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Chen

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(54) **THIN FILM TRANSISTOR LIQUID CRYSTAL DISPLAY AND FABRICATION METHOD THEREOF**

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(22) Filed: **Aug. 25, 2003**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Dec. 24, 2002 (TW) ..... 91137146 A

(51) **Int. Cl.**[7] **H01L 29/04**; H01L 31/036; H01L 31/0376; H01L 29/76; G02F 1/1343

(52) **U.S. Cl.** **257/72**; 257/57; 257/59; 257/66; 349/145

(58) **Field of Search** 257/72, 59, 66, 257/57; 349/145

(56) **References Cited**

U.S. PATENT DOCUMENTS

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* cited by examiner

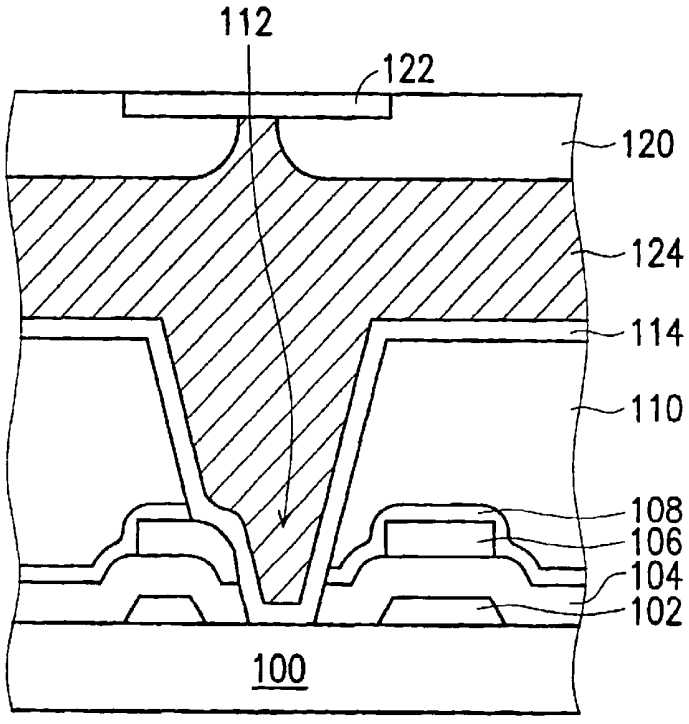
Primary Examiner—Steven Loke

(74) *Attorney, Agent, or Firm*—Thomas, Kayden, Horstemeyer, & Risley

(57) **ABSTRACT**

A thin film transistor liquid crystal display (TFT-LCD) and fabrication method thereof. The fabrication method includes depositing a first metal layer on a transparent substrate, patterning the first metal layer to form at least two adjacent gate electrodes, forming a gate insulating layer on the gate electrodes, forming a semiconductor layer on the insulating layer, patterning the semiconductor layer into a predetermined shape, depositing a second metal layer on the transparent substrate, patterning the second metal layer to form a source/drain electrode layer, and depositing an insulating layer on the transparent substrate. A contact hole is defined via the insulating layer, source/drain electrode layer, and gate insulating layer, exposing a part of the surface of transparent substrate between the adjacent gate electrodes. A transparent conductive layer is deposited on the transparent substrate, and a light-shielding matrix is formed directly above the contact hole.

10 Claims, 6 Drawing Sheets



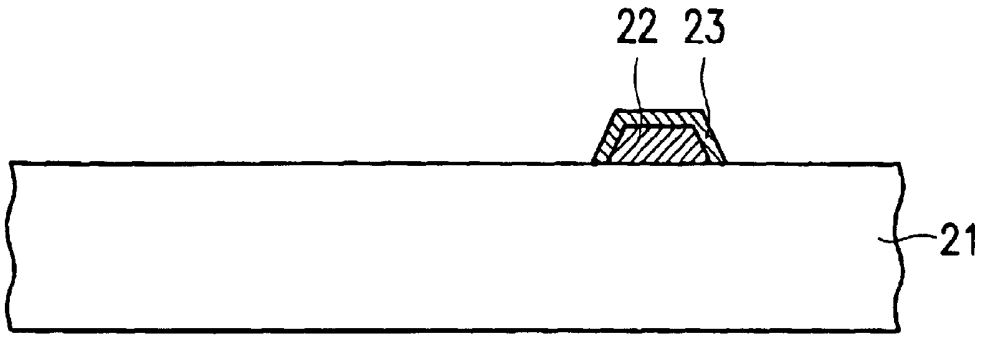


FIG. 1A (PRIOR ART)

