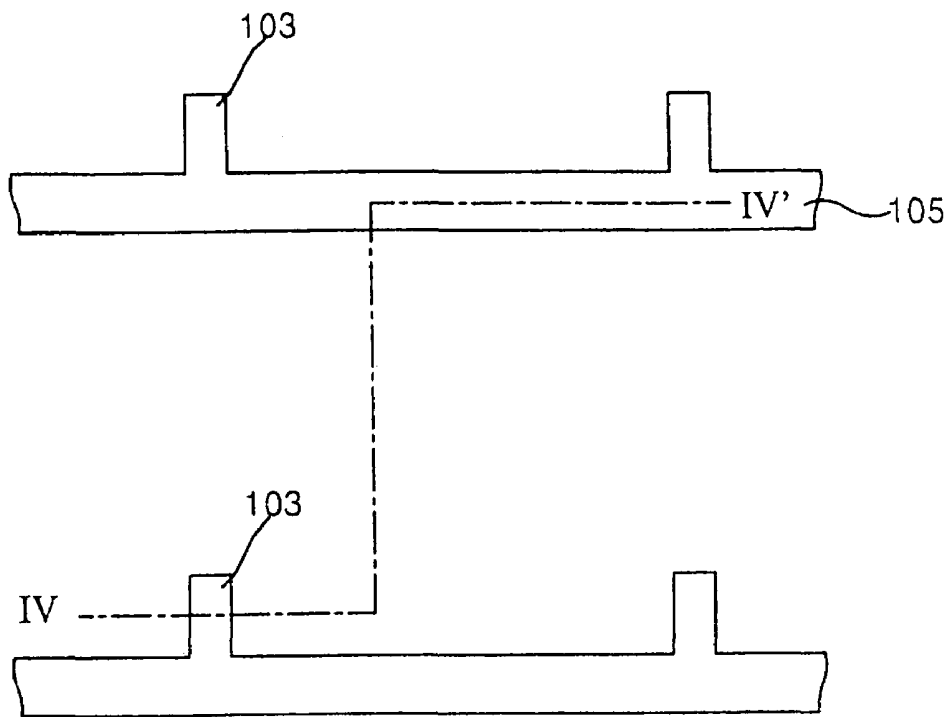


FIG. 17B

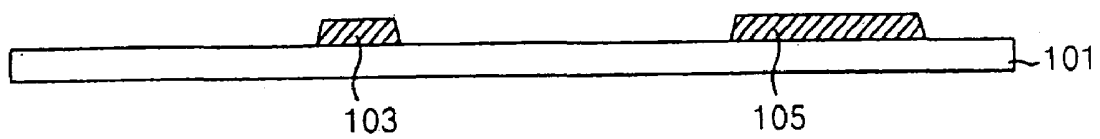




FIG. 18

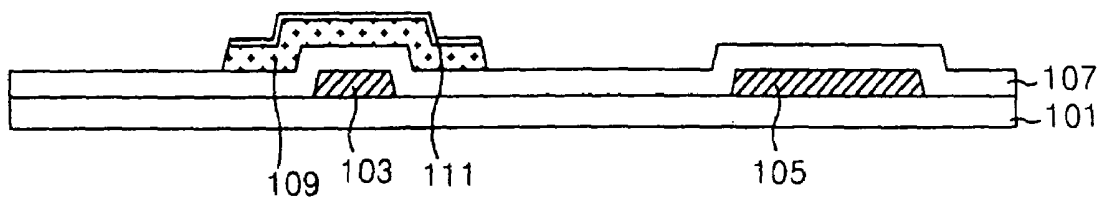


FIG. 19A

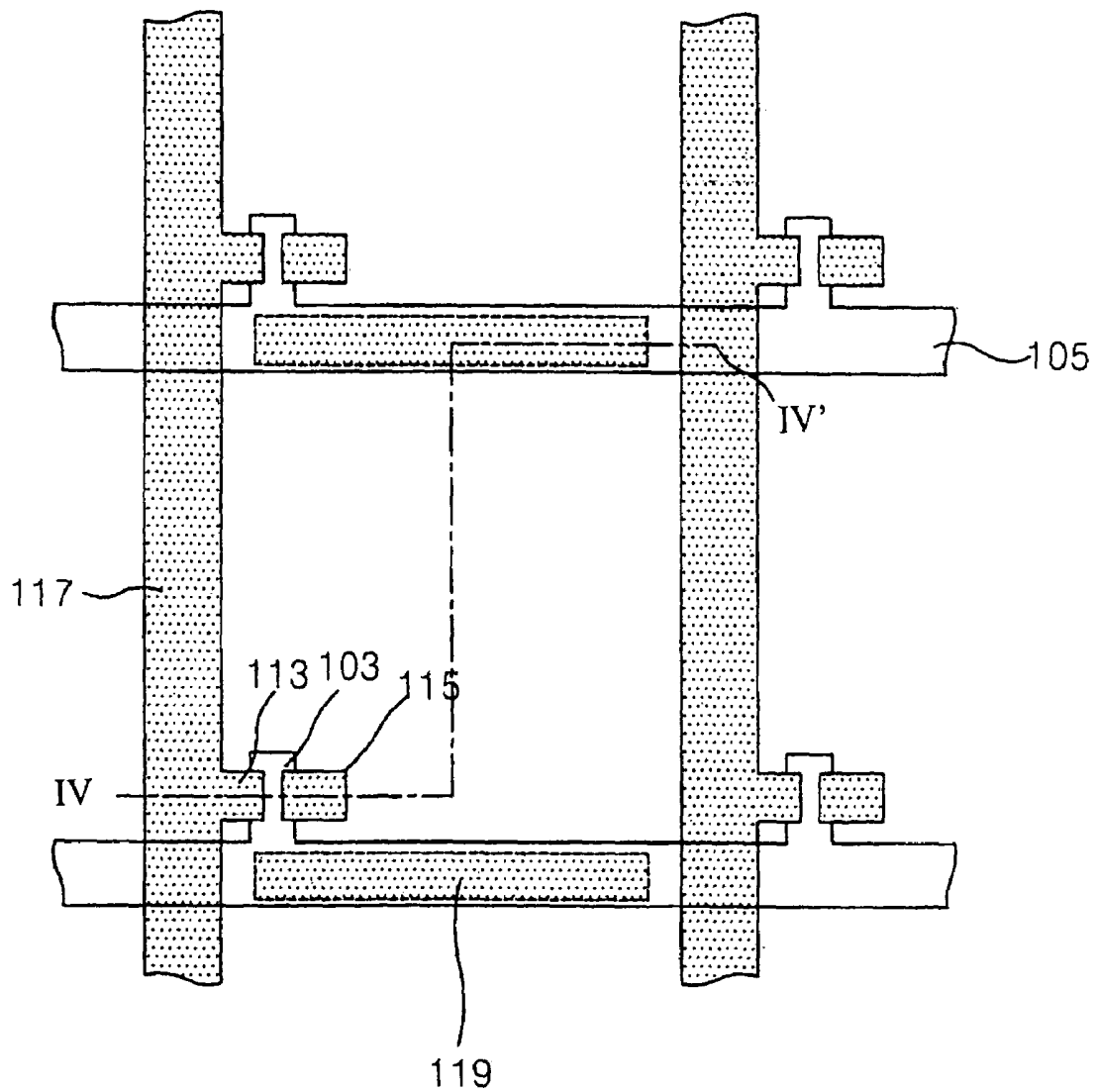


