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Lim et al.(10) **Pub. No.: US 2005/0140874 A1**(43) **Pub. Date: Jun. 30, 2005**(54) **TRANSFLECTIVE LIQUID CRYSTAL
DISPLAY DEVICE AND FABRICATING
METHOD THEREOF****Publication Classification**(51) **Int. Cl.⁷** **G02F 1/1335**(52) **U.S. Cl.** **349/114**(75) **Inventors: Byoung-Ho Lim**, Gyeongsangbuk-do
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Dec. 30, 2003 (KR) 2003-100667

(57) **ABSTRACT**

A substrate for a transflective liquid crystal display device includes a plurality of gate lines on a substrate; at least one data line crossing the plurality of gate lines to define a pixel region including a transmissive portion and a reflective portion; a thin film transistor connected to one of the plurality of gate lines and the at least one data line, the thin film transistor including a gate electrode, a semiconductor layer, a source electrode and a drain electrode; a first insulating layer covering a portion of the thin film transistor, the first insulating layer uncovering the pixel region and a portion of the drain electrode; a transparent electrode in the pixel region, the transparent electrode directly contacting the drain electrode and the semiconductor layer; and a reflective layer in the reflective portion, the reflective layer having a first uneven surface.

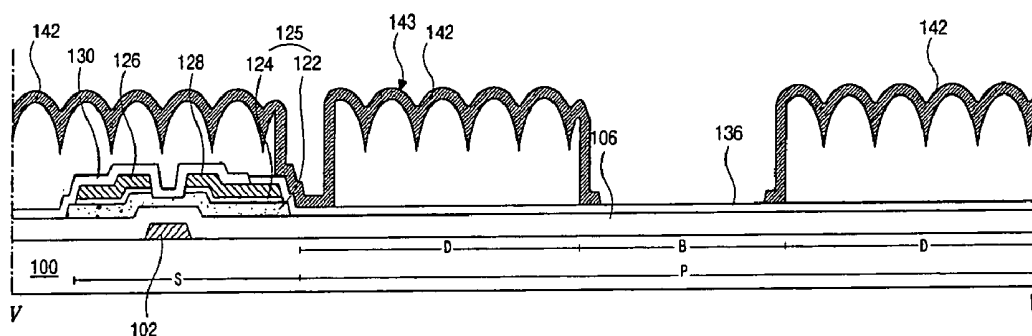


FIG. 1
RELATED ART