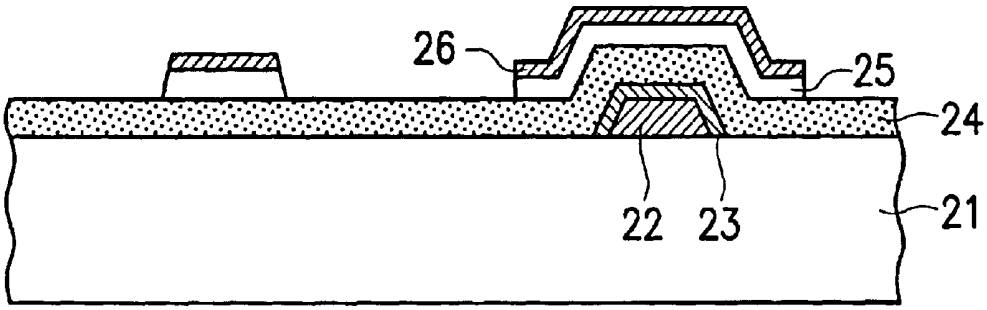


FIG. 1B (PRIOR ART)

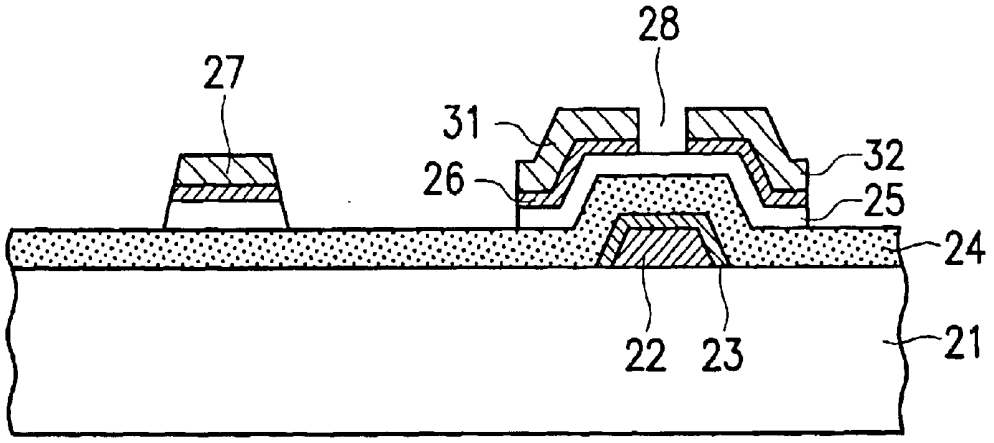


FIG. 1C (PRIOR ART)

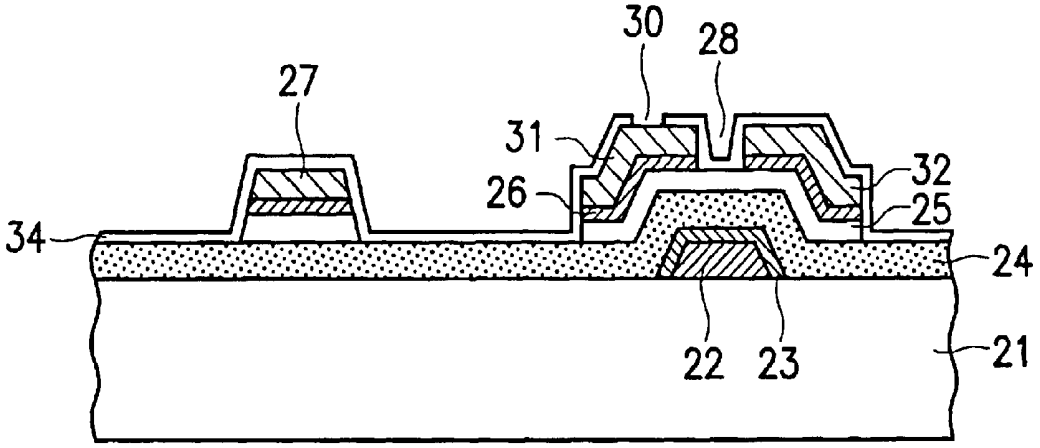


FIG. 1D (PRIOR ART)

