US007483101B2

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

(10) **Patent No.: US 7,483,101 B2**
(45) **Date of Patent: Jan. 27, 2009**

(54) **TRANSREFLECTION-TYPE LIQUID CRYSTAL DISPLAY DEVICE AND METHOD OF FABRICATING THE SAME**

(75) Inventors: **Byoung Ho Lim**, Kyongsangbuk-do (KR); **Seong Hee Kim**, Kyongsangbuk-do (KR); **Chul Nam**, Gangwon-do (KR); **Jong Woo Park**, Taegu-kwangyokshi (KR); **Gyu Bong Kim**, Taegu-kwangyokshi (KR)

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

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 32 days.

(21) Appl. No.: **11/649,780**

(22) Filed: **Jan. 5, 2007**

(65) **Prior Publication Data**

US 2007/0109475 A1 May 17, 2007

Related U.S. Application Data

(62) Division of application No. 10/747,073, filed on Dec. 30, 2003, now Pat. No. 7,161,648.

(30) **Foreign Application Priority Data**

Apr. 15, 2003 (KR) 10-2003-23654

(51) **Int. Cl.**
G02F 1/1335 (2006.01)

(52) **U.S. Cl.** **349/114**; 349/113; 349/138

(58) **Field of Classification Search** 349/114, 349/113, 138
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,208,395	B1	3/2001	Kanoh et al.	
6,255,130	B1	7/2001	Kim	
6,400,431	B1	6/2002	Morio et al.	
6,697,138	B2	2/2004	Ha et al.	
6,919,945	B2 *	7/2005	Ha	349/114
6,961,111	B1	11/2005	Kuramasu	
2002/0105604	A1 *	8/2002	Ha et al.	349/43
2002/0113927	A1	8/2002	Ha et al.	
2005/0094067	A1	5/2005	Sakamoto et al.	

FOREIGN PATENT DOCUMENTS

JP	2002-023181	1/2002
JP	2002-072229	3/2002

* cited by examiner

Primary Examiner—David Nelms
Assistant Examiner—Thanh-Nhan P Nguyen
(74) *Attorney, Agent, or Firm*—Morgan, Lewis & Bockius LLP

(57) **ABSTRACT**

A transreflection-type liquid crystal display (LCD) device includes a plurality of gate and data lines on a substrate crossing each other defining a plurality of pixel regions, a plurality of storage lines parallel to the gate lines, each storage line positioned between the gate lines, a plurality of thin film transistors disposed at the crossings of the gate and data lines, each thin film transistor having source and drain electrodes and a U-shaped channel region, a negative-type organic insulating layer within the pixel region except for a transmission part, the negative type organic insulating layer having at least one of concave and convex patterns thereon, a reflective electrode on the negative-type organic insulating layer within the pixel region except for the transmission part, and a transparent electrode within the pixel region in electrical contact with the drain electrode.