FIG. 19B

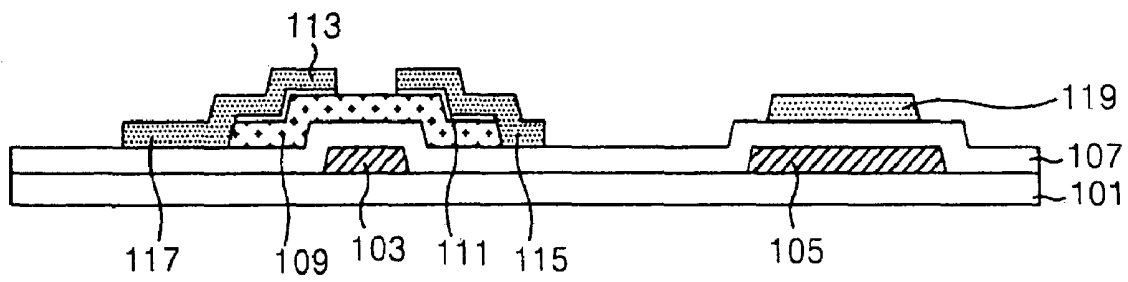


FIG. 20A

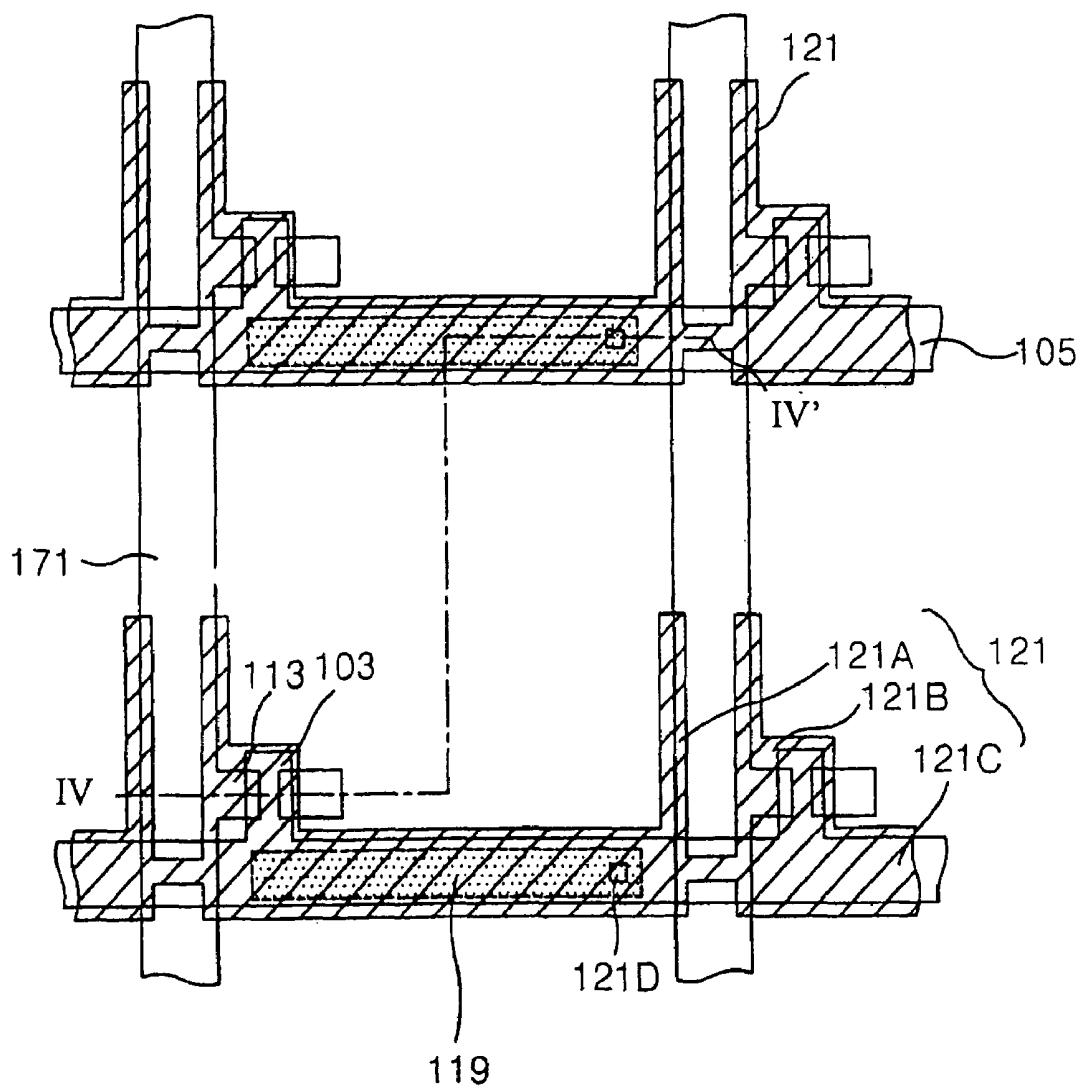


FIG. 20B

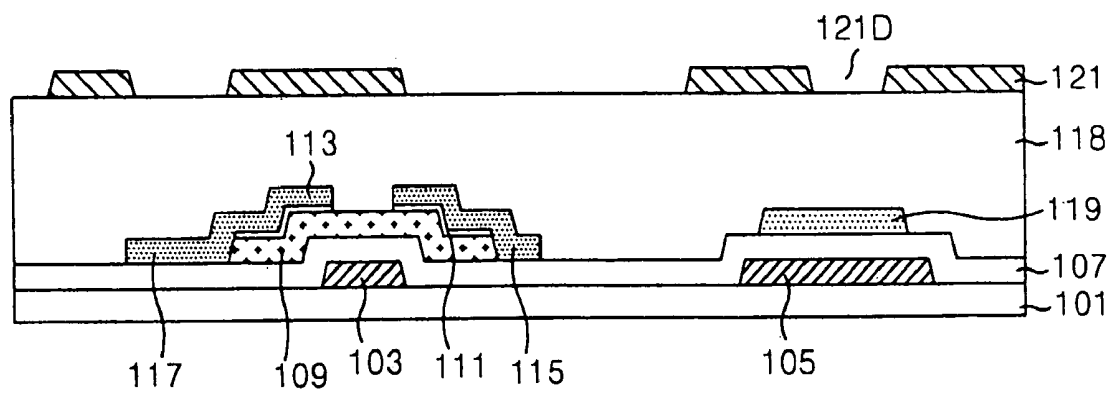


FIG. 21A

