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Qiu et al.

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(54) **MANUFACTURING METHOD FOR A THIN FILM TRANSISTOR-LIQUID CRYSTAL DISPLAY HAVING AN INSULATING LAYER EXPOSING PORTIONS OF A GATE ISLAND**

(75) Inventors: **Haijun Qiu**, Beijing (CN); **Zhangtao Wang**, Beijing (CN); **Xu Chen**, Beijing (CN); **Tae Yup Min**, Beijing (CN)

(73) Assignee: **Beijing BOE Optoelectronics Technology Co., Ltd.**, Beijing (CN)

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G02F 1/1343 (2006.01)
G02F 1/13 (2006.01)

(52) **U.S. Cl.** **349/43**; 349/148; 349/187

(58) **Field of Classification Search** 349/42, 349/43, 147, 148, 187; 438/30
See application file for complete search history.

(56) **References Cited**

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* cited by examiner

Primary Examiner — Mark Robinson

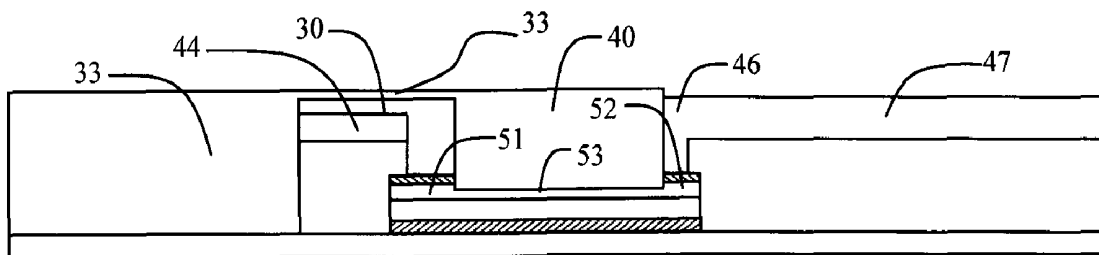
Assistant Examiner — Paul Lee

(74) *Attorney, Agent, or Firm* — Hasse & Nesbitt LLC; Daniel F. Nesbitt

(57) **ABSTRACT**

A pixel unit of TFT-LCD array substrate and a manufacturing method thereof is disclosed. In the manufacturing method, besides a first insulating layer and a passivation layer, a second insulating layer is adopted to cover the gate island, and forms an opening on the gate island to expose the channel region, the source region and the drain region of the TFT. A gray tone mask and a photoresist lifting-off process are utilized to perform patterning, so that the TFT-LCD array substrate can be achieved with just three masks.

