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**Park et al.**

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(54) **LIQUID CRYSTAL DISPLAY DEVICE INCLUDING BLACK MATRIX AND METHOD OF FABRICATING THE SAME**

USPC ..... 349/38, 39, 42-44, 110, 139, 143  
See application file for complete search history.

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(56) **References Cited**

U.S. PATENT DOCUMENTS

5,696,568	A	12/1997	Yamamoto et al.	
6,175,395	B1 *	1/2001	Yamazaki et al.	349/44
6,900,856	B2 *	5/2005	Kim et al.	349/44
2003/0153110	A1	8/2003	Hotta et al.	
2003/0169380	A1 *	9/2003	Arao	349/43
2004/0109098	A1 *	6/2004	Kim et al.	349/38
2004/0179157	A1 *	9/2004	Kim et al.	349/114

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(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 193 days.

FOREIGN PATENT DOCUMENTS

JP	07-128685	5/1995
JP	09-105953	4/1997
JP	2000-275676	10/2000
JP	2005-196157	7/2005

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OTHER PUBLICATIONS

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<b>G02F 1/1343</b>	(2006.01)
<b>G02F 1/136</b>	(2006.01)
<b>G02F 1/1362</b>	(2006.01)
<b>H01L 27/12</b>	(2006.01)
<b>H01L 29/786</b>	(2006.01)
<b>G02F 1/1345</b>	(2006.01)

\* cited by examiner

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(52) **U.S. Cl.**

CPC ..... **G02F 1/136209** (2013.01); **H01L 27/1214** (2013.01); **G02F 2201/40** (2013.01); **H01L 29/78633** (2013.01); **G02F 1/13454** (2013.01)  
USPC ..... 349/110; 349/38; 349/43; 349/44; 349/143

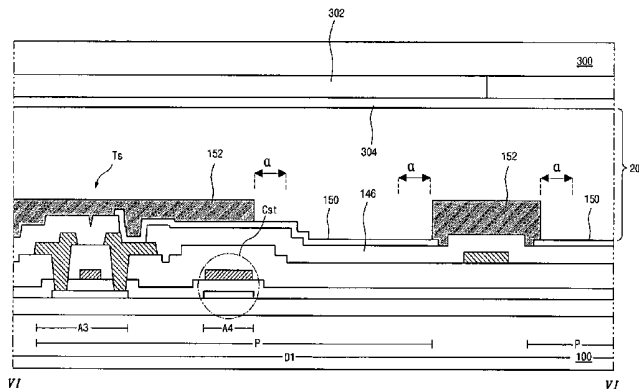
(57) **ABSTRACT**

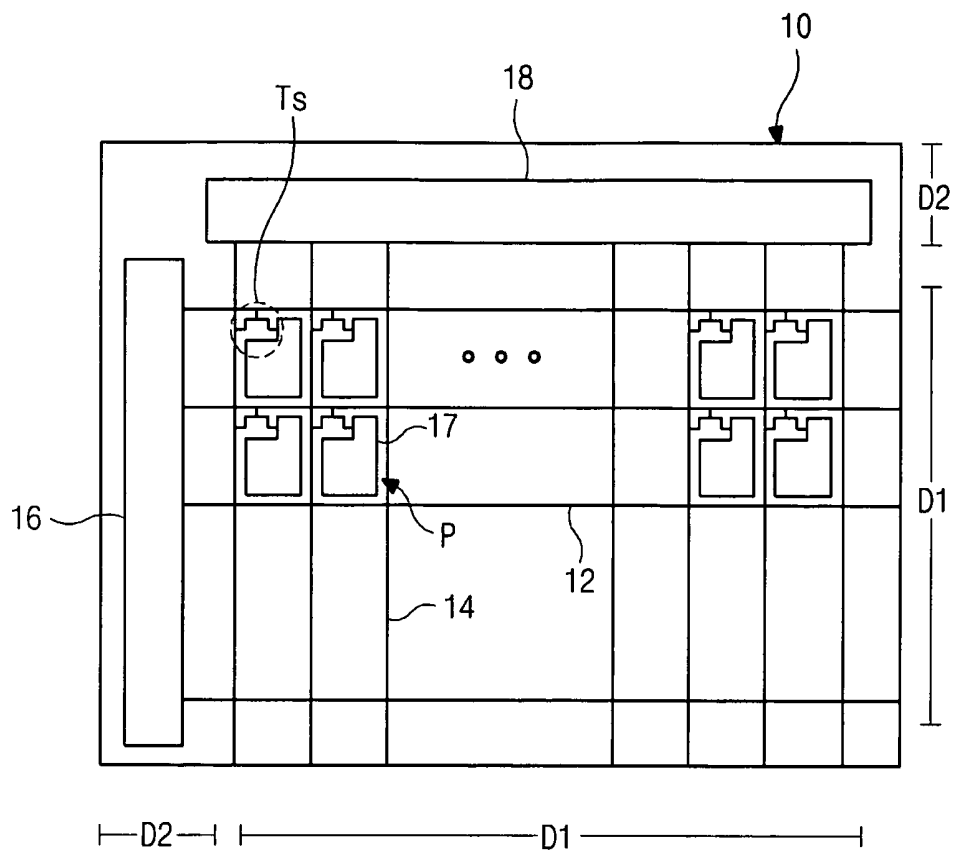
A liquid crystal display (LCD) device and a method fabricating the same are provided. The LCD device and the method of fabricating the same have the shielding means formed directly on the array substrate instead of the color filter substrate of the opposite substrate to the array substrate.