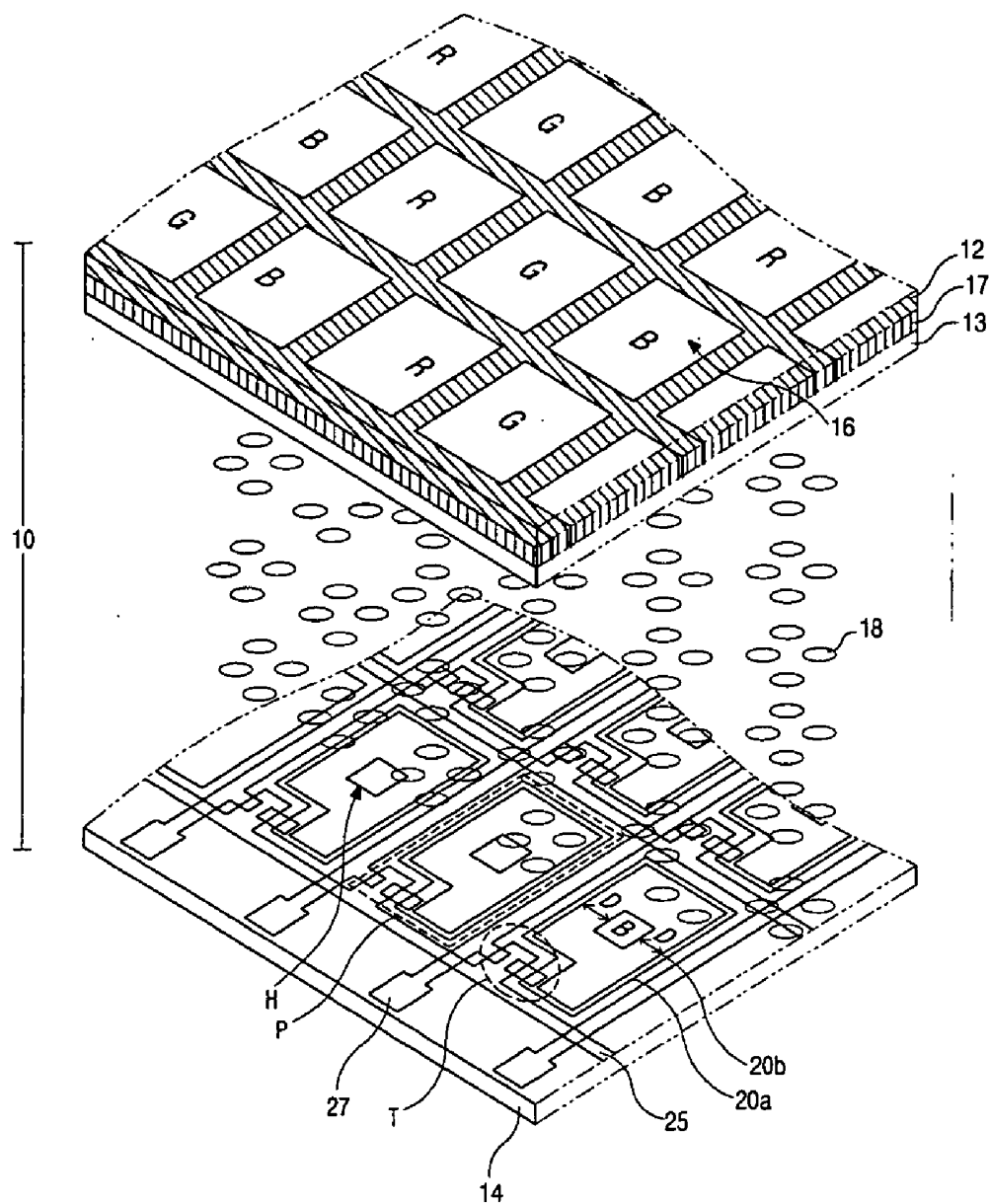


FIG. 2

RELATED ART

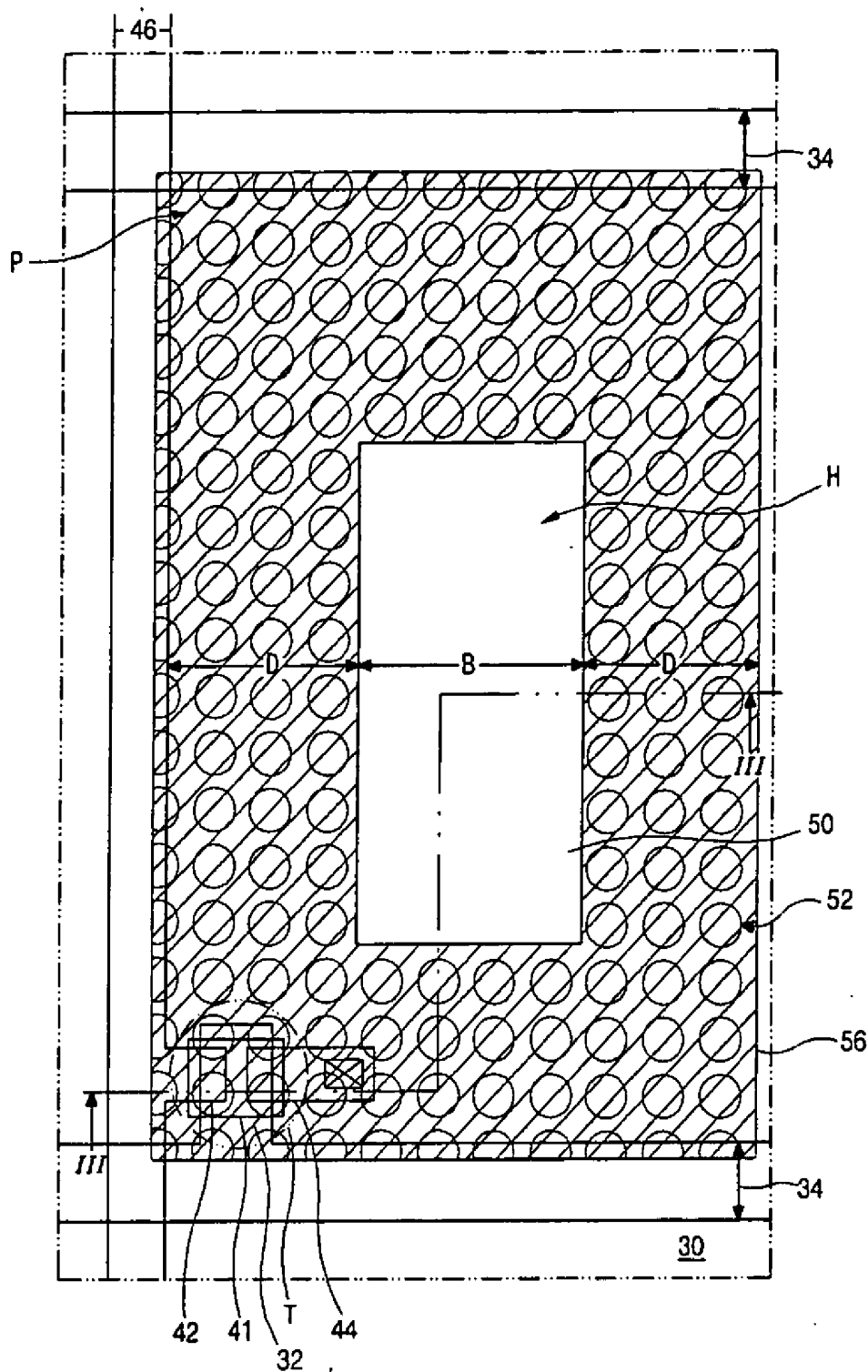


FIG. 3A
RELATED ART

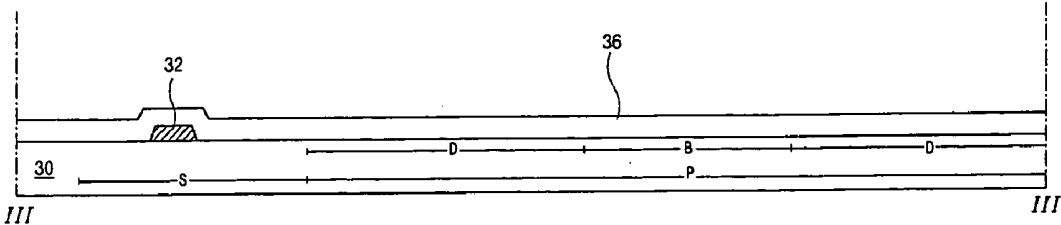


FIG. 3B
RELATED ART

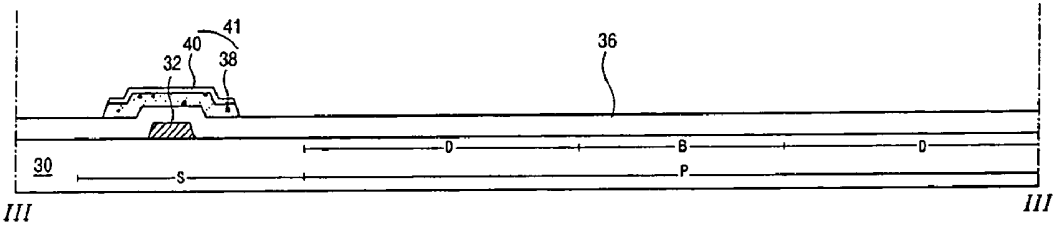


FIG. 3C
RELATED ART

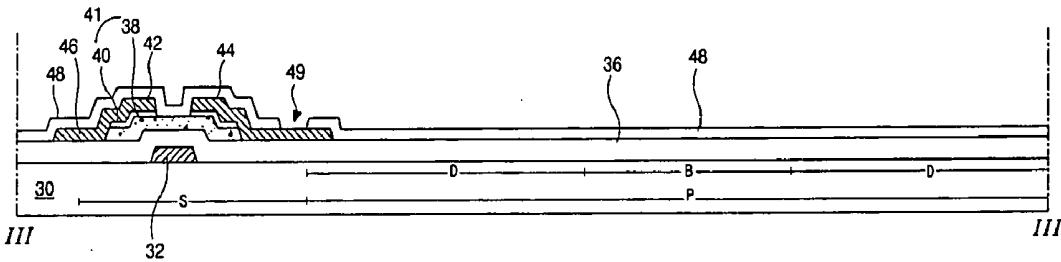


FIG. 3D
RELATED ART

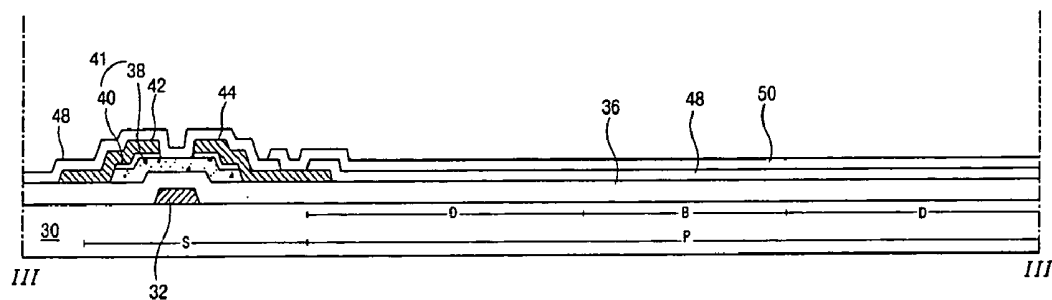


FIG. 3E
RELATED ART

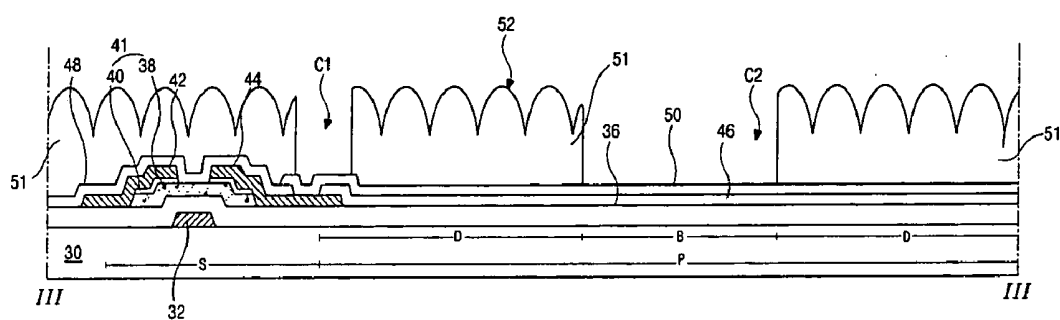


FIG. 3F
RELATED ART

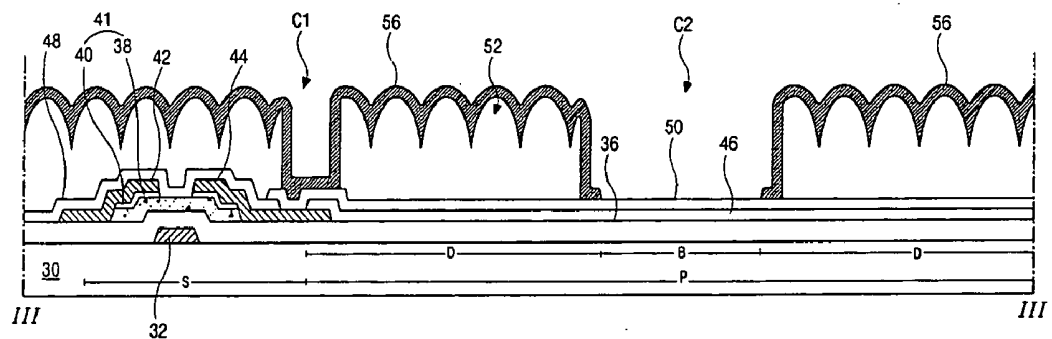


FIG. 4

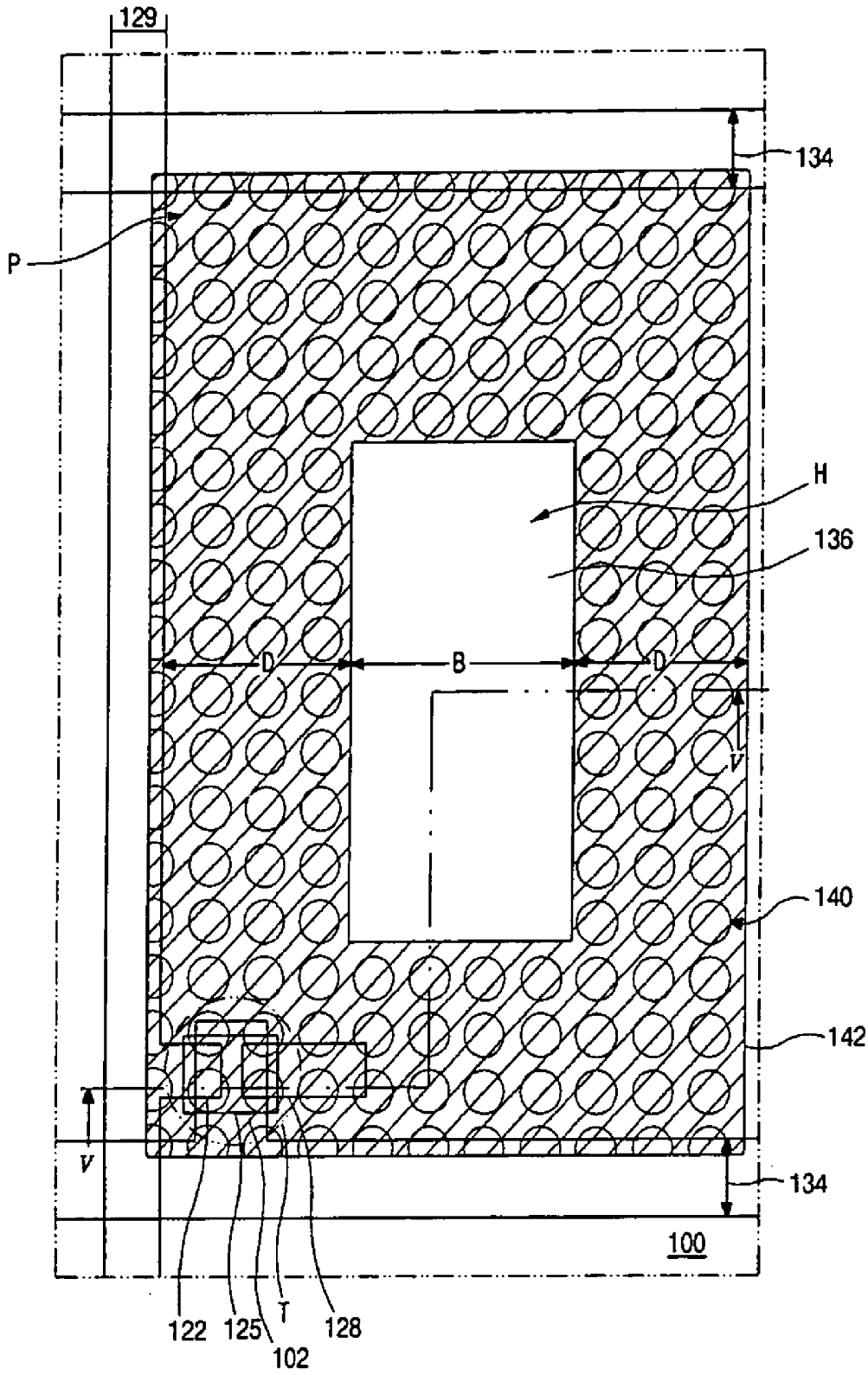


FIG. 5A

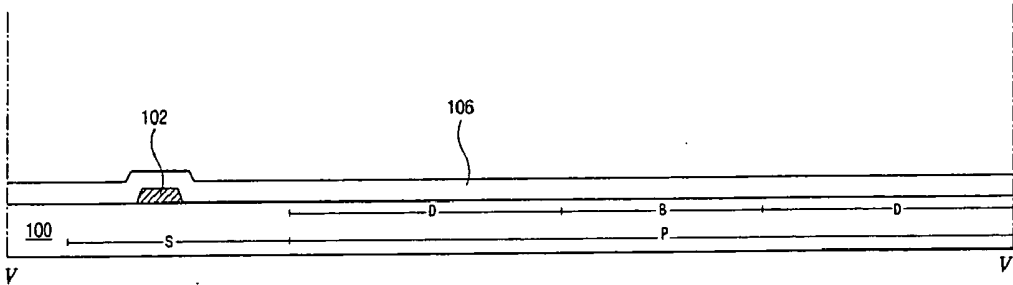


FIG. 5B

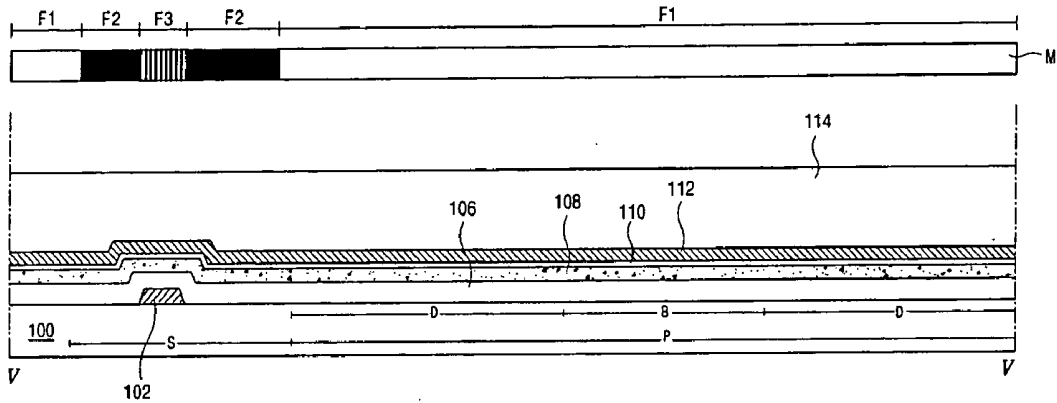


FIG. 5C

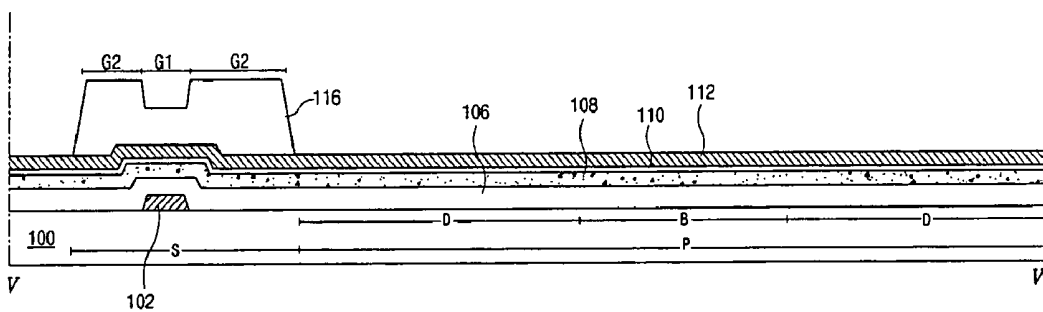


FIG. 5D

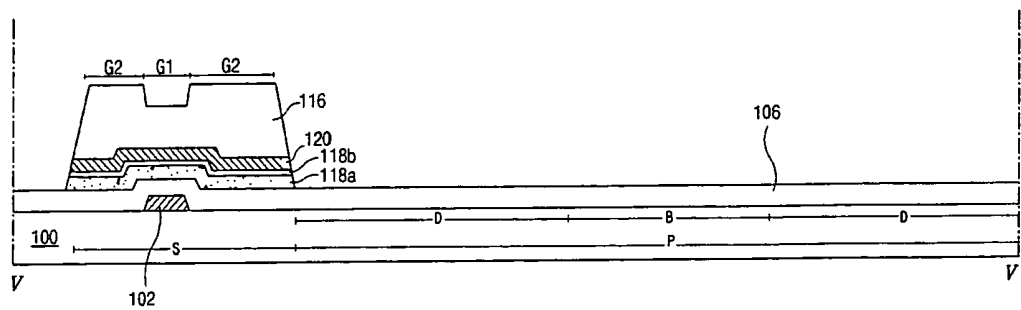


FIG. 5E

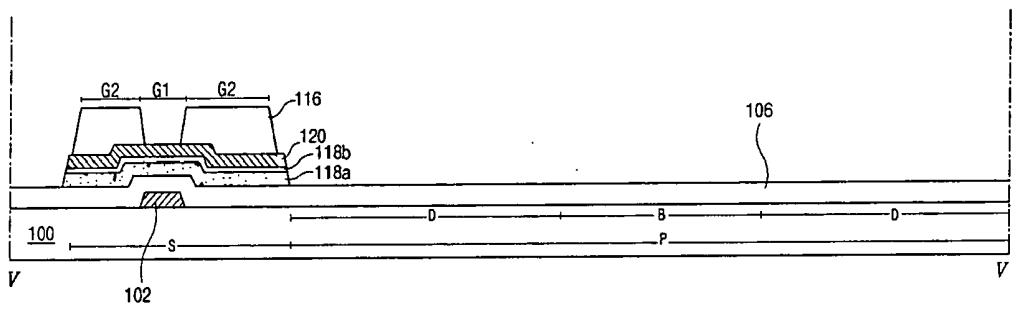


FIG. 5F

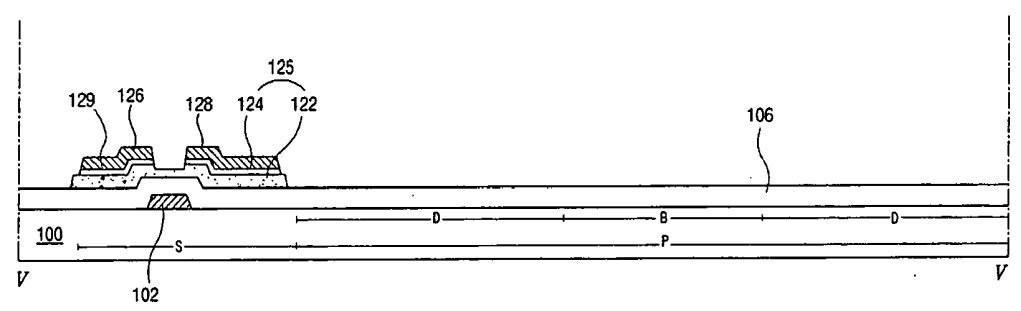


FIG. 5G

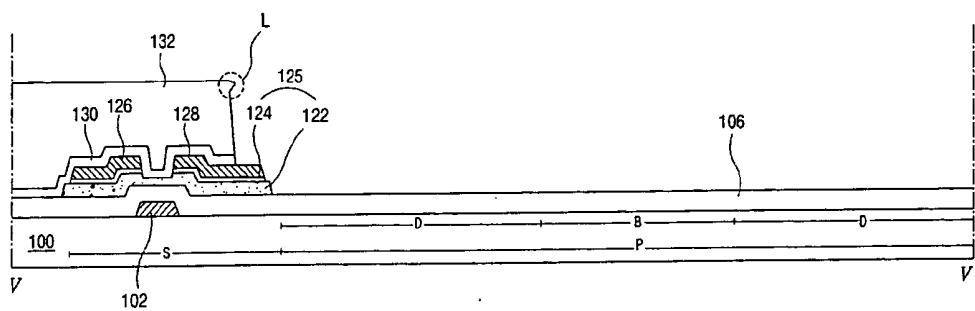


FIG. 5H

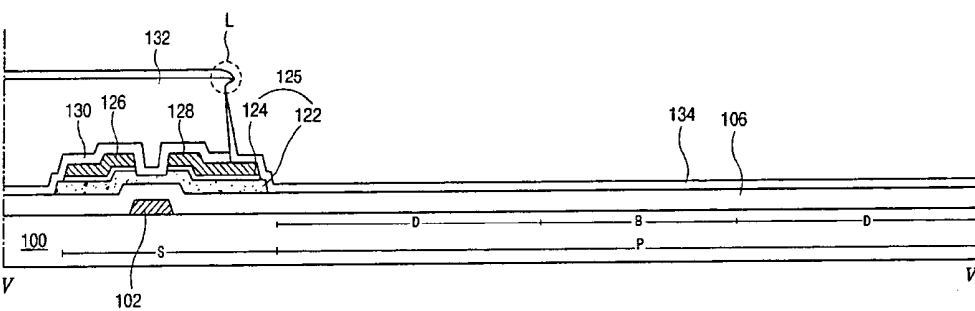
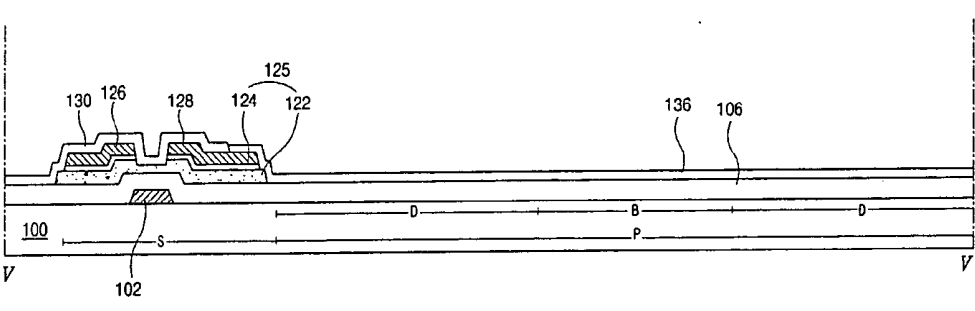


FIG. 5I



TRANSFLECTIVE LIQUID CRYSTAL DISPLAY DEVICE AND FABRICATING METHOD THEREOF

[0001] The present invention claims the benefit of Korean Patent Application No. 2003-100667, filed in Korea on Dec. 30, 2003, which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a liquid crystal display device, and more particularly, to a transfective liquid crystal display device and a fabricating method thereof.