7 Claims, 8 Drawing Sheets



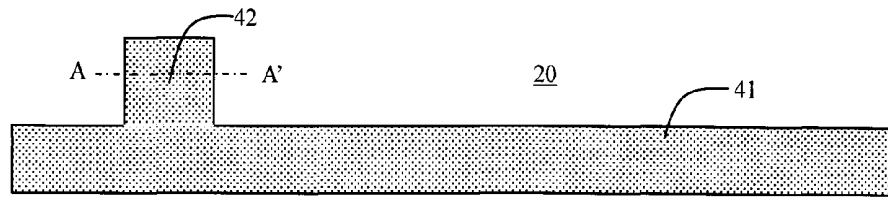


Fig. 1a

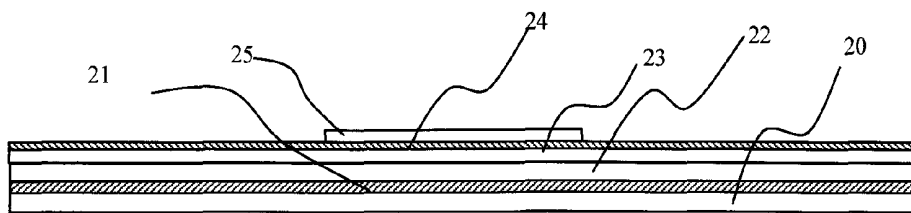


Fig. 1b

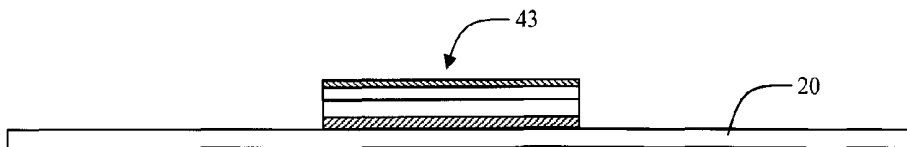


Fig. 1c

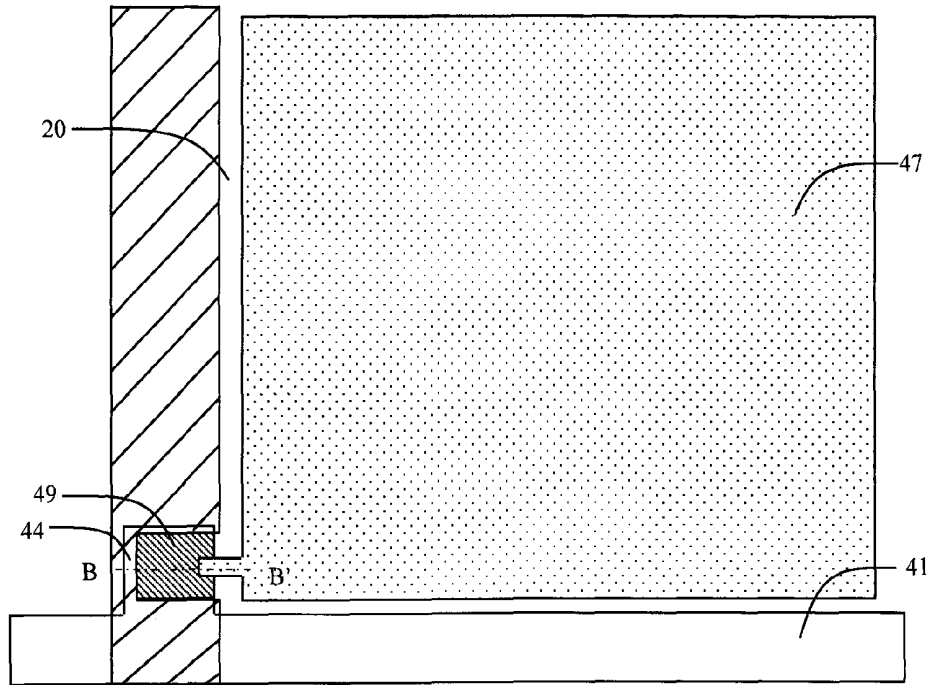


Fig. 2a

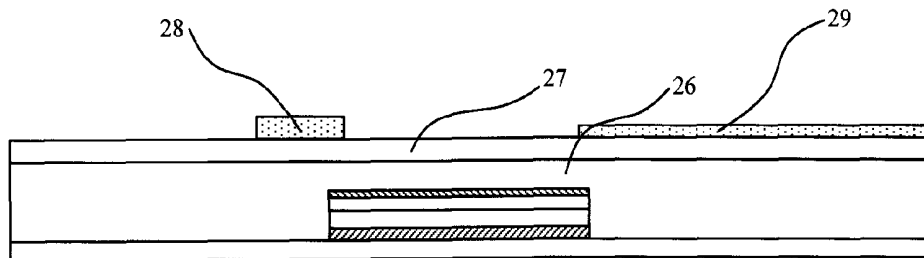


Fig. 2b

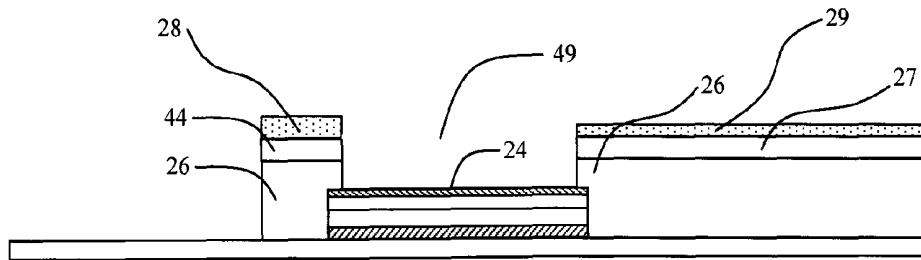


Fig. 2c

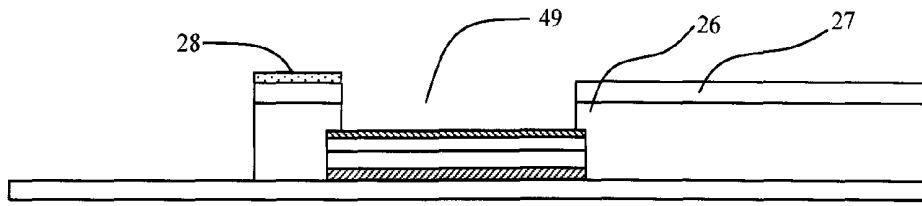


Fig. 2d

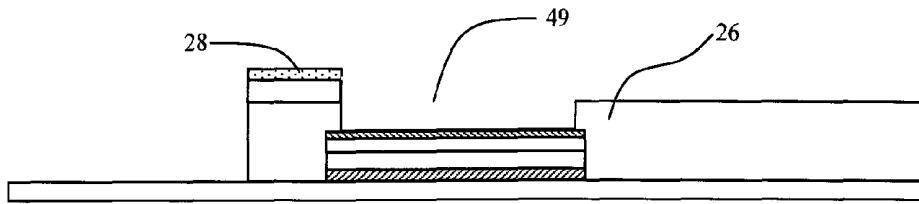


Fig. 2e

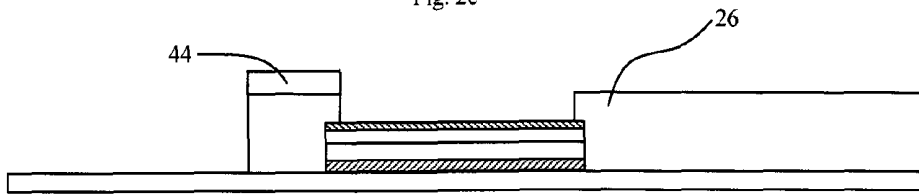


Fig. 2f

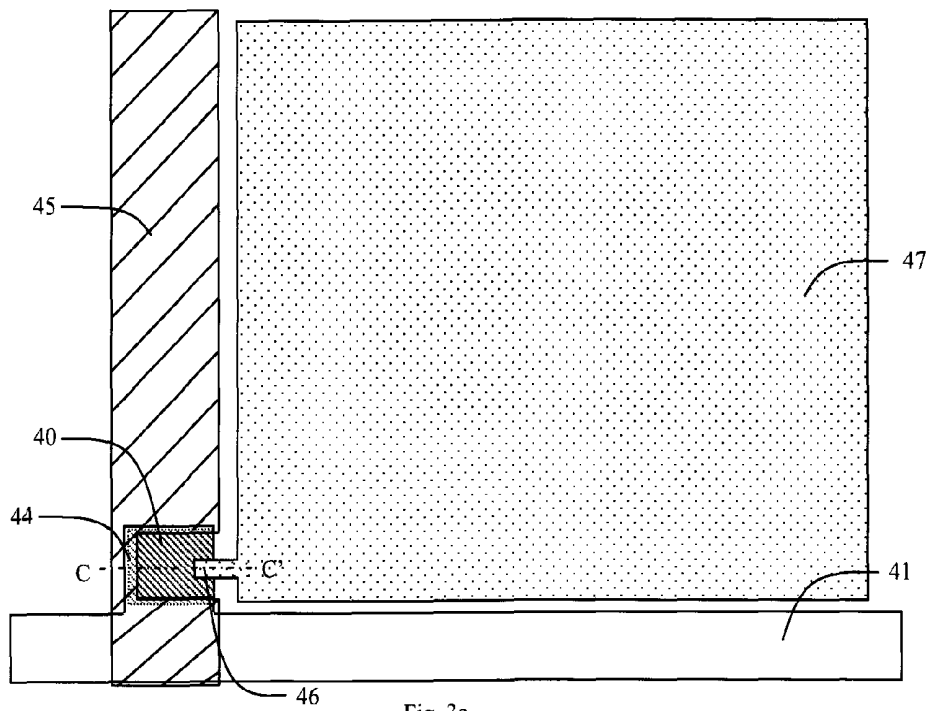


Fig. 3a

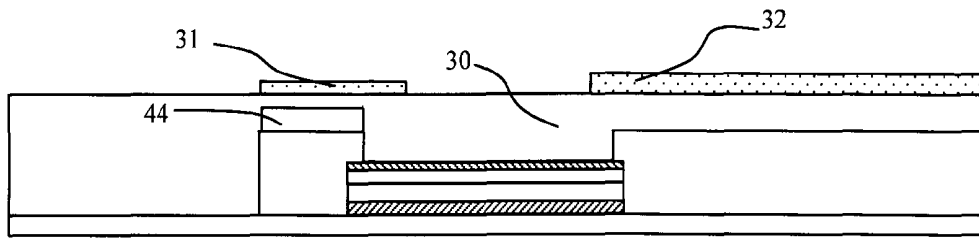


Fig. 3b

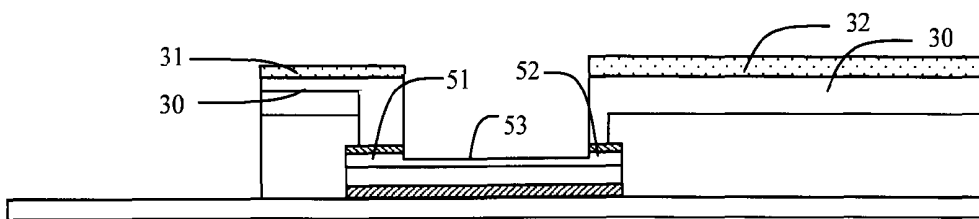


Fig. 3c

