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(54) LIQUID CRYSTAL DISPLAY DEVICE

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(57) **ABSTRACT**

A thin film transistor (TFT) array panel includes: a substrate; gate lines including gate electrodes and storage electrode lines including storage electrodes, the gate lines and the storage electrode lines being formed on the substrate; a gate insulating layer formed on the substrate; a semiconductor layer formed on the gate insulating layer; data lines and drain electrodes formed on the gate insulating layer and the semiconductor layer; storage conductors formed together with the data lines on the gate insulating layer and connected with the drain electrodes; a passivation layer formed on the data lines, the drain electrodes, and the storage conductors; and pixel electrodes formed on the passivation layer, connected with the drain electrodes, and having a plurality of cutout portions, wherein each storage electrode and each storage conductor has slant portions that overlap with the cutout portions and overlap with each other with the gate insulating layer interposed therebetween. The storage electrode and the storage conductor have the slant portions that overlap the cutout portions of the pixel electrode, thereby providing an increased aperture ratio. The horizontal component of the electric field allows the sets of cutout portions of the pixel electrode to control the direction of the liquid crystal molecules compared with conventional LCD device in which the storage electrode and the storage conductor do not have slant portions.

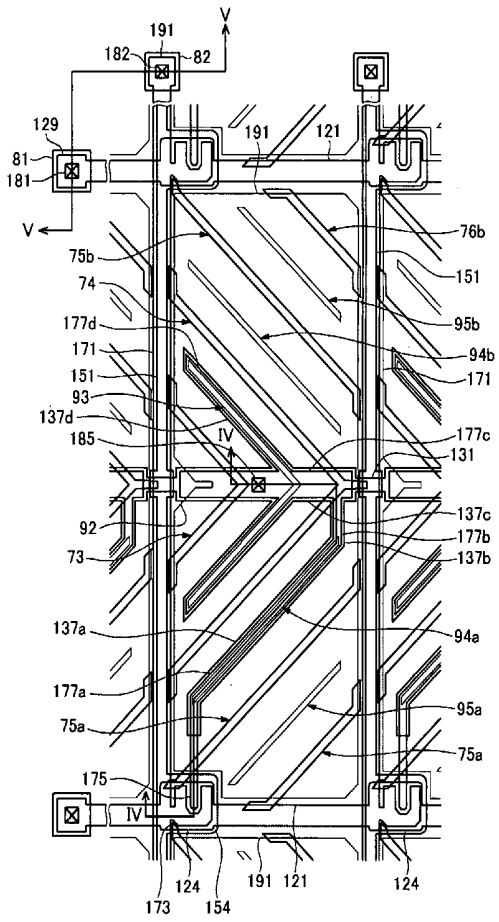
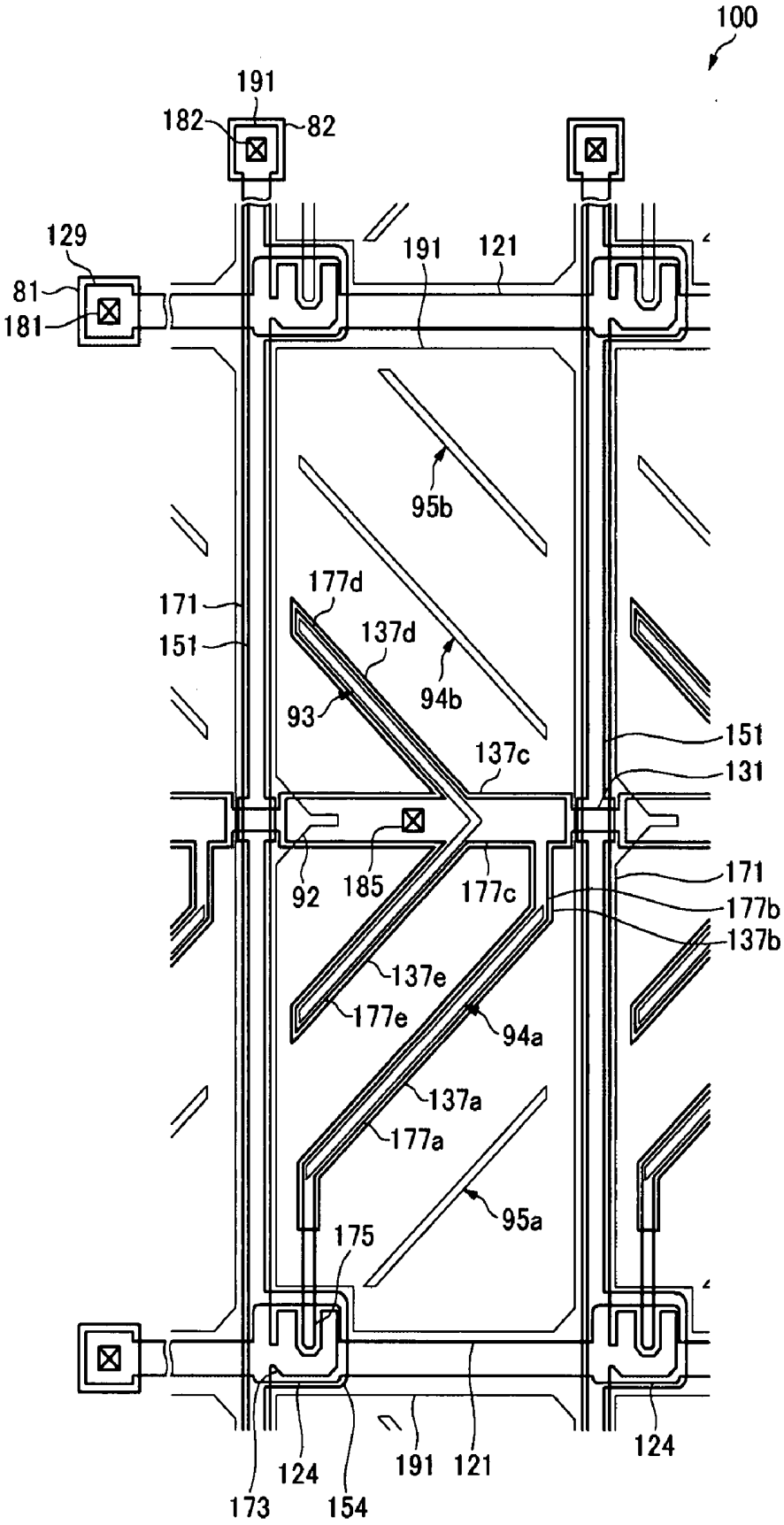