20 Claims, 14 Drawing Sheets

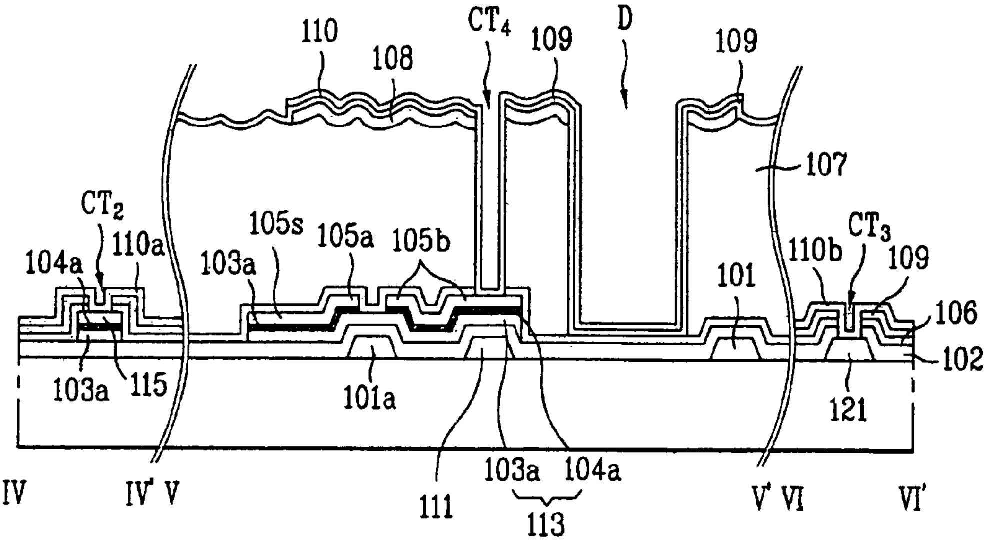


FIG. 1
Related Art

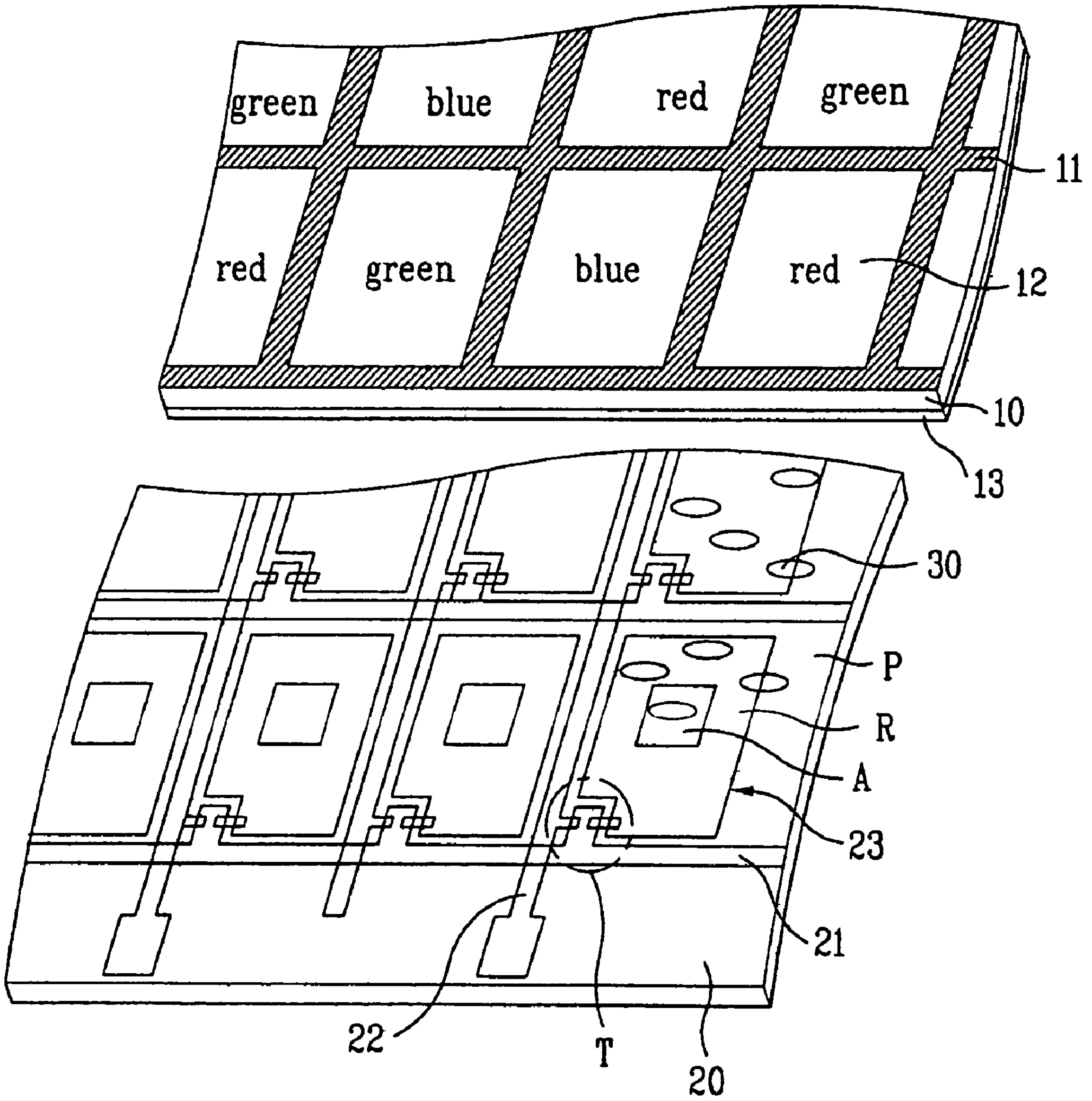


FIG. 2
Related Art

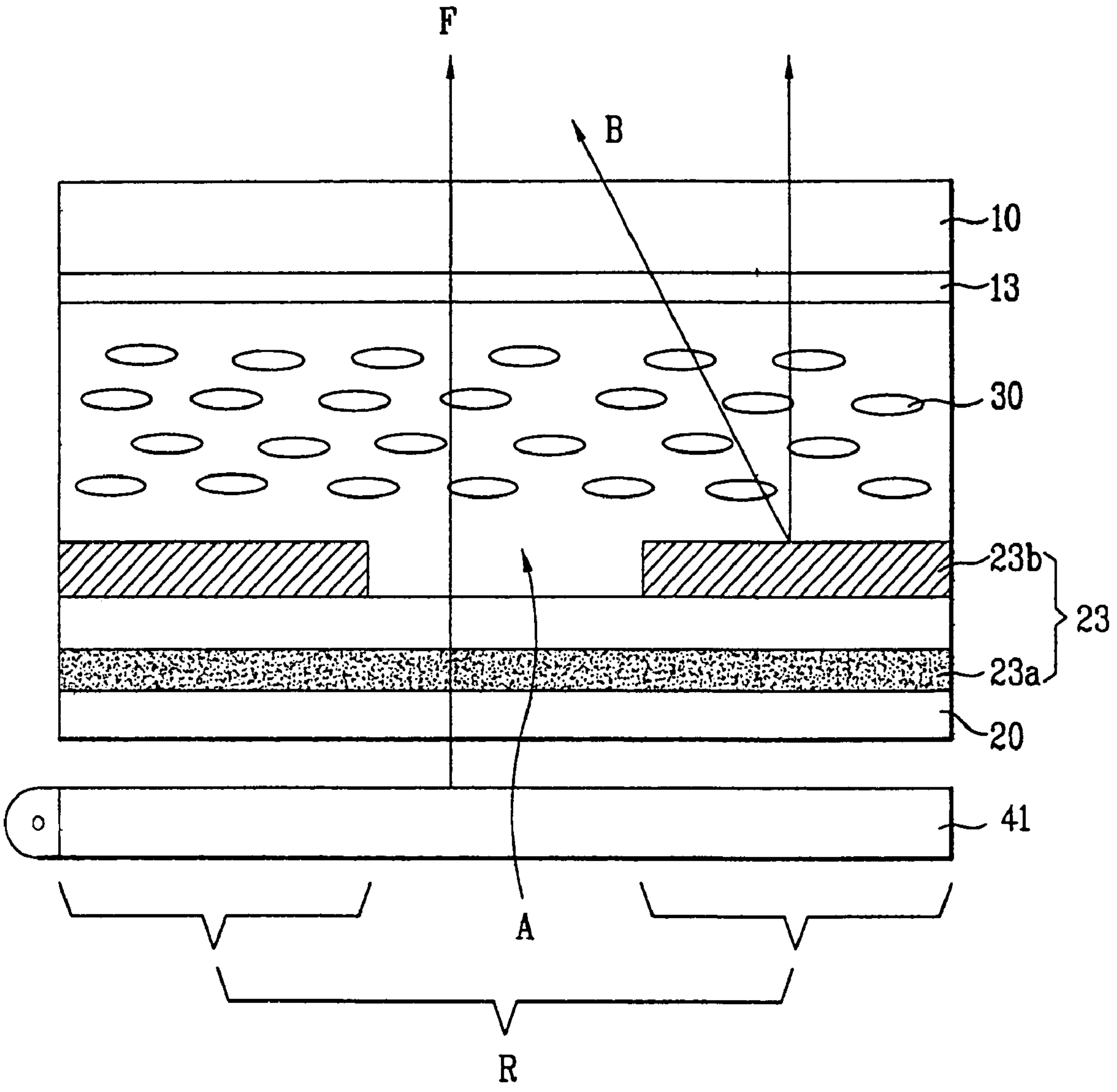


FIG. 3
Related Art

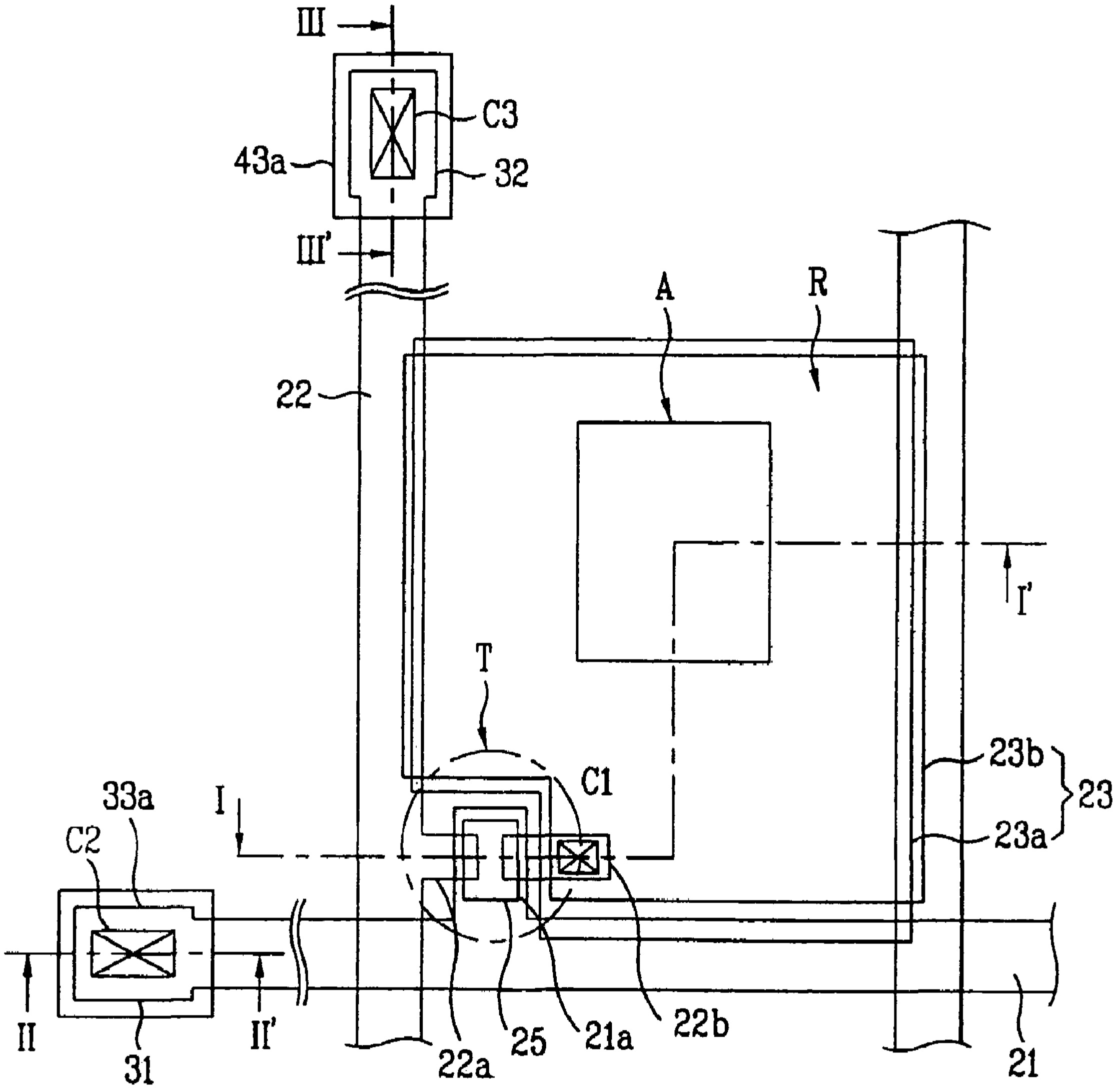


FIG. 4A
Related Art

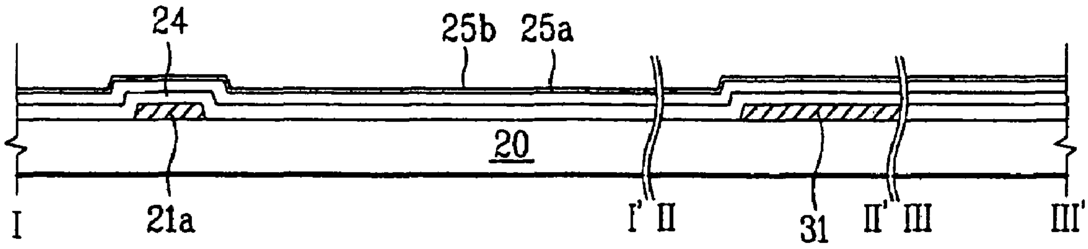


FIG. 4B
Related Art

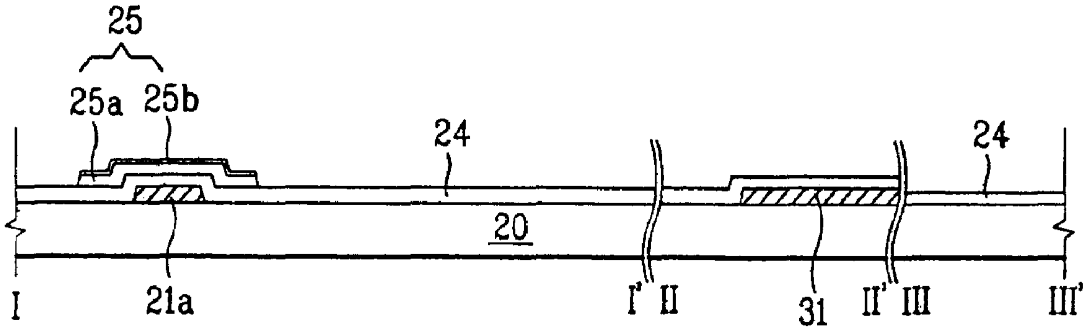


FIG. 4C
Related Art

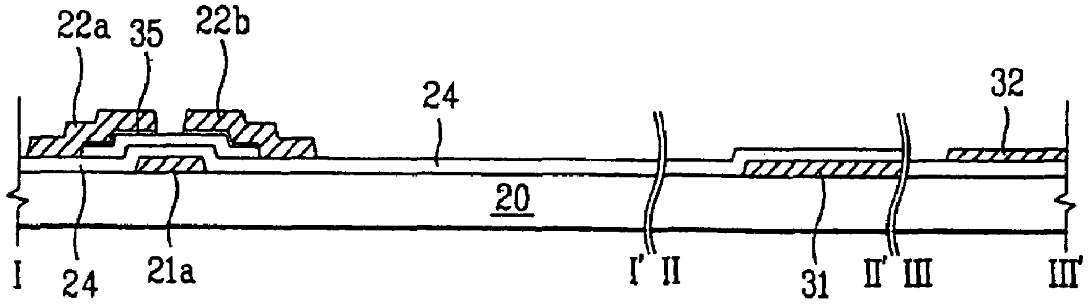


FIG. 4D
Related Art