[0004] 2. Discussion of the Related Art

[0005] Generally, a transfective liquid crystal display (LCD) device functions both as a transmissive LCD device and a reflective LCD device. Transfective LCD devices are more versatile because they can use both a backlight and ambient light as light sources. Moreover, transfective LCD devices have low power consumption.

[0006] FIG. 1 is an exploded perspective view of an LCD device according to the related art. Referring to FIG. 1, a liquid crystal display (LCD) device 10 has an upper substrate 12 having a black matrix 17. A color filter layer 16 of the LCD device 10 includes sub-color filters. The LCD device 10 includes a common electrode 13 on the color filter layer 16, and a lower substrate 14 having a switching element, a thin film transistor (TFT) T, and a transparent electrode 20a connected to the TFT T. A liquid crystal material 18 is interposed between the upper and lower substrates 12 and 14. The lower substrate 14 is referred to as an array substrate because an array of lines, including gate lines 25 and data lines 27, is formed thereon. The gate lines 25 and the data lines 27 cross each other to form a matrix. The TFT T is connected to one of the gate lines 25 and one of the data lines 27. A pixel region P is defined between the gate lines 25 and the data lines 27. The TFT T is formed near a crossing of the gate lines 25 and the data lines 27. The transparent electrode 20a is formed of a transparent conductive material, such as indium-tin-oxide (ITO) and indium-zinc-oxide (IZO), in the pixel region P. The upper substrate 12 is referred to as a color filter substrate because the color filter layer 16 is formed thereon.

[0007] A reflective electrode 20b consisting of a reflective material, such as aluminum (Al) or Al alloy, is formed in the pixel region P. The reflective electrode 20b has a transmissive hole H so that the pixel region P is divided into a reflective portion D and a transmissive portion B. The transmissive portion B corresponds to the transmissive hole H and the reflective portion D corresponds to the reflective electrode 20b.

[0008] The transfective LCD device is manufactured to selectively use a reflective mode, which depends on natural light, or a transmissive mode, which depends on a light source. The utilization efficiency of light is lower in the reflective mode than in the transmissive mode. Thus, brightness variation occurs in a transition from the reflective mode to the transmissive mode. To solve the problem, an uneven reflective layer is formed on the reflective portion in the related art LCD device to induce an irregular reflection by minimizing a specular-reflection of the incident ambient

light and to improve brightness uniformity in the reflected mode and the transmissive mode.