FIG.1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191
182
82
129
81
181
191
121
95b
177d
171
137d
151
94b
93
151
137c
131
92
185
177c
171
177b
137b
137e
177e
94a
137a
177a
95a
175
124
173
154
124
191
121
124

FIG.2

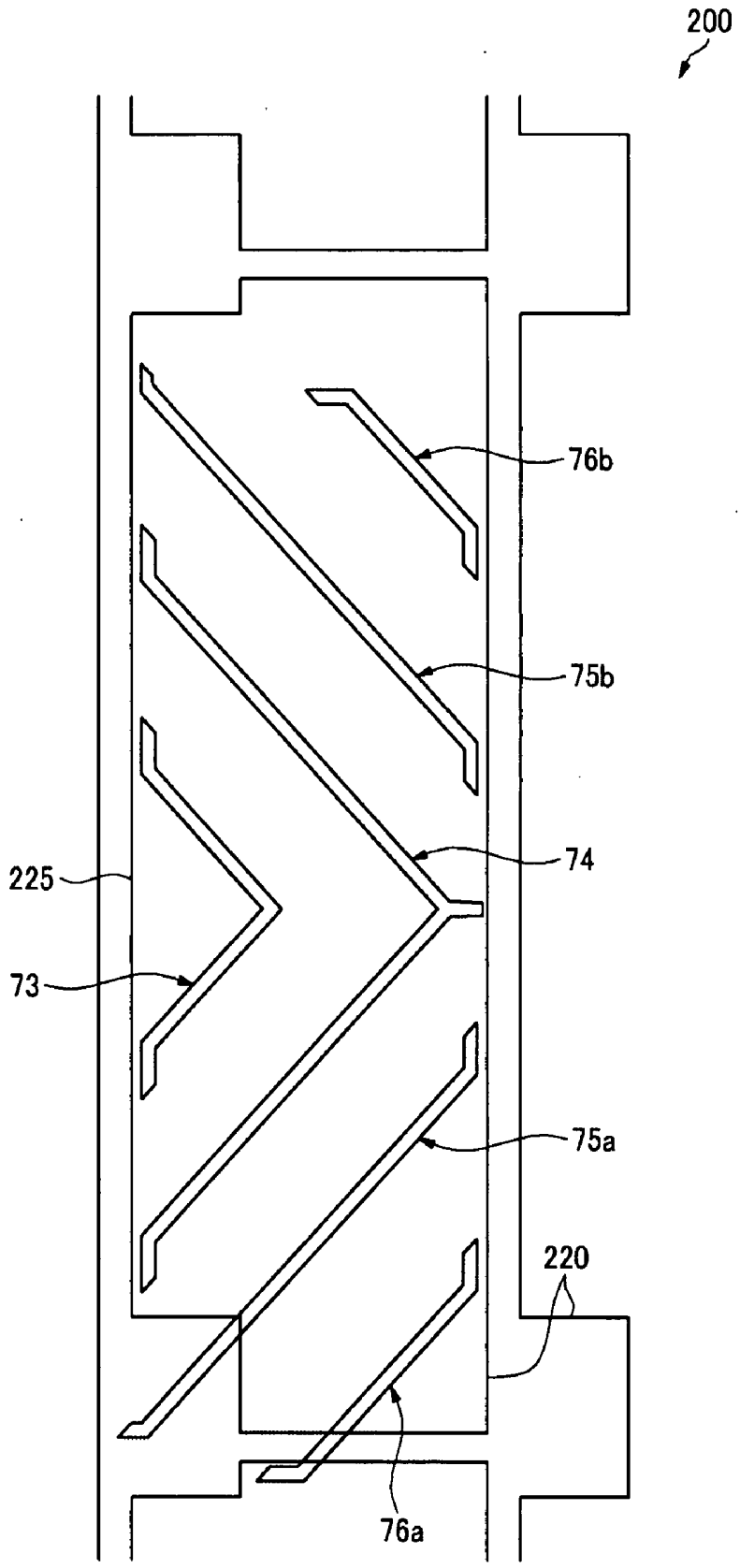