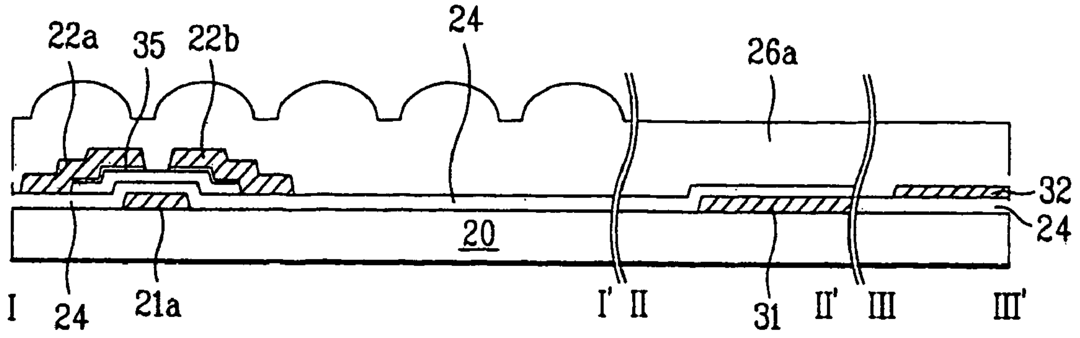


FIG. 4E
Related Art

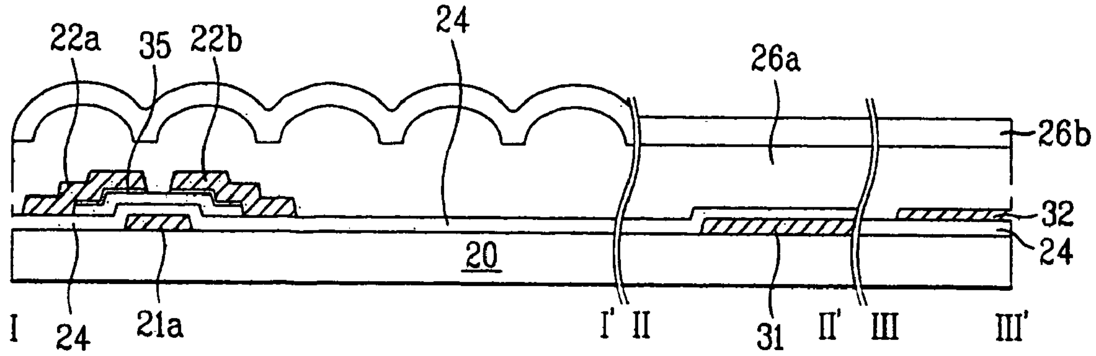


FIG. 4F
Related Art

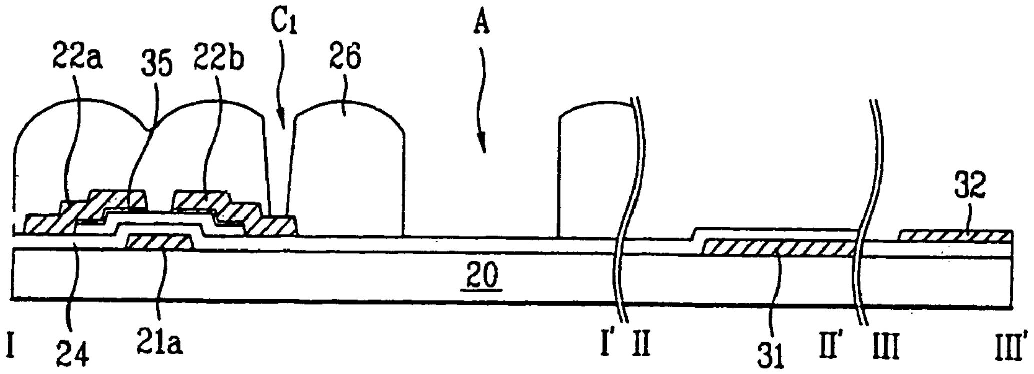


FIG. 4G
Related Art

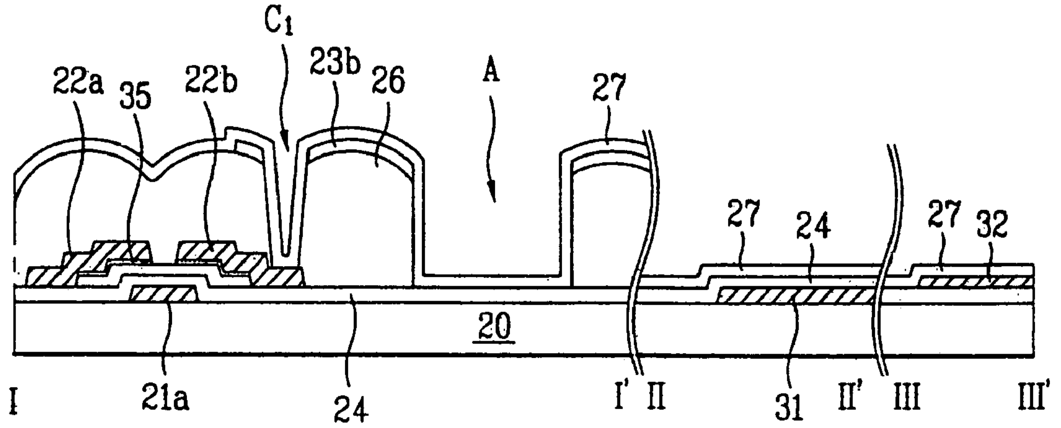


FIG. 4H
Related Art

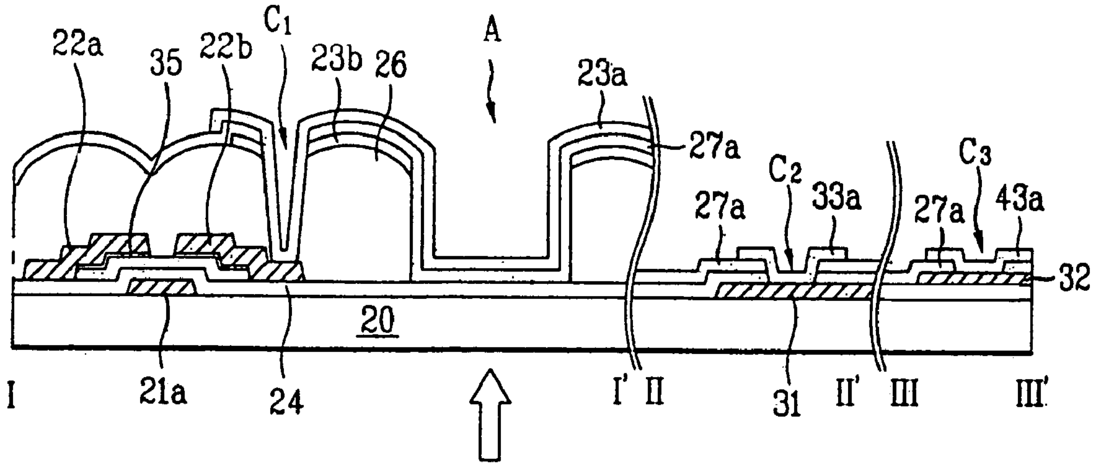


FIG. 5
Related Art

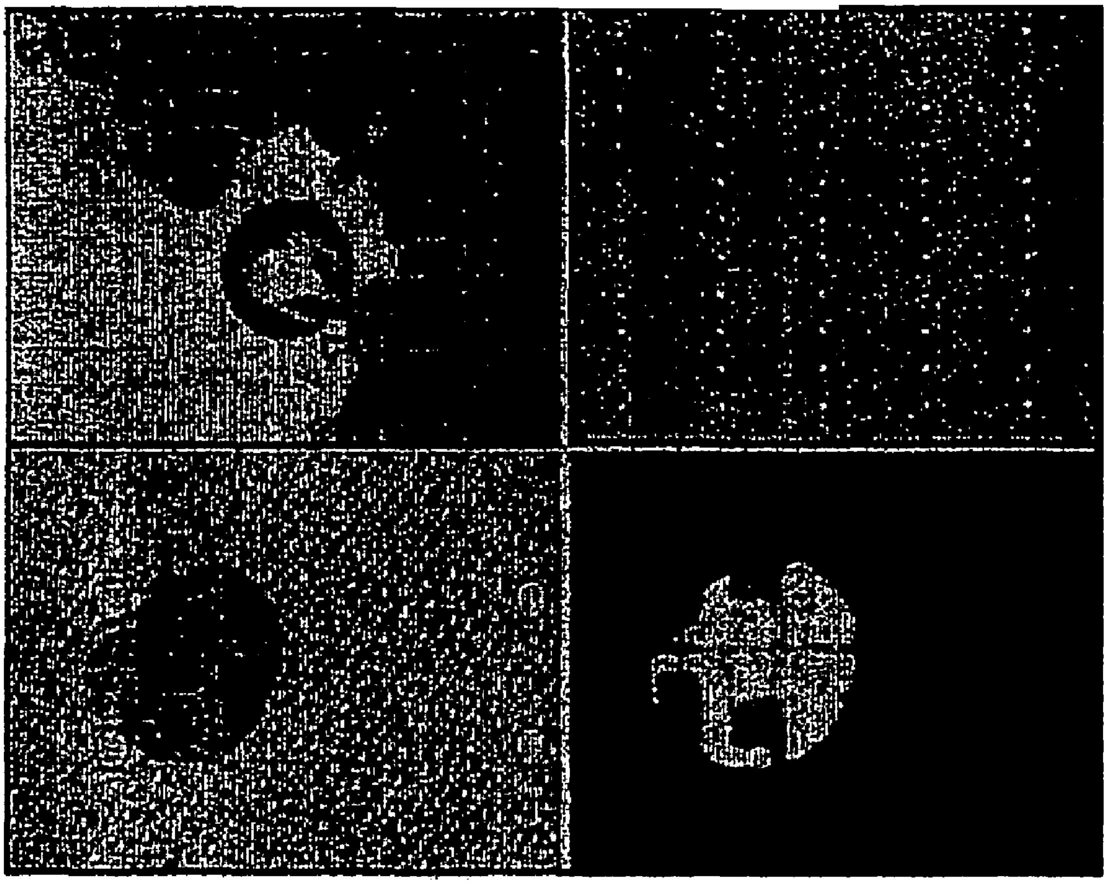


FIG. 6

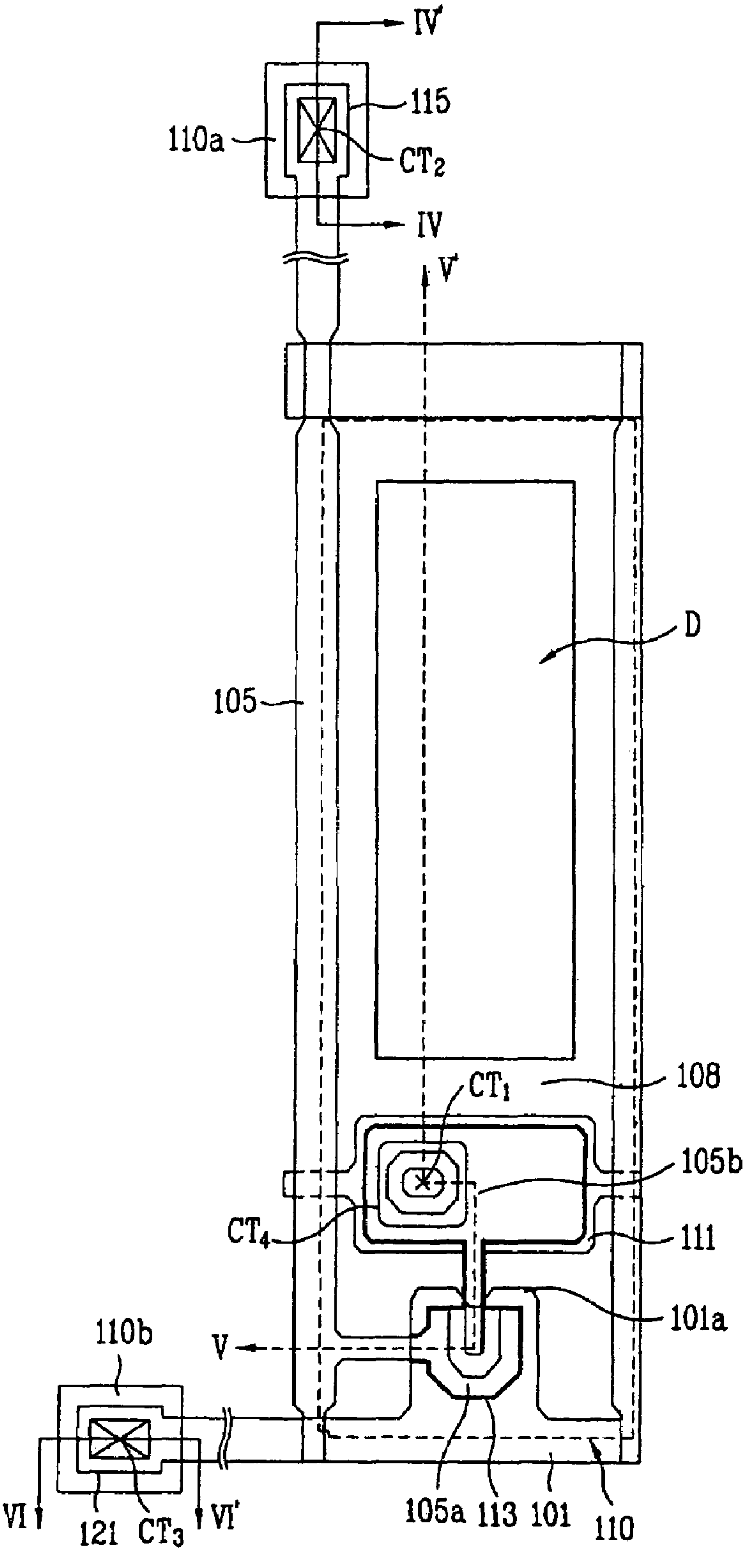

IV'
115
110a
CT_2
IV
V'
D
105
CT_1
108
105b
CT_4
111
101a
110b
V
VI
121
CT_3
VI'
105a
113
101
110