(58) **Field of Classification Search**

CPC ..... G02F 1/136209; G02F 1/136213

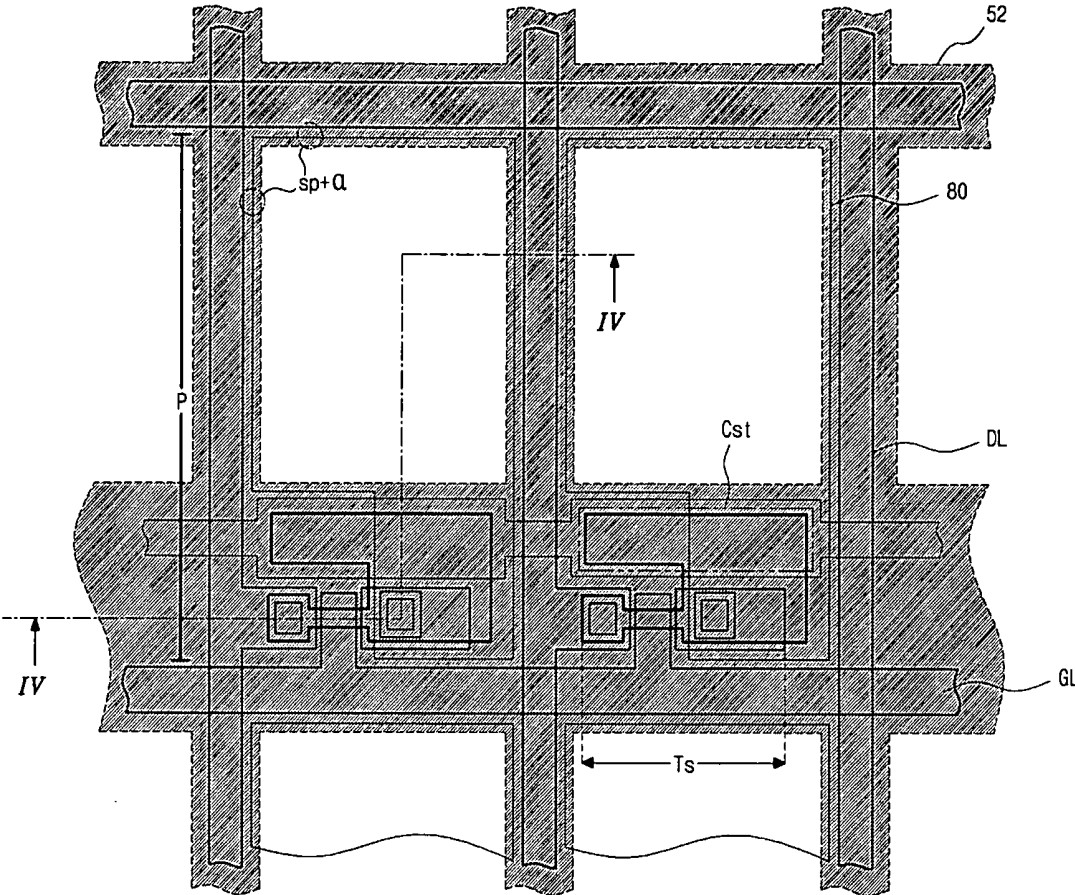
**5 Claims, 16 Drawing Sheets**





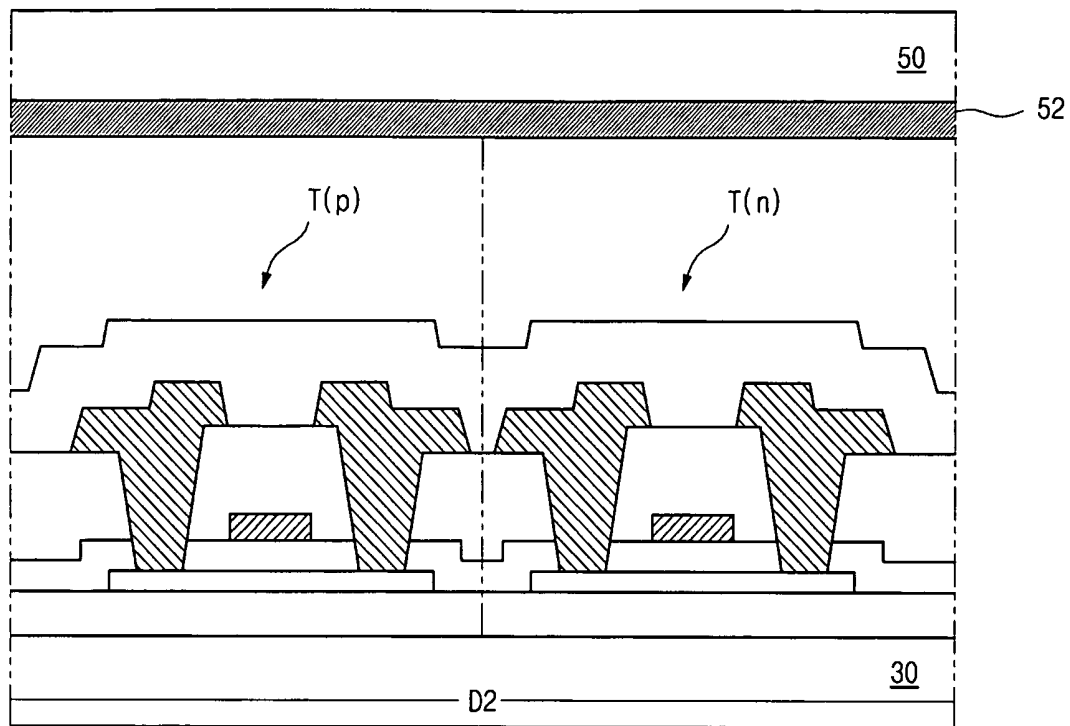
*(related art)*

**FIG. 1**



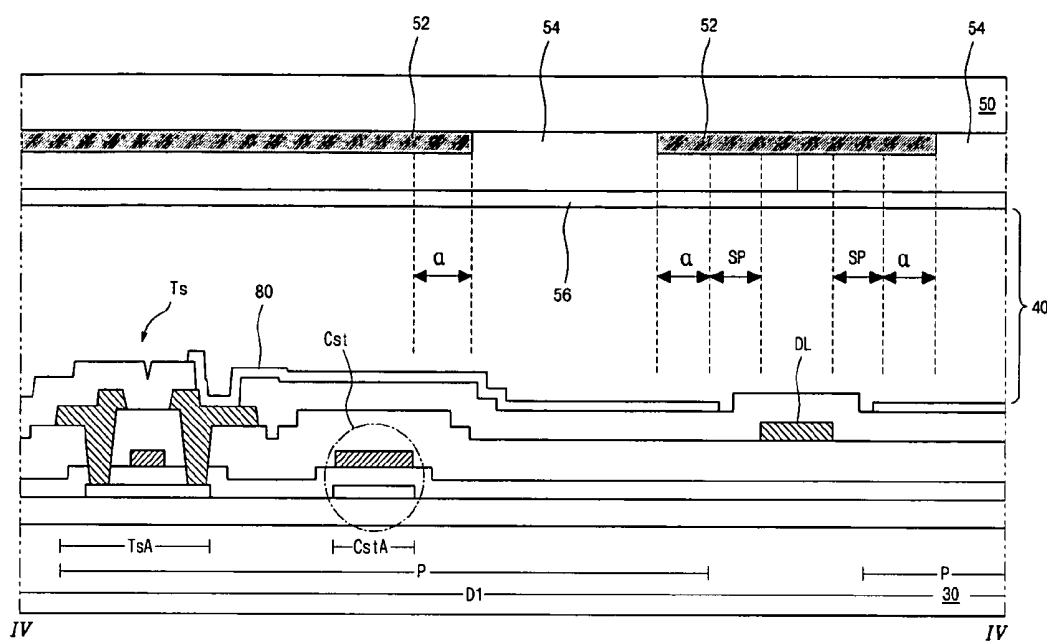
*(related art)*

**FIG. 2**



*(related art)*

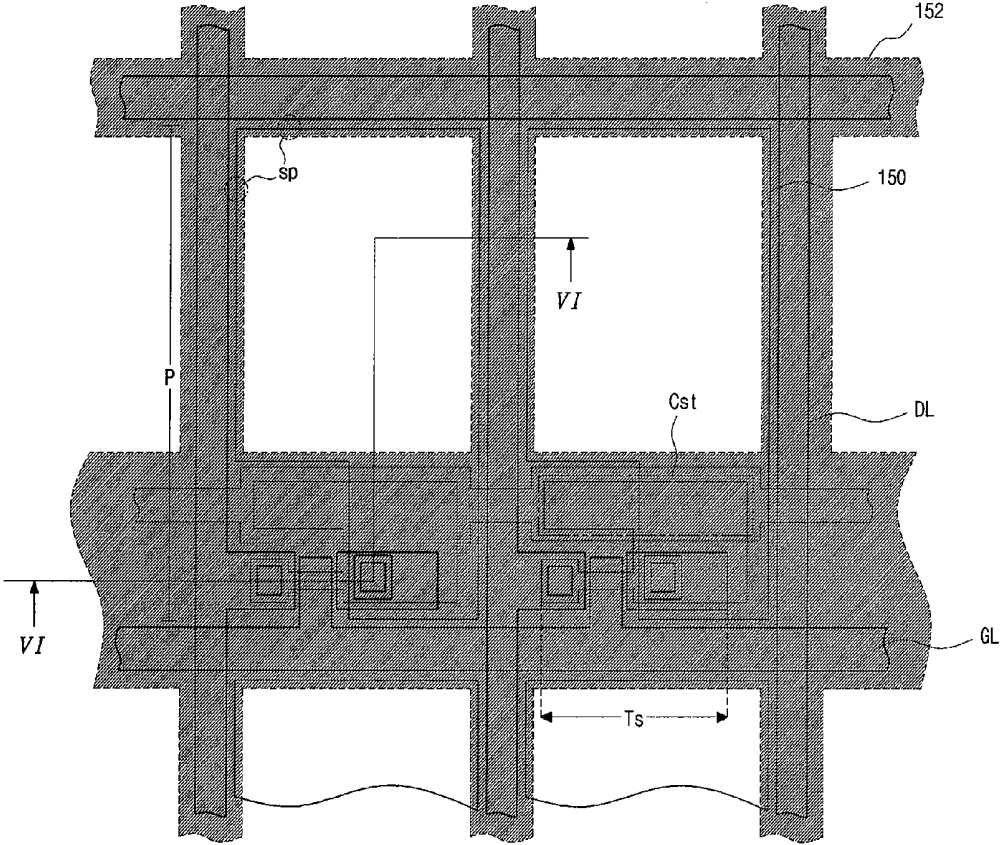