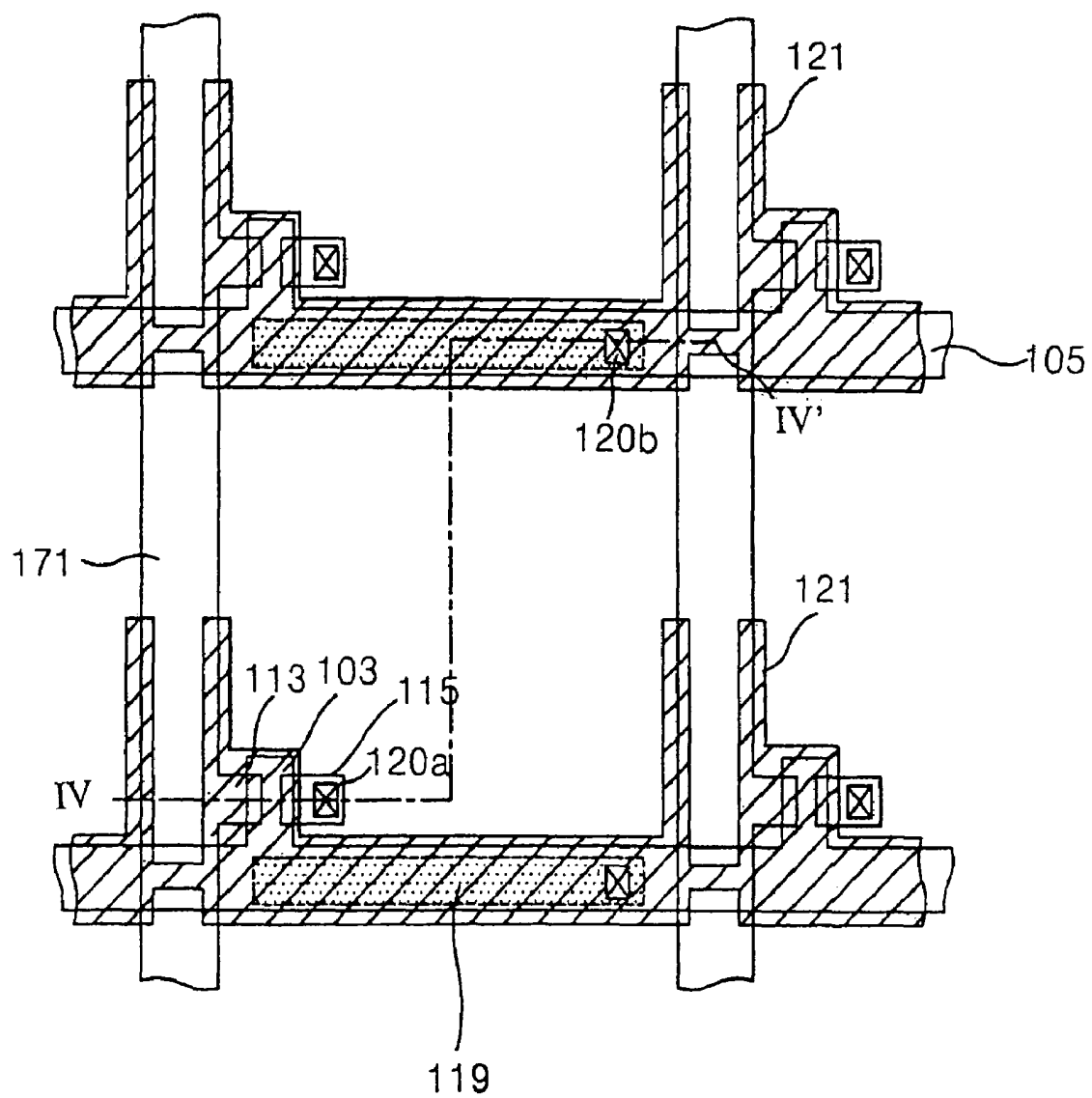


FIG. 21B

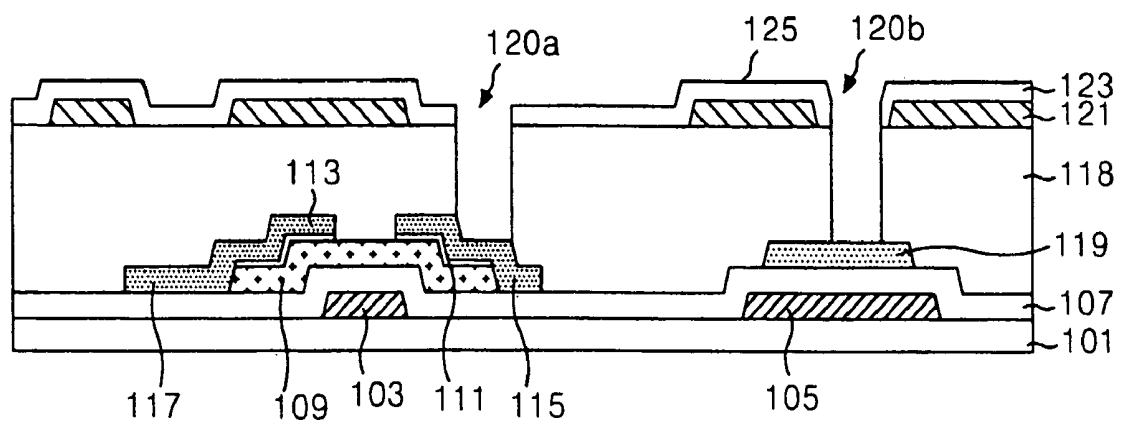


FIG. 22A

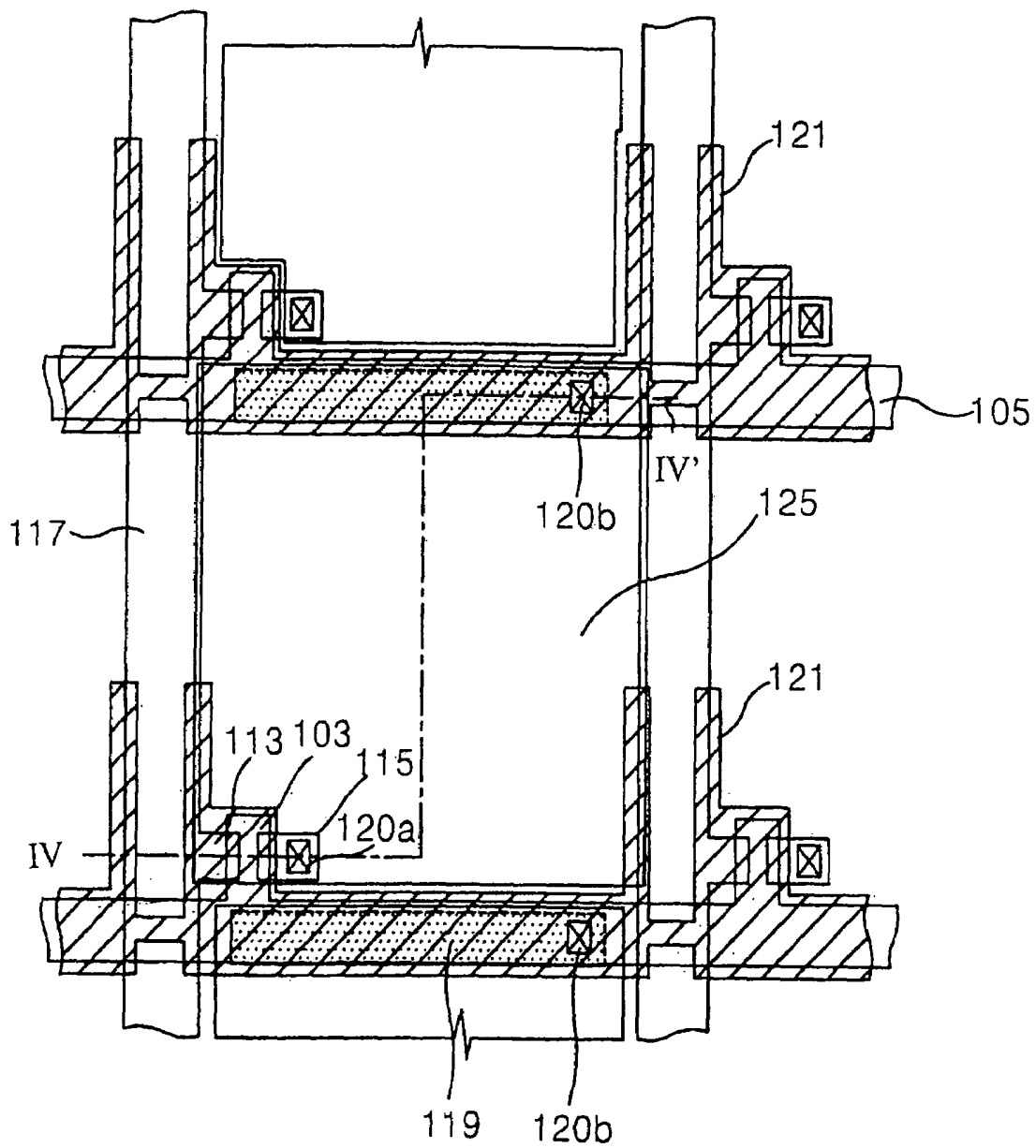
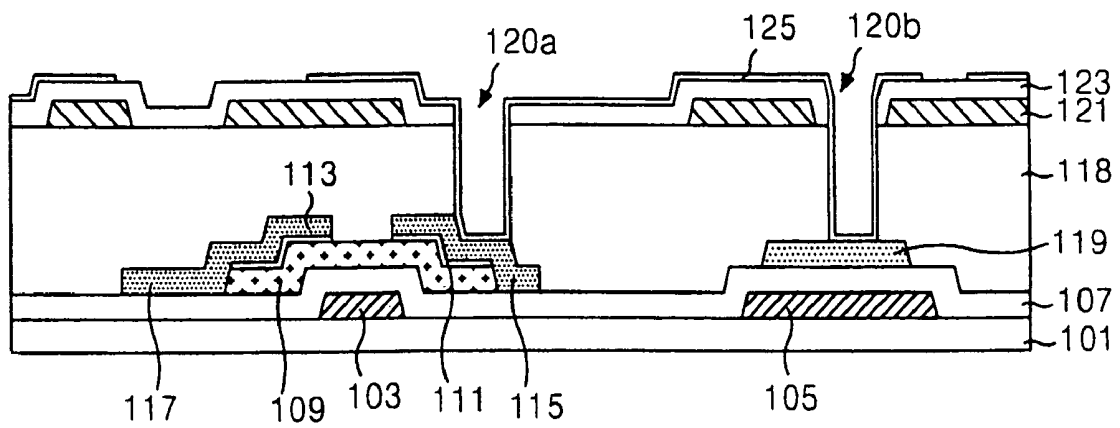