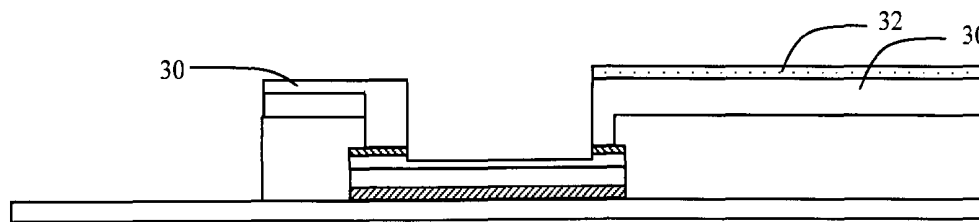


Fig. 3d

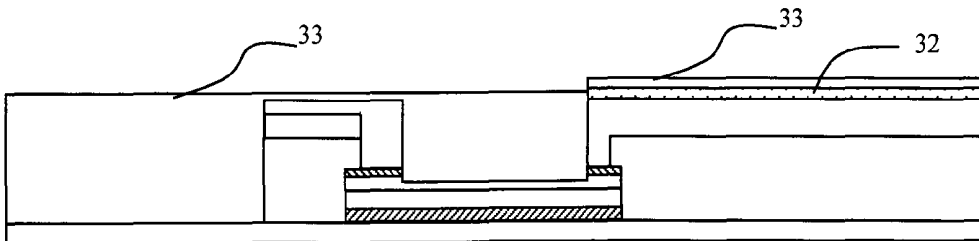


Fig. 3e

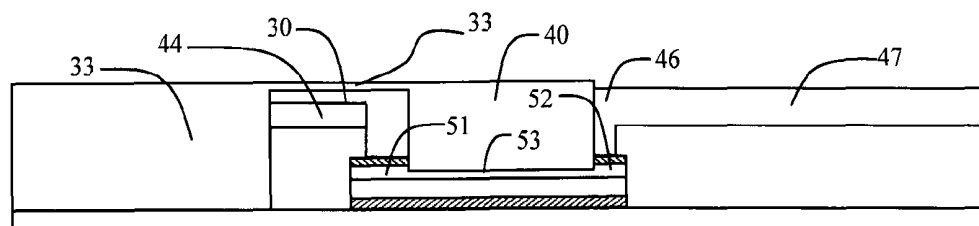


Fig. 3f

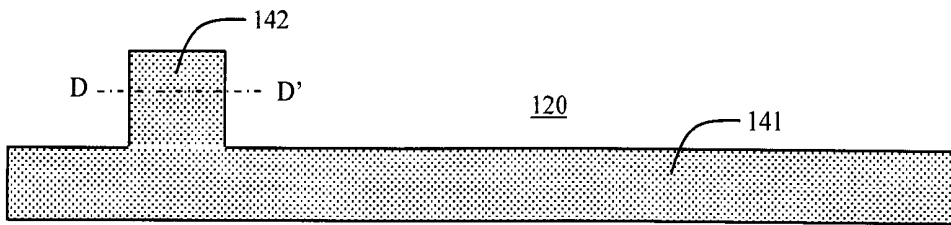


Fig. 4a

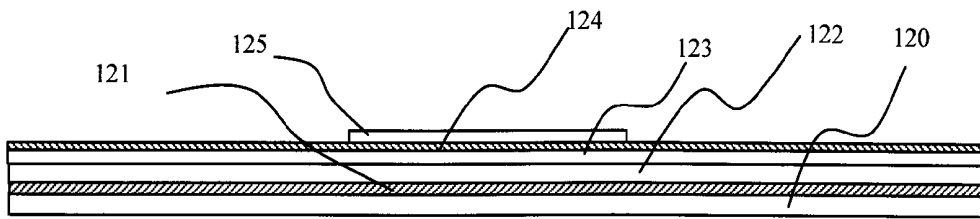


Fig. 4b

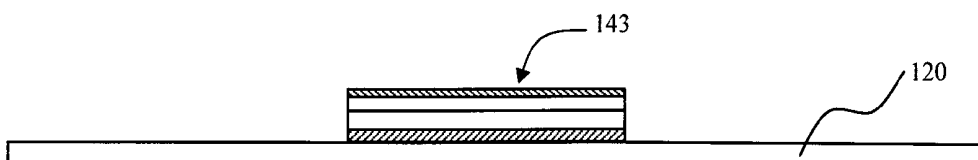


Fig. 4c

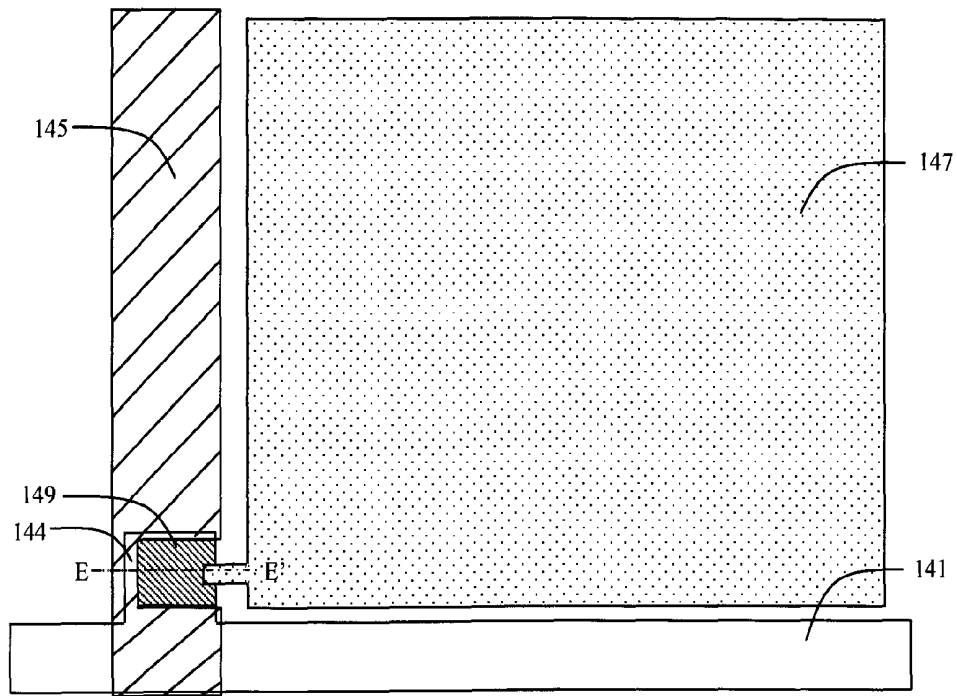


Fig. 5a

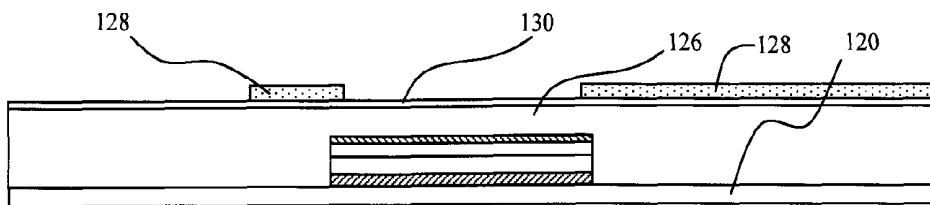


Fig. 5b

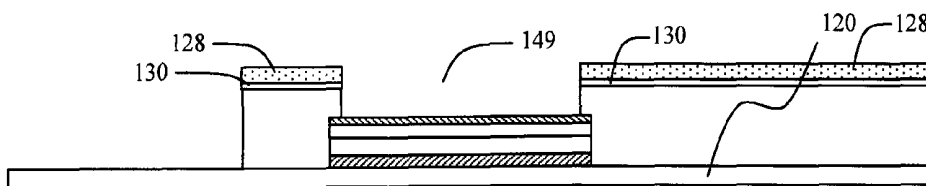


Fig. 5c

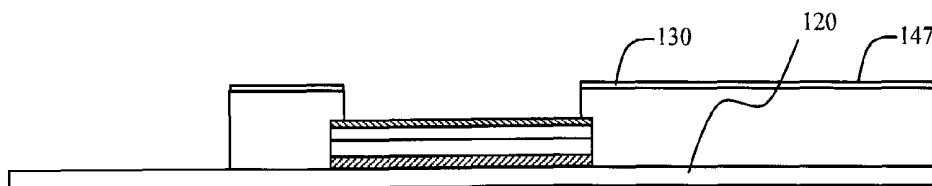


Fig. 5d

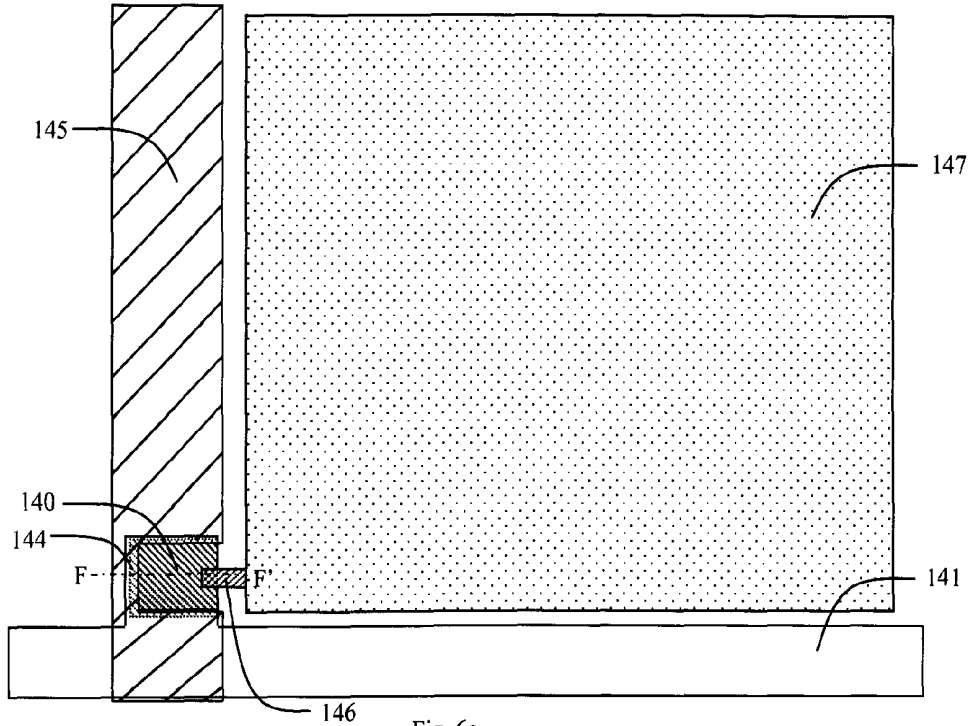


Fig. 6a

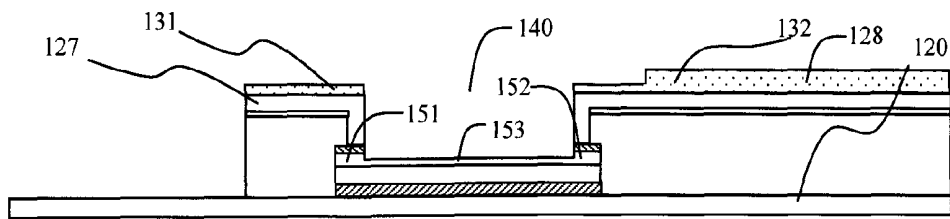


Fig. 6b

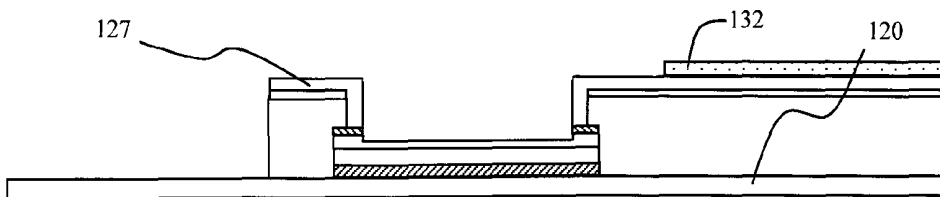