**FIG. 3**



*(related art)*

**FIG. 4**

Fig. 5





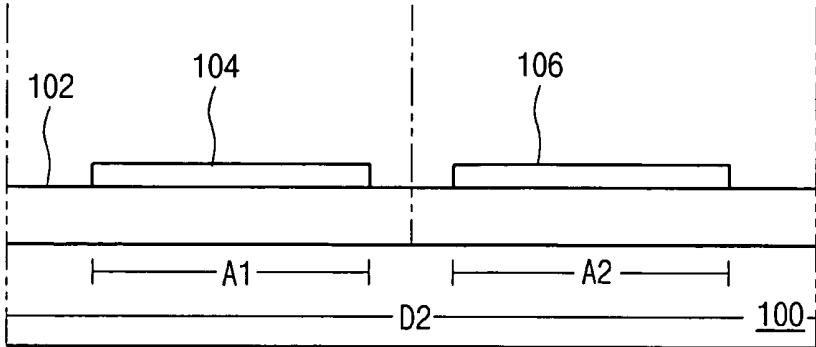


FIG. 7A

n+ ion doping

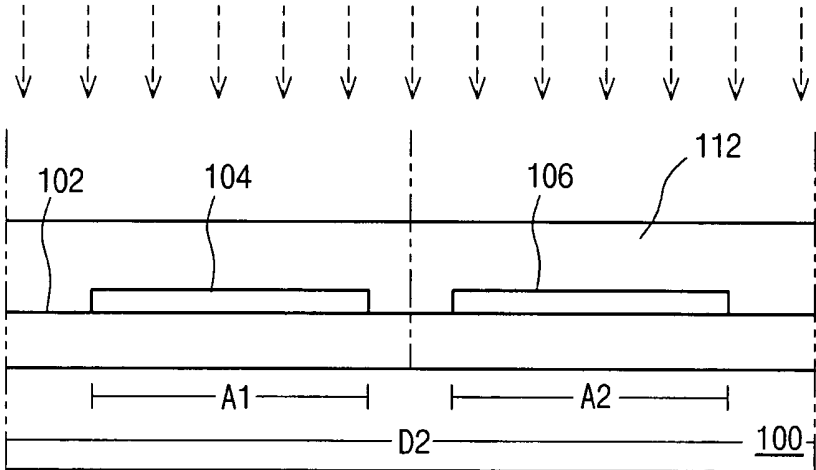


FIG. 7B

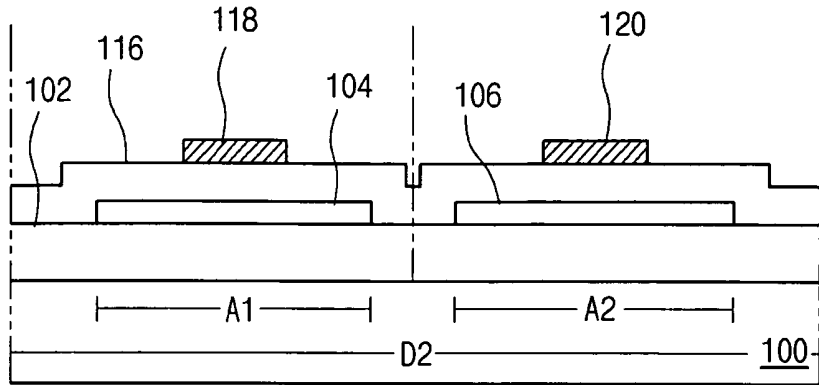


FIG. 7C

n+ ion doping

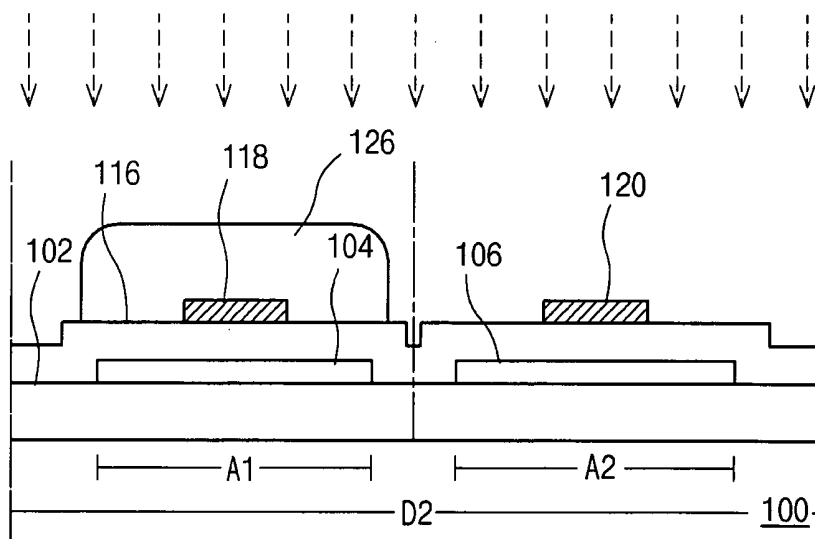
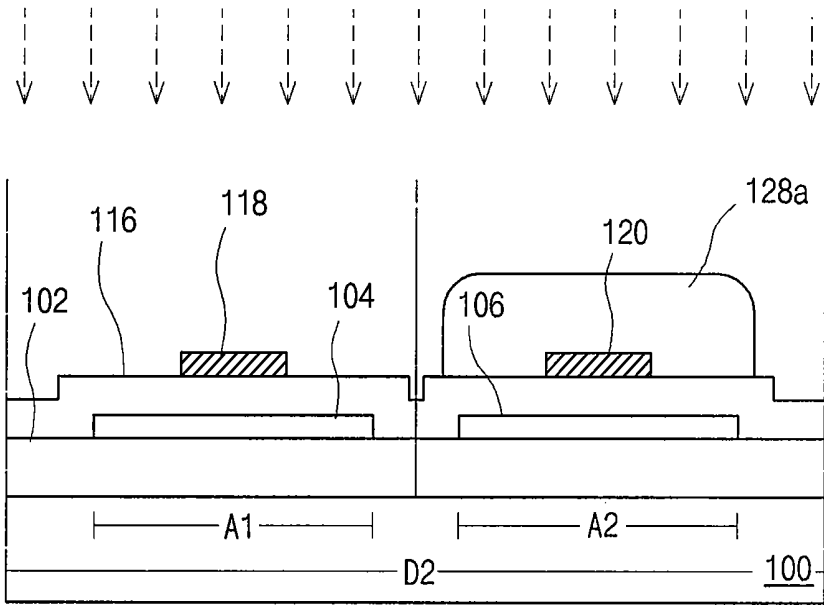