FIG. 22B



# ARRAY SUBSTRATE OF LIQUID CRYSTAL DISPLAY AND FABRICATING METHOD THEREOF

This application is a Divisional of U.S. patent application Ser. No. 10/141,848, filed May 10, 2002 now U.S. Pat. No. 7,133,087 and claims the benefit of Korean Patent Application No. P2001-31511 filed in Korea on Jun. 5, 2001, both of which are hereby incorporated by reference in their entirety.

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

This invention relates to a liquid crystal display, and more particularly to an array substrate of a liquid crystal display and a fabricating method thereof that are adaptive for increasing an aperture ratio and a capacitance value of a storage capacitor.

### 2. Discussion of the Related Art

Generally, a liquid crystal display (LCD) controls light transmittances of liquid crystal cells in response to a video signal, thereby display image data (picture). An active matrix LCD having a switching device for each liquid crystal cell is suitable for displaying a moving picture. In general, the active matrix LCD uses a thin film transistor (TFT) as the switching device.

The LCD uses a storage capacitor for sustaining a voltage charged in a liquid crystal cell to ensure stability of a gray level display. The storage capacitor may be classified into two categories: a storage-on-gate (SOG) system that overlaps a portion of the (n-1)th gate line with the nth pixel electrode to form a storage capacitor of the nth pixel; and a storage-on-common (SOC) system that provides a separate common electrode at a lower portion of a pixel electrode to form a storage capacitor.

FIG. 1 is a plan view showing a structure of an array substrate of a conventional LCD adopting a storage-on-gate system, and FIG. 2 is a cross sectional view of the array substrate taking along I-I' in FIG. 1. In FIGS. 1 and 2, a lower substrate 11 of the LCD includes a TFT arranged at an intersection between a gate line 15' and a data line 17, a pixel electrode 33 connected to a drain electrode 27 of the TFT, and a storage capacitor positioned at an overlapping portion between the pixel electrode 33 and the pre-stage gate line 15.

The TFT includes a gate electrode 13 connected to the gate line 15', a source electrode 25 connected to the data line 17, and a drain electrode 27 connected, via a first contact hole 30a, to the pixel electrode 33. The TFT further includes a gate insulating film 19 for electrically insulating the gate electrode 13 and the source and drain electrodes 25 and 27, and semiconductor layers 21 and 23 defining a conduction channel between the source electrode 25 and the drain electrode 27 by application of a gate voltage to the gate electrode 13. The TFT responds to a gate signal from the gate line 15' to selectively apply a data signal from the data line 17 to the pixel electrode 33.

The pixel electrode 33 is positioned at a cell area divided by the data line 17 and the gate line 15' and is made from a transparent conductive material having a high light transmittance. The pixel electrode 33 is provided on a protective film 31 coated on an entire surface of the lower substrate 11 and is electrically connected, via the first contact hole 30a defined at the protective film 31, to the drain electrode 27. The pixel electrode 33 generates a potential difference from a common transparent electrode (not shown) provided at an upper substrate (not shown) by the data signal applied via the TFT. This potential difference allows a liquid crystal positioned

between the lower substrate 11 and the upper substrate (not shown) to change a liquid crystal molecule arrangement owing to its dielectric anisotropy characteristic. Accordingly, an arrangement of the liquid crystal molecules is changed for each pixel in accordance with the data voltage applied via the TFT, thereby displaying image data information on the LCD.

The storage capacitor should have a large capacitance value enough to keep the pixel voltage stable. Accordingly, the storage capacitor includes a capacitor electrode 29 electrically connected, via a second contact hole 30b, to the pixel electrode, and a gate line 15 having the gate insulating film 19 disposed therebetween.

FIGS. 3A to 3E are cross sectional views showing a method of fabricating the array substrate of the LCD shown in FIG. 2.

In FIG. 3A, the gate electrode 13 and the gate line 15 are provided on the substrate 11. The gate electrode 13 and the gate line 15 are formed by depositing aluminum (Al) or copper (Cu) material, using a deposition technique such as a sputtering, and then patterning the material.

In FIG. 3B, a gate insulating film 19, an active layer 21 and an ohmic contact layer 23 are provided on the substrate 11. The gate insulating film 19 is formed by depositing an insulating material such as silicon nitride (SiN<sub>x</sub>) or silicon oxide (SiO<sub>x</sub>) using a plasma enhanced chemical vapor deposition (PECVD) technique to cover the gate electrode 13 and the gate line 15. The active layer 21 and the ohmic contact layer 23 are formed by sequentially depositing two semiconductor layers on the gate insulating film 19 and patterning the deposited semiconductor layers. The active layer 21 is formed from amorphous silicon that is not doped with an impurity, and the ohmic contact layer 23 is formed from amorphous silicon doped with an n-type or p-type impurity at a high concentration.

In FIG. 3C, a data line 17 (in FIG. 1), the source and drain electrodes 25 and 27 and the capacitor electrode 29 are provided on the gate insulating film 19 by depositing a metal layer using a CVD or sputtering technique and patterning. After the source and drain electrodes 25 and 27 are patterned, the ohmic contact layer 23 at an area corresponding to the gate electrode 13 is patterned to expose the active layer 21. The area of the active layer 21 corresponding to the gate electrode 13 between the source and drain electrodes 25 and 27 provides a channel. The capacitor electrode 29 overlaps with the gate line 15. The data line 17 (in FIG. 1), the source and drain electrodes 25 and 27, and the capacitor electrode 29 are made from chrome (Cr) or molybdenum (Mo) material.