FIG. 7A

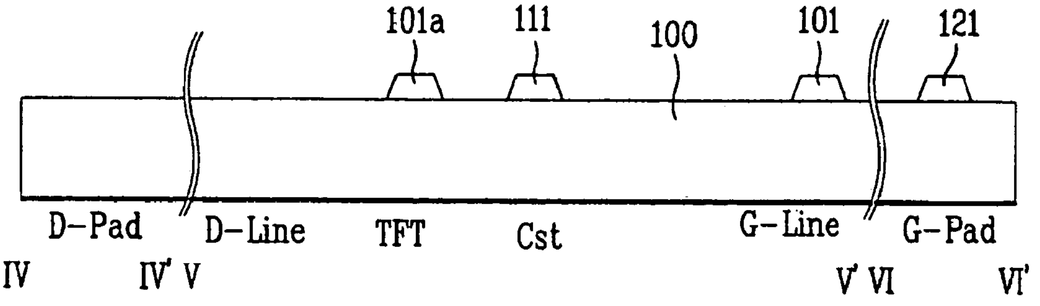


FIG. 7B

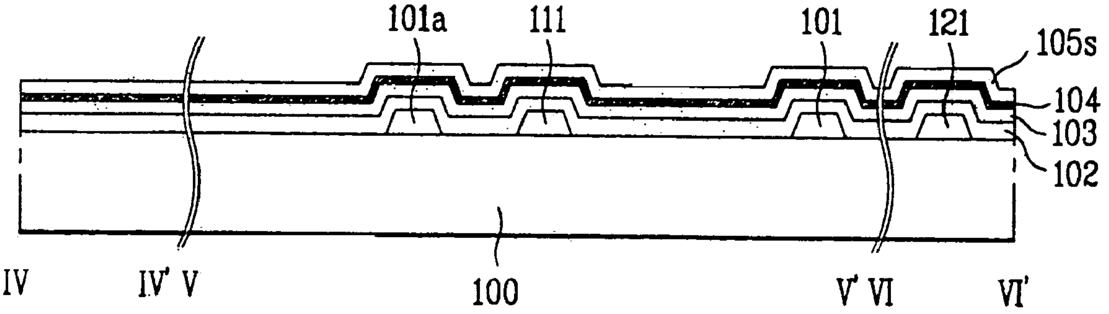


FIG. 7C

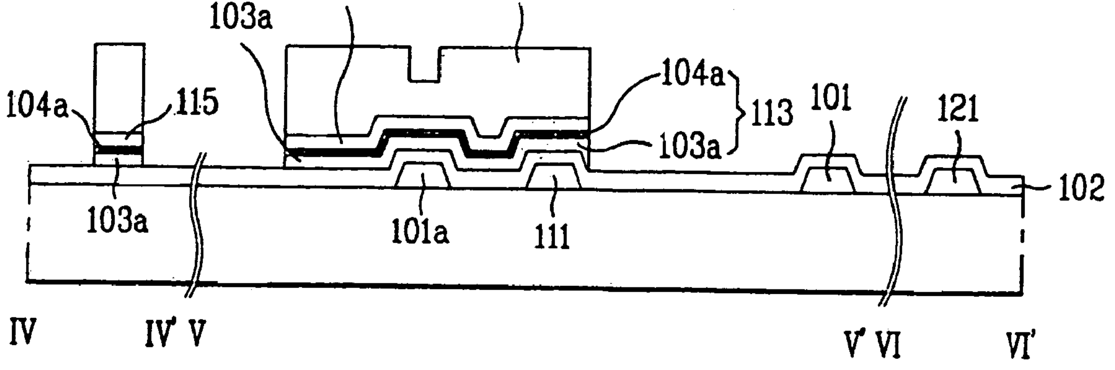


FIG. 7D

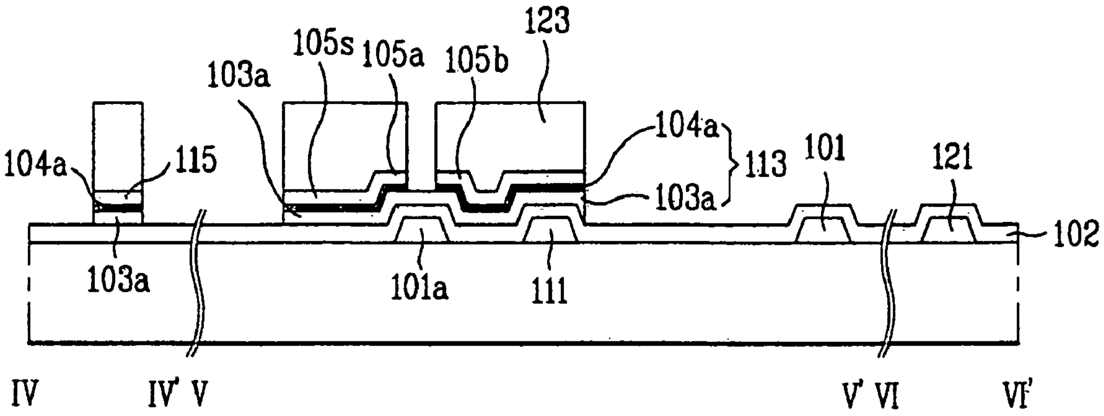

123
105s
105a
105b
103a
104a
115
104a
113
103a
101
121
102
103a
101a
111
IV
IV' V
V' VI
VI'

FIG. 7E

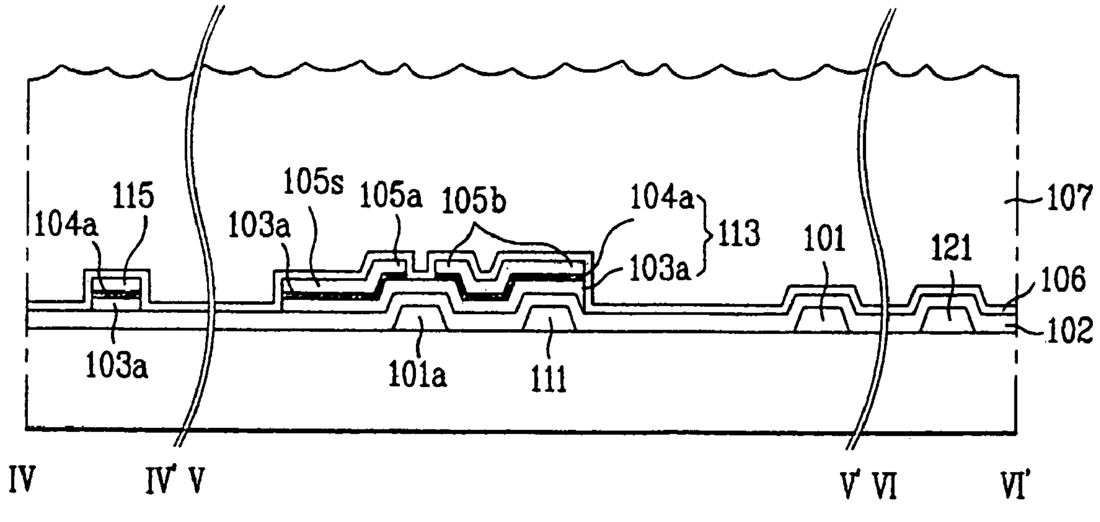

107
104a
115
105s
105a
105b
103a
104a
113
103a
101
121
106
102
103a
101a
111
IV
IV' V
V' VI
VI'

FIG. 7F

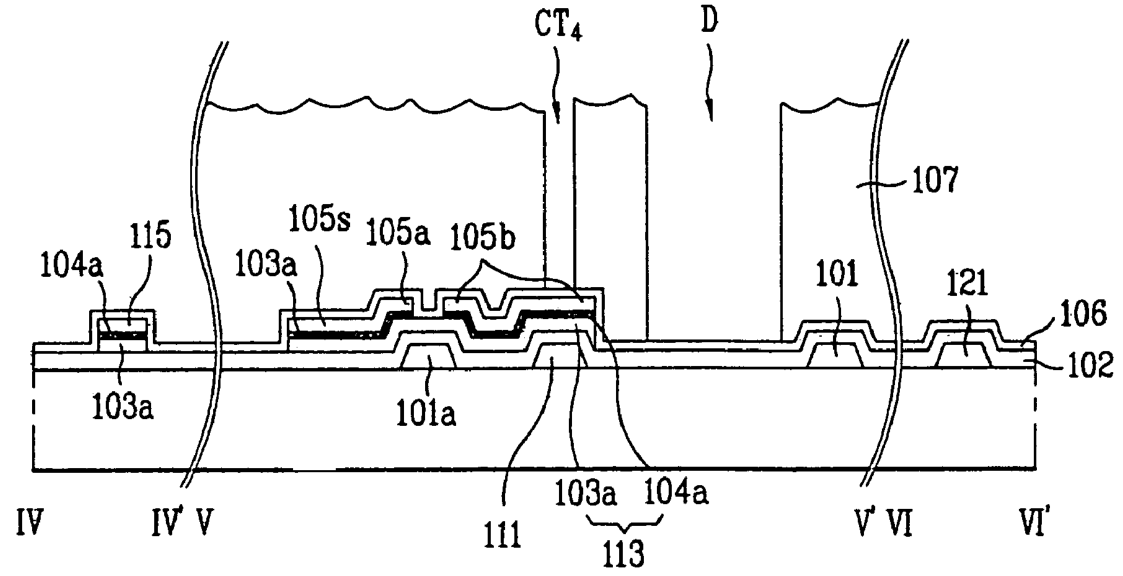

CT_4
D
107
105s
105a
105b
115
104a
103a
101
121
106
102
103a
101a
111
103a
104a
113
IV
IV' V
V' VI
VI'

FIG. 7G

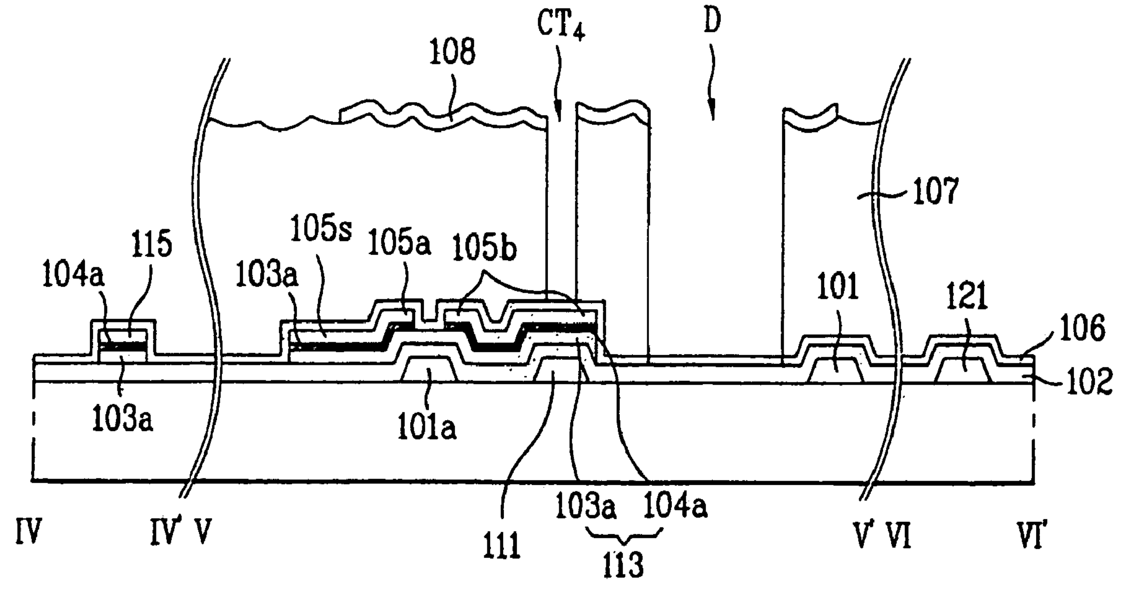

CT_4
D
108
107
105s
105a
105b
115
104a
103a
101
121
106
102
103a
101a
111
103a
104a
113
IV
IV' V
V' VI
VI'