FIG. 7D

Fig. 7E

p+ ion doping



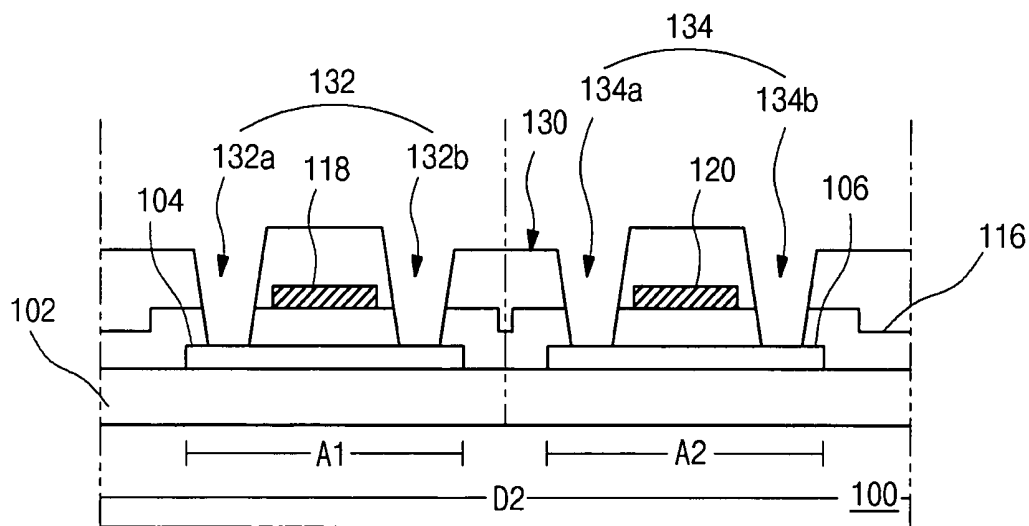
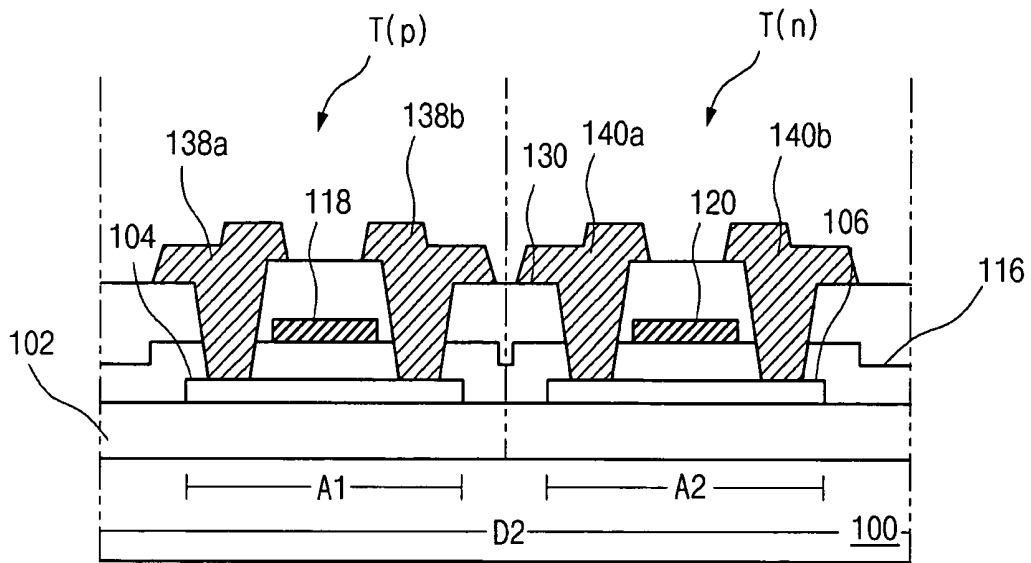
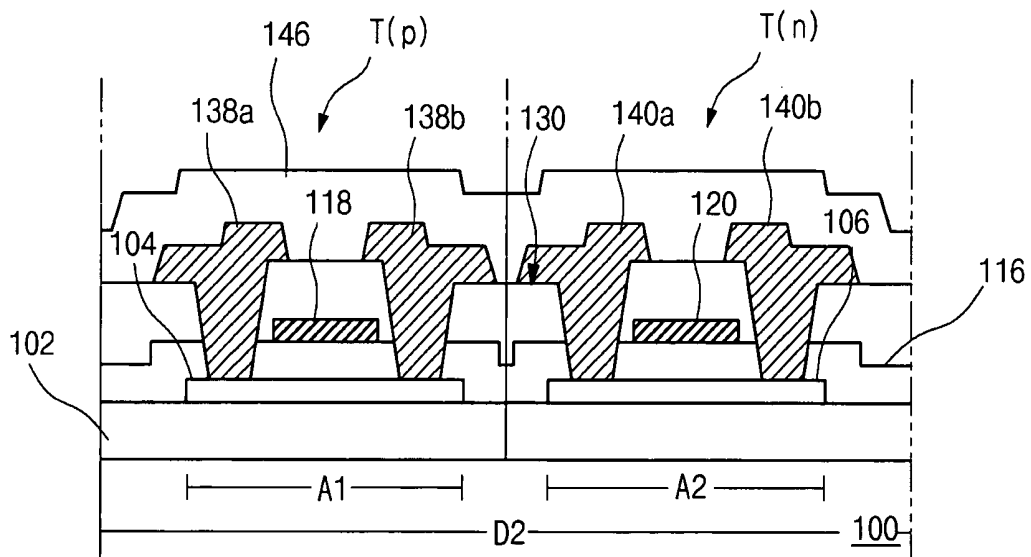