In FIG. 3D, a protective film 31 having first and second contact holes 30a and 30b is provided. The protective layer 31 is formed by depositing an insulating material on the gate insulating layer 19 and patterning the material to cover the source and drain electrodes 25 and 27. The protective film 31 is made from an inorganic insulating material such as silicon nitride (SiN<sub>x</sub>) or silicon oxide (SiO<sub>x</sub>).

In FIG. 3E, a pixel electrode 33 is provided on the protective film 31. The pixel electrode 33 is formed by depositing a transparent conductive material on the protective film 31 and then patterning the material. The pixel electrode 33 is electrically connected, via the first contact hole 30a, to the drain electrode 27 and is electrically connected, via the second contact hole 30b, to the capacitor electrode 29. The pixel electrode 33 is made from a transparent conductive material such as indium-tin-oxide (ITO), indium-zinc-oxide (IZO) or indium-tin-zinc-oxide (ITZO).

FIG. 4 is a plan view showing a structure of an array substrate of a conventional LCD adopting a storage-on-common system, and FIG. 5 is a cross sectional view of the array substrate taking along II-II' in FIG. 4. In FIG. 4, a storage

capacitor 50 is positioned at center portion of a pixel area. The storage capacitor 50 should have a capacitance value large enough to keep a pixel voltage stable. Accordingly, the storage capacitor 50 includes a pixel electrode 55 electrically connected to a drain electrode 59, and a capacitor common electrode 45 having a gate insulating film 49 disposed therebetween.

FIGS. 6A to 6D are cross sectional views showing a method of fabricating the array substrate of the LCD shown in FIG. 5.

In FIG. 6A, a gate electrode 43, a capacitor electrode 45, and a gate line 47 are provided on the substrate 41 by depositing aluminum (Al) or copper (Cu) material using a deposition technique such as a sputtering and then patterning the material.

In FIG. 6B, a gate insulating film 49, an active layer 51, and an ohmic contact layer 53 are provided on the substrate 41. The gate insulating film 49 is formed by depositing an insulating material such as silicon nitride ( $\text{SiN}_x$ ) or silicon oxide ( $\text{SiO}_x$ ) using a plasma enhanced chemical vapor deposition (PECVD) technique to cover the gate electrode 43, the capacitor common electrode 45, and the gate line 47. The active layer 51 and the ohmic contact layer 53 are formed by sequentially depositing two semiconductor layers on the gate insulating film 49 and then patterning the disposed semiconductor layers. The active layer 51 is formed from amorphous silicon that is not doped with an impurity, and the ohmic contact layer 53 is formed from amorphous silicon doped with an n-type or p-type impurity at a high concentration.

In FIG. 6C, a pixel electrode 55, a data line 63, and source and drain electrodes 57 and 59 are provided on the gate insulating film 49. The pixel electrode 55 is formed by depositing a transparent conductive material on the gate insulating film 49 and then patterning the material. The pixel electrode 55 is made from any one of ITO, IZO and ITZO. Subsequently, the data line 63, and the source and drain electrodes 57 and 59 are provided. The data line 63, and the source and drain electrodes 57 and 59 are formed by depositing a metal layer using a CVD or sputtering technique, and then patterning the metal layer. After the source and drain electrodes 57 and 59 are patterned, the ohmic contact layer 53 is patterned at an area corresponding to the gate electrode 43 to expose the active layer 51. The area of the active layer 51 corresponding to the gate electrode 43 between the source and drain electrodes 57 and 59 provides a channel. The drain electrode 59 electrically contacts the pixel electrode 55 without any contact hole. The data line 63 and the source and drain electrodes 57 and 59 are made from chrome (Cr) or molybdenum (Mo).

In FIG. 6D, a protective film 61 is provided at a TFT area. The protective film 61 is formed by depositing an insulating material on the gate insulating layer 19, and then patterning the material to cover the source and drain electrodes 57 and 59. The protective film 61 is made from an inorganic insulating material such as silicon nitride ( $\text{SiN}_x$ ) or silicon oxide ( $\text{SiO}_x$ ).

To overcome a flicker phenomenon, the capacitance of the storage capacitor is increased by increasing an area of the capacitor electrode. Accordingly, in a storage-on-gate system, a width of the gate line is increased to increase the capacitance of the storage capacitor. However, since an aperture ratio is reduced, and a line delay effect of a gate signal is enhanced when a width of the gate line is widened, there is a limit in widening the gate line. Furthermore, since the LCD of a storage-on-common system has the storage capacitor provided at a center of the pixel cell, the aperture ratio is reduced more than the LCD of a storage-on-gate system. As previously described, as an area of the capacitor electrode is

increased, aperture ratio is reduced. In particular, high pixel density, ferroelectric, and semi-ferroelectric LCD's require high capacitance storage capacitors and high aperture ratios.

## SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to an array substrate of a liquid crystal display and fabricating method thereof that substantially obviates one or more of the problems due to limitations and disadvantages of the related art.

An object of the present invention is to provide an array substrate of a liquid crystal display and a fabricating method thereof that are adaptive for increasing a capacitance value of a storage capacitor without reducing an aperture ratio.

Another object of the present invention is to provide an array substrate of a liquid crystal display with improved performance that can be efficiently manufactured.

Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

To achieve these and other advantages and in accordance with the purpose of the invention, as embodied and broadly described, an array substrate of a liquid crystal display includes a gate line, a data line crossing the gate line, a thin film transistor including a gate electrode connected to the gate line, a semiconductor layer having first and second sides, a source electrode contacting the first side of the semiconductor layer and connected to the data line, and a drain electrode contacting the second side of the semiconductor layer, a gate insulating film provided between the gate line and the data line, an organic protective film formed on the gate insulating film, a capacitor common line provided on the organic protective film to overlap the gate line, an upper insulating layer provided on the organic protective film, and a pixel electrode provided on the upper insulating layer partially overlapping the capacitor common line and the data line, the pixel electrode connected to the drain electrode via a contact hole through the upper insulating layer and the organic protective film.

In another aspect, an array substrate of a liquid crystal display includes a gate line, a data line crossing the gate line, a thin film transistor including a gate electrode connected to the gate line, a semiconductor layer having first and second sides, a source electrode contacting the first side of the semiconductor layer and connected to the data line, and a drain electrode contacting the second side of the semiconductor layer, a gate insulating film provided between the gate line and the data line, a capacitor electrode provided on the gate insulating film to overlap the gate line, the capacitor electrode includes a plurality of sub-pixel units, an organic protective film formed on the gate insulating film, a capacitor common line provided on the organic protective film to overlap the gate line, an upper insulating layer provided on the organic protective film, and a pixel electrode partially overlapping the capacitor common line and the data line, the pixel electrode connected to the drain electrode and capacitor electrode via first and second contact holes, respectively, provided through the upper insulating layer and the organic protective film.

In another aspect, a method of fabricating an array substrate of a liquid crystal display includes forming a gate line and a gate electrode connected to the gate line on a substrate, forming a gate insulating film on the substrate, forming a semiconductor layer overlapping the gate electrode, forming

a data line crossing the gate line, a source electrode on a first side of the semiconductor layer and connected to the data line, and a drain electrode on a second side of the semiconductor layer, forming an organic protective film on the gate insulating film, forming a capacitor common line overlapping the gate line, forming an upper insulating layer on the organic protective film, forming a contact hole through the upper insulating layer and the organic protective film, and forming a pixel electrode partially overlapping the capacitor common line and the data line, and connected to the drain electrode via the contact hole.