[0009] FIG. 2 is a plan view of a pixel region of a transfective LCD device having an uneven reflective layer according to the related art. Referring to FIG. 2, a gate line 34 is formed on a substrate 30 along a first direction. A data line 46 crosses the gate line 34 to define a pixel region P. A thin film transistor T is formed near a crossing of the gate line 34 and the data line 46. The thin film transistor T includes a gate electrode 32, a semiconductor layer 41, a source electrode 42 and a drain electrode 44.

[0010] A transparent electrode 50 is formed in the pixel region P. The transparent electrode 50 is connected to the thin film transistor T. A reflective electrode 56 is also formed in the pixel region P. The reflective electrode 56 has a transmissive hole H that exposes the central portion of the transparent electrode 50.

[0011] A reflective portion D of the pixel region P corresponds to the transmissive hole H. A transmissive portion B of the pixel region P corresponds to the transparent electrode 50 excluding the reflective portion D. Specifically, the transparent electrode 50, which is located in the transmissive portion B and is connected to the drain electrode 44, generates a vertical field with respect to the common electrode 13 (shown in FIG. 1) through the liquid crystal layer 18 (shown in FIG. 1). The reflective electrode 56 reflects incident light.

[0012] The reflective layer is formed with an uneven surface to improve reflection efficiency. Thus, the brightness of the LCD device is improved and the viewing angle is widened. However, fabrication of the transfective LCD device increases the manufacturing complexity because of the additional mask process for forming the uneven reflective layer.

[0013] FIG. 3A is a cross-sectional view taken along line III-III of FIG. 2, showing a first mask process for fabricating a transfective LCD device according to the related art. Referring to FIG. 3A, a pixel region P is defined as a unit region for displaying an image. A switching device (shown in FIG. 2) is positioned in a switching region S on the substrate 30. The pixel region P includes a transmissive portion B and a reflective portion D. A gate line 34 (shown in FIG. 2) and a gate electrode 32 are formed using a metallic material having a low resistance on the substrate 30 through a first mask process. The gate electrode 32 is connected to the gate line 34.

[0014] Although not shown, the first mask process, which is a photolithography process, includes coating a photoresist on the metallic material layer, exposing the photoresist using a photo mask and developing the photoresist to form a photoresist pattern (not shown). The photoresist pattern is formed to shield the metallic material in a subsequent process. The first mask process further includes etching the metallic material using the photoresist pattern as a shield to pattern the gate line 34 (shown in FIG. 2) and the gate electrode 32. The steps of the first mask process can also be used in subsequent mask processes.

[0015] FIG. 3B is a cross-sectional view taken along line III-III of FIG. 2, showing a second mask process for fabricating a transfective LCD device according to the related art. Referring to FIG. 3B, a gate insulating layer 36

is formed using an inorganic insulating material over the entire surface of the substrate **30** including the gate line **34** (shown in **FIG. 2**) and the gate electrode **32** through a second mask process. An active layer **38** and an ohmic contact layer **40** are formed by patterning intrinsic amorphous silicon and impurity-doped amorphous silicon on the gate insulating layer **36** through the second mask process. In other words, the active layer **38** and the ohmic contact layer **40** are made of the intrinsic amorphous silicon and the impurity-doped amorphous silicon, respectively. The active layer **38** and the ohmic contact layer **40** constitute a semiconductor layer **41**.

[0016] **FIG. 3C** is a cross-sectional view taken along line III-III of **FIG. 2**, showing third and fourth mask processes for fabricating a transfective LCD device according to the related art. Referring to **FIG. 3C**, a source electrode **42** and a drain electrode **44** are formed on the semiconductor layer **41** by a third mask process using a metallic material similar to that mentioned in **FIG. 3A**. A passivation layer **48** having a drain contact hole **49** that exposes the portion of the drain electrode **44** is formed by a fourth mask process using an organic or an inorganic insulating material over the entire surface of the substrate **30** having the source and drain electrodes **42** and **44**.

[0017] **FIG. 3D** is a cross-sectional view taken along line III-III of **FIG. 2**, showing a fifth mask process for fabricating a transfective LCD device according to the related art. Referring to **FIG. 3D**, a transparent electrode **50** is formed through a fifth mask process using a transparent conductive material on the passivation layer **48**. The transparent electrode **50** is connected to the drain electrode **44** via the drain contact hole **49**.

[0018] **FIG. 3E** is a cross-sectional view taken along line III-III of **FIG. 2**, showing a sixth mask process for fabricating a transfective LCD device according to the related art. Referring to **FIG. 3E**, an organic insulating layer **51** is formed through a sixth mask process using an organic insulating material over the entire surface of the substrate **30** including the transparent electrode **50**. The organic insulating material has good step-coverage property.

[0019] In the same mask process, a contact hole **C1**, a transmissive hole **C2**, and an uneven portion **52** are formed. The contact hole **C1** exposes a portion of the transparent electrode **50**. The transmissive hole **C2** exposes a main portion of the transparent electrode **50** in the pixel region **P**. The uneven portion **52** is formed on the surface of the organic insulating layer **51** in the reflective portion **D** including the switching region **S**. The uneven portion **52** may be formed by melting the patterned organic insulating layer **51** that initially had a saw-tooth cross-section.

[0020] **FIG. 3F** is a cross-sectional view taken along line III-III of **FIG. 2**, showing a seven mask process for fabricating a transfective LCD device according to the related art. Referring to **FIG. 3F**, a reflective electrode **56** is formed through a seven mask process using a metallic material having good reflectivity. The reflective electrode **56** is formed over the substrate **30** including the unevenness **52**. The reflective electrode **56** is located in the reflective portion **D** and is connected to the transparent electrode **50**.

[0021] The related art fabricating method of the transfective LCD device has several problems. The mask processes

are very complicated. Moreover, the production yield is reduced by the additional process for forming the uneven reflective pattern.

SUMMARY OF THE INVENTION

[0022] Accordingly, the present invention is directed to a transfective LCD device and a fabricating method thereof that substantially obviate one or more of the problems due to limitations and disadvantages of the related art.

[0023] An object of the present invention is to provide a transfective LCD device having high-reflectivity.

[0024] Another object of the present invention is to provide a method of fabricating a transfective LCD device having high-reflectivity.

[0025] Another object of the present invention is to provide a reduced number of mask processes for fabricating a transfective LCD device.

[0026] Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0027] To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, a substrate for a transfective liquid crystal display device includes a plurality of gate lines on a substrate; at least one data line crossing the plurality of gate lines to define a pixel region including a transmissive portion and a reflective portion; a thin film transistor connected to one of the plurality of gate lines and the at least one data line, the thin film transistor including a gate electrode, a semiconductor layer, a source electrode and a drain electrode; a first insulating layer covering a portion of the thin film transistor, the first insulating layer uncovering the pixel region and a portion of the drain electrode; a transparent electrode in the pixel region, the transparent electrode directly contacting the drain electrode and the semiconductor layer; and a reflective layer in the reflective portion, the reflective layer having a first uneven surface.

[0028] In another aspect, a method of fabricating a substrate for a transfective liquid crystal display device includes forming a plurality of gate lines on a substrate; forming at least one data line, a thin film transistor including a source electrode and a drain electrode, the at least one data line crossing the plurality of gate lines to define a pixel region including a transmissive portion and a reflective portion, the source electrode being connected to the at least one data line, and the drain electrode being spaced apart from the source electrode; forming a first insulating layer covering a portion of the thin film transistor, the first insulating layer uncovering the pixel region and a portion of the drain electrode; forming a transparent electrode in the pixel region, the transparent electrode directly contacting the drain electrode and the semiconductor layer; forming a second insulating layer on the transparent electrode, the second insulating layer having a first uneven surface; and forming a reflective layer in the reflective portion, the

reflective layer having a second uneven surface corresponding to the first uneven surface.

[0029] 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

[0030] 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 embodiments of the invention and together with the description serve to explain the principles of the invention.

[0031] FIG. 1 is an exploded perspective view of an LCD device according to the related art.

[0032] FIG. 2 is a plan view of a pixel region of a transfective LCD device having an uneven reflective layer according to the related art.

[0033] FIG. 3A is a cross-sectional view taken along line III-III of FIG. 2, showing a first mask process for fabricating a transfective LCD device according to the related art.

[0034] FIG. 3B is a cross-sectional view taken along line III-III of FIG. 2, showing a second mask process for fabricating a transfective LCD device according to the related art.