FIG. 7F



**FIG. 7G**



**FIG. 7H**

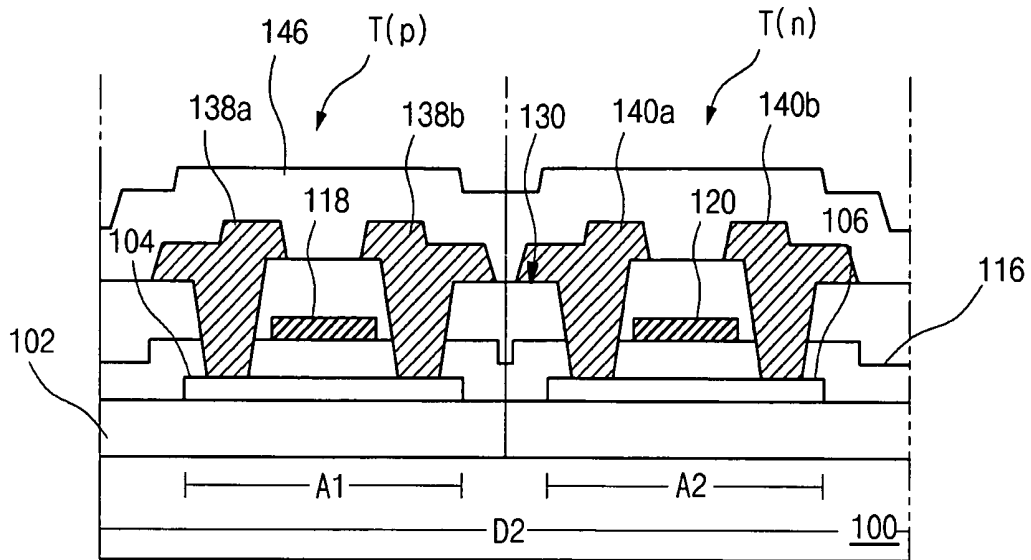


FIG. 7I

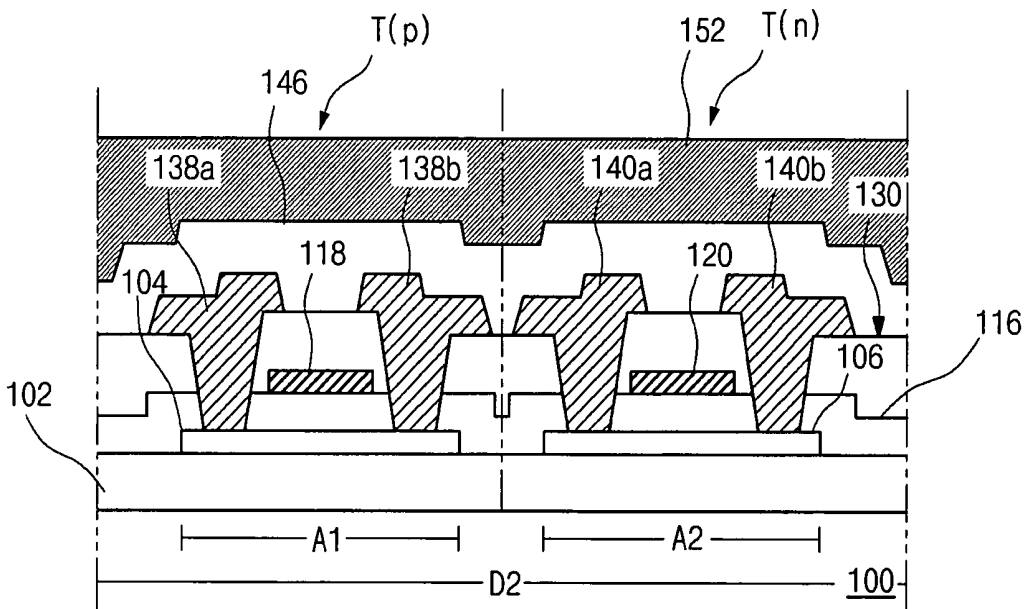


FIG. 7J

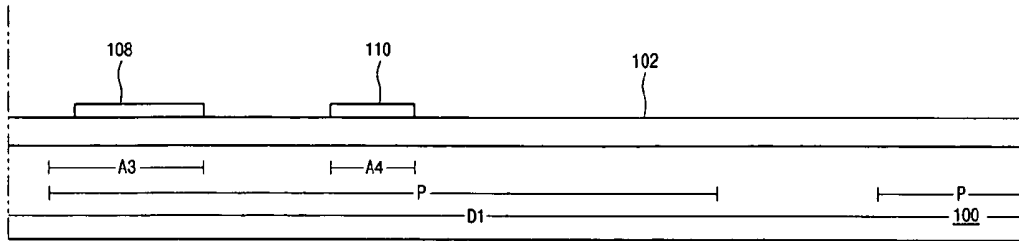


FIG. 8A

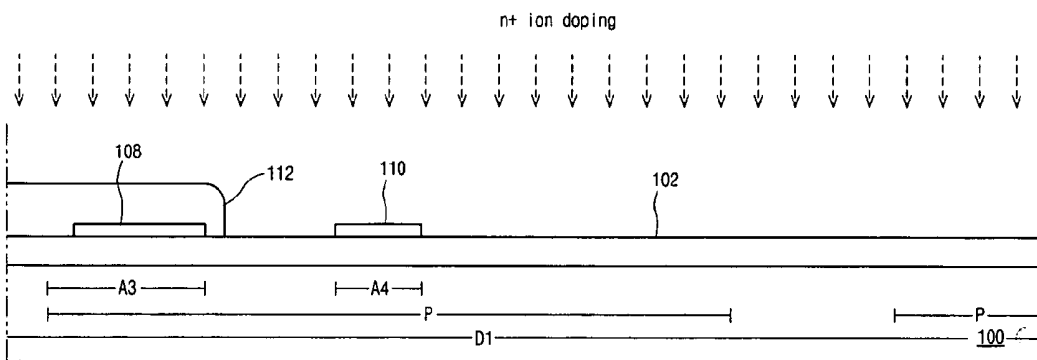


FIG. 8B

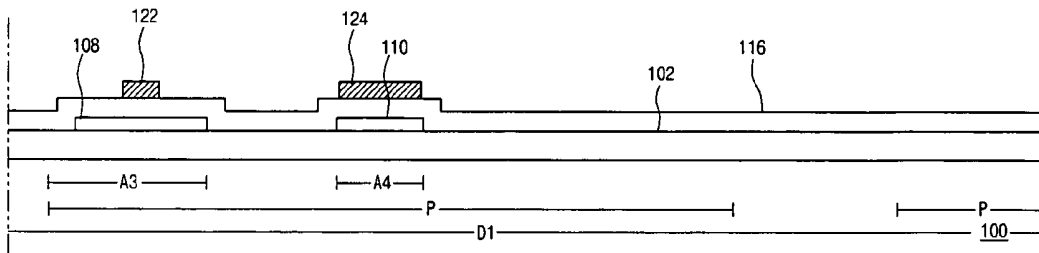


FIG. 8C

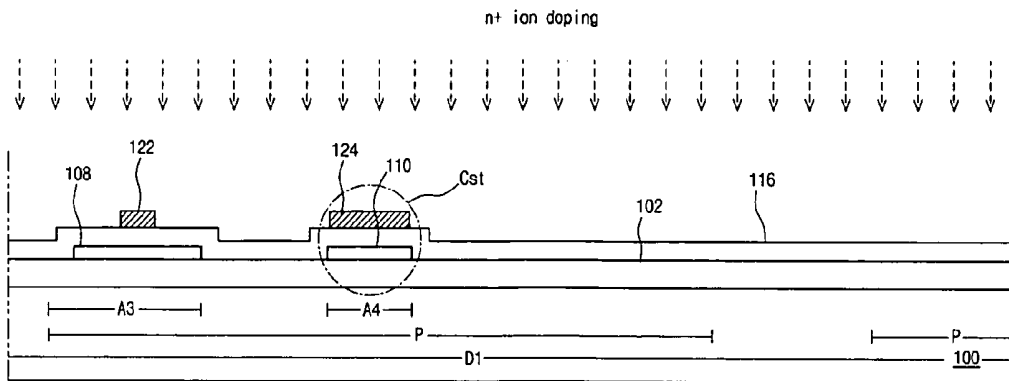


FIG. 8D

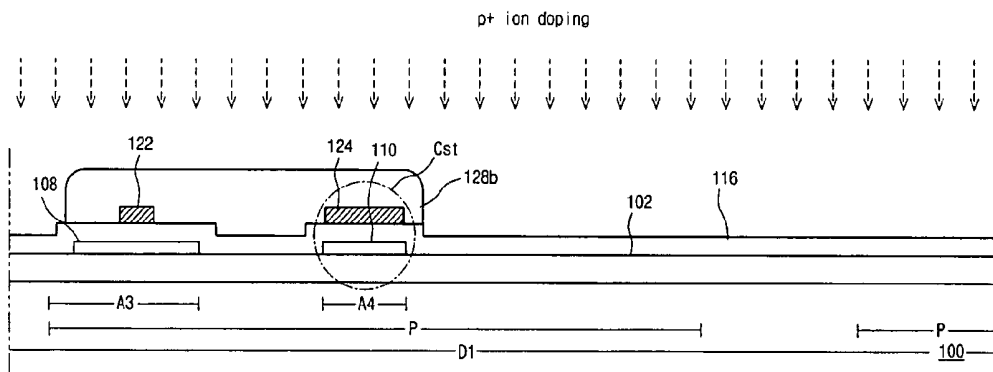


FIG. 8E

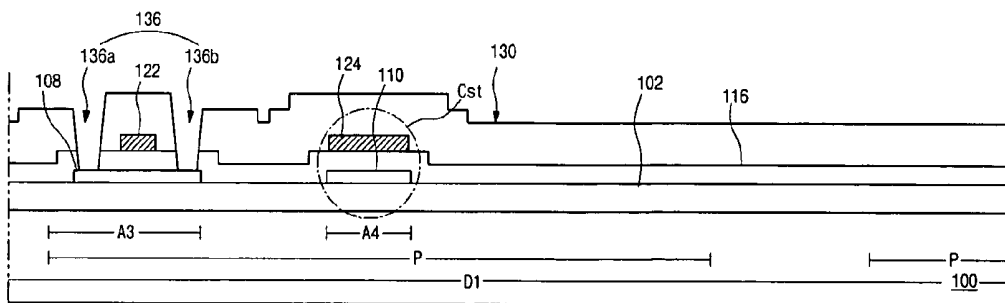


FIG. 8F





**LIQUID CRYSTAL DISPLAY DEVICE  
INCLUDING BLACK MATRIX AND METHOD  
OF FABRICATING THE SAME**

This application claims the benefit of Korean Patent Application No. 2005-0087265, filed on Sep. 20, 2005, which is hereby incorporated by reference for all purposes as if set forth herein.

BACKGROUND

1. Field

A liquid crystal display (LCD) device and a method fabricating the same is provided.

2. Related Art

Flat panel display (FPD) devices that have high portability and low power consumption have been the subject of recent research and development. Among various types of FPD devices, liquid crystal display (LCD) devices are commonly used as monitors for notebook and desktop computers because of their ability to display high-resolution images, wide ranges of different colors, and moving images.

Generally, the LCD device includes a color filter substrate and an array substrate separated from each other by a liquid crystal layer interposed between the two substrates. The color filter substrate and the array substrate include a common electrode and a pixel electrode, respectively. When a voltage is supplied to the common electrode and the pixel electrode, an electric field is generated that changes the orientation of liquid crystal molecules of the liquid crystal layer due to optical anisotropy within the liquid crystal layer. Light transmittance characteristics of the liquid crystal layer are modulated and images are displayed by the LCD device.

Active matrix type display devices are commonly used because of their superiority in displaying moving images. Active matrix-type display devices include pixel regions disposed in a matrix form where a thin film transistor (TFT) is formed in the pixel region as a switching element. While forming the TFT, hydrogenated amorphous silicon (a-Si:H) is selected to be deposited over a large area of substrate. Hydrogenated amorphous silicon yields higher productivity while easily fabricated on the large area of the substrate. The hydrogenated amorphous silicon (a-Si:H) is deposited at a relatively low temperature, in which a glass substrate of low cost can be used. The hydrogenated amorphous silicon is used mainly in the TFT, which is referred to as an amorphous silicon thin film transistor (a-Si TFT).