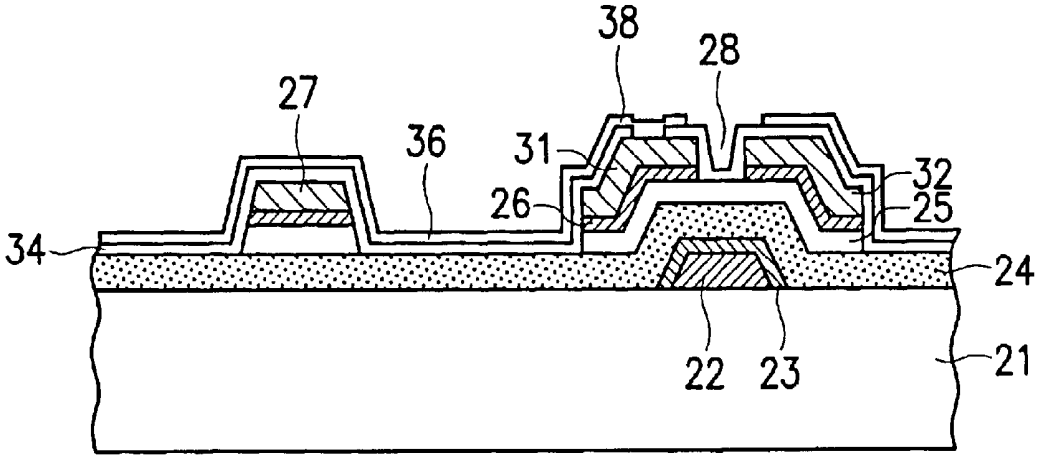


FIG. 1E (PRIOR ART)

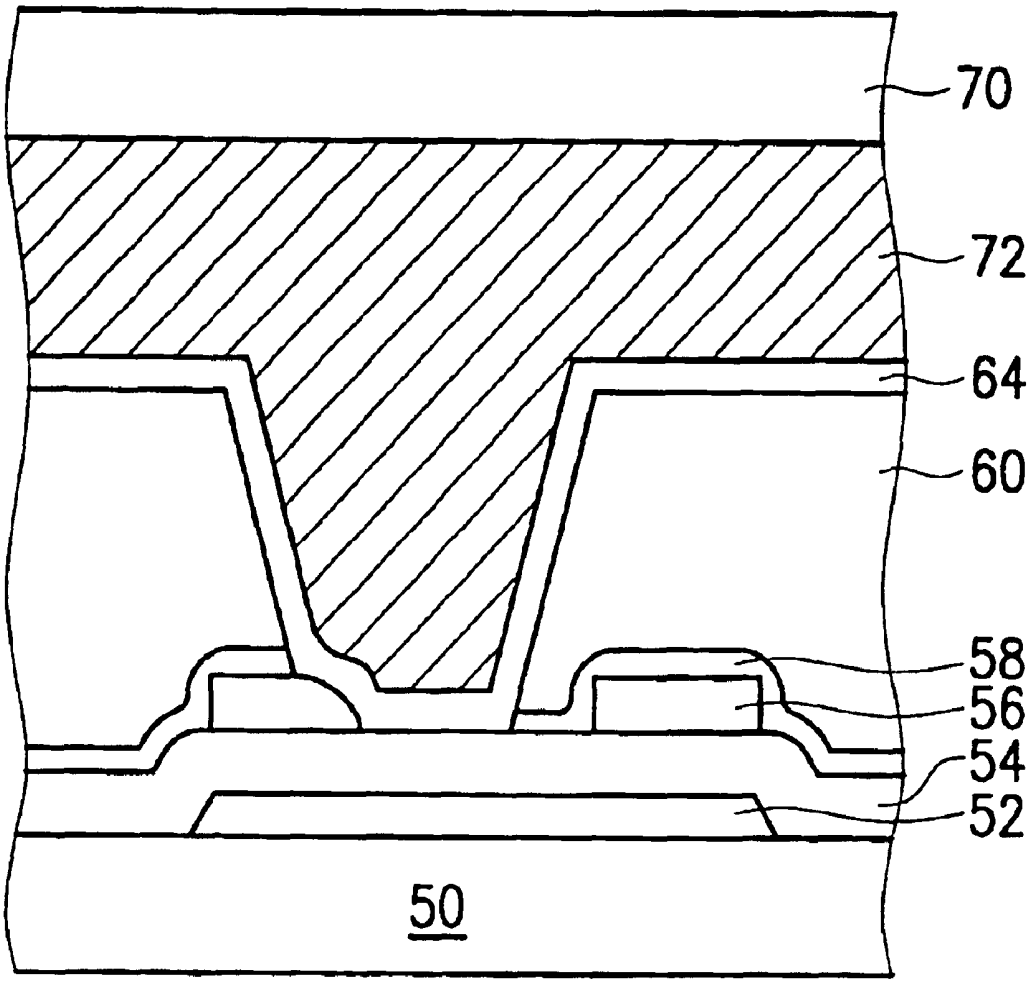


FIG. 2 (PRIOR ART)