FIG. 7H

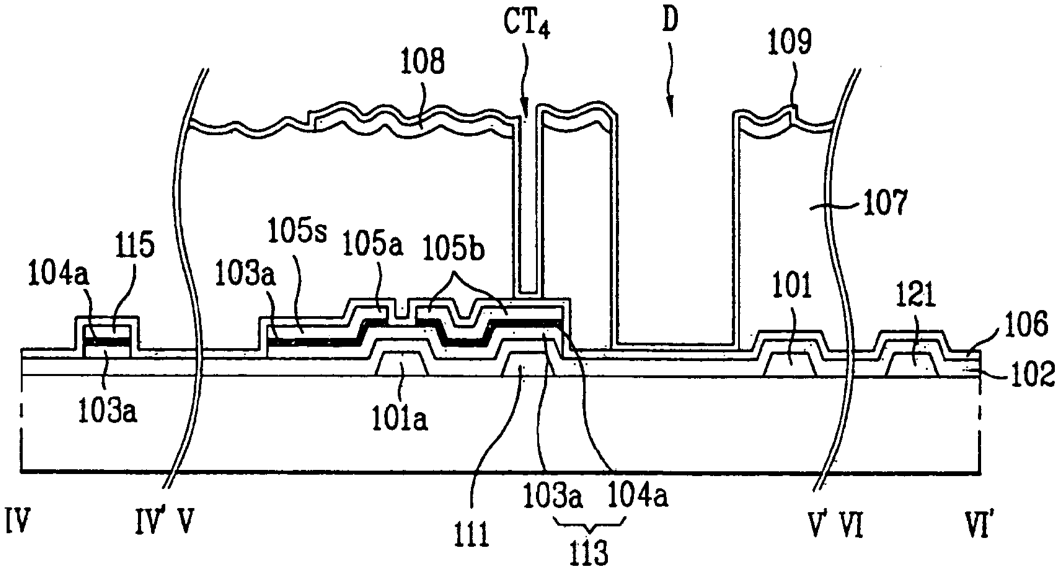

CT4
D
108
109
107
104a
115
105s
105a
105b
103a
101
121
106
102
103a
101a
111
103a
104a
113
IV
IV' V
V' VI
VI'

FIG. 7I

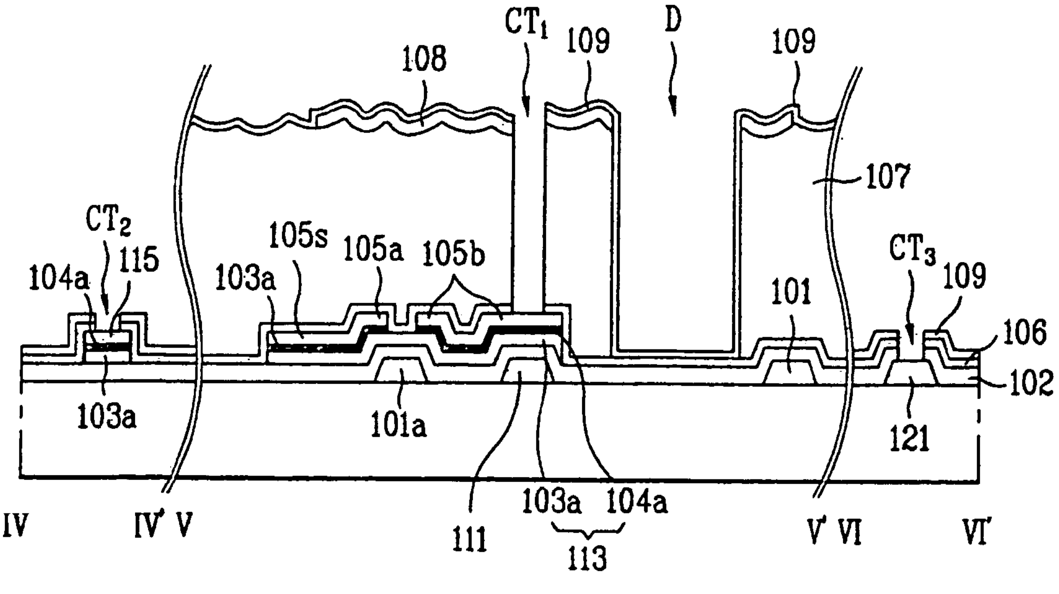

CT1
109
D
109
108
107
CT2
104a
115
105s
105a
105b
103a
CT3
109
101
106
102
103a
101a
121
111
103a
104a
113
IV
IV' V
V' VI
VI'

FIG. 7J

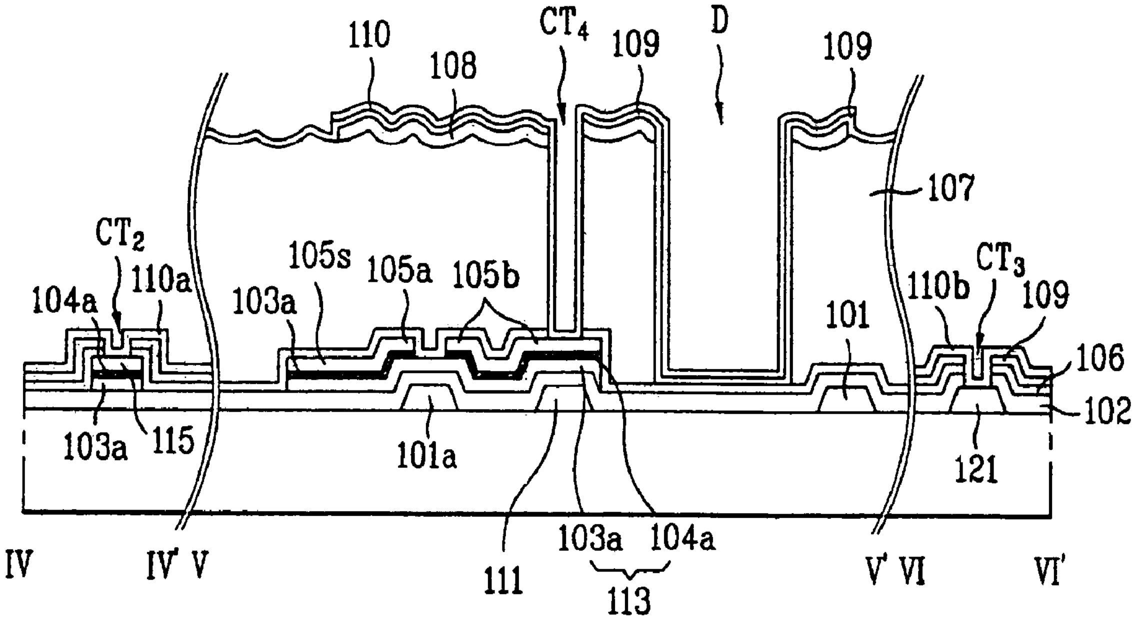
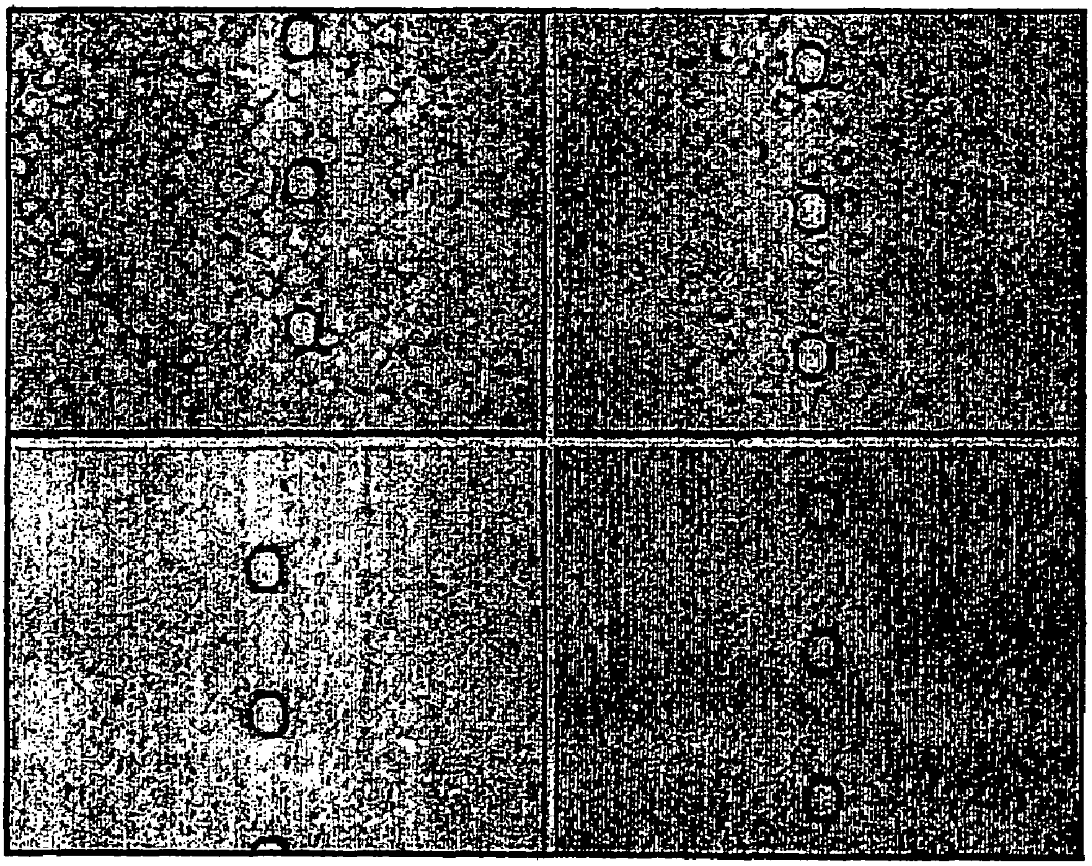

110
108
CT_4
109
D
109
107
CT_2
104a
110a
103a
105s
105a
105b
101
110b
CT_3
109
106
102
103a
115
101a
121
111
103a
104a
113
IV
IV'
V
V'
VI
VI'

FIG. 8



TRANSREFLECTION-TYPE LIQUID CRYSTAL DISPLAY DEVICE AND METHOD OF FABRICATING THE SAME

This application is a Divisional of U.S. patent application Ser. No. 10/747,073 filed Dec. 30, 2003, now U.S. Pat. No. 7,161,648 (now allowed) and claims the benefit of the Korean Application No. P2003-23654 filed on Apr. 15, 2003, both of which are hereby incorporated by reference in their entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a liquid crystal display (LCD) device and a method of fabricating an LCD device, and more particularly, to a trans-reflection type LCD device and a method of fabricating a trans-reflection type LCD device.

2. Discussion of the Related Art

As demand for various types of display devices increases, efforts have been made to develop various flat display devices, such as liquid crystal display (LCD) devices, plasma display panel (PDP) devices, electroluminescent display (ELD) devices, and vacuum fluorescent display (VFD) devices. Currently, some type of the flat display devices have been incorporated into various display equipment.

Among the various types of flat display devices, the LCD devices have been commonly used in portable devices due to their advantageous characteristics, such as thin profile, light weight, and low power consumption. Thus, the LCD devices are commonly substituted for cathode ray tube (CRT) display devices. In addition, the LCD devices have been developed for computer monitors and television systems to receive and display broadcast signals.

The LCD devices are usually driven by making use of optical anisotropy and polarizing characteristics of liquid crystal molecules of liquid crystal materials. The liquid crystal molecules have long and thin structures, whereby it is possible to align the liquid crystal molecules along a specific direction. For example, when an electric field is induced to the liquid crystal material, the liquid crystal molecules become aligned along the specific direction. Thus, by controlling the alignment direction of the liquid crystal molecules, light is refracted according to the alignment direction of the liquid crystal molecules, thereby displaying an image.

The LCD devices are classified into one of reflective-type LCD devices and transmitting-type LCD devices. In the transmitting-type LCD devices, light is emitted from a backlight and transmitted to an LCD panel, thereby displaying an image. However, in the reflective-type LCD devices, ambient or front light is reflected within a reflecting plate of an LCD panel to display an image.