Fig. 6c

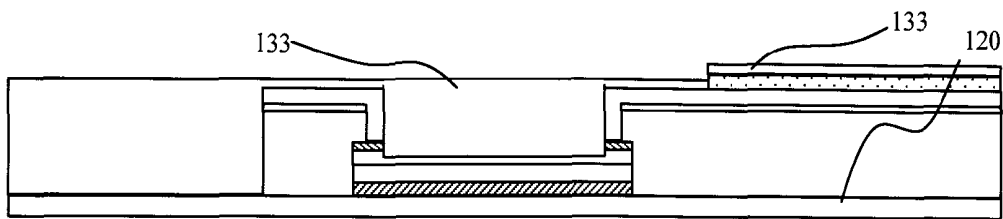


Fig. 6d

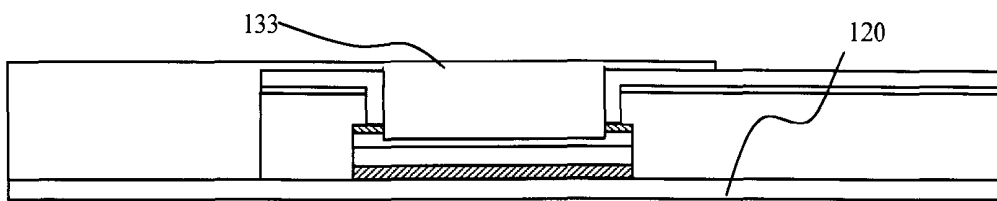


Fig. 6e

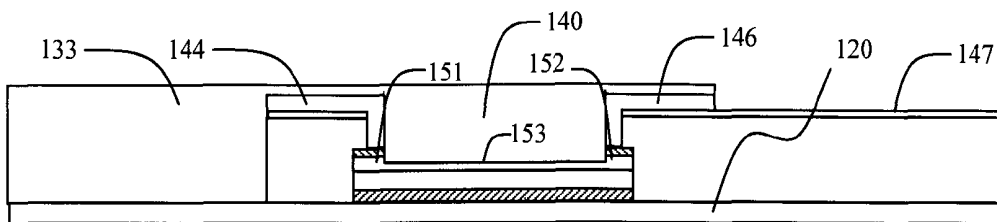


Fig. 6f

**MANUFACTURING METHOD FOR A THIN
FILM TRANSISTOR-LIQUID CRYSTAL
DISPLAY HAVING AN INSULATING LAYER
EXPOSING PORTIONS OF A GATE ISLAND**

CROSS-REFERENCE TO RELATED
APPLICATIONS

This application is a divisional application of U.S. Ser. No. 11/834,118 filed Aug. 6, 2007, now U.S. Pat. No. 7,916,230 which claims the priority of Chinese Patent Application Nos. CN200610103866.0 and CN 200610103865.6 both filed Aug. 4, 2006, the disclosures of which are incorporated herein by reference.