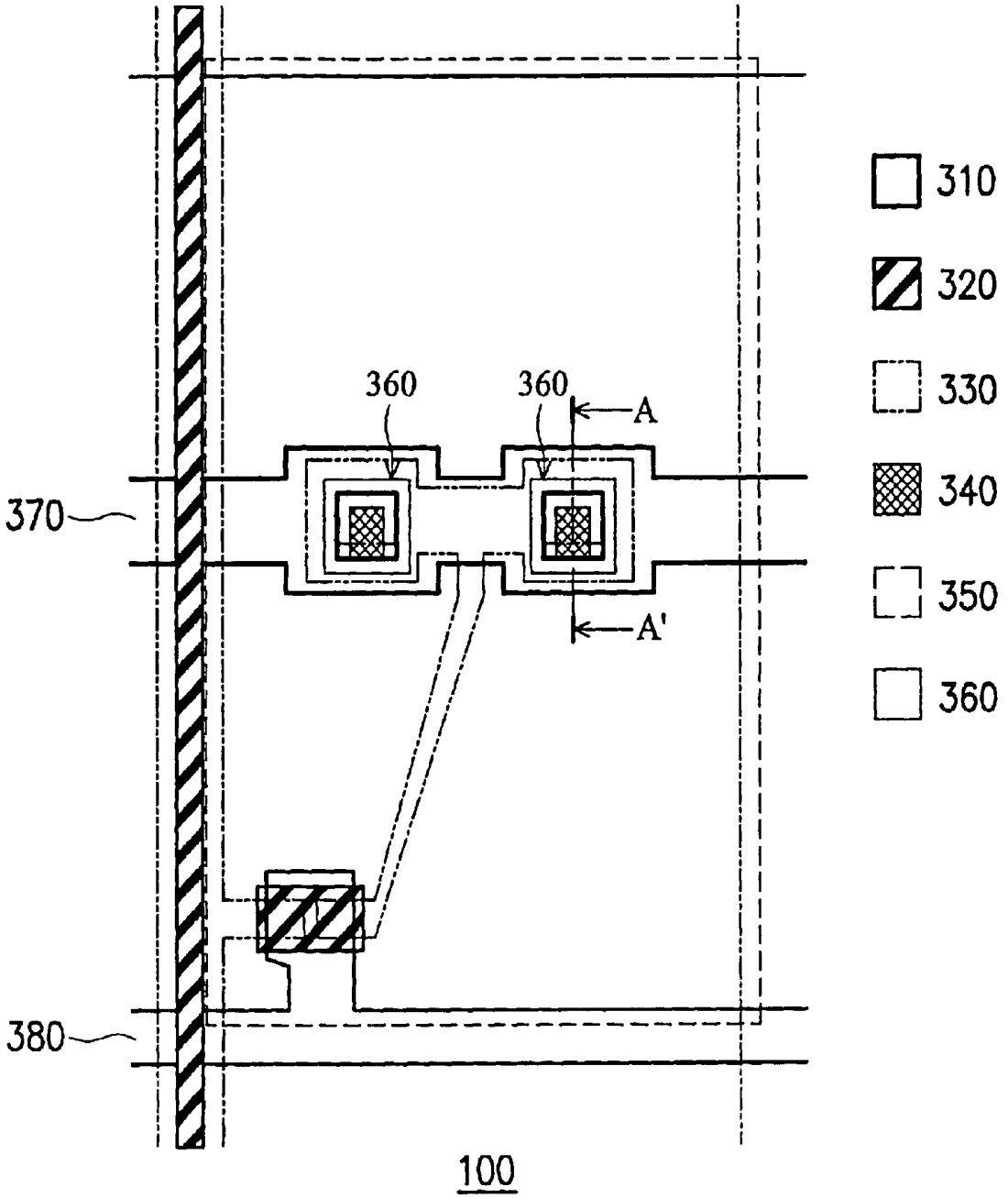


FIG. 3

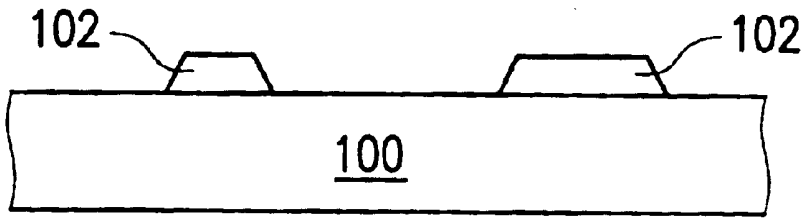


FIG. 4A

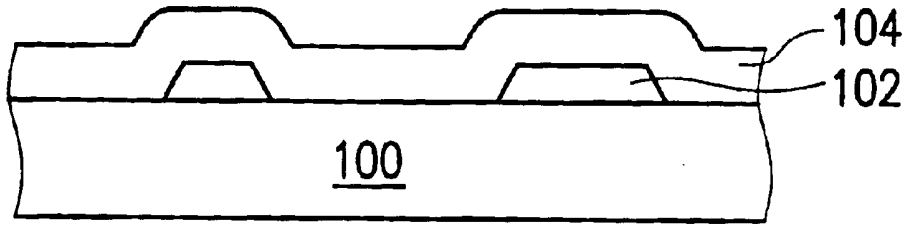


FIG. 4B

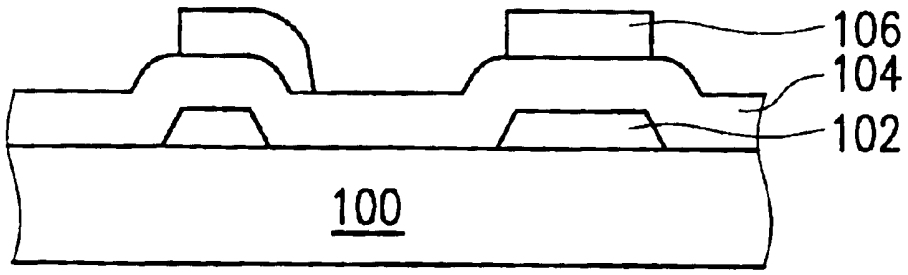


FIG. 4C

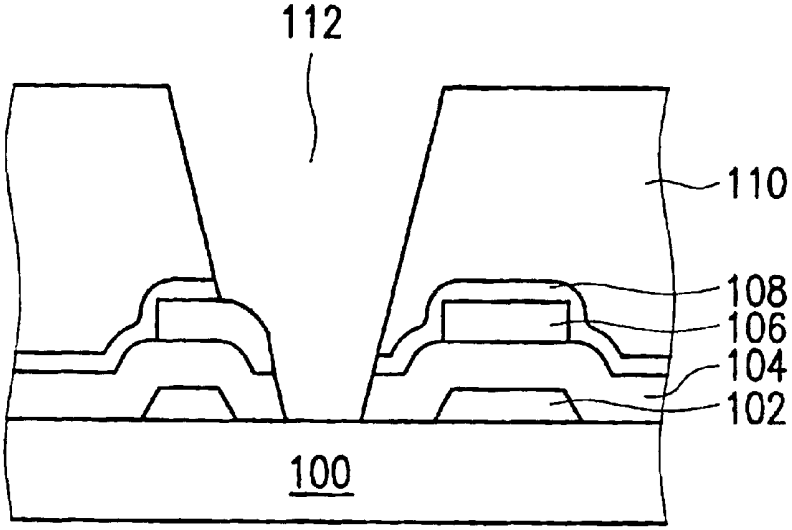

112
110
108
106
104
102
100

FIG. 4D

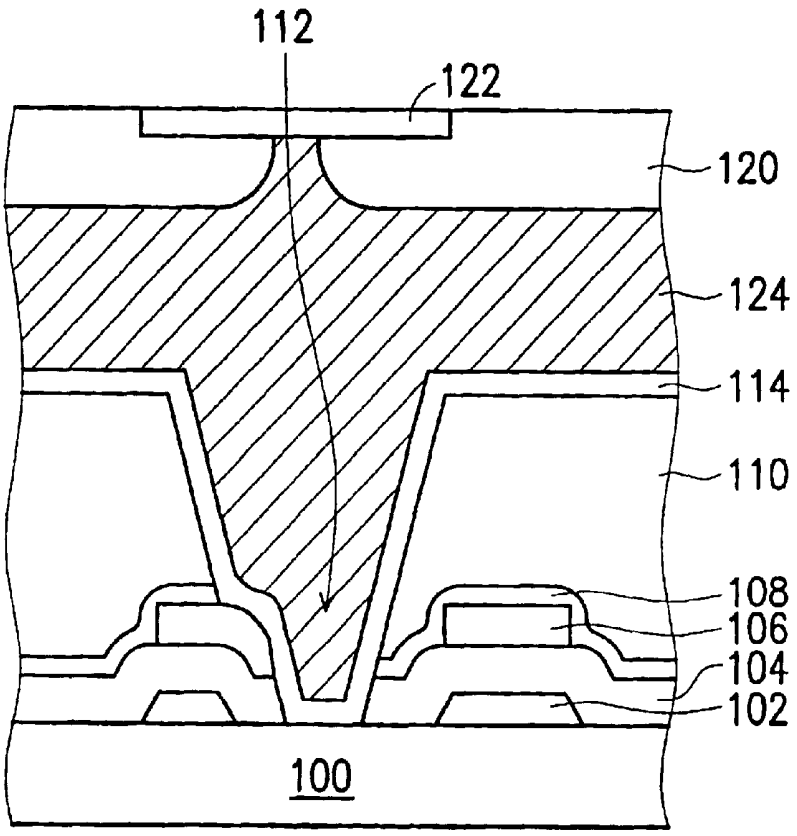

112
122
120
124
114
110
108
106
104
102
100

FIG. 4E

THIN FILM TRANSISTOR LIQUID CRYSTAL DISPLAY AND FABRICATION METHOD THEREOF

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a thin film transistor liquid crystal display (TFT-LCD), and more particularly to a TFT-LCD manufacturing process with fewer photolithography steps.