In general, a transreflection-type LCD device selectively uses both a transmission and reflection method to display an image. For example, the transreflection-type LCD device uses light emitted from a backlight, and ambient light or a light source, thereby decreasing power consumption.

FIG. **1** is a perspective view of a transreflection-type LCD device according to the related art. In FIG. **1**, a transreflection-type LCD device includes upper and lower substrates **10** and **20** facing each other, and a liquid crystal layer **30** between the upper and lower substrates **10** and **20**. In addition, a black-matrix layer **11** is formed on the upper substrate **10** to shield portions, except for pixel regions of the lower substrate **20**, from the light, and a color filter layer **12** is formed to produce colored light within the pixel regions. Moreover, a common electrode **13** is formed on an entire surface of the upper substrate **10** including the black-matrix layer **11** and the color filter layer **12**.

The lower substrate **20** is commonly called an array substrate, in which a plurality of thin film transistors, which serve as switching devices T, are disposed in a matrix configuration, and a plurality of gate and data lines **21** and **22** are formed to cross each other at the respective thin film transistors. In addition, the pixel region P includes a transmission part A and a reflective part R, wherein the transmission part A is an open area of a reflective electrode (not shown).

FIG. **2** is a cross sectional view of the transreflection-type LCD device of FIG. **1** according to the related art. In FIG. **2**, the transreflection-type LCD device includes the upper substrate **10** having the common electrode **13** disposed thereon, and the lower substrate **20** having the pixel electrode **23**. The pixel electrode **23** of the lower substrate **20** includes a transparent electrode **23***a* formed within portions corresponding to the transmission part A and the reflective part R, and on the reflective electrode **23***b* having the open area within the transmission part A. In addition, the liquid crystal layer **30** is formed between the upper and lower substrates **10** and **20**, and a backlight **41** is provided below the lower substrate **20** to emit light during a transmission mode of the transflection-type LCD device.

When the transreflection-type LCD device is operated in a reflection mode, the ambient light or the front light is commonly used as the light source. Accordingly, the light B incident on the upper substrate **10** is reflected to the reflective electrode **23***b*, and then the light is transmitted to the liquid crystal layer **30** having liquid crystal molecules aligned by an electric field between the reflective electrode **23***b* and the common electrode **13**. Thus, the light transmittance transmitting the liquid crystal layer **30** is controlled according to the alignment of the liquid crystal layer **30** to display an image.

During the transmission mode, the light F emitted from the backlight **41** provided below the lower substrate **20** is used as the light source. When the light F emitted from the backlight **41** is incident on the liquid crystal layer **30** through the transparent electrode **23***a*, the light transmittance is controlled by the alignment of the liquid crystal molecules in the liquid crystal layer **30**. For example, the liquid crystal molecules are aligned by the electric field induced between the common electrode **13** and the transparent electrode **23***a* below a transmission hole to display an image.

FIG. **3** is an enlarged plan view of a pixel of a transreflection-type LCD device according to the related art. In FIG. **3**, a unit pixel includes gate and data lines **21** and **22**, a pixel electrode **23**, and a thin film transistor T, wherein the gate and data lines **21** and **22** cross each other to define a pixel region. In addition, the pixel electrode **23** includes a transparent electrode **23***a* and a reflective electrode **23***b* within the pixel region, and the thin film transistor T is formed at the crossing point of the gate and data lines **21** and **22**. The thin film transistor T includes a gate electrode **21***a*, a source electrode **22***a*, and a drain electrode **22***b*, and a scanning signal is supplied to the gate electrode **21***a*. In addition, the source electrode **22***a* protrudes from a portion of the data line **22** and receives video signals from the data line **22**, and the drain electrode **22***b* is formed at a predetermined interval from the source electrode **22***a* to supply video signals to the pixel electrode **23**. Then, a gate pad **31** and a source pad **32** are respectively formed at end portions of the gate line **21** and the data line **22** and are connected to drive ICs (not shown).

In FIG. **3**, the pixel electrode **23** includes the transparent electrode **23***a* that is formed in portions corresponding to the transmission part A and the reflective part R, and on the reflective electrode **23***b* formed within the reflective part R, except for the transmission part A. Accordingly, the transparent electrode **23***a* is connected to the drain electrode **22***b* through a contact part C**1** to receive the video signals. In addition, the reflective electrode **23***b* is formed to contact the transparent electrode **23***a* within the contact part C**1** to which the video signals are supplied.

FIGS. **4**A to **4**H are cross sectional views along I-I', II-II', and III-III' of FIG. **3** of an array substrate fabrication process of a transreflection-type LCD device according to the related art. In FIGS. **4**A to **4**H, the line I-I' extends from a thin film transistor to a pixel region within a unit pixel region, the line II-II' includes a section of a gate pad, and the line III-III' includes a section of a source pad.

In FIG. **4**A, a conductive metal layer is deposited on the transparent substrate **20**, and is selectively removed using a first mask (not shown), thereby forming the plurality of gate lines **21** (in FIG. **3**) and the gate electrodes **21***a*. Accordingly, as shown in FIG. **3**, each gate line **21** includes a gate pad **31** at one end portion thereof, and the gate electrode **21***a* protrudes from the gate line **21**. Subsequently, a first insulating layer **24**, an amorphous silicon layer **25***a*, and an impurity layer (n^+ layer) **25***b* are sequentially deposited on an entire surface of the transparent substrate **20**.

In FIG. **4**B, the impurity layer **25***b* and the amorphous silicon layer **25***a* are selectively removed using a second mask (not shown) to form an island-shaped semiconductor active layer **25** (later shown in FIG. **4**C as semiconductor layer **35**).

In FIG. **4**C, a conductive metal layer is deposited on the transparent substrate **20** having the semiconductor layer **35**, and is selectively removed using a third mask (not shown), thereby forming the plurality of data lines **22** (in FIG. **3**) crossing the gate lines **21** (in FIG. **3**), the source electrode **22***a*, and the drain electrode **22***b*. Accordingly, the source electrode **22***a* protrudes from each data line **22** (in FIG. **3**) toward the semiconductor layer **35**, and the drain electrode **22***b* is positioned at a predetermined interval from the source electrode **22***a* on the other side of the semiconductor layer **35**. Subsequently, the impurity layer **25***b* of the semiconductor layer **35**, which is exposed between the source and drain electrodes **22***a* and **22***b*, is removed using the source and drain electrodes **22***a* and **22***b* as a mask, thereby forming the semiconductor layer **35**.

In FIG. **4**D, an organic insulating layer is coated along an entire surface of the transparent substrate **20** including the data lines **22** (in FIG. **3**), and exposure and developing processes are performed using a fourth mask (not shown) having a predetermined open area. Then, the organic insulating layer corresponding to the open area of the fourth mask is removed at a predetermined thickness. Then, a heat treatment is performed to form a first organic insulating layer **26***a* having embossing patterns at a portion of the organic insulating layer that is relatively thicker than the portion removed using the fourth mask. The organic insulating layer is formed of a positive-type organic insulating layer, such as Benzocyclobutene (BCB), or is formed of a positive-type material, such as photoacryl.

In FIG. **4**E, a second organic insulating layer **26***b* having a constant thickness is coated on the first organic insulating layer **26***a*, wherein the second organic insulating layer **26***b* is formed of the same material as the first organic insulating layer **26***a*. Since the second organic insulating layer **26***b* is coated on the first organic insulating layer **26***a* at the constant thickness, it is possible to maintain the embossing patterns of the first organic insulating layer **26***a* after coating the second organic insulating layer **26***b* on the first organic insulating layer **26***a*.

In FIG. **4**F, the first and second organic insulating layers **26***a* and **26***b* are selectively removed using a fifth mask (not shown) having a predetermined open area, thereby defining the contact part C**1** that exposes a predetermined portion of the drain electrode **22***b* and defining the transmission part A. After selectively removing the first and second organic insulating layers **26***a* and **26***b*, the remaining first and second organic insulating layers **26***a* and **26***b* are referred to as a first passivation layer **26**. When selectively removing the first and second organic insulating layers **26***a* and **26***b*, the first and second organic insulating layers **26***a* and **26***b* corresponding to the gate and source pads are removed to expose the gate insulating layer **24** and the source pad **32**.

In FIG. **4**G, a reflective metal layer is deposited along an entire surface of the first passivation layer **26**, and is selectively removed using a sixth mask (not shown), whereby the reflective electrode **23***b* is formed in the pixel region except for the transmission part A and the first contact part C**1**. Next, an inorganic insulating layer **27** of SiNx is deposited along the entire surface of the lower substrate **20** including the reflective electrode **23***b*. For example, the inorganic insulating layer **27** is deposited on the lower substrate **20** at a high temperature of 300° C. or more. However, the embossing patterns of the first passivation layer **26** are destroyed by thermal flow.

In FIG. **4**H, the inorganic insulating layer **27** is selectively removed at the first contact part C**1**, the second contact part C**2**, and the third contact part C**3** using a seventh mask (not shown), thereby forming a second passivation layer **27***a*. Subsequently, a transparent metal layer is deposited along the entire surface of the lower substrate **20** including the second passivation layer **27***a*, and is selectively removed using an eighth mask (not shown). Thus, the transparent electrode **23***a* is formed within the pixel region including the transmission part A and the first contact part C**1**. In addition, a gate pad terminal **33***a* is formed in the second contact part C**2** to be connected with the gate pad **31**, and a source pad terminal **43***a* is formed in the third contact part C**3** to be connected with the source pad **32**.

According to the related art, the embossing patterns (or concave pattern) are formed of the organic insulating layer to improve reflexibility of the reflective electrode by increasing a surface area of the reflective electrode having the embossing patterns.

FIG. **5** is a photomicrograph showing a peeling phenomenon of a reflective electrode according to the related art. In FIG. **5**, after forming the organic insulating layer having the embossing patterns, the reflective electrode is formed. Then, the inorganic insulating layer, such as SiNx, is deposited at a temperature of about 300° C. Accordingly, the peeling phenomenon occurs due to stress caused by inferior adhesion between the reflective electrode and the organic insulating layer.

According to the related art transreflection-type LCD device, the embossing pattern (i.e., the concave pattern) is formed using a positive-type organic insulating layer, such as Benzocyclobutene (BCB), or using a positive-type photoacryl to improve the reflexibility. However, when using the positive-type organic insulating layer, mask process steps for forming the embossing pattern of the organic insulating layer must be performed, as well as the other mask process steps for removing the transmission part. Thus, according to the related art, a dual-coating process is required during the process for forming the organic insulating layer, thereby complicating fabrication process steps.

For example, when forming the embossing pattern using BCB, it is difficult to perform the complicated fabrication process steps, thereby degrading the reflexibility of the reflective electrode. In addition, since the positive-type photoacryl has a transition glass temperature, the thermal flow is generated at the high process temperatures, thereby destroying the embossing pattern of the first passivation layer due to the thermal flow.

Moreover, after forming the organic insulating layer having the embossing pattern (i.e., the concave pattern), the reflective electrode is formed on the organic insulating layer. Then, the inorganic insulating layer, such as SiNx, is deposited thereon, and the transparent electrode is formed. Thus, when the passivation layer of SiNx is deposited at the high process temperatures, it may generate the peeling phenomenon due to stress from the inferior adhesion between the reflective electrode and the organic insulating layer.

SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to a transreflection-type liquid crystal display (LCD) device and a method of fabricating a transreflection-type liquid crystal display (LCD) device that substantially obviates one or more problems due to limitations and disadvantages of the related art.

An object of the present invention is to provide a transreflection type LCD device and a method for manufacturing the same, which is formed in simplified manufacturing process steps with 6 masks since concave and/or convex patterns are formed in a negative type organic insulating layer in a stamp process without a mask.