FIELD OF THE INVENTION

The present invention relates to a thin film transistor liquid crystal display (TFT-LCD) array substrate and a manufacturing method thereof, and more particularly, to a TFT-LCD array substrate manufactured with three masks and a manufacturing method thereof.

BACKGROUND OF THE INVENTION

A liquid crystal display (LCD) comprises an upper substrate, a lower substrate, and a liquid crystal layer interposed therebetween. A common electrode and color filters are formed on the upper substrate, which is generally called a color filter substrate. The lower substrate is generally called an array substrate, on which a plurality of gate lines parallel to each other and a plurality of data lines parallel to each other are formed. The gate lines and data lines intersect with each other orthogonally, defining a plurality of pixel units in a matrix on the substrate. In each of the pixel unit, a pixel electrode and a switching element such as a thin film transistor (TFT) connected with the pixel electrode are included. The gate electrode of the TFT is connected with one of the gate lines, and the source electrode of the TFT is connected with one of the data lines.

The conventional method of manufacturing a TFT-LCD array substrate generally employs a five-mask (5Mask) technology or a four-mask (4Mask) technology. The 4Mask technology performs etching on both the source/drain metal layer and the active layer in the channel region of the TFT by using a gray tone mask. Such conventional 4Mask technology comprises the following steps.

Firstly, a gate metal layer is formed on the substrate by a conventional gate process, and then a gate insulating layer is formed by depositing.

Secondly, a semiconductor layer (active layer), a doped layer (ohmic contact layer), a source/drain metal layer are deposited sequentially on the substrate. A gate island of the TFT is formed by coating a photoresist layer and patterning with a gray tone mask, an ashing process is performed on the photoresist layer to expose the channel region of the TFT, the source/drain metal layer in the channel region is etched, and thereafter the doped layer and the active layer in the channel region are etched. Since it is necessary to etch the metal layer, the doped layer, and the active layer in the above processes, the photoresist in the gray toned region in the channel portion should be controlled strictly. In addition, there are strict requirements on the selection ratio and uniformity of the etching, and accordingly there are strict requirements on the process tolerance.

SUMMARY OF THE INVENTION

One object of the present invention is to overcome the drawbacks in the related arts by providing a pixel unit of a

TFT-LCD array substrate and the manufacturing method thereof, which not only can reduce the requirements on the process tolerance and simplifies the design of the TFT but also can obtain the array substrate with just reduced masks.

To achieve the above object, one embodiment according to the present invention provides a pixel unit of a TFT-LCD array substrate, comprising: a substrate; a TFT formed on the substrate; a passivation layer covering the TFT; and a pixel electrode connected with the TFT. The TFT comprises: a gate island formed by a gate electrode, a first insulating layer, an active layer, and an ohmic contact layer stacked sequentially on the substrate, wherein the ohmic contact layer is formed in a source region and a drain region and exposes the active layer in a channel region; a second insulating layer, covering the gate island and forming on the gate island an opening which exposes the source region, the drain region and the channel region; a source electrode and drain electrode, formed on the second insulating layer and electrically connected with the ohmic contact layer in the source region and the drain region, respectively. The pixel electrode is formed on the second insulating layer and is connected with the drain electrode of the TFT.

Another embodiment according to the present invention provides a manufacturing method of a pixel unit of a TFT-LCD array substrate, comprising the steps of: depositing sequentially on a substrate stacked layers of a gate metal layer, a first gate insulating layer, an active layer, and an ohmic contact layer, and then patterning the stacked layers to form a gate island; depositing sequentially a second insulating layer and a source/drain metal layer on the substrate, patterning the second insulating layer and the source/drain metal layer, forming a source electrode on the second insulating layer, and forming an opening on the gate island to expose the ohmic contact layer in a source region, a drain region, and a channel region of the TFT; depositing a pixel electrode material layer on the substrate, patterning the pixel electrode material layer and the ohmic contact layer exposed in the opening so that the ohmic contact layer on the channel region is removed, the source electrode is connected with the ohmic contact layer in the source region via the pixel electrode material layer on the source electrode, the drain electrode and the pixel electrode connected with each other are formed on the second insulating layer, and the drain electrode is connected with the ohmic contact layer in the drain region; and depositing a passivation layer on the substrate to cover the TFT.

Further another embodiment according to the present invention provides another manufacturing method of a pixel unit of a TFT-LCD array substrate, comprising the following steps of: depositing sequentially on a substrate stacked layers of a gate metal layer, a first gate insulating layer, an active layer, and an ohmic contact layer, and then patterning the stacked layers to form a gate island; depositing sequentially a second insulating layer and a pixel electrode material layer on the substrate, patterning the second insulating layer and the pixel electrode material layer, so as to form an opening on the gate island to expose the ohmic contact layer in a source region, a drain region, and a channel region of the TFT, and form a pixel electrode; depositing a source/drain metal layer on the substrate, and patterning the ohmic contact layer exposed in the opening and the source/drain metal layer, so as to form on the second insulating layer a source electrode connected with the ohmic contact layer in the source region and a drain electrode connected with the ohmic contact layer in the drain region, and remove the ohmic contact layer on the channel region; and depositing a passivation layer on the substrate.

Compared with the conventional manufacturing method of array substrate in the related art, besides a first insulating layer (a gate insulating layer) and a passivation layer, the pixel unit and the method according to the present invention form a second insulating layer to cover the gate island, form an opening on the gate island to expose the channel region of TFT as well as the source region and the drain region, and conduct patterning with a gray tone mask and a photoresist lifting-off process, so that the TFT-LCD array substrate is possible to be completed with just three masks, which increases the feasibility of the process, reduces the manufacturing cost of the array substrate process and occupied time of the equipment, and improves productivity.