In another aspect, a method of fabricating an array substrate of a liquid crystal display includes forming a gate line and a gate electrode connected to the gate line on a substrate, forming a gate insulating film on the substrate, forming a semiconductor layer overlapping the gate insulating film above the gate electrode, forming a data line crossing the gate line, a source electrode connected to the data line contacting a first side of a semiconductor layer, a drain electrode contacting a second side of the semiconductor layer, and a capacitor electrode overlapping the gate line to form a sub-pixel unit, forming an organic protective film on the gate insulating film, the source and drain electrodes, and the capacitor electrode, forming a capacitor common line overlapping the gate line, forming an upper insulating layer on the organic protective film, forming first and second contact holes going through the upper insulating layer and the organic protective film, and forming a pixel electrode partially overlapping the capacitor common line and the data line and connected to the drain electrode via the first contact hole and to the capacitor electrode via the second contact hole.

In another aspect, an array substrate of a liquid crystal display includes a gate line, a data line crossing the gate line, a gate insulating film between the gate line and the data line, a thin film transistor connected to the gate line and the data line, a pixel electrode connected to the thin film transistor, the pixel electrode at least partially overlapping the gate line and the data line with an organic protective film and an upper dielectric layer therebetween, and a storage capacitor including at least a capacitor common line overlapping the gate line, and the pixel electrode overlapping the capacitor common electrode.

In another aspect, an array substrate of a liquid crystal display includes a gate line, a data line crossing the gate line, a gate insulating film between the gate line and the data line, a thin film transistor connected to the gate line and the data line, a pixel electrode connected to the thin film transistor, the pixel electrode partially overlapping the data line, the gate line, and the gate insulating film with an organic protective film and an upper dielectric layer therebetween, a first storage capacitor including a capacitor electrode connected to the pixel electrode via a contact hole through the organic protective film and the upper dielectric layer, and a second storage capacitor including a capacitor common line overlapping the gate line, and the pixel electrode overlapping the capacitor common electrode, the first storage capacitor being connected, in parallel, to the second storage capacitor.

In the array substrate, the capacitor common line includes an arm member partially overlapping with each side portion of the data line.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

## BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention. In the drawings:

FIG. 1 is a plan view showing a structure of an array substrate of a conventional liquid crystal display adopting a storage-on-gate system;

FIG. 2 is a cross sectional view of the array substrate taken along I-I' in FIG. 1;

FIGS. 3A to 3E are cross sectional views of a method of fabricating the array substrate shown in FIG. 2 according to the conventional art;

FIG. 4 is a plan view showing a structure of an array substrate of a conventional liquid crystal display adopting a storage-on-common system;

FIG. 5 is a cross sectional view of the array substrate taken along II-II' in FIG. 1;

FIGS. 6A to 6D are cross sectional views of a method of fabricating the array substrate shown in FIG. 5 according to the conventional art;

FIG. 7 is a plan view showing an exemplary array substrate of a liquid crystal display according to the present invention;

FIG. 8 is a cross sectional view of the array substrate taken along III-III' in FIG. 7;

FIGS. 9 to 14 are cross sectional views of an exemplary method of fabricating the array substrate shown in FIG. 8 according to the present invention;

FIG. 15 is a plan view showing another exemplary array substrate of a liquid crystal display according to the present invention;

FIG. 16 is a cross sectional view of the array substrate taken along IV-IV' in FIG. 15; and

FIGS. 17 to 22 are cross sectional views of another exemplary method of fabricating the array substrate shown in FIG. 16 according to the present invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 7 is a plan view showing an exemplary array substrate of a liquid crystal display according to the present invention, and FIG. 8 is a cross sectional view of the array substrate taken along III-III' in FIG. 7.

In FIGS. 7 and 8, a lower substrate 71 of an LCD may include a TFT arranged at an intersection between a gate line 75 and a data line 93, a pixel electrode 91 connected to a drain electrode 85 of the TFT, and a storage capacitor to overlap with a partial area of the gate line 75 and the data line 93.

The TFT may include a gate electrode 73 connected to the gate line 75, a source electrode 83 connected to the data line 93, and a drain electrode 85 connected, via a contact hole 90a, to the pixel electrode 91. Furthermore, the TFT may include a gate insulating film 77 insulating the gate electrode 73, and the source and drain electrodes 83 and 85, and semiconductor layers 79 and 81 defining a conduction channel between the source electrode 83 and the drain electrode 85 by application of a gate voltage to the gate electrode 73. Accordingly, the TFT responds to a gate signal from the gate line 75 to selectively apply a data signal from the data line 93 to the pixel electrode 91.

The pixel electrode 91 may be positioned on an upper insulating layer 89 at a cell area divided by the data line 93 and the gate line 75, and may be made from a transparent conduc-

tive material having a high light transmittance, for example. The pixel electrode **91** may use an organic protective film **79** having a small dielectric constant formed such that a portion overlaps the data line **93**. Accordingly, the pixel electrode **91** may have an increased aperture ratio as compared to a pixel electrode that uses an inorganic protective film. The pixel electrode **91** may be electrically connected, via the contact hole **90a** defined at the organic protective film **79** and the upper insulating film **89**, to the drain electrode **85**. The pixel electrode **91** 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. The potential difference allows a liquid crystal positioned between the lower substrate **71** and the upper substrate (not shown) to change a liquid crystal molecule arrangement owing to its dielectric anisotropy characteristic. Accordingly, an arrangement of liquid crystal molecules is changed for each pixel in accordance with a data voltage applied via the TFT, thereby expressing image data (picture information) on the LCD.

The pixel electrode **91**, the gate line **75**, and a portion of the data line **93** should have a large capacitance value to maintain a stable pixel voltage. Accordingly, the storage capacitor may include a pixel electrode **91** electrically connected, via the contact hole **90a**, to the drain electrode **85**, and a capacitor common line **87** having the upper insulating film **89** disposed therebetween. The capacitor common line **87** may overlap the gate line **75**, and a portion of the data line **93** to create a relatively large electrode area, thereby increasing a capacitance value of the storage capacitor. In addition, the capacitor common line **87** may overlap the gate line **75**, and the data line **93** so as not to occupy additional area, thereby increasing an aperture ratio. The capacitor common line **87** may extend to be commonly connected to the common line **75** and apply a similar common voltage as the common electrode (not shown) of the upper substrate (not shown). Also, the capacitor common line **87** may serve as a black matrix for extinguishing light along the gate line **75** and the data line **93**, whereby formation of an additional black matrix on the upper substrate is unnecessary.

FIGS. **9** to **14** are cross sectional views of an exemplary method of fabricating the array substrate of the LCD shown in FIG. **8** according to the present invention.

In FIGS. **9A** and **9B**, a gate electrode **73**, and a gate line **75** may be provided on a substrate **71**. The gate electrode **73** and the gate line **75** may be formed by depositing aluminum (Al) or copper (Cu) material, for example, using a deposition technique such as a sputtering, for example, and patterning the material.

In FIG. **10**, a gate insulating film **77**, an active layer **79** and an ohmic contact layer **81** may be provided on the substrate **71**. The gate insulating film **77** may be formed by depositing an insulating material such as silicon nitride ( $\text{SiN}_x$ ) or silicon oxide ( $\text{SiO}_x$ ), for example, onto the substrate **71** using a plasma enhanced chemical vapor deposition (PECVD) technique, for example, to cover the gate electrode **73** and the gate line **75**. The active layer **79** and the ohmic contact layer **81** may be formed by sequentially depositing two semiconductor layers on the gate insulating film **77** and patterning the deposited semiconductor layers. The active layer **79** may be formed from amorphous silicon that is not doped with an impurity, for example, and the ohmic contact layer **81** may be formed from amorphous silicon doped with an n-type or p-type impurity at a high concentration, for example.