Because the hydrogenated amorphous silicon has a disordered atomic arrangement, weak silicon-silicon (Si—Si) bonds and dangling bonds exist in the hydrogenated amorphous silicon. These types of bonds become metastable when light or an electric field is applied to the hydrogenated amorphous silicon. This metastability makes the TFT unstable. Electrical characteristics of the hydrogenated amorphous silicon are especially degraded due to light irradiation. A TFT that uses the hydrogenated amorphous silicon is difficult to implement in a driving circuit due to degraded electric characteristics such as a relatively low field effect mobility and a poor reliability.

To solve these problems, a polycrystalline silicon thin film transistor (p-Si TFT) is suggested. Due to the higher field effect mobility of a p-Si TFT compared to a a-Si TFT, fabrication of a driving circuit and a switching element can be achieved simultaneously. The production cost is reduced and a driving circuit is simply fabricated on a substrate where a switching element is formed.

FIG. 1 is a schematic view that shows an LCD device according to the related art where a switching element and a driving circuit are formed on a single substrate. In FIG. 1, a display area D1 and a non-display area D2 in a periphery of the display area D1 are defined on a single substrate 10. The display area D1 is disposed at a central portion of the substrate 10, while the non-display area D2 is disposed at left and top portions of the display area D1. The non-display area D2 includes a gate driving circuit 16 and a data driving circuit 18.

The display area D1 includes a plurality of gate lines 12 connected to the gate driving circuit 16 and a plurality of data lines 14 connected to the data driving circuit 18. The gate line 12 and the data line 14 intersect each other to define a pixel region P. A pixel electrode 17 is formed in the pixel region P. A thin film transistor (TFT) Ts formed as a switching element is connected to the pixel electrode 17. The gate driving circuit 16 supplies a scan signal to the TFT Ts through the gate line 12 and the data driving circuit 18 supplies a data signal to the pixel electrode 17 through the data line 14.

The gate driving circuit 16 and the data driving circuit 18 are connected to an input terminal (not shown) to receive external signals (not shown). The gate driving circuit 16 and the data driving circuit 18 process the external signals from the input terminal to generate the scan signal and the data signal. To generate the scan signal and the data signal, the gate driving circuit 16 and the data driving circuit 18 include a plurality of TFTs that form complementary metal-oxide-semiconductor (CMOS) elements. For example, an inverter that includes negative (n)-type and positive (p)-type TFTs may be formed in the gate driving circuit 16 and the data driving circuit 18.

FIG. 2 is a schematic plane view that shows a display area of an LCD device according to the related art.

In FIG. 2, a gate line GL and a data line DL cross each other to define a pixel region P. A thin film transistor Ts is connected to the gate line GL and the data line DL. A pixel electrode 80, which is disposed in the pixel region P, is connected to the thin film transistor Ts. A storage capacitor Cst is disposed to be adjacent to the thin film transistor Ts in the pixel region P.

Typically, the pixel electrode 80 is spaced apart from the gate and the data lines GL and DL with a predetermined distance. When the pixel electrode 80 is overlapped with the gate line GL and the data line DL, cross-talk that deteriorates an image quality occurs. The pixel electrode 80 is formed to be spaced from the gate and the data lines GL and DL. Shield spaces SP are between the gate line GL and the pixel electrode 80 and between the data line DL and the pixel electrode 80. A black matrix 52 should be formed to overlap with the space SP. The black matrix 52 is formed to overlap with regions of the thin film transistor Ts and the storage capacitor Cst as well as the space SP.

FIG. 3 is a schematic cross-sectional view showing a driving circuit of an LCD according to the related art where a switching element and a driving circuit are formed on a single substrate. FIG. 4 is a schematic cross-sectional view taken along a line IV-IV of FIG. 2.

As shown in FIGS. 3 and 4, an LCD device includes a display area D1 and a non-display area D2. The display area D1 includes a pixel region P that includes a thin film transistor region TsA and a storage capacitor region CstA.

The LCD includes a first substrate 30, a second substrate 50 that faces the first substrate 30 and a liquid crystal layer 40 between the first and the second substrate 30 and 50 in the display area D1. A black matrix 52, which is disposed in the display area D1 and the non-display area D2, is disposed on an inner surface of the second substrate 50 and a color filter layer 54, which is disposed in the display area D1, on the

black matrix **52**, and a common electrode **56**, which is disposed in the display area **D1**, is formed on the color filter layer **54**. Although not shown, the color filter layer **54** includes red, green and blue sub-color filter layers (not shown) that are repeatedly arranged in that order. The black matrix **52** is overlapped with regions of the gate line **GL**, the data line **DL** and spaces **SP** between the gate line **GL** and the pixel electrode **80** and between the data line **DL** and the pixel electrode **80**.

An align margin  $\alpha$  should be considered before attaching the first and the second substrates **30** and **50** because light leakage may occur even if the black matrix **52** is formed in the mentioned regions due to an align error. Therefore, an image quality of the LCD device is deteriorated due to light leakage.

The black matrix **52** according to the related art should be manufactured with at least 5 micrometers ( $\mu\text{m}$ ) as the align margin  $\alpha$ . Therefore, although the light leakage is solved from the LCD, an aperture ratio is deteriorated concerning the align margin.

### SUMMARY

An LCD device and a method of fabricating the same is provided.

A method that fabricates an array substrate for a liquid crystal display device includes: forming first to third semiconductor layers on a substrate that includes a display area and a non-display area, the first to second semiconductor layers in the non-display area and the third semiconductor layer in the display area; sequentially forming a gate insulating layer and first to third gate electrodes, the gate insulating layer on the substrate that includes the first to third semiconductor layers, the first to third gate electrodes correspond to central portions of the first to third semiconductor layers, respectively; forming an interlayer insulating layer on the substrate that includes the first to third gate electrodes, the interlayer insulating layer that has first to third contact holes that expose ohmic contact regions of the first to third semiconductor layers, respectively; forming first to third source and first to third drain electrodes and a data line on the interlayer insulating layer, the data line connected to the third source electrode and that crosses the gate line to define a pixel region, each of the first to third source and the first to third drain electrodes contact each of the first to third ohmic contact regions via each of the first to third contact holes; forming a passivation layer on the substrate that includes the first to third source and the first to third drain electrodes, the passivation layer having a drain contact hole that exposes a portion of the third drain electrode; forming a pixel electrode on the passivation layer, the pixel electrode connected to the third drain electrode via the drain contact hole; and forming a black matrix on the substrate including the pixel electrode, the black matrix in the non-display region and a non-pixel region of the display area.

In another embodiment, a method of fabricating an array substrate for a liquid crystal display device includes: preparing a substrate including a display area and a non-display area; forming a buffer layer on the substrate; depositing and crystallizing an amorphous silicon material and patterning the crystallized silicon material to form first and second semiconductor layers in the non-display area, a third semiconductor layer and a first storage electrode in the display region through a first mask process; forming a first photoresist pattern that covers the first to third semiconductor layers except the first storage electrode through a second mask process; doping the first storage electrode with high concentration n-type (n+) impurities; depositing a gate insulating layer and

a first conductive metallic material, patterning the first conductive metallic material to form first to third gate electrodes on central portions of the first to third semiconductor layers, a second storage electrode on the first storage electrode and a gate line connected to the third gate electrode through a third mask process; forming a second PR pattern that covers the first gate electrode, the second PR pattern corresponds to a region in which the first semiconductor layer is formed through a fourth mask process; doping the second and third semiconductor layers with high concentration n-type (n+) impurities; forming a third PR pattern that covers the second gate electrode and a fourth PR pattern that covers the third gate electrode and the second storage electrode through a fifth mask process; doping the first semiconductor layer exposed from the second and the third PR patterns with high concentration p-type (p+) impurities; forming an interlayer insulating layer on the doped second and third semiconductor layers and patterning the interlayer insulating layer and the gate insulating layer to form first to third contact holes that expose ohmic contact regions of the first to third semiconductor layers, through a sixth mask process; depositing and patterning a second conductive metallic material on the substrate where the interlayer insulating layer that has the first to third contact holes formed thereon to form first source and first drain electrodes, second source and second drain electrodes, third source and third drain electrodes and a data line connected to the third source electrode, the data line crossing the gate line to define a pixel region, the first source and the first drain electrodes, the second source and the second drain electrodes, the third source and the third drain electrodes contacting the first to third ohmic contact regions via the first to third contact holes, respectively, through a seventh mask process; forming a passivation layer on the substrate where the first to third source and the first to third drain electrodes, the passivation layer patterned to have a drain contact hole that exposes a portion of the third drain electrode through an eighth mask process; depositing and patterning a transparent conductive material to form a pixel electrode connected to the third drain electrode via the drain contact hole through a ninth mask process; and coating and patterning a black resin on the substrate including the pixel electrode to form a black matrix through a tenth mask process, the black matrix in the non-display region and a non-pixel region of the display region.