The present invention will be described in detail by reference to the accompanying drawings and the preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1a is a plan view showing a pixel after patterning with the first mask according to the first embodiment of the present invention;

FIGS. 1b and 1c are cross-sectional views along the line A-A' in FIG. 1a during patterning with the first mask according to the first embodiment;

FIG. 2a is a plan view showing a pixel after patterning with the second mask (a gray tone mask) according to the first embodiment of the present invention;

FIG. 2b-2f are cross-sectional views along the line B-B' in FIG. 2a during patterning with the second mask according to the first embodiment;

FIG. 3a is a plan view showing a pixel after patterning with the third mask (a gray tone mask) according to the first embodiment of the present invention;

FIG. 3b-3f are cross-sectional views along the line C-C' in FIG. 3a during patterning with the second mask according to the first embodiment;

FIG. 4a is a plan view showing a pixel after patterning with the first mask according to the second embodiment of the present invention;

FIGS. 4b and 4c are cross-sectional views along the line D-D' in FIG. 4a during patterning with the first mask according to the second embodiment;

FIG. 5a is a plan view showing a pixel after patterning with the second mask according to the second embodiment of the present invention;

FIG. 5b-5d are cross-sectional views along the line E-E' in FIG. 5a during patterning with the second mask according to the second embodiment;

FIG. 6a is a plan view showing a pixel after patterning with the third mask (a gray tone mask) according to the second embodiment of the present invention;

FIG. 6b-6f are cross-sectional views along the line F-F' in FIG. 6a during patterning with the third mask according to the second embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiments of the TFT LCD array substrate according to the present invention will be described in detail with reference to the accompanying drawings.

The First Embodiment

The TFT-LCD array substrate and the manufacturing method thereof according to the first embodiment of the present invention will be described in detail with reference to FIGS. 1a-3f.

To manufacture an array substrate, as shown in FIG. 1b, in the beginning a gate metal layer 21 is deposited on a clean substrate (e.g., a glass or quartz substrate) 20, a first insulating layer (a gate insulating layer) 22 is deposited on the gate metal layer 21, an active layer (a semiconductor layer) 23 is deposited on the first insulating layer 22, and an ohmic contact layer 24 is deposited on the active layer 23.

The gate metal layer 21 may be a single-layer film of AlNd, Al, Cu, Mo, MoW or Cr, or a composite film of any combination of AlNd, Al, Cu, Mo, MoW, and Cr.

The first insulating layer 22 may be a single-layer film of SiNx, SiOx, or SiOxNy, or a composite film of any combination of SiNx, SiOx, and SiOxNy.

The active layer 23 may be for example a semiconductor layer of mono-crystalline silicon, amorphous silicon (a-Si), polycrystalline silicon (p-Si) and the like.

The ohmic contact layer 24 may be a doped semiconductor layer, e.g., n+ doped a-Si or p+ doped a-Si, and also may be a microcrystalline silicon layer.

The methods for depositing the above layers are generally known in the art, e.g., sputtering, plasma enhanced chemical vapor deposition (PECVD), atmospheric pressure chemical vapor deposition and the like.

The stacked layers of the above-mentioned gate metal layer 21, the first insulating layer 22, the active layer 23, and the ohmic contact layer 24 are patterned with a first mask to form a gate pattern, which comprises a gate electrode 42 and a gate line 41. The gate electrode 42 together with the first insulating layer 22, the active layer 23, and the ohmic contact layer 24 formed thereon forms a gate island 43 for the thin film transistor (TFT) 40. FIG. 1a is a plan view of the substrate after patterning with the first mask, in which the gate electrode 42 branches from the gate line 41.

In particular, a photoresist layer is applied or coated (e.g., by spin coating) onto the uppermost ohmic contact layer 24, and then the photoresist layer is exposed with the first mask and developed to form the photoresist pattern 25 corresponding to the gate pattern to be formed, as shown in FIG. 1b. The above-mentioned stacked layers are etched by using the photoresist pattern 25, and the gate line 41 and the gate electrode 42 in the gate island 43 are formed, as shown in FIGS. 1a and 1c.

Then, the second insulating layer 26 and the source/drain metal layer 27 are deposited sequentially on the resultant substrate. The second insulating layer 26, which is similar with the first insulating layer 22, may be a single-layer film of SiNx, SiOx, or SiOxNy, or a composite film of any combination of SiNx, SiOx, and SiOxNy. The source/drain metal layer 27 may be a single-layer film of Mo, MoW or Cr, and can also be a composite film of any combination of Mo, MoW, and Cr.

The second insulating layer 26 and the source/drain metal layer 27 are patterned to attain the source electrode 44 and the data line 45 connected with the source electrode, as shown in FIG. 2a, which is a plan view of the substrate after patterning.

For example, the patterning may be performed with a second mask which is a gray tone one. More particularly, a photoresist layer is coated onto the source/drain metal layer 27, and then the photoresist layer is exposed with the gray tone mask and developed to form a first gray tone photoresist pattern. The first gray tone photoresist pattern comprises a full photoresist region 28 and a partial photoresist region 29, and the remaining region above the source/drain metal layer 27 is a photoresist-free region, as shown in FIG. 2b. The thickness of the photoresist layer in the full photoresist region 28 is larger than that of the photoresist layer in the partial photoresist region 29. On the substrate, the full photoresist region 28 comprises a data line forming region and a source

electrode forming region in the pixel unit; the partial photoresist region 29 comprises a drain electrode forming region and a pixel electrode forming region in the pixel unit; and the photoresist-free region comprises a source forming region, a drain forming region, a channel forming region of the TFT in the pixel unit. The above-mentioned forming regions, such as the source electrode forming region, the source forming region, and the pixel electrode forming region, refer to the portions in the photoresist pattern that correspondingly overlap the regions on the substrate in which the respective elements, such as the source electrode, the source of the TFT, and the pixel electrode, are to be formed.

Then, the source/drain metal layer 27 and the second insulating layer 26 are etched sequentially with the first gray tone photoresist pattern, so as to form the source electrode 44 and the data line 45 connected therewith and form an opening 49, which exposes the ohmic contact layer 24, in the second insulating layer 26 on the gate island 43, as shown in FIG. 2c. The exposed ohmic contact layer 24 will be patterned in the subsequent step to form the source region 51, the drain region 52, and the channel region 53 of the TFT, respectively. In addition, the source/drain metal layer 27 within the drain electrode forming region and the pixel electrode forming region on the second insulating layer 26 is left.

An ashing process is performed on the first gray tone photoresist pattern to remove the photoresist in the partial photoresist region 29 and reduce the thickness of the photoresist in the full photoresist region 28, so as to expose the source/drain metal layer 27 left in the drain electrode forming region and the pixel electrode forming region, as shown in FIG. 2d.

With the photoresist pattern left after the ashing process, the source/drain metal layer 27 in the drain electrode forming region and the pixel electrode forming region is removed by etching, as shown in FIG. 2e. Then, the photoresist left in the full photoresist region 28 after the ashing process is removed with a photoresist lifting-off process, as shown in FIG. 2f.

Next, a pixel electrode material layer 30, such as transparent conductive material such as indium tin oxide (ITO), indium zinc oxide (IZO) and the like, is deposited on the resultant substrate.

The pixel electrode material layer 30 is patterned to complete the pixel unit comprising the TFT 40 and the pixel electrode 47, as shown in FIG. 3a, which is a plan view of the substrate after this patterning.