[0035] FIG. 3C is a cross-sectional view taken along line III-III of FIG. 2, showing third and fourth mask processes for fabricating a transfective LCD device according to the related art.

[0036] FIG. 3D is a cross-sectional view taken along line III-III of FIG. 2, showing a fifth mask process for fabricating a transfective LCD device according to the related art.

[0037] FIG. 3E is a cross-sectional view taken along line III-III of FIG. 2, showing a sixth mask process for fabricating a transfective LCD device according to the related art.

[0038] FIG. 3F is a cross-sectional view taken along line III-III of FIG. 2, showing a seven mask process for fabricating a transfective LCD device according to the related art.

[0039] FIG. 4 is a plan view of an exemplary pixel region of a transfective LCD device having an uneven reflective layer according to an embodiment of the present invention.

[0040] FIG. 5A is a cross-sectional view taken along line V-V of FIG. 4, showing an exemplary first mask process for patterning a first metal layer for a transfective LCD device according to the embodiment of the present invention depicted in FIG. 4.

[0041] FIG. 5B is a cross-sectional view taken along line V-V of FIG. 4, showing the exposure of a first photoresist layer of the transfective LCD device through a second mask process according to the embodiment of the present invention depicted in FIG. 4.

[0042] FIG. 5C is a cross-sectional view taken along line V-V of FIG. 4, showing the formation of a photoresist

pattern of the transfective LCD device through the second mask process according to the embodiment of the present invention depicted in FIG. 4.

[0043] FIG. 5D is a cross-sectional view taken along line V-V of FIG. 4, showing the formation of a second metal pattern and semiconductor patterns of the transfective LCD device through the second mask process according to the embodiment of the present invention depicted in FIG. 4.

[0044] FIG. 5E is a cross-sectional view taken along line V-V of FIG. 4, showing an exposure of the second metal pattern and the semiconductor patterns for the transfective LCD device through the second mask process according to the embodiment of the present invention depicted in FIG. 4.

[0045] FIG. 5F is a cross-sectional view taken along line V-V of FIG. 4, showing the formation of an active layer and an ohmic contact layer for the transfective LCD device through the second mask process according to the embodiment of the present invention depicted in FIG. 4.

[0046] FIG. 5G is a cross-sectional view taken along line V-V of FIG. 4, showing an exemplary third mask process for forming a second photoresist layer of the transfective LCD device according to the embodiment of the present invention depicted in FIG. 4.

[0047] FIG. 5H is a cross-sectional view taken along line V-V of FIG. 4, showing the formation of a transparent metal layer of the transfective LCD device through the third mask process according to the embodiment of the present invention depicted in FIG. 4.

[0048] FIG. 5I is a cross-sectional view taken along line V-V of FIG. 4, showing the formation of a transparent electrode of the transfective LCD device through the third mask process according to the embodiment of the present invention depicted in FIG. 4.

[0049] FIG. 5J is a cross-sectional view taken along line V-V of FIG. 4, showing an exemplary fourth mask process for forming holes and uneven patterns on an organic insulating layer of the transfective LCD device according to the embodiment of the present invention depicted in FIG. 4.

[0050] FIG. 5K is a cross-sectional view taken along line V-V of FIG. 4, showing an exemplary fifth mask process for forming a reflective electrode on an organic insulating layer of the transfective LCD device according to the embodiment of the present invention depicted in FIG. 4.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0051] Reference will now be made in detail to the illustrated embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

[0052] FIG. 4 is a plan view of an exemplary pixel region of a transfective LCD device having an uneven reflective layer according to an embodiment of the present invention. Referring to FIG. 4, a plurality of gate lines 134 is formed on a substrate 100 along a first direction. At least one data line 129 crosses the plurality of gate lines 134 to define a pixel region P.

[0053] A thin film transistor T is formed near a crossing of one of the plurality of gate lines 134 and the at least one data line 129. The thin film transistor T includes a gate electrode

102, a semiconductor layer **125**, source electrode **122** and drain electrode **128**. Although not shown, a first insulating layer covers a portion of the thin film transistor T. The pixel region P and a portion of the drain electrode **128** are exposed through the first insulating layer.

[0054] A transparent electrode **136** is located in the pixel region P. The transparent electrode **136** directly contacts the drain electrode **128**. A reflective electrode **142** is formed in the pixel region P. The reflective electrode **142** has a transmissive hole H that exposes a central portion of the transparent electrode **136**. A reflective portion D of the pixel region P corresponds to a portion unexposed by the transmissive hole H. A transmissive portion B of the pixel region is defined by the portion corresponding to the transparent electrode **136** excluding the reflective portion D.

[0055] FIG. 5A is a cross-sectional view taken along line V-V of FIG. 4, showing an exemplary first mask process for patterning a first metal layer for a transfective LCD device according to the embodiment of the present invention depicted in FIG. 4. Referring to FIG. 5A, a pixel region P and a switching region S are defined on the substrate **100**. The pixel region P is a unit region for displaying an image. A switching device is located in the switching region S on the substrate **100**. The pixel region P includes a transmissive portion B and a reflective portion D.

[0056] A metallic material having a low resistance is deposited on the substrate **100** including the pixel region P and the switching region S. The deposited metallic material is patterned into a plurality of gate lines **134** (shown in FIG. 4) and a gate electrode **102** using a first mask process. The gate electrode **102** is connected to the plurality of gate lines **134**.

[0057] The first mask process is a photolithography process. Although not shown, the first mask process includes coating a photoresist on the metallic material layer, exposing the photoresist using a photo mask, and developing the photoresist to form a photoresist pattern (not shown) by shielding the metallic material. The first mask process further includes etching the metallic material using the photoresist pattern as a shield to pattern the plurality of gate lines **134** and the gate electrode **102**. Other mask processes can be performed using steps similar to those used in the first mask process.

[0058] The metallic material having low resistance may be one of a single metallic material, such as aluminum (Al), Al alloy, tungsten (W) and chromium (Cr), and a double metallic material, such as Al/Cr and Al/molybdenum (Mo). In an embodiment of the present invention using a double metallic material, the Al material is closer to the substrate **100** than the other metallic material. Intrinsic Al has chemically weak corrosion resistance and hillocks are formed on the top surface of the intrinsic Al when high temperature processes are later performed.

[0059] A gate insulating layer **106** is subsequently formed over the entire surface of the substrate **100**, including the plurality of gate lines **134** and the gate electrode **102**, by depositing an inorganic insulating material or by coating an organic insulating material. The inorganic insulating material may be one of silicon nitride (SiNx) and silicon oxide (SiOx). The organic insulating material may be one of benzocyclobutene (BCB) and acrylic resin.

[0060] FIG. 5B is a cross-sectional view taken along line V-V of FIG. 4, showing the exposure of a first photoresist layer of the transfective LCD device through a second mask process according to the embodiment of the present invention depicted in FIG. 4. Referring to FIG. 5B, first and second semiconductor layers **108** and **110** are sequentially formed by depositing intrinsic amorphous silicon and impurity-doped amorphous silicon on the gate insulating layer **106**, respectively. Thus, the first semiconductor layer **108** includes the intrinsic amorphous silicon. The second semiconductor layer **110** includes the impurity-doped amorphous silicon.

[0061] A metal layer **112** is formed by depositing a conductive metallic material on the substrate **110** including the semiconductor layers **108** and **110** in a manner similar to FIG. 5A. Next, a photoresist layer **114** is formed by coating a photosensitive material, such as a photoresist, over the entire surface of the substrate **100** including the metal layer **112**. Then, a mask M is disposed over the substrate **100** including the photoresist layer **114**.

[0062] The mask M includes a transmissive region F1, a shielding region F2 and a half-transmissive region F3. The half-transmissive region F3 of the mask M lowers light intensity or reduces light transmission. The half-transmissive region F3 includes a plurality of slits or a half-transmissive layer.

[0063] Portions of the photoresist layer **114** are then exposed by irradiating light through the mask M. A first portion of the photoresist layer **114** corresponding to the transmissive region F1 of the mask M is fully exposed to the irradiated light. A second portion of the photoresist layer **114** corresponding to the shielding region F2 of the mask M is shielded from the irradiated light. A third portion of the photoresist layer **114** corresponding to the half-transmissive region F3 of the mask M is only partially exposed to the light.