In FIGS. **11A** and **11B**, a data line **93**, and source and drain electrodes **83** and **85** may be provided on the substrate **71**. The data line **93**, and the source and drain electrodes **83** and **85**

may be formed by depositing a metal layer using CVD or sputtering techniques, for example, and patterning the metal layer. After the source and drain electrodes **83** and **85** are formed, the ohmic contact layer **81** at an area corresponding to the gate electrode **73** may be patterned to expose the active layer **79**, thereby creating a channel within an area of the active layer **79** corresponding to the gate electrode **73** between the source and drain electrodes **83** and **85**. The data line **93**, and the source and drain electrodes **83** and **85** may include chrome (Cr) or molybdenum (Mo) material, for example.

In FIGS. **12A** and **12B**, an organic protective film **79** and a capacitor common line **87** may be sequentially provided on the substrate **71**. The organic protective film **79** may be formed by coating an insulating material on the gate insulating layer **77** using a spin coating technique to cover the source and drain electrodes **83** and **85**, for example. Accordingly, a surface of the organic protective film **79** may be flattened. The capacitor common line **87** may be provided to overlap the gate line **75** and a portion of the data line **93** by depositing a conductive material on the organic protective film **79**, for example, and patterning the material. Accordingly, the capacitor common line **87** may include a body **87C** overlapping end portions of the pixel electrode **91**, and the gate line **75**, and two arms **87A** and **87B** connected to the body **87C** and overlapping opposing sides of the data line **93**. The body **87C** of the capacitor common line **87** may be set to have a width larger than widths of each of the arms **87A** and **87B**.

The organic protective film **79** may be formed from an organic insulating material having a small dielectric constant such as Teflon<sup>®</sup>, benzocyclobutene (BCB), Cytop<sup>®</sup> or perfluorocyclobutane (PFCB), for example. Preferably, a dielectric constant of the organic protective film **79** is between about 2 and about 4. In addition, a thickness of the organic protective film **79** is preferably between about 1  $\mu\text{m}$  and about 3  $\mu\text{m}$  to sufficiently reduce a parasitic capacitance formed at the overlapping portions between the capacitor common line **87** and the gate line **75**.

In FIGS. **13A** and **13B**, an upper insulating layer **89** may be provided on the organic protective film **79**. The upper insulating layer **89** may be formed by depositing an insulating material on the organic protective film **79** using a plasma enhanced chemical vapor deposition (PECVD) technique, for example, to cover the capacitor common line **87**. Subsequently, the upper insulating layer **89** and the organic protective film **79** may be patterned to form the contact hole **90a** to expose the drain electrode **85**. The upper insulating layer **89** may include an inorganic insulating material such as silicon nitride ( $\text{SiN}_x$ ) or silicon oxide ( $\text{SiO}_x$ ), for example.

In FIGS. **14A** and **14B**, a pixel electrode **91** may be provided on the upper insulating layer **89**. The pixel electrode **91** may be formed by depositing a transparent conductive material on the upper insulating layer **89**, and patterning the material, for example. The pixel electrode **91** may be electrically connected, via the contact hole **90a**, to the drain electrode **85**, and may include any one of ITO, IZO and ITZO, for example.

FIG. **15** is a plan view showing another exemplary array substrate of a liquid crystal display according to the present invention, and FIG. **16** is a cross sectional view of the array substrate taken along IV-IV' in FIG. **15** according to the present invention.

In FIGS. **15** and **16**, a lower substrate **101** of a LCD may include a TFT arranged at an intersection between a gate line **105** and a data line **117**, a pixel electrode **125** connected to a drain electrode **115** of the TFT, and a storage capacitor positioned at an overlapping portion between the gate line **105** and a part of the data line **117**.

The TFT may include a gate electrode **103** protruding from the gate line **105**, a source electrode **113** protruding from the data line **117**, and a drain electrode **115** connected, via a first contact hole **120a**, to the pixel electrode **125**. Furthermore, the TFT may include a gate insulating film **107** insulating the gate electrode **113** and the source and drain electrodes **113** and **115**, and semiconductor layers **109** and **111** defining a conduction channel between the source electrode **113** and the drain electrode **115** by application of a gate voltage to the gate electrode **103**. Accordingly, the TFT responds to a gate signal from the gate line **105** to selectively apply a data signal from the data line **117** to the pixel electrode **125**.

The pixel electrode **125** may be positioned on an upper insulating layer **123** coated on an entire surface of the lower substrate **101** at a cell area divided by the data line **93** and the gate line **75**. The pixel electrode may include a transparent conductive material having a high light transmittance, for example. The pixel electrode **125** may use an organic protective film **118** having a small dielectric constant such that a portion overlaps the data line **117**. Accordingly, the pixel electrode may have an increased aperture ratio as compared to a pixel electrode that uses an inorganic protective film. The pixel electrode **125** may be electrically connected, via the first contact hole **120a** defined by the upper insulating layer **123** and the organic protective film **118**, to the drain electrode **115**.

The storage capacitor should have a large capacitance to maintain a stable pixel voltage. Accordingly, the storage capacitor may include a parallel connection of a first storage capacitor of a storage-on-common system, and a second storage capacitor of a storage-on-gate system. The first storage capacitor may include the pixel electrode **125**, and a capacitor common line **121** having an upper insulating layer **123** disposed therebetween with the capacitor common line **121** overlapping the gate line **105** and a portion of the data line **117**. In addition, the capacitor common line **121** may serve as a black matrix for extinguishing light along the gate line **105** and the data line **117**, whereby formation of an additional black matrix on the upper substrate is unnecessary. The second storage capacitor may include a capacitor electrode **119** connected, via a second contact hole **120b**, to the pixel electrode **119**, and the gate line having the gate insulating film **107** disposed therebetween.

A capacitance value of the storage capacitor is increased by a combination of the first and second storage capacitors. In addition, the capacitor common line **121** and the capacitor electrode **119** overlap with the gate line **105** and the data line **117** so as not to occupy additional area, thereby increasing an aperture ratio.

FIGS. **17** to **22** are cross sectional views of another exemplary method of fabricating the array substrate of the LCD shown in FIG. **16** according to the present invention.

In FIGS. **17A** and **17B**, a gate electrode **103** and a gate line **105** may be provided on a substrate **101**. The gate electrode **103** and the gate line **105** may be formed by depositing aluminum (Al) or copper (Cu) material, for example, using a deposition technique such as a sputtering, for example, and patterning the material.

In FIG. **18**, a gate insulating film **107**, an active layer **109** and an ohmic contact layer **111** may be provided on the substrate **101**. The gate insulating film **107** may be formed by depositing an insulating material such as silicon nitride ( $\text{SiN}_x$ ) or silicon oxide ( $\text{SiO}_x$ ), for example, onto the substrate **101** using a plasma enhanced chemical vapor deposition (PECVD) technique, for example, to cover the gate electrode **103** and the gate line **105**. The active layer **109** and the ohmic contact layer **111** may be formed by sequentially depositing two semiconductor layers on the gate insulating film **107** and

patterning the deposited semiconductor layers. The active layer **109** may be formed from amorphous silicon that is not doped with an impurity, for example, and the ohmic contact layer **111** may be formed from amorphous silicon doped with an n-type or p-type impurity at a high concentration, for example.

In FIGS. **19A** and **19B**, a data line **117**, source and drain electrodes **113** and **115**, and a capacitor electrode **119** may be provided on the substrate **101**. The data line **117**, the source and drain electrodes **113** and **115**, and the capacitor electrode **119** may be formed by depositing a metal layer using CVD or sputtering techniques, for example, and patterning the metal layer. The data line **117**, the source and drain electrodes **113** and **115**, and the capacitor electrode **119** may include chrome (Cr) or molybdenum (Mo) material, for example. Next, a portion of the ohmic contact layer **111** at an area corresponding to the gate electrode **103** may be patterned to expose the active layer **109**, thereby creating a channel within an area of the active layer **109** corresponding to the gate electrode **103** between the source and drain electrodes **113** and **115**.