In another embodiment an array substrate for a liquid crystal display device comprises a p-type driving TFT, an n-type driving TFT and a switching TFT on a substrate that includes a display area and a non-display area, wherein the p-type and the n-type driving TFTs are the non-display area region and the switching TFT is in the display region; a gate insulating layer on the p-type and the n-type driving TFTs and the switching TFT; first, second and third gate electrodes and a gate line connected to the third gate electrode on the gate insulating layer, wherein the first, second and third gate electrodes correspond to central portions of the first, second and third semiconductor layers; an interlayer insulating layer on the substrate that includes the first, second and third gate electrodes, wherein the interlayer insulating layer has first, second and third contact holes that expose portions of ohmic contact regions of the p-type and the n-type driving TFTs and the switching TFT; first, second and third source electrodes and first, second and third drain electrodes and a data line on the interlayer insulating layer, wherein the data line is connected to the third source electrode and crosses the gate line to define a pixel region, wherein each of the first, second and third source electrodes and the first, second and third drain electrodes contacts each of the first, second and third ohmic contact regions via each of the first to third contact holes; a

passivation layer on the substrate that includes the first, second and third source electrodes and the first, second and third drain electrodes, wherein the passivation layer has a drain contact hole that exposes a portion of the third drain electrode; a pixel electrode on the passivation layer, wherein the pixel electrode connects to the third drain electrode via the drain contact hole; and a black matrix on the substrate that includes the pixel electrode, wherein the black matrix is in the non-display region and a non-pixel region of the display area.

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 embodiments as claimed.

#### DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the embodiments and are incorporated in and constitute a part of this specification, serve to explain the principles of the embodiments.

In the drawings:

FIG. 1 is a schematic view that shows an LCD device according to the related art where a switching element and a driving circuit are formed on a single substrate;

FIG. 2 is a schematic plane view that shows a display area of an LCD device according to the related art;

FIG. 3 is a schematic cross-sectional view that shows a driving circuit of an LCD according to the related art where a switching element and a driving circuit are formed on a single substrate;

FIG. 4 is a schematic cross-sectional view taken along a line IV-IV of FIG. 2;

FIG. 5 is a schematic plane view that shows a display area of an LCD device;

FIG. 6A is a schematic cross-sectional view that shows a driving circuit of an LCD where a switching element and a driving circuit are formed on a single substrate;

FIG. 6B is a schematic cross-sectional view taken along a line VI-VI of FIG. 5; and

FIGS. 7A to 7J and FIGS. 8A to 8J are schematic cross-sectional views that shows a fabricating process of an LCD device.

#### DESCRIPTION

A LCD device includes a first substrate **100**, as shown in FIGS. **5**, **6A** and **6B**. A second substrate **300** faces the first substrate **100** and a liquid crystal layer **200** is disposed between the first and the second substrates **100** and **300** in the display area **D1**. The first and the second substrates **100** and **300** include a display area **D1** and a non-display area **D2**. A p-type thin film transistor T(p) and an n-type thin film transistor T(n) are formed on an inner surface of the first substrate **100** disposed in the non-display area **D2** and are used as a driving circuit. A gate line **GL**, a data line **DL**, a switching thin film transistor **Ts**, a storage capacitor **Cst** and a pixel electrode **150** are formed on the inner surface of the first substrate **100** in the display area **D1**. A passivation layer **146** is formed on a surface of the first substrate **100** where the gate line **GL**, the data line **DL**, the switching thin film transistor **Ts**, the storage capacitor **Cst** are formed.

A black matrix **152** is formed on the passivation layer **146** over the gate line **GL**, the data line **DL**, the switching thin film transistor **Ts**, the storage capacitor **Cst** and spaces **SP** between the gate line **GL** and the pixel electrode **150** and between the

data line **DL** and the pixel electrode **150** in the display area **D1** and in the non-display area **D2**. For example, the black matrix **152** includes a black resin.

A color filter layer **302** is formed on an inner surface of the second substrate **300** and a common electrode **304** is formed on the color filter layer **302**. The color filter layer **302** may be formed on the first substrate **100** instead of the second substrate **300**.

It is unnecessary to consider the align margin  $\alpha$ , because the black matrix **152** is formed on the first substrate **100**. An aperture region that corresponds to the align margin  $\alpha$  can be formed because the black matrix **152** is formed on the first substrate **100**.

FIGS. **7A** to **7J** and FIGS. **8A** to **8J** are schematic cross-sectional views that show a fabricating process of an LCD device.

As shown in FIGS. **7A** and **8A**, a first substrate **100** includes a display area **D1** and a non-display area **D2**. The non-display area **D2** includes first and second regions **A1** and **A2**, and the display area **D1** includes a pixel region **P** that has third and fourth regions **A3** and **A4**.

A buffer layer **102** is formed on the first substrate **100** in the display area **D1** and the non-display area **D2**. First and second semiconductor layers **104** and **106** in the non-display area **D2**, a third semiconductor layer **108** and a first storage electrode **110** in the display region **D1** are formed by depositing and crystallizing an amorphous silicon material and patterning the crystallized silicon material through a first mask process.

In FIGS. **7B** and **8B**, a first photoresist pattern **112** that covers the first to third semiconductor layers **104**, **106** and **108**, except the first storage electrode **110**, is formed through a second mask process. The first storage electrode **110** that is exposed from the first photoresist pattern **112** is doped with high concentration n-type (n+) impurities.

The first photoresist pattern **112** is removed from the substrate **100** after the doping step.

As shown in FIGS. **7C** and **8C**, a gate insulating layer **116** and a first conductive metallic material is sequentially deposited, the first conductive metallic material, and patterned into first to third gate electrodes **118**, **120** and **122** and a second storage electrode **124** through a third mask process. The first to third gate electrodes **118**, **120** and **122** are disposed on central portions of the first to third semiconductor layers **104**, **106** and **108**. The second storage electrode **124** is disposed over the first storage electrode **110**. Although not shown, a gate line is connected to the third gate electrode **122**. For example, the gate insulating layer **116** includes at least one of an inorganic insulating material group consisting of silicon nitride (SiNx) and silicon oxide (SiOx).

As shown in FIGS. **7D** and **8D**, a second PR pattern **126** that covers the first gate electrode **118** is formed through a fourth mask process. The second PR pattern **126** corresponds to the first semiconductor layer **104**. The second and third semiconductor layers **106** and **108** are doped with high concentration n-type (n+) impurities.

A portion between the second and the third semiconductor layers has an ohmic-contact property.

Since the first storage electrode **110** of poly silicon material is doped with the same n (+) impurities through the previous second mask, an additional PR pattern that shields the fourth region **A4** includes the first and the second storage electrodes **110** and **124** and may be unnecessary.

The second PR pattern **126** is removed from the substrate **100** after the doping process.

As shown in FIGS. **7E** and **8E**, a third PR pattern **128a** that covers the second gate electrode **120** and a fourth PR pattern **128b** that covers the third gate electrode **122** and the second

storage electrode **124** are formed through a fifth mask process. The third PR pattern **128a** corresponds to the second semiconductor layer **106**, and the fourth PR pattern **128b** corresponds to the third semiconductor layer **108**, the first storage electrode **110**, and a portion between the third semiconductor layer **108** and the first storage electrode **110**. The first semiconductor layer **104** that is exposed from the second and the third PR patterns **128a** and **128b** is doped with high concentration p-type (p+) impurities through a fifth mask process.