Additional advantages, objects, and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

To achieve these objects and other advantages and in accordance with the purpose of the invention, as embodied and broadly described, a transreflection-type liquid crystal display (LCD) device includes a plurality of gate and data lines on a substrate crossing each other defining a plurality of pixel regions, a plurality of storage lines parallel to the gate lines, each storage line positioned between the gate lines, a plurality of thin film transistors disposed at the crossings of the gate and data lines, each thin film transistor having source and drain electrodes and a U-shaped channel region, a negative-type organic insulating layer within the pixel region except for a transmission part, the negative type organic insulating layer having at least one of concave and convex patterns thereon, a reflective electrode on the negative-type organic insulating layer within the pixel region except for the transmission part, and a transparent electrode within the pixel region in electrical contact with the drain electrode.

In another aspect, a method for fabricating a transreflection-type liquid crystal display (LCD) device includes forming a gate line and a storage line on a substrate using a first mask, forming a data line and a thin film transistor having source and drain electrodes using a second mask by depositing a semiconductor layer and a metal layer on the substrate including the gate line and the storage line, the data line being perpendicular to the gate line to define a pixel region, forming a negative-type organic insulating layer having at least one of concave and convex patterns therein using a third mask, the concave and convex patterns formed within the pixel region except for a transmission part, forming a reflective electrode on the negative-type organic insulating layer formed within the pixel region except for the transmission part, using a fourth mask, forming a contact hole on a drain electrode using a fifth mask, and forming a transparent electrode within the pixel region using a sixth mask to be connected with the drain electrode through the contact hole.

In another aspect, a method for fabricating a transreflection-type liquid crystal display (LCD) device includes forming a plurality of gate lines and a plurality of storage lines on a substrate, each gate line having a gate electrode protruding therefrom and each storage line is disposed between the gate lines in parallel to the gate lines, forming a plurality of data lines and a plurality of drain electrodes on the substrate, forming a semiconductor layer on a portion of the substrate including the gate lines, the plurality of data lines, and the plurality of drain electrodes, each data line perpendicular to the gate line on the semiconductor layer to define a pixel region, forming a negative-type organic insulating layer having at least one of concave and convex patterns along an entire surface of the substrate including the data lines, the negative-type organic insulating layer including a contact part and a transmission part therein, forming a reflective electrode corresponding to the pixel region except for the contact part and the transmission part, forming an inorganic insulating layer along an entire surface of the substrate except for the contact part, and forming a transparent electrode corresponding to the pixel region including the transmission part to be connected with the drain electrode within the contact part.

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

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiment(s) of the invention and together with the description serve to explain the principle of the invention. In the drawings:

FIG. **1** is a perspective view of a transreflection-type LCD device according to the related art;

FIG. **2** is a cross sectional view of the transreflection-type LCD device of FIG. **1** according to the related art;

FIG. **3** is an enlarged plan view of a pixel of a transreflection-type LCD device according to the related art;

FIGS. **4**A to **4**H are cross sectional views along I-I', II-II', and III-III' of FIG. **3** of an array substrate fabrication process of a transreflection-type LCD device according to the related art;

FIG. **5** is a photomicrograph showing a peeling phenomenon of a reflective electrode according to the related art;

FIG. **6** is an enlarged plan view of an exemplary pixel of a transreflection-type LCD device according to the present invention;

FIGS. **7**A to **7**J are cross sectional views along IV-IV', V-V', and VI-VI' of an exemplary array substrate fabrication process steps of a transreflection-type LCD device according to the present invention; and

FIG. **8** is a photomicrograph of an exemplary pattern of a transreflection-type LCD device according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

FIG. **6** is an enlarged plan view of an exemplary pixel of a transreflection-type LCD device according to the present invention. In FIG. **6**, a unit pixel of a trans-reflection type LCD device may include gate and data lines **101** and **105**, a thin film transistor, a transparent electrode **110**, and a reflective electrode **108**, wherein the gate and data lines **101** and **105** may cross each other to define a pixel region and the thin film transistor may be formed at a crossing point of the gate and data lines **101** and **105**. In addition, the transparent electrode **110** may be formed within the pixel region, and the reflective electrode **108** may have a transmission part D below the transparent electrode **110**. Furthermore, a storage line **111** may be formed in parallel to the gate line **101**, and may function as an electrode of a storage capacitor.

In FIG. **6**, the thin film transistor may include a gate electrode **101***a*, a semiconductor layer **113**, a source electrode **105***a*, and a drain electrode **105***b*, wherein scanning signals may be supplied to the gate electrode **101** through the gate line **101**, and the semiconductor layer **113** may be formed to partially overlap the gate electrode **110***a* and the storage line **111**. In addition, the source electrode **105***a* may protrude from a portion of the data line **105** that receives video signals from the data line **105**, and the drain electrode **105***b* may be formed at an interval from the source electrode **105***a* to supply the video signals to the transparent electrode **110**. Accordingly, the source electrode **105***a* may extend to the gate electrode **101***a* in a "U"-shaped to cover three sides of the gate electrode **101** within an opening along one side within the gate electrode **101**. Then, the drain electrode **105***b* may extend to the source electrode **105***a* to overlap the storage line **111**, and the extending portion of the drain electrode **105***b* may be spaced apart from the source electrode **105***a*. Thus, since the U-shaped source electrode **105***a* may surround the drain electrode **105***b*, a channel region may be increased.

The drain electrode **105***b* may be electrically connected to the transparent electrode **110** within a first contact part CT**1**. Then, a gate pad **121** and a source pad **115** may be formed at extended end portions of the gate line **101** and the data line **105**, respectively, to be connected to drive ICs (not shown). For example, the gate pad **121** may be electrically connected to a transparent gate pad terminal **110***b* through a third contact part CT**3**, and the source pad **115** may be electrically connected to a transparent source pad terminal **110***a* through a second contact part CT**2**.

In FIG. **6**, the gate pad **121** may be formed at one end portion extended from the gate line **101**, wherein the gate pad **121** may be larger than the gate line **101**. Similarly, the source pad **115** may be formed at one end portion extended from the data line **105**, wherein the source pad **115** may be larger than the data line **105**. In addition, the transparent electrode **110** may partially overlap the gate and data lines **101** and **105** along both sides of the pixel region, and the reflective electrode **108** may have a planar shape formed below the transparent electrode **110** to have an open area within the transmission part D.

FIGS. **7**A to **7**J are cross sectional views along IV-IV', V-V', and VI-VI' of an exemplary array substrate fabrication process steps of a transreflection-type LCD device according to the present invention. In FIGS. 7A to 7J, the line IV-IV' includes a section of a source pad D-Pad, the line V-V' includes a section from a data line D-Line to a gate line G-Line through a thin film transistor TFT and a storage capacitor Cst, and the line VI-VI' includes a section of a gate pad G-Pad.

As shown in FIG. **7**A, a conductive metal layer, such as Al, Cr, or MoW, may be deposited on a transparent substrate **100**, and patterned using a first mask (not shown) to simultaneously form the gate pad **121** having one enlarged end portion, the gate line **101** extended from the gate pad **121** along a first direction, and the gate electrode **101***a* protruding from the gate line **101**. In addition, the storage line **111** may be formed between the gate lines **101** to be parallel to the gate lines **101**.

In FIG. **7**B, a gate insulating layer **102**, an amorphous silicon layer **103**, an impurity layer (n^+ layer) **104**, and source/drain metal layers **105***s* may be sequentially deposited along an entire surface of the transparent substrate **100** including the gate electrode **101***a*. The gate insulating layer **102** may include an inorganic insulating layer, such as SiO_x or SiN_x. Then, the source/drain metal layers **105***s* may include conductive metal layers, such as Al, Cr, or MoW.

In FIG. 7C, a photo-resist layer **123** may be coated on the transparent substrate **100** including the source/drain metal layers **105***s*, and exposure and developing processes may be performed using a second mask (not shown) that may include a transmission part, a semi-transmission part, and a closed part. When performing the exposure and developing processes, the second mask (not shown) may be a diffraction mask. For example, the photo-resist layer **123** corresponding to the transmission part may be completely removed, and the photo-resist layer **123** corresponding to the semi-transmission part is removed at a predetermined thickness. In this case, the photo-resist layer **123** corresponding to the closed part may be maintained at the initial coating thickness.

In addition, the closed part may define a region for forming the source/drain electrodes and the data line, the semi-transmission part may define a channel region between the source and the drain electrodes, and the transmission part may define the remaining region. Thus, the source/drain metal layers **105***s*, which may correspond to the transmission part, the impurity layer **104***a*, and the amorphous silicon layer **103***a* may be removed first using the photo-resist layer **123** patterned using the second mask, thereby forming the source pad **115** and the data line **105** as a single body with the source/drain metal layers **105***s*, the amorphous silicon layer **103***a*, and the impurity layer **104**. Within the gate pad portion, the source/drain metal layers **105***s*, the impurity layer **104**, and the amorphous silicon layer **103** may be completely removed. In addition, the source pad **115** may be formed at one enlarged end portion of the data line **105**.

In FIG. 7D, after ashing the photo-resist layer **123** patterned using the second mask, the photo-resist layer **123** corresponding to the closed part and the semi-transmission part may be removed at the thickness corresponding to that of the semi-transmission part, whereby the photo-resist layer **123** of the semi-transmission part may be completely removed, and the photo-resist layer **123** may remain on the closed part. Then, the source/drain metal layers **105***s* corresponding to the semi-transmission part may be wet-etched using the patterned photo-resist layer **123** as a mask, thereby forming the source/drain electrodes **105***a* and **105***b*. Next, the impurity layer **104** may be dry-etched by using the photo-resist layer **123**, thereby forming the semiconductor layer **113** including the amorphous silicon layer **103***a* and the impurity layer **104***a*. Accordingly, a channel region may be defined between the source electrode **105***a* and the drain electrode **105***b*, and the photo-resist layer **123** may be completely removed.

In FIG. 7E, a first passivation layer **106** of an inorganic insulating material, such as SiN_x or SiO_x, may be deposited along the entire surface of the substrate **100** including the source/drain electrodes **105***a* and **105***b*. Then, a negative-type organic insulating layer **107** may be coated at a first thickness, and round-shaped concave patterns may be formed along an entire surface of the negative-type organic insulating layer **107** using a stamp process. Although the concave patterns may be formed on the surface of the negative type organic insulating layer according to the present invention, the embossing patterns may be formed on the surface of the negative-type organic insulating layer.

The stamp process may be performed using a stamp having patterns inverse to the round-shaped concave patterns of the negative-type organic insulating layer **107**. For example, the negative-type organic insulating layer **107** may be formed according to a negative-type process in which the organic insulating layer **107** may be patterned to form the concave patterns according to embossing patterns of the stamp. Accordingly, the negative-type organic insulating layer **107** may be formed of negative photoacryl. Subsequently, a UV-curing process may be performed to the patterned negative-type organic insulating layer **107** to stably maintain the concave patterns of the negative-type organic insulating layer **107**.

In FIG. 7F, the portions of the negative-type organic insulating layer **107** corresponding to the transmission part D, the upper part CT4 of the storage line **111**, the upper part of the gate pad **121**, and the upper part of the source pad **115** may be selectively removed according to a dry-etch process. Then, a re-curing process may be performed to the patterned negative-type organic insulating layer **107** at a temperature between about 160° C. and about 240° C. for a period of about 40 to about 80 minutes. In addition, the re-curing process may be performed at a temperature of about 220° C. for a period of about 60 minutes. Accordingly, the re-curing process may improve adhesion between the reflective electrode **108** and the negative-type organic insulating layer **107**.