[0064] FIG. 5C is a cross-sectional view taken along line V-V of FIG. 4, showing the formation of a photoresist pattern of the transfective LCD device through the second mask process according to the embodiment of the present invention depicted in FIG. 4. Referring to FIG. 5C, the fully exposed portion of the photoresist layer **114** (shown in FIG. 5B) is developed to form a first photoresist pattern **116**. The first photoresist pattern **116** covers the switching region S. A portion of the metal layer **112** is exposed by the removal of the fully exposed portion of the photoresist layer. The exposed portion of the metal layer **112** corresponds to the pixel region P and excludes the first photoresist pattern **116**.

[0065] The first photoresist pattern **116** includes a first portion G1 and a second portion G2. The first portion G1 corresponds to the portion of the photoresist layer **114** (shown in FIG. 5B) that was partially exposed by the half-transmissive region F3 of the mask M (shown in FIG. 5B). The second portion G2 corresponds to the portion of the photoresist layer **114** (shown in FIG. 5B) that was shielded by the shielding region F2 of the mask M (shown in FIG. 5B). The first portion G1 of the first photoresist pattern **116** is partially removed during the developing process. Thus, the first photoresist pattern **116** in the first portion G1 is thinner than in the second portion G2.

[0066] FIG. 5D is a cross-sectional view taken along line V-V of FIG. 4, showing the formation of a second metal

pattern and semiconductor patterns of the transfective LCD device through the second mask process according to the embodiment of the present invention depicted in FIG. 4. Referring to FIG. 5D, the exposed portion of the metal layer 112 is removed. Thereby, a metal pattern 120 is formed underneath the first photoresist pattern 116. Portions of the first and second semiconductor layers 108 and 110 corresponding to and underneath the exposed portion of the metal layer 112 are subsequently removed. Thereby, first and second semiconductor patterns 118a and 118b are formed underneath the metal pattern 120 and the first photoresist pattern 116. Thus, the first semiconductor pattern 118a, the second semiconductor pattern 118b and the metal pattern 120 are disposed in successive order upward on the substrate 100.

[0067] FIG. 5E is a cross-sectional view taken along line V-V of FIG. 4, showing an exposure of the second metal pattern and the semiconductor patterns for the transfective LCD device through the second mask process according to the embodiment of the present invention depicted in FIG. 4. Referring to FIG. 5E, the first portion G1 of the first photoresist pattern 116 is removed by an ashing process. Thereby, a portion of the metal pattern 120 corresponding to the first portion G1 is exposed. The exposed portion of the metal pattern 120 is removed by using the first photoresist pattern 116 as a shield. Then, a portion of the second semiconductor pattern 118b corresponding to the exposed metal pattern 120 is removed, thereby forming a channel region. After removing the exposed portions of the metal pattern 120 and the second semiconductor pattern 118b, the first photoresist pattern 116 is stripped using a stripping agent (not shown).

[0068] FIG. 5F is a cross-sectional view taken along line V-V of FIG. 4, showing the formation of an active layer and an ohmic contact layer for the transfective LCD device through the second mask process according to the embodiment of the present invention depicted in FIG. 4. Referring to FIG. 5F, after the stripping process, the first and second semiconductor patterns 118a and 118b (shown in FIG. 5E) are patterned into an active layer 122 and an ohmic contact layer 124, respectively. In addition, the pre-patterned metal pattern 120 (shown in FIG. 5E) is patterned into a source electrode 126 and a drain electrode 128 spaced apart from each other. The active layer 122 and the ohmic contact layer 124 form a semiconductor layer 125.

[0069] According to an embodiment of the present invention, the active layer 122, the ohmic contact layer 124, the source electrode 126, the drain electrode 128, and a data line 129 are formed in the same process, which is the second mask process described above in reference to FIGS. 5B to 5F. The data line 129 is formed using the same material as the source and drain electrodes 126 and 128 and is connected to the source electrode 126. The data line 129 covers a corresponding portion of the first and second semiconductor patterns 118a and 118b (shown in FIG. 5E).

[0070] FIG. 5G is a cross-sectional view taken along line V-V of FIG. 4, showing an exemplary third mask process for forming a second photoresist layer of the transfective LCD device according to the embodiment of the present invention depicted in FIG. 4. Referring to FIG. 5G, a passivation layer 130 is formed by depositing or coating an insulating material over the entire surface of the substrate 100 includ-

ing the source and drain electrodes 126 and 128. The passivation layer 130 may include an inorganic insulating material, for example one of silicon nitride (SiNx) and silicon oxide (SiOx).

[0071] A second photoresist pattern 132 is subsequently formed to cover a portion of the passivation layer 130 including a portion of the thin film transistor T. A remaining portion of the passivation layer 130, which overlaps the pixel region P and a portion of the drain electrode 128, is not covered by the second photoresist pattern 132. The exposed portion of the passivation layer 130 is removed, thereby exposing the overlapped portion of the drain electrode 128 and a portion of the gate insulating layer 106 within the pixel region P. Moreover, the second photoresist pattern 132 includes a shoulder portion L overlooking the exposed portion of the drain electrode 128.

[0072] FIG. 5H is a cross-sectional view taken along line V-V of FIG. 4, showing the formation of a transparent metal layer of the transfective LCD device through the third mask process according to the embodiment of the present invention depicted in FIG. 4. Referring to FIG. 5H, a transparent metal layer 134 is formed by depositing a transparent conductive material, such as indium tin oxide (ITO), indium zinc oxide (IZO) or indium tin zinc oxide (ITZO), over the entire surface of the substrate 100, including the patterned passivation layer 130 and the exposed portion of the gate insulating layer 106. The transparent metal layer 134 is not uniformly deposited at the sides of the second photoresist pattern 132, particularly, at the shoulder portion L. Thus, the portion of the transparent metal layer 134 in the shoulder portion L may be separated such that the second photoresist pattern 132 is exposed.

[0073] The substrate 100 having the transparent metal layer 134 is dipped in a stripping agent solution to remove the second photoresist pattern 132. The portion of the transparent metal layer 134 on the second photoresist pattern 132 is easily removed because the stripper has access to the second photoresist pattern 132 at the shoulder portion L. Thus, the portions of the transparent metal layer 134 deposited on the top and sides of the second photoresist pattern 132 are removed concurrently with the second photoresist pattern 132.

[0074] FIG. 5I is a cross-sectional view taken along line V-V of FIG. 4, showing the formation of a transparent electrode of the transfective LCD device through the third mask process according to the embodiment of the present invention depicted in FIG. 4. Referring to FIG. 5I, the remaining portion of the transparent metal layer 134 (shown in FIG. 5H) acts as a transparent electrode 136 in the pixel region P. The transparent electrode 136 directly contacts the drain electrode 128, the ohmic contact layer 124 and the active layer 122. Thus, the passivation layer 130 and the transparent electrode 136 can be patterned through the third mask process described in reference to FIGS. 5G to 5I without an additional mask process.

[0075] FIG. 5J is a cross-sectional view taken along line V-V of FIG. 4, showing an exemplary fourth mask process for forming holes and uneven patterns on an organic insulating layer of the transfective LCD device according to the embodiment of the present invention depicted in FIG. 4. Referring to FIG. 5J, an organic insulating layer 139 is formed by coating an organic insulating material having a

good step-coverage property over the entire substrate **100** including the transparent electrode **136**. The organic insulating material may include a photosensitive acrylic resin.

[0076] Through the fourth mask process, a contact hole **C1**, a transmissive hole **C2** and a first uneven surface **140** are formed. The contact hole **C1** exposes a portion of the transparent electrode **136** near the switching region **S**. The transmissive hole **C2** exposes a central portion of the transparent electrode **136** in the pixel region **P**. The first uneven surface **140** extends over a part of the surface of the organic insulating layer **139** within the reflective portion **D** including the switching region **S**.

[0077] The central portion of the transparent electrode **136** corresponding to the transmissive hole **C2** through the organic insulating layer **139** defines a transmissive portion **B**. The portion of the organic insulating layer **139** covered by the first uneven surface **140** and including the switching region **S** defines a reflective portion **D**. The portion of the transparent electrode **136** exposed through the contact hole **C1** may correspond to the contact portion of the transparent electrode **136** and the drain electrode **128** as shown in **FIG. 5J**. The first uneven surface **140** may be formed in an hemispherical shape by melting the patterned organic insulating layer **139** at about 350° after initially forming a plurality of saw-tooth shapes as viewed in a cross-sectional view.