2. Description of the Related Art

Liquid crystal display (LCD) is a commonly used flat panel display technology. Owing to dielectric anisotropy and conductive anisotropy of liquid crystal molecules, molecular orientation of liquid crystals can be shifted under an external electronic field, such that various optical effects are produced.

An LCD panel is generally made up of two substrates, with a certain gap preserved therebetween, and a liquid crystal layer filled in the gap. Respective electrodes are formed on the two substrates, respectively, to control the orientation and shift of liquid crystal molecules.

A TFT-LCD panel is generally made up of a TFT array substrate and a color filter substrate. The detailed structures are described as follows.

FIGS. **1A–1E** are cross-sections showing the conventional manufacturing process of a TFT-LCD. First, as in FIG. **1A**, a metal layer of, for example, Mo—Al—Nd is deposited on a transparent substrate **21**. The metal layer is then defined to form a gate electrode **22** by photolithography. A gate insulating layer **23** is then formed on the gate electrode **22**.

Next, as in FIG. **1B**, an insulating layer **24**, a first semiconductor layer **25** of, for example, amorphous silicon (a-Si) and a second semiconductor layer **26** of, for example, n+ doped amorphous silicon are deposited on the transparent substrate **21** sequentially. The insulating layer **24**, first semiconductor layer **25** and second semiconductor layer **26** are then defined to form an island-shaped structure.

Next, as in FIG. **1C**, an Al alloy layer of, for example, Al, Al—Nb, Al—Nd, Al—Ti or Al—Si—Cu is then deposited on the transparent substrate **21**. The metal layer is then defined to form a signal line **27** and a source/drain metal layer by photolithography, wherein the source/drain metal layer includes a source electrode **31** and drain electrode **32**, with a channel **28**, exposing the first semiconductor layer **25**, formed therebetween.

Next, as in FIG. **1D**, a protective layer **34** is deposited on the transparent substrate **21**, covering the TFT element while exposing the contact hole **30**, to protect the TFT element from erosion. The protective layer **34** is, for example, a silicon nitride layer.

Next, as in FIG. **1E**, an indium tin oxide layer is deposited on the transparent substrate **21**. The indium tin oxide layer is then defined to form a signal line area **36** and a pixel area **38**.

FIG. **2** is a cross-section of another conventional TFT-LCD, showing the storage capacitor thereof. Manufacturing of the TFT-LCD requires six photolithography steps. First, a first metal layer is deposited on a transparent substrate **50**. The first metal layer is then defined to form a gate electrode **52** by a first photolithography step. A gate insulating layer **54** is then formed on the gate electrode **52** and defined by a second photolithography step. A semiconductor layer (not shown) is then formed on the gate insulating layer **54** and defined by a third photolithography step. Next, a second metal layer is deposited on the transparent substrate **50**, followed by a fourth photolithography step to form a source/drain metal layer **56**. Next, a protective layer **58** and a planarization layer **60** are formed sequentially on the transparent substrate **50**, covering the TFT element for protection from erosion. The planarization layer **60** and protective layer **58** are then defined by a fifth photolithography step to form a contact hole. Finally, an indium tin oxide layer **64** is deposited on the transparent substrate **50** and defined by a sixth photolithography step to form a signal line area and a pixel area.

Afterwards, fabrication of a color filter **70** and liquid crystal layer **72** is performed.

Owing to the two steps of contact-hole manufacture, up to six photolithography steps are required, lowering throughput, and increasing costs.

SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to reduce the number of required photolithography steps in production of a TFT-LCD.

Therefore, the invention provides a TFT-LCD and the fabrication method thereof. The TFT-LCD comprises a transparent substrate provided with at least two adjacent gate electrodes, a gate insulating layer on the gate electrodes, a semiconductor layer in a predetermined shape on the insulating layer, a source/drain electrode layer on a predetermined area of the transparent substrate, and an insulating layer on the source/drain electrode layer. A contact hole is defined via the insulating layer, source/drain electrode layer, and gate insulating layer, exposing a part of the surface of transparent substrate between the adjacent gate electrodes. A transparent conductive layer is on the transparent substrate, and a light-shielding matrix is directly above the contact hole.

The fabrication method of the TFT-LCD comprises depositing a first metal layer on a transparent substrate, patterning the first metal layer to form at least two adjacent gate electrodes, forming a gate insulating layer on the gate electrodes, forming a semiconductor layer on the insulating layer, patterning the semiconductor layer into a predetermined shape, depositing a second metal layer on the transparent substrate, patterning the second metal layer to form a source/drain electrode layer, and depositing an insulating layer on the transparent substrate. A contact hole is defined via the insulating layer, source/drain electrode layer, and gate insulating layer, exposing a part of the surface of transparent substrate between the adjacent gate electrodes. A transparent conductive layer is deposited on the transparent substrate, and a light-shielding matrix is formed directly above the contact hole.