In FIGS. **20A** and **20B**, an organic protective film **118** and a capacitor common line **121** may be sequentially provided on the substrate **101**. The organic protective film **118** may be formed by coating an insulating material on the gate insulating layer **107** using a spin coating technique, for example, to cover the source and drain electrodes **113** and **115**. Accordingly, a surface of the organic protective film **118** may be flattened. The capacitor common line **121** may be provided to overlap the gate line **105** and a portion of the data line **117** by depositing a transparent conductive material onto the organic protective film **118**, for example, and patterning the material. Accordingly, the capacitor common line **121** may include a body **121C** overlapping upper end portions of the pixel electrode **125** and the gate line **105**, and two arms **121A** and **121B** connected to the body **121C** and overlapping opposing sides of the data line **121**. The body **121C** of the capacitor common line **121** may be set to have a width larger than each of the arms **121A** and **121B**. In particular, a hole **121D** may be defined at a portion where a contact hole is to be formed during post-processing in the body **121C** of the capacitor common line **121** overlapping the storage capacitor **119**.

The organic protective film **118** may be formed from an organic insulating material having a small dielectric constant such as Teflon<sup>®</sup>, benzocyclobutene (BCB), Cytop<sup>®</sup> or perfluorocyclobutane (PFCB). Preferably, a dielectric constant of the organic protective film **118** is between about 2 and about 4. In addition, a thickness of the organic protective film **118** is preferably between about 1  $\mu\text{m}$  and about 3  $\mu\text{m}$  to sufficiently reduce a parasitic capacitance formed at the overlapping portions between the capacitor common line **121** and the gate line **105**.

In FIGS. **21A** and **21B**, an upper insulating layer **123**, and first and second contact holes **120a** and **120b** may be provided in the organic protective film **118**. The upper insulating layer **123** may be formed by depositing an insulating material on the organic protective film **118** using a plasma enhanced chemical vapor deposition (PECVD) technique, for example, to cover the capacitor common line **121**. Subsequently, the upper insulating layer **123** and the organic protective film **118** may be simultaneously patterned to form the first and second contact holes **120a** and **120b** to expose the drain electrode **115**, and the capacitor electrode **119**, respectively. The upper insulating layer **123** may include an inorganic insulating material such as silicon nitride ( $\text{SiN}_x$ ) or silicon oxide ( $\text{SiO}_x$ ), for example.

In FIGS. **22A** and **22B**, a pixel electrode **125** may be provided on the upper insulating layer **125**. The pixel elec-

## 11

trode **125** may be formed by depositing a transparent conductive material on the upper insulating layer **123**, and patterning the material, for example. The pixel electrode **125** may be electrically connected, via the first contact hole **120a**, to the drain electrode **115**, and may include. Moreover, the pixel electrode **125** may electrically contact the capacitor electrode **119** through the second contact hole **120b**. The pixel electrode **125** may include any one of ITO, IZO and ITZO, for example.

It will be apparent to those skilled in the art that various modifications and variations can be made in the array substrate of an liquid crystal display and fabricating method thereof of the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. An array substrate of a liquid crystal display, comprising:  
a gate line;  
data line crossing the gate line;  
a thin film transistor including a gate electrode connected to the gate line, a semiconductor layer having first and second sides, a source electrode contacting the first side of the semiconductor layer and connected to the data line, and a drain electrode contacting the second side of the semiconductor layer;  
a gate insulating film provided between the gate line and the data line; a capacitor electrode provided on the gate insulating film to overlap the gate line, the capacitor electrode includes a plurality of sub-pixel units;  
an organic protective film formed on the gate insulating film;  
a capacitor common line provided on the organic protective film to overlap the gate line;  
an upper insulating layer provided on the organic protective film; and  
a pixel electrode partially overlapping the capacitor common line and the data line, the pixel electrode connected to the drain electrode and capacitor electrode via first and second contact holes, respectively, provided through the upper insulating layer and the organic protective film.
2. The array substrate according to claim 1, wherein the capacitor common line includes an arm member partially overlapping opposing side portions of the data line.
3. The array substrate according to claim 1, wherein the organic protective film includes an organic insulating material selected from one of an acrylic organic compound, Teflon®, benzocyclobutene(BCB), Cytop®, and perfluorocyclobutane (PFCB).

## 12

4. The array substrate according to claim 1, wherein a thickness of the organic protective film is between about 1 μm and about 3 μm.

5. The array substrate according to claim 1, wherein the upper insulating layer includes an inorganic insulating material selected from one of silicon nitride (SiN<sub>x</sub>) and silicon oxide (SiO<sub>x</sub>).

6. An array substrate of a liquid crystal display, comprising:  
a gate line of a plurality of gate lines;  
a data line of a plurality of data lines crossing the gate line;  
a gate insulating film between the gate line and the data line;  
a thin film transistor connected to the gate line and the data line;  
a pixel electrode connected to the thin film transistor, the pixel electrode partially overlapping the data line and a pre-stage gate line;  
an organic protective film provided on the gate insulating film;  
an upper dielectric layer provided on the organic protective film;  
a first storage capacitor including the pre-stage gate line, a capacitor electrode connected to the pixel electrode via a contact hole, and the gate insulating film disposed between the pre-stage gate line and the capacitor electrode; and  
a second storage capacitor including a capacitor common line overlapping the pre-stage gate line, the pixel electrode connected to the capacitor electrode and overlapping the capacitor common line, and the upper dielectric layer disposed between the capacitor common line and the pixel electrode, thereby electrically connecting the first storage capacitor to the second storage capacitors in parallel.
7. The array substrate according to claim 6, wherein the capacitor common line includes an arm member partially overlapping side portions of the data line.
8. The array substrate according to claim 6, wherein the contact hole extends through the capacitor common line.
9. The array substrate according to claim 8, wherein the upper dielectric layer at least partially extends into the contact hole.

\* \* \* \* \*

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	<a href="#">US7425997</a>	公开(公告)日	2008-09-16
申请号	US11/528591	申请日	2006-09-28
[标]申请(专利权)人(译)	乐金显示有限公司		
申请(专利权)人(译)	LG 飞利浦LCD CO. , LTD.		
当前申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
[标]发明人	KIM WOO HYUN		
发明人	KIM, WOO HYUN		
IPC分类号	G02F1/1333 G02F1/136 G02F1/1362		
CPC分类号	G02F1/136213 H01L27/1255 G02F1/136227		
优先权	1020010031511 2001-06-05 KR		
其他公开文献	US20070019124A1		
外部链接	<a href="#">Espacenet</a> <a href="#">USPTO</a>		

#### 摘要(译)

液晶显示器的阵列基板包括栅极线，与栅极线交叉的数据线，包括连接到栅极线的栅电极的薄膜晶体管，具有第一和第二侧的半导体层，与第一侧接触的源电极半导体层的一侧连接到数据线，漏电极接触半导体层的第二侧，栅极绝缘膜设置在栅极线和数据线之间，有机保护膜形成在栅极绝缘膜上，设置在有机保护膜上以与栅极线重叠的电容器公共线，设置在有机保护膜上的上绝缘层，以及设置在上绝缘层上的像素电极，部分地与电容器公共线和数据线重叠，像素电极通过上绝缘层和有机保护膜的接触孔连接到漏电极。