In FIG. 7G, a reflective metal layer, such as Al, Al alloy, Au, or Au alloy, may be deposited along an entire surface of the substrate **100** including the negative-type organic insulating layer **107**, and may be selectively removed using a wet-etch process including a fourth mask (not shown). Accordingly, the reflective electrode **108** may be formed within the pixel region, except within the transmission part D and the upper part CT4 of the storage line **111**.

In FIG. 7H, a second passivation layer **109** of an inorganic insulating material, such as SiN_x or SiO_x, may be deposited on the substrate **100** including the reflective the transparent electrode along an interface therebetween. Accordingly, the negative-type organic insulating layer **107** may be stably maintained at a temperature of about 240° C. In addition, the second passivation layer **109** nay be deposited on the negative-type organic insulating layer **107** at a temperature between about 180° C. and 220° C., thereby preventing destruction of the concave patterns on the surface of the negative-type organic insulating layer **107** and preventing occurrence of the peeling phenomenon. Moreover, the second passivation layer may be deposited on the negative-type organic insulating layer at a relatively low temperature of about 200° C., thereby stably maintaining the negative-type organic insulating layer **107** and the reflective electrode **108**.

In FIG. 7I, the second passivation layer **109** may be selectively removed using a fifth mask (not shown), thereby forming the first contact part CT**1** in the upper part of the storage line **111**, and the second and third contact parts CT**2** and CT**3**, which may function as contact parts of the gate pad and the source pad. Accordingly, the second contact part CT**2** may be formed by removing the first passivation layer **106** and the second passivation layer **109** above the predetermined portion of the source pad **115** at a constant thickness, and the third contact part CT**3** may be formed by removing the gate insulating layer **102** and the first passivation layer **106** at a constant thickness. Similarly, the first passivation layer **106** may be etched within the first contact part CT**1**, thereby exposing a portion of the drain electrode **105***b*.

In FIG. 7J, a transparent metal layer, such as ITO (Indium-Tin-Oxide), IZO (Indium-Zinc-Oxide), or ITZO (Indium-Tin-Zine-Oxide), may be deposited on the substrate including the second passivation layer **109**, and selectively removed using a sixth mask (not shown), thereby forming the transparent electrode **110** within the pixel region, the gate pad terminal **110***b* within the gate pad **121**, and the source pad terminal **110***a* within the source pad **115**. Accordingly, the transparent electrode **110** may contact the drain electrode **105***b* through the first contact part CT**1**, and the transparent electrode **110** may be formed within the pixel region including the transmission part D. In addition, the gate pad terminal **110***b* may contact the gate pad **121** through the third contact part CT**3**, and the source pad terminal **110***a* may contact the source pad **115** through the second contact part CT**2**.

FIG. **8** is a photomicrograph of an exemplary pattern of a transreflection-type LCD device according to the present invention. In FIG. **8**, after forming the reflective electrode in the trans-reflection type LCD device according to the present invention, the second passivation layer **109** may be deposited at a temperature between about 180° C. and about 220° C. that is lower than the temperature (i.e., 240° C.) at which the patterns of the negative-type organic insulating layer **107** may undergo the thermal flow phenomenon. Thus, it may be possible to maintain stabilization of the patterns of the negative-type organic insulating layer **107** after forming the second passvation layer **109**, and may prevent occurrence of the peeling phenomenon. In addition, the transmission hole may be exposed within the pixel region.

According to the present invention, the fabrication process of the transreflection-type LCD device may be performed using six masks for patterning the gate electrode, the semiconductor layer, the source/drain electrodes, the negative type inorganic insulating layer, the reflective electrode, and the transparent electrode. Thus, fabrication of the transreflection-type LCD device according to the present invention decreases the number of the masks. In addition, the transreflection-type LCD device according to the present invention may include a semiconductor layer formed of amorphous silicon material or polysilicon-type material.

According to the present invention, the transreflection-type LCD device and method of fabricating a transreflection-type LCD device has the following advantages. First, the semiconductor layer and the source/drain electrodes may be formed using a diffraction mask, and the concave patterns of the negative-type organic insulating layer may be formed using a stamping process, whereby the number of the masks may be decreased to six, thereby making exposure and developing processes unnecessary.

Second, by using the negative-type organic insulating layer, the patterns may be formed during the stamping process instead of during the exposure and developing processes using the mask, whereby the round-shaped concave patterns may be formed without destruction of the patterns.

Third, after the stamping process of the negative-type organic insulating layer, UV light may be first irradiated thereto, and a re-curing process may be performed thereto after the etching process of the transmission part. In addition, the second passivation layer may be deposited at a relatively low temperature of about 200° C., thereby making it possible to stably maintain the round-shaped patterns of the negative-type organic insulating layer, the reflective electrode, and the transparent electrode without occurrence of the peeling phenomenon and causing destruction of the patterns.

Fourth, the concave patterns may be formed during the stamping process at a single time without use of a mask, thereby making a dual-coating process for the organic insulating layer unnecessary and simplifying the fabrication processing steps. By decreasing the number of mask process steps, it may be possible to decrease the number of exposure, developing, and etching processes, thereby improving yield.

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

What is claimed is:

1. A transreflection-type liquid crystal display (LCD) device, comprising:

- a plurality of gate and data lines on a substrate crossing each other defining a plurality of pixel regions;
- a plurality of storage lines parallel to the gate lines, each storage line positioned between the gate lines;
- a plurality of thin film transistors disposed at the crossings of the gate and data lines, each thin film transistor having source and drain electrodes and a U-shaped channel region;
- a negative-type organic insulating layer within the pixel region except for a transmission part, the negative type organic insulating layer having at least one of concave and convex patterns thereon;
- a reflective electrode on the negative-type organic insulating layer within the pixel region except for the transmission part;
- an inorganic passivation layer over the reflective electrode and the negative-type organic insulating layer; and
- a transparent electrode within the pixel region in electrical contact with the drain electrode.

2. The device according to claim **1**, wherein each of the gate and data lines have a pad disposed at one extending end portion and includes a pad terminal formed of a same material as the transparent electrode.

3. The device according to claim **1**, wherein the thin film transistor includes an active layer disposed beneath the data line and the source and drain electrodes.

4. The device according to claim **1**, wherein the source electrode protrudes from each of the data lines and overlaps a gate electrode of the thin film transistor.

5. The device according to claim **1**, wherein the negative-type organic insulating layer includes a negative-type photo-acryl.

6. The device according to claim **1**, wherein the concave and convex patterns of the negative-type organic insulating layer are formed using a stamping process.

7. The device according to claim **1**, wherein the passivation layer includes one of SiO_x and SiN_x.

8. A method for fabricating a transreflection-type liquid crystal display (LCD) device, comprising:

- forming a plurality of gate lines and a plurality of storage lines on a substrate, each gate line having a gate electrode protruding therefrom and each storage line is disposed between the gate lines in parallel to the gate lines;
- forming a plurality of data lines and a plurality of drain electrodes on the substrate;
- forming a semiconductor layer on a portion of the substrate including the gate lines, the plurality of data lines, and the plurality of drain electrodes, each data line perpendicular to the gate line on the semiconductor layer to define a pixel region;
- forming a negative-type organic insulating layer having at least one of concave and convex patterns along an entire surface of the substrate including the data lines, the negative-type organic insulating layer including a contact part and a transmission part therein;
- forming a reflective electrode corresponding to the pixel region except for the contact part and the transmission part;
- forming an inorganic insulating layer along an entire surface of the substrate except for the contact part; and
- forming a transparent electrode corresponding to the pixel region including the transmission part to be connected with the drain electrode within the contact part.

9. The method according to claim **8**, wherein the forming of the semiconductor layer, the source and drain electrodes and the data lines includes:

- depositing a gate insulating layer, an amorphous silicon layer, an impurity layer, a metal layer, and a photo-resist layer along an entire surface of the substrate including the gate lines;
- patterning the photo-resist layer to reduce a thickness portion of the photo-resist layer corresponding to a channel region of a thin film transistor by a diffraction exposure using a diffraction mask;
- etching the amorphous silicon layer, the impurity layer, and the metal layer using the patterned photo-resist layer as a mask;
- ashing the photo-resist layer to remove the portion corresponding to the channel region; and
- etching the metal layer and the impurity layer using the photo-resist layer as a mask.

10. The method according to claim **9**, wherein the diffraction mask includes a closed part corresponding to portions for forming the data lines and the source and drain electrodes, and a semi-transmission part corresponding to a portion for forming the channel region.

11. The method according to claim **8**, wherein the source electrode includes a U-shape.

12. The method according to claim **8**, wherein the drain electrode overlaps the storage line.

13. The method according to claim **8**, wherein the forming of the negative-type organic insulating layer includes:

- depositing a negative-type organic insulating material along an entire surface of the substrate including the data lines;
- patterning the at least one of the concave and convex patterns on the surface of the negative-type organic insulating layer to a predetermined thickness using a stamping method; and
- forming the contact part and the transmission part by selectively removing the negative-type organic insulating layer.

14. The method according to claim **13**, further comprising hardening the negative-type organic insulating layer using UV light after the forming of the negative-type organic insulating layer.

15. The method according to claim **13**, further comprising re-curing the negative-type organic insulating layer after the selectively removing of the contact part and the transmission part of the negative-type organic insulating layer.

16. The method according to claim **15**, wherein the re-curing process is performed at a temperature between about 160 EC and about 240 EC during a period of about 40 to about 80 minutes.

17. The method according to claim **8**, wherein the negative-type organic insulating layer includes a negative-type photo-acryl.

18. The method according to claim **8**, wherein the inorganic insulating layer includes one of SiO_x and SiN_x.

19. The method according to claim **8**, wherein the inorganic insulating layer is formed at a temperature between about 180 EC and about 220 EC.

20. The method according to claim **8**, further comprising:

forming an inorganic insulating layer on the substrate before forming the negative-type organic insulating layer.

* * * * *

专利名称(译)	透射反射型液晶显示装置及其制造方法		
公开(公告)号	US7483101	公开(公告)日	2009-01-27
申请号	US11/649780	申请日	2007-01-05
[标]申请(专利权)人(译)	乐金显示有限公司		
申请(专利权)人(译)	LG飞利浦LCD CO.，LTD.		
当前申请(专利权)人(译)	LG DISPLAY CO.，LTD.		
[标]发明人	LIM BYOUNG HO KIM SEONG HEE NAM CHUL PARK JONG WOO KIM GYU BONG		
发明人	LIM, BYOUNG HO KIM, SEONG HEE NAM, CHUL PARK, JONG WOO KIM, GYU BONG		
IPC分类号	G02F1/1335 G02F1/136 G02F1/1345 G02F1/1362 G02F1/1368		
CPC分类号	G02F1/133555 G02F1/136227 G02F1/133504 G02F1/1345 G02F2001/136231		
审查员(译)	内尔姆斯，DAVID		
优先权	1020030023654 2003-04-15 KR		
其他公开文献	US20070109475A1		
外部链接	Espacenet USPTO		

摘要(译)

透射反射型液晶显示（LCD）装置包括在彼此交叉的基板上的多条栅极线和数据线，所述多条像素区域限定多个像素区域，多条存储线与栅极线平行，每条存储线位于栅极之间线，多个薄膜晶体管设置在栅极线和数据线的交叉处，每个薄膜晶体管具有源电极和漏电极以及U形沟道区，像素区内的负型有机绝缘层除外透射部分，其上具有凹凸图案中的至少一个的负型有机绝缘层，除了透射部分之外的像素区域内的负型有机绝缘层上的反射电极，以及像素区域内的透明电极与漏电极电接触。