According to the invention, the required photolithography steps are reduced, shortening the manufacturing time, increasing throughput and lowering costs. Meanwhile, the design of forming the gate electrodes on both sides of the contact hole prevents over-etching of the contact hole, protecting the gate electrodes from short-circuiting. In addition, the light-shielding matrix directly above the contact hole prevents light leakage around the contact hole.

DESCRIPTION OF THE DRAWINGS

The present invention can be more fully understood by reading the subsequent detailed description and examples with references made to the accompanying drawings, wherein:

FIGS. 1A–1E are cross-sections showing the conventional manufacturing process of a TFT-LCD;

FIG. 2 is a cross-section of a conventional TFT-LCD;

FIG. 3 is a top view of a TFT-LCD in the invention; and

FIGS. 4A–4E are cross-sections of the TFT-LCD taken at the line A—A' in FIG. 3, showing the manufacturing process of TFT-LCD in the invention.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 3 is a top view showing a TFT-LCD in the invention. The TFT-LCD comprises a transparent substrate **100**, gate line area **310**, n+ doped a-Si layer **320**, source/drain electrode area **330**, contact-hole area **340**, indium tin oxide layer **350**, light shielding matrix (black matrix) **360** on a color filter, capacitor line **370**, and gate line **380**.

FIGS. 4A–4E are cross-sections of the TFT-LCD taken at the line A—A' in FIG. 3, showing the manufacturing process of TFT-LCD in the invention.

First, as in FIG. 4A, a first metal layer of, for example, Mo—Al—Nd alloy is deposited on a transparent substrate **100**, and then defined by a first photolithography step to form gate electrodes **102**.

Next, as in FIG. 4B, a gate insulating layer **104** is formed on the gate electrodes **102**. For example, an oxide layer is formed on the gate electrodes **102** by chemical vapor deposition (CVD). Next, a semiconductor layer (not shown) of, for example, n+ doped a-Si is formed on the gate insulating layer **104**, and then defined by a second photolithography step.

Next, as in FIG. 4C, a second metal layer of, for example, Al, Al—Nb, Al—Nd, Al—Ti or Al—Si—Cu is deposited on the transparent substrate **100**, and then defined by a third photolithography step to form a source/drain electrode layer **106**.

Next, as in FIG. 4D, insulating layers, for example, a protective layer **108** and a planarization layer **110** are formed on the transparent substrate **100** sequentially, covering the TFT elements to protect them from erosion. The protective layer **108** is, for example, an oxide or nitride layer formed by chemical vapor deposition. The planarization layer **110** is, for example, an oxide layer formed by chemical vapor deposition. Next, the planarization layer **110**, protective layer **108**, source/drain electrode layer **106** and the gate insulating layer **104** are defined by a fourth photolithography step to form a contact hole **112** between two adjacent gate electrodes **102**, separated from the two gate electrodes.

Next, as in FIG. 4E, a transparent conductive layer **114** of, for example, indium tin oxide is deposited on the transparent substrate **100**, and then defined by a fifth photolithography step to form a signal line area and a pixel area.

As shown in FIG. 4E, the TFT-LCD in the invention further comprises a color filter **120** provided a predetermined distance above the transparent substrate **100**. A light-shielding matrix area **122** is disposed on the color filter **120**, directly above the contact hole **112**, whereby light leakage around the edge domain is prevented. Next, a liquid crystal layer **124** is filled between the color filter **120** and the transparent substrate **100**.

Thus, the TFT-LCD of the embodiment comprises a transparent substrate **100** provided with at least two adjacent gate electrodes **102**, a gate insulating layer **104** on the gate electrodes **102**, a predetermined-shaped semiconductor layer (not shown) on the gate insulating layer **104**, a source/drain electrode layer **106** on a predetermined area of the transparent substrate **100**, a protective layer **108** and a planarization layer **110** on the source/drain electrode layer **106**, a contact hole **112** via the protective layer **108**, planarization layer **110**, source/drain electrode layer **106** and gate insulating layer **104**, exposing a part of the surface of transparent substrate **100**, an indium-tin oxide layer **114** on the transparent substrate **100**, and a light-shielding matrix **122** directly above the contact hole **112**.

According to the invention, in the step of etching the protective layer **108** to form a contact hole **112**, the source/drain electrode layer **106** and the gate insulating layer **104** are etched together with the protective layer **108** in a single photolithography step, and the step of defining the gate insulating layer **104** is, therefore, eliminated.