For example, the patterning may be performed with a third mask which is also a gray tone mask. More particularly, a photoresist layer is applied to the pixel electrode material layer, and then the photoresist layer is exposed by the gray tone mask and developed to form a second gray tone photoresist pattern. The second gray tone photoresist pattern comprises a full photoresist region 32 and a partial photoresist region 31, and the remaining region is a photoresist-free region, as shown in FIG. 3b. The thickness of the photoresist layer in the full photoresist region 32 is larger than that of the photoresist layer in the partial photoresist region 31. On the substrate, the full photoresist region 32 comprises a drain forming region, a drain electrode forming region and a pixel electrode forming region in the pixel unit; the partial photoresist region 31 comprises a source electrode forming region and a source forming region in the pixel unit; and the photoresist-free region comprises a channel forming region in the pixel unit. These forming regions are defined the same as the above-mentioned ones.

Then, the pixel electrode material layer 30 is etched with the second gray tone photoresist pattern, so as to expose the ohmic contact layer 24 in the opening 49 of the second insulating layer 26 on the gate island 43, and then the ohmic

contact layer 24 is patterned by etching to form the channel region 53, the source region 51 and the drain region 52 of the TFT 40. In addition, the source electrode 44 formed on the second insulating layer 26 is connected with the ohmic contact layer 24 in the source region 51 of TFT 40 via the pixel electrode material layer 30 on the source electrode 44. The pixel electrode material layer 30 on the drain forming region, the drain electrode forming region and the pixel electrode forming region forms the drain electrode 46 and the pixel electrode 47, which are integrated with each other and contact the ohmic contact layer 24 in the drain region 52, as shown in FIG. 3c.

An ashing process is performed on the second gray tone photoresist pattern to remove the photoresist in the partial photoresist region 31 and reduce the thickness of the photoresist in the full photoresist region 32, so as to expose the source electrode 44 and the data line 45 connected therewith, as shown in FIG. 3d.

A passivation layer 33 is deposited on the resultant substrate comprising the remaining photoresist pattern, as shown in FIG. 3e. Thereafter, the remaining photoresist pattern in the full photoresist region 32 is lifted off to expose the pixel electrode 47 and the drain electrode 46, so as to obtain the complete pixel unit on the array substrate, as shown in FIG. 3f.

With the manufacturing method according to the first embodiment of the present invention, the TFT-LCD array substrate can be manufactured with just three masks, which include two gray tone masks, in combination with the photoresist lifting-off process.

However, those skilled in the art should appreciate that the conventional mask can be used in place of any of the gray tone mask to realize the same patterning. For example, two conventional masks can be used instead of the first gray tone mask, to form the source electrode, the data line, and the opening in the second insulating layer on the gate island with two photolithography processes.

In another example, the source electrode, the data line, and the drain electrode can be formed at the same time. Thus, in the first gray tone photoresist pattern shown in FIG. 2b, the full photoresist region 28 further comprises the drain electrode forming region; in the step shown in FIG. 3b, the pixel electrode material layer 30 also covers the drain electrode 46; and in the step shown in FIG. 3e, the drain electrode 46 is formed to be connected with the pixel electrode 47 and connected with the ohmic contact layer 24 in the drain region 52 via the pixel electrode material layer 30 thereon in a similar manner as the source electrode 44 does.

In addition, the passivation layer may cover the pixel electrode without being removed, so that when patterning is performed on the pixel electrode, it is not necessary to use the gray tone mask but a conventional mask.

The Second Embodiment

The TFT-LCD array substrate and the manufacturing method thereof according to the second embodiment of the present invention will be described in detail with reference to FIGS. 4a-6f.

In the second embodiment, the elements like those in the first embodiment are indicated with the like reference number, and can be formed with the same materials and methods, the description of which thus will not be repeated herein for simplicity.

As shown in FIG. 4b, in the beginning a gate metal layer 121 is deposited on a clean substrate 120, a first insulating layer (a gate insulating layer) 122 is deposited on the gate

metal layer **121**, an active layer (a semiconductor layer) **123** is deposited on the first insulating layer **122**, and an ohmic contact layer **124** is deposited on the active layer **123**.

The stacked layers of the above-mentioned gate metal layer **121**, the first insulating layer **122**, the active layer **123**, and the ohmic contact layer **124** are patterned with a first mask to form a gate pattern comprising the gate electrode **142** and gate line **141**. The gate electrode **142** together with the first insulating layer **122**, the active layer **123**, and the ohmic contact layer **124** formed thereon forms the gate island **143** for the TFT **140**. FIG. **4a** is a plan view of the substrate after patterning with the first mask, in which the gate electrode **142** branches from the gate line **141**.

In particular, a photoresist layer is applied onto the uppermost ohmic contact layer **124**, and then the photoresist layer is exposed with the first mask and developed to form the photoresist pattern **125** corresponding to the gate pattern to be formed, as shown in FIG. **4b**. The above-mentioned stacked layers are etched with the photoresist pattern **125**, and the gate line **141** and the gate electrode **142** in the gate island **143** are formed, as shown in FIGS. **4a** and **4c**.

Then, the second insulating layer **126** and the pixel electrode material layer **130** are deposited sequentially on the resultant substrate. The second insulating layer **126** and the pixel electrode material layer **130** are patterned, as shown in FIG. **5a**, which is a plan view of the substrate after patterning. More particularly, a photoresist layer is applied onto the pixel electrode material layer **130**, and then the photoresist layer is exposed by the second mask and developed to form a photoresist pattern **128**, as shown in FIG. **5b**. Then, the pixel electrode material layer **130** and the second insulating layer **126** are etched sequentially with the photoresist pattern **128**, so as to form the pixel electrode material layer **130** in the source electrode forming region and the drain electrode forming region and form the pixel electrode **147**. An opening **149**, which exposes the ohmic contact layer **124**, is also formed in the second insulating layer **126** on the gate island **143**, as shown in FIG. **5c**. The exposed ohmic contact layer **124** in the opening **149** will be patterned in the subsequent step to form the source region **151**, the drain region **152** and the channel region **153** of the TFT **140**, respectively. Then the photoresist pattern **128** is removed, as shown in FIG. **5d**.

Subsequently, a source/drain metal layer **127** is deposited on the resultant substrate, and is patterned to complete the pixel unit comprising the TFT and the pixel electrode, as shown in FIG. **6a**, which is a plan view of the substrate after patterning.

For example, the patterning may be performed with a third mask which is a gray tone one. More particularly, a photoresist layer is applied onto the source/drain metal layer **127**, and then the photoresist layer is exposed by the gray tone mask and developed to form a gray tone photoresist pattern on the substrate. The gray tone photoresist pattern comprises a full photoresist region **132** and a partial photoresist region **131**, and the remaining region is a photoresist-free region, as shown in FIG. **6b**. The thickness of the photoresist layer in the full photoresist region **132** is larger than that of the photoresist layer in the partial photoresist region **131**. On the substrate, the full photoresist region **132** comprises pixel electrode forming region in the pixel unit; the partial photoresist region **131** comprises a data line forming region and a source electrode forming region, a source forming region, a drain electrode forming region, and a drain forming region in the pixel unit; and the photoresist-free region comprises a channel forming region in the pixel unit. These forming regions are defined the same as the above-mentioned ones in the first embodiment.