[0078] **FIG. 5K** is a cross-sectional view taken along line V-V of **FIG. 4**, showing an exemplary fifth mask process for forming a reflective electrode on an organic insulating layer of the transmissive LCD device according to the embodiment of the present invention depicted in **FIG. 4**. Referring to **FIG. 5K**, a reflective electrode **142** is formed by depositing and patterning a metallic material having a good reflectivity over the substrate **100** including the first uneven surface **140**. The reflective electrode **142** is located in the reflective portion **D**. The metallic material used for the reflective **142** may include one of aluminum (Al) and silver (Ag).

[0079] According to an embodiment of the present invention, as shown in **FIG. 5K**, the reflective electrode **142** is connected to the transparent electrode **136** through the contact hole **C1**. The reflective electrode **142** includes a second uneven surface **143** corresponding to the first uneven surface **140**. According to another embodiment of the present invention, the uneven reflective layer may be electrically isolated from the transparent electrode.

[0080] A transmissive LCD device according to embodiments of the present invention has the following advantages. The array substrate of the transmissive LCD device may be formed using five mask processes or photolithography processes. Processing time and production costs can be reduced because of the omission of two mask processes in comparison with the related art. The uneven reflective electrode increases reflection efficiency, thus providing high brightness. The reduction in mask processes lowers defect probability, thereby improving the production yield and providing competitive advantage in production.

[0081] It will be apparent to those skilled in the art that various modifications and variations can be made in the transmissive liquid crystal display device and fabricating method thereof of the present invention without departing

from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A substrate for a transmissive liquid crystal display device, comprising:

a plurality of gate lines on a substrate;

at least one data line crossing the plurality of gate lines to define a pixel region including a transmissive portion and a reflective portion;

a thin film transistor connected to one of the plurality of gate lines and the at least one data line, the thin film transistor including a gate electrode, a semiconductor layer, a source electrode and a drain electrode;

a first insulating layer covering a portion of the thin film transistor, the first insulating layer uncovering the pixel region and a portion of the drain electrode;

a transparent electrode in the pixel region, the transparent electrode directly contacting the drain electrode and the semiconductor layer; and

a reflective layer in the reflective portion, the reflective layer having a first uneven surface.

2. The substrate according to claim 1, further comprising a second insulating layer formed below the reflective layer, the second insulating layer having a second uneven surface corresponding to the first uneven surface.

3. The substrate according to claim 2, wherein the first and second uneven surfaces have hemispherical shapes.

4. The substrate according to claim 2, wherein the reflective layer is connected to the transparent electrode.

5. The substrate according to claim 4, wherein the second insulating layer includes a first hole that exposes the exposed portion of the transparent electrode, the reflective layer being connected to the transparent electrode through the first hole.

6. The substrate according to claim 5, wherein the reflective layer includes a second hole that exposes a portion of the transparent electrode, the second hole corresponding to the transmissive portion of the pixel region.

7. The substrate according to claim 2, wherein the second insulating layer is selected from one of organic materials consisting of benzocyclobutene (BCB) and acrylic resin.

8. The substrate according to claim 1, wherein the first insulating layer is separated from the transparent electrode.

9. The substrate according to claim 8, wherein the transparent electrode directly contacts the exposed portion of the drain electrode.

10. The substrate according to claim 1, wherein the reflective layer is electrically isolated.

11. The substrate according to claim 1, wherein the reflective layer is selected from one of aluminum (Al) and silver (Ag).

12. The substrate according to claim 1, wherein the transparent electrode is selected from one of indium tin oxide (ITO), indium zinc oxide (IZO) and indium tin zinc oxide (ITZO).

13. The substrate according to claim 1, wherein the semiconductor layer includes an active layer and an ohmic contact layer, the ohmic contact layer is positioned between the drain electrode and the active layer.

14. The substrate according to claim 13, wherein the transparent electrode contacts the ohmic contact layer.

15. A method of fabricating a substrate for a transreflective liquid crystal display device, comprising:

forming a plurality of gate lines on a substrate;

forming at least one data line, a thin film transistor including a source electrode and a drain electrode, the at least one data line crossing the plurality of gate lines to define a pixel region including a transmissive portion and a reflective portion, the source electrode being connected to the at least one data line, and the drain electrode being spaced apart from the source electrode;

forming a first insulating layer covering a portion of the thin film transistor, the first insulating layer uncovering the pixel region and a portion of the drain electrode;

forming a transparent electrode in the pixel region, the transparent electrode directly contacting the drain electrode and the semiconductor layer;

forming a second insulating layer on the transparent electrode, the second insulating layer having a first uneven surface; and

forming a reflective layer in the reflective portion, the reflective layer having a second uneven surface corresponding to the first uneven surface.

16. The method according to claim 15, wherein forming the at least one data line, the source electrode and the drain electrode includes forming a semiconductor layer, the semiconductor layer being formed below the at least one data line, the source electrode and the drain electrode, a pattern of the semiconductor layer corresponding to a pattern of the at least one data line, the source electrode and the drain electrode.

17. The method according to claim 15, wherein forming the at least one data line, the source electrode and the drain electrode includes:

forming a gate insulating layer on an entire surface of the substrate including the plurality of gate lines;

sequentially forming an intrinsic amorphous silicon layer on the gate insulating layer, an impurity-doped amorphous silicon layer on the intrinsic amorphous silicon layer, and a metal layer on the impurity-doped amorphous silicon layer;

forming a first photoresist pattern including a first portion and a second portion, the first portion of the first

photoresist pattern being thinner than the second portion of the first photoresist pattern, etching the metal layer, the impurity-doped amorphous silicon layer and the intrinsic amorphous silicon layer using the first photoresist pattern as a shield; and

removing the first portion of the first photoresist pattern, and removing a corresponding portion of the metal layer and a corresponding portion of the impurity-doped amorphous silicon layer to define a channel region corresponding to the exposed portion of the intrinsic amorphous silicon layer.

18. The method according to claim 15, wherein forming the first insulating layer includes:

forming a first insulating material layer over the entire surface of the substrate including the thin film transistor;

forming a second photoresist pattern to cover a portion of the first insulating material layer including a portion of the thin film transistor, a remaining portion of the first insulating layer overlapping the pixel region and a portion of the drain electrode; and

removing the remaining portion of the first insulating material layer uncovered by the second photoresist pattern to expose the portion of the drain electrode and a portion of the gate insulating layer within the pixel region.

19. The method according to claim 15, wherein forming the transparent electrode includes:

forming a transparent material layer over the entire surface of the substrate including the second photoresist pattern and the first insulating layer; and

simultaneously removing the second photoresist pattern and a portion of the transparent material formed on the second photoresist pattern by lifting off the second photoresist pattern.

20. The method according to claim 15, wherein the second insulating layer includes a first hole that exposes a portion of the transparent electrode corresponding to the exposed portion of the drain electrode.

21. The method according to claim 20, wherein the reflective layer is connected to the transparent electrode through the first hole.

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专利名称(译)	透反液晶显示装置及其制造方法		
公开(公告)号	US20050140874A1	公开(公告)日	2005-06-30
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[标]申请(专利权)人(译)	乐金显示有限公司		
申请(专利权)人(译)	LG.PHILIPS LCD CO. , LTD.		
当前申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
[标]发明人	LIM BYOUNG HO LEE SUN HWA		
发明人	LIM, BYOUNG-HO LEE, SUN-HWA		
IPC分类号	G02F1/13 G02F1/1335 G02F1/136 G02F1/1362 G02F1/1368 G03F7/20 G03F7/42 G09F9/35 H01L21/00 H01L21/77 H01L21/84 H01L27/12 H01L29/786		
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摘要(译)

用于透反液晶显示装置的基板包括在基板上的多条栅极线;至少一条数据线与多条栅极线交叉以限定包括透射部分和反射部分的像素区域;薄膜晶体管, 连接到所述多条栅极线和所述至少一条数据线中的一条, 所述薄膜晶体管包括栅电极, 半导体层, 源电极和漏电极;第一绝缘层, 覆盖薄膜晶体管的一部分, 第一绝缘层露出像素区域和漏电极的一部分;在像素区域中的透明电极, 透明电极直接接触漏电极和半导体层;反射层中的反射层, 反射层具有第一不平坦表面。