According to the invention, the required photolithography steps are reduced, shortening manufacturing time, increasing throughput and lowering costs. Meanwhile, the design of forming the gate electrodes on both sides of the contact hole prevents over-etching of the contact hole, protecting the gate electrodes from short circuit. In addition, the light-shielding matrix directly above the contact hole prevents light leakage around the contact hole.

The foregoing description has been presented for purposes of illustration and description. Obvious modifications or variations are possible in light of the above teaching. The embodiments were chosen and described to provide the best illustration of the principles of this invention and its practical application to thereby enable those skilled in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the present invention as determined by the appended claims when interpreted in accordance with the breadth to which they are fairly, legally, and equitably entitled.

What is claimed is:

1. A thin film transistor-LCD, comprising:

a transparent substrate provided with at least two adjacent gate electrodes;

a gate insulating layer on the gate electrodes;

a semiconductor layer in a predetermined shape on the insulating layer;

a source/drain electrode layer on a predetermined area of the transparent substrate;

an insulating layer on the source/drain electrode layer;

a contact hole via the insulating layer, source/drain electrode layer, and gate insulating layer, exposing a part of the surface of transparent substrate between the adjacent gate electrodes;

a transparent conductive layer on the transparent substrate; and

a light-shielding matrix directly above the contact hole.

2. The thin film transistor-LCD as claimed in claim **1**, wherein each of the gate electrodes is a Mo—Al—Nd electrode.

3. The thin film transistor-LCD as claimed in claim **1**, wherein the source/drain electrode layer is an Al, Al—Nb, Al—Nd, Al—Ti or Al—Si—Cu layer.

4. The thin film transistor-LCD as claimed in claim **1**, wherein the gate insulating layer is an oxide layer formed by chemical vapor deposition.

5. The thin film transistor-LCD as claimed in claim **1**, wherein the insulating layer is an oxide or nitride layer formed by chemical vapor deposition.

6. The thin film transistor-LCD as claimed in claim **1**, further comprising a color filter a predetermined distance

above the transparent substrate, wherein the light-shielding matrix directly above the contact hole is disposed on the color filter.

7. The thin film transistor-LCD as claimed in claim **1**, wherein the gate electrodes are separate from the contact hole.

8. A thin film transistor-LCD, comprising:

a transparent substrate provided with at least two adjacent gate electrodes;

a gate insulating layer on the gate electrodes;

a semiconductor layer in a predetermined shape on the insulating layer;

a source/drain electrode layer on a predetermined area of the transparent substrate;

an insulating layer on the source/drain electrode layer;

a contact hole, separate from the gate electrodes, via the insulating layer, source/drain electrode layer, and gate insulating layer, exposing a part of the surface of transparent substrate between the adjacent gate electrodes;

an indium tin oxide layer on the transparent substrate;

a color filter provided a predetermined distance above the transparent substrate; and

a light-shielding matrix on the color filter, directly above the contact hole.

9. The thin film transistor-LCD as claimed in claim **8**, wherein each of the gate electrodes is a Mo—Al—Nd electrode, and the source/drain electrode layer is an Al, Al—Nb, Al—Nd, Al—Ti or Al—Si—Cu layer.

10. The thin film transistor-LCD as claimed in claim **8**, wherein the gate insulating layer is an oxide layer and the insulating layer is an oxide or nitride layer formed by chemical vapor deposition.

* * * * *

专利名称(译)	薄膜晶体管液晶显示器及其制造方法		
公开(公告)号	US6861671	公开(公告)日	2005-03-01
申请号	US10/647885	申请日	2003-08-25
[标]申请(专利权)人(译)	陈鱼鳔宋		
申请(专利权)人(译)	陈MAW-SONG		
当前申请(专利权)人(译)	广辉INC.		
[标]发明人	CHEN MAW SONG		
发明人	CHEN, MAW-SONG		
IPC分类号	G02F1/13 G02F1/1343 H01L21/00 H01L29/04 H01L29/66 H01L29/02 H01L31/036 H01L29/76 H01L31/0376 G02F1/1335 G02F1/1362 H01L21/84		
CPC分类号	G02F1/136227 G02F1/133512		
优先权	091137146 2002-12-24 TW		
其他公开文献	US20040119074A1		
外部链接	Espacenet USPTO		

摘要(译)

薄膜晶体管液晶显示器（TFT-LCD）及其制造方法。制造方法包括在透明基板上沉积第一金属层，图案化第一金属层以形成至少两个相邻的栅电极，在栅电极上形成栅极绝缘层，在绝缘层上形成半导体层，图案化半导体将所述第二金属层沉积在所述透明基板上，图案化所述第二金属层以形成源/漏电极层，以及在所述透明基板上沉积绝缘层。通过绝缘层，源/漏电极层和栅极绝缘层限定接触孔，从而在相邻的栅电极之间暴露透明衬底的一部分表面。透明导电层沉积在透明基板上，并且在接触孔的正上方形成遮光基质。