The doped portions of the first semiconductor layer **104** have an ohmic-contact property. The third and the fourth PR patterns **128a** and **128b** are removed from the substrate **100** after the doping process.

As shown in FIGS. **7F** and **8F**, an interlayer insulating layer **130** is formed over the substrate **100**. The gate insulating layer **116** and the interlayer insulating layer **130** are patterned into first to third contact holes **132**, **134** and **136** that expose ohmic contact regions (not shown) of the first to third semiconductor layers **104**, **106** and **108**, respectively, through a sixth mask process. For example, the interlayer insulating layer **130** includes an inorganic insulating material such as silicon nitride (SiNx) or silicon oxide (SiOx).

The first to third contact holes **132**, **134** and **136** includes first source and first drain contact holes **132a** and **132b**, second source and second drain contact holes **134a** and **134b**, and third source and third drain contact holes **136a** and **136b**.

As shown in FIGS. **7G** and **8G**, first source and first drain electrodes **138a** and **138b**, second source and second drain electrodes **140a** and **140b**, third source and third drain electrodes **142a** and **142b**, and a data line DL are formed by depositing and patterning a second conductive metallic material through a seventh mask process using, for example, aluminum neodymium (AlNd). For example, the second conductive metallic material may be selected from the group consisting of chromium (Cr), molybdenum (Mo), tungsten (W), copper (Cu) and aluminum alloy.

The data line DL is substantially connected to the third source electrode **142a** and crosses the gate line GL (of FIG. **5**) to define the pixel region P. The first source and the first drain electrodes **138a** and **138b** are connected to the ohmic contact regions of the first semiconductor layer **104** via the first source and the first drain contact holes **132a** and **132b**, the second source and the second drain electrodes **140a** and **140b** are connected to the ohmic contact regions of the second semiconductor layer **106** via the second source and the second drain contact holes **134a** and **134b**, and the third source and the third drain electrodes **142a** and **142b** are connected to the ohmic contact regions of the third semiconductor layer **108** via the third source and the third drain contact holes **136a** and **136b**.

The first semiconductor layer **104**, the first gate electrode **118**, the first source electrode **138a** and the first drain electrode **138b** constitute a p-type thin film transistor T(p), the second semiconductor layer **106**, the second gate electrode **120**, the second source electrode **140a** and the second drain electrode **140b** constitute an n-type thin film transistor T(n). The p-type thin film transistor T(p) and the n-type thin film transistor T(n) constitute a CMOS element.

The third gate electrode **108**, the third source electrode **142a** and the third drain electrode **142b** constitute a switching thin film transistor Ts. For example, the switching thin film transistor Ts consists of an n-type thin film transistor as shown in FIG. **8G**. The first and the second storage electrodes **110** and **124** with the gate insulating layer **116** therebetween constitute a storage capacitor Cst.

As shown in FIGS. **7H** and **8H**, a passivation layer **146** is formed over the substrate **100** and is patterned to have a drain contact hole **148** that exposes a portion of the third drain electrode **142b** through an eighth mask process.

As shown in FIGS. **7I** and **8I**, a pixel electrode **150** is formed by depositing and patterning a transparent conductive material such as indium tin oxide (ITO) or indium zinc oxide (IZO) through a ninth mask process. The pixel electrode **150** is connected to the third drain electrode **142b** via the drain contact hole **148**.

The pixel electrode **150** is formed to have spaces SP from the gate and the data lines GL and DL.

In FIGS. **7J** and **8J**, a black resin **152** is formed by coating and patterning a black resin over the substrate **100** in the non-display area D2 and a non-pixel region of the display area D1 through a tenth mask process. The non-pixel region corresponds to the gate line GL, the data line DL, the switching thin film transistor Ts, the storage capacitor Cst, and the spaces SP between the gate line GL and the pixel electrode **150** and between the data line DL and the pixel electrode **150**.

The align margin  $\alpha$  that considers a misalignment can be omitted because the black matrix **152** is directly formed on an array substrate that includes the gate line GL, the data line DL.

An aperture region may be increased more than at least 4 micrometers ( $\mu\text{m}$ ) in comparison with that of the related art.

According to the LCD device and the method of fabricating the same, since the black matrix as a light shielding means is directly formed on the array substrate instead of the color filter substrate of the opposite substrate to the array substrate, the align margin can be omitted. Therefore, the aperture region that corresponds to the omitted align margin can be obtained, thereby providing the LCD having a high brightness.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present embodiments without departing from the spirit or scope of the embodiments. It is intended that the present invention cover the modifications and variations of the embodiments provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. An array substrate for a liquid crystal display device including a plurality of pixel regions, comprising:
  - a p-type driving TFT, an n-type driving TFT and a switching TFT on a substrate that includes a display area and a non-display area, wherein the p-type and the n-type driving TFTs are in the non-display area and the switching TFT is in the display area;
  - a gate insulating layer on the substrate that includes first, second and third semiconductor layers;
  - first, second and third gate electrodes and a gate line connected to the third gate electrode on the gate insulating layer, wherein the first, second and third gate electrodes correspond to central portions of the first, second and third semiconductor layers;
  - a first storage electrode in the display area and a second storage electrode over the first storage electrode, wherein the first and second storage electrodes form a storage capacitor with the gate insulating layer therebetween;
  - an interlayer insulating layer on the substrate that includes the first, second and third gate electrodes, wherein the interlayer insulating layer has first, second and third contact holes that expose ohmic contact regions of the first, second and third semiconductor layers;

first, second and third source electrodes and first, second and third drain electrodes and a data line on the inter-layer insulating layer, wherein the data line is connected to the third source electrode and crosses the gate line to define a pixel region, wherein each of the first, second and third source electrodes and the first, second and third drain electrodes contacts each of the ohmic contact regions of the first, second and third semiconductor layers via each of the first to third contact holes;

a passivation layer on the substrate that includes the first, second and third source electrodes and the first, second and third drain electrodes and the data line, wherein the passivation layer has a drain contact hole that exposes a portion of the third drain electrode;

a pixel electrode on the passivation layer, wherein the pixel electrode connects to the third drain electrode via the drain contact hole; and

a black matrix on the substrate that includes the pixel electrode, the pixel electrode having an overlapping portion that overlaps with the black matrix and a non-overlapping portion exposed from the black matrix and connected to the overlapping portion, wherein the overlapping portion of the pixel electrode is in direct contact with the black matrix and connected to the third drain electrode under the black matrix, the storage capacitor being disposed between the non-overlapping portion of the pixel electrode and the third drain electrode in a same pixel region,

wherein the black matrix is in the non-display area and a non-pixel area of the display area,

wherein the black matrix is formed on upper surfaces of the passivation layer and the pixel electrode,

wherein the black matrix directly contacts a portion of the passivation layer between the pixel electrode and the data line and directly contacts an end portion of the pixel electrode, and

wherein the black matrix completely covers the storage capacitor and the data line.

2. The array substrate according to claim 1, wherein the non-pixel region includes regions that correspond to the gate line, the data line, a space between the pixel electrode and the data line, and the switching TFT.

3. The array substrate according to claim 1 coupled to a color filter substrate, wherein the color filter substrate includes a color filter layer on another substrate and a common electrode on the color filter layer.

4. The array substrate according to claim 3, wherein the color filter layer includes red, green and blue sub-color filter layers, each of the red, green and blue sub-color filter layers in the pixel region, wherein the black matrix corresponds to boundaries between the red, green and blue sub-color filter layers.

5. The array substrate according to claim 1, wherein the black matrix covers a portion between the gate line and the second storage electrode.

\* \* \* \* \*

专利名称(译)	包括黑色矩阵的液晶显示装置及其制造方法		
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摘要(译)

提供一种液晶显示 ( LCD ) 装置及其制造方法。 LCD 装置及其制造方法具有直接形成在阵列基板上的屏蔽装置，而不是与阵列基板相对的基板的滤色器基板。