Then, the source/drain metal layer **127** is etched with the gray tone photoresist pattern, so as to expose the ohmic contact layer **124** in the opening **149** in the second insulating layer **126** on the gate island **143**, and then the ohmic contact layer **124** is further etched to form the channel region **153**, the source region **151** and the drain region **152** of the TFT **140**. In addition, through the etching the source electrode **144**, the data line **145**, and the drain electrode **146** are formed on the second insulating layer **126**, wherein the source electrode **144** is connected with the ohmic contact layer **124** in the source region **151** of the TFT **140**, and the drain electrode **146** is connected with the ohmic contact layer **124** in the drain region **152** and the pixel electrode **147** of the TFT **140**, respectively, as shown in FIG. **6b**.

An ashing process is performed on the gray tone photoresist pattern to remove the photoresist in the partial photoresist region **131** and reduce the thickness of the photoresist in the full photoresist region **132**, so as to expose the source electrode **144**, the data line **145**, and the drain electrode **146**, as shown in FIG. **6c**.

A passivation layer **133** is deposited on the resultant substrate comprising the remaining photoresist pattern, as shown in FIG. **6d**. At this time, the remaining photoresist pattern is lifted off to expose the pixel electrode forming region which is covered by the source/drain metal layer **127**, as shown in FIG. **6e**. Then, the source/drain metal layer **127** in the pixel electrode forming region is etched by using the remaining passivation layer **133** as the etching mask, so as to obtain the complete pixel unit on the array substrate, as shown in FIG. **6f**.

With the manufacturing method according to the second embodiment of the present invention, the TFT-LCD array substrate can be manufactured with just three masks, which include a gray tone mask, in combination with the photoresist lifting-off process.

However, those skilled in the art will appreciate that the conventional mask can be used in place of the above gray tone mask to realize the same patterning. For example, after the deposition of the source/drain metal layer **127**, two conventional masks can be used instead of the gray tone mask, to expose the channel region of the active layer on the gate island and form the source electrode, the data line and the drain electrode in one photolithography process, and form the pixel electrode in another photolithography process and then the passivation layer is deposited, in which case the passivation layer over the pixel electrode may not be removed, or after the passivation layer is deposited, the another one photolithography process is performed to remove the passivation layer in the pixel forming region to form the pixel electrode.

In addition, in the step shown in FIG. **5d**, there may be no pixel electrode material layer remained in the source electrode forming region and the drain electrode forming region on the second insulating layer **126**.

In the present invention, the source and drain electrodes of the TFT is connected with the ohmic contact layers in the source and drain region directly by contacting with the ohmic contact layers or indirectly via other conductive layer, such as the pixel electrode material layer, that contacts with the ohmic contact layer.

It should be appreciated that the embodiments described above are intended to illustrate but not limit the present invention. Although the present invention has been described in detail herein with reference to the preferred embodiments, it should be understood by those skilled in the art that the present invention can be realized with different material and equipment as necessary, and that various modification and

equivalents thereof can be made herein without departing from the spirit and scope of the present invention.

What is claimed is:

1. A manufacturing method of a pixel unit of a TFT-LCD array substrate, comprising the steps of:

depositing sequentially on a substrate stacked layers of a gate metal layer, a first gate insulating layer, an active layer, and an ohmic contact layer, and then patterning the stacked layers to form a gate island;

depositing sequentially a second insulating layer and a source/drain metal layer on the substrate, patterning the second insulating layer and the source/drain metal layer so as to form a source electrode on the second insulating layer and form an opening on the gate island to expose the ohmic contact layer in a source region, a drain region, and a channel region between the source region and the drain region of the TFT;

depositing a pixel electrode material layer on the substrate, patterning the pixel electrode material layer and the ohmic contact layer exposed in the opening so that the ohmic contact layer on the channel region is removed, the source electrode is connected with the ohmic contact layer in the source region via the pixel electrode material layer on the source electrode, the drain electrode and the pixel electrode connected with each other are formed on the second insulating layer, and the drain electrode is connected with the ohmic contact layer in the drain region; and

depositing a passivation layer on the substrate to cover the TFT.

2. The manufacturing method according to claim 1, wherein the passivation layer on the pixel electrode is removed to expose the pixel electrode.

3. The manufacturing method according to claim 1, wherein the second insulating layer and the source/drain metal layer are patterned with a first gray tone mask.

4. The manufacturing method according to claim 3, wherein patterning with the first gray tone mask comprises the steps of:

forming a first photoresist layer on the source/drain metal layer;

exposing and developing the first photoresist layer with the first gray tone mask to form a first gray tone photoresist pattern, comprising a first full photoresist region that comprises a source electrode forming region, a first pho-

toresist-free region that comprises a source forming region, a drain forming region, and a channel forming region, and a first partial photoresist region that comprises a pixel electrode forming region and a drain electrode forming region;

etching sequentially the source/drain metal layer and the second insulating layer to form an opening in the second insulating layer on the gate island;

processing the first gray tone photoresist pattern to completely remove the photoresist in the first partial photoresist region and reduce the thickness of the photoresist in the first full photoresist region;

etching the source/drain metal layer to form the source electrode; and

removing the photoresist remaining on the source electrode.

5. The manufacturing method according to claim 1, wherein the pixel electrode layer is patterned with a second gray tone mask.

6. The manufacturing method according to claim 5, wherein patterning with the second gray tone mask comprises the steps of:

forming a second photoresist layer on the pixel electrode material layer;

exposing and developing the second photoresist layer with the second gray tone mask to form a second gray tone photoresist pattern, comprising a second partial photoresist region that comprises a source electrode forming region and a source forming region, a second photoresist-free region that comprises a channel forming region, a second full photoresist region that comprises a pixel electrode forming region, a drain electrode forming region, and a drain forming region; and etching the pixel electrode material layer.

7. The manufacturing method according to claim 6, further comprises:

processing the second gray tone photoresist pattern after etching the pixel electrode material layer to completely remove the photoresist in the second partial photoresist region and reduce the thickness of the photoresist in the second full photoresist region; and

depositing the passivation layer on the substrate, and lifting off the second photoresist pattern to remove the passivation layer thereon, so as to expose the pixel electrode.

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| 专利名称(译) | 一种薄膜晶体管 - 液晶显示器的制造方法，具有暴露栅极岛部分的绝缘层 | | |
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| [标]申请(专利权)人(译) | 北京京东方光电科技有限公司 | | |
| 申请(专利权)人(译) | 北京京东方光电科技有限公司. | | |
| 当前申请(专利权)人(译) | 北京京东方光电科技有限公司. | | |
| [标]发明人 | QIU HAIJUN WANG ZHANGTAO CHEN XU MIN TAE YUP | | |
| 发明人 | QIU, HAIJUN WANG, ZHANGTAO CHEN, XU MIN, TAE YUP | | |
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摘要(译)

公开了一种TFT-LCD阵列基板的像素单元及其制造方法。在该制造方法中，除了第一绝缘层和钝化层之外，采用第二绝缘层覆盖栅极岛，并在栅极岛上形成开口，以暴露栅极岛的沟道区，源极区和漏极区。TFT。利用灰色调掩模和光致抗蚀剂剥离工艺进行图案化，从而可以仅用三个掩模实现TFT-LCD阵列基板。