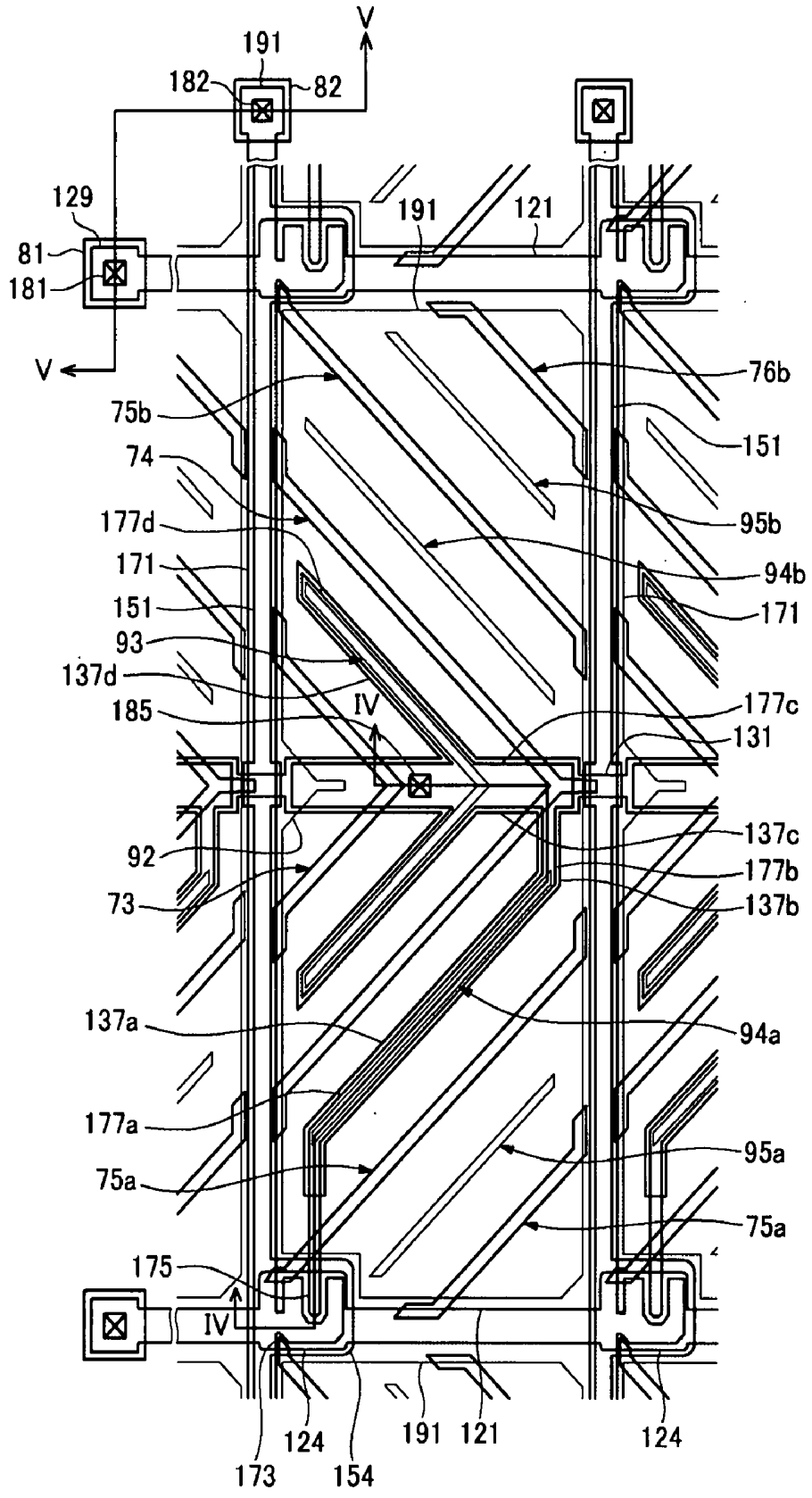


FIG.3


V
191
182
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129
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181
V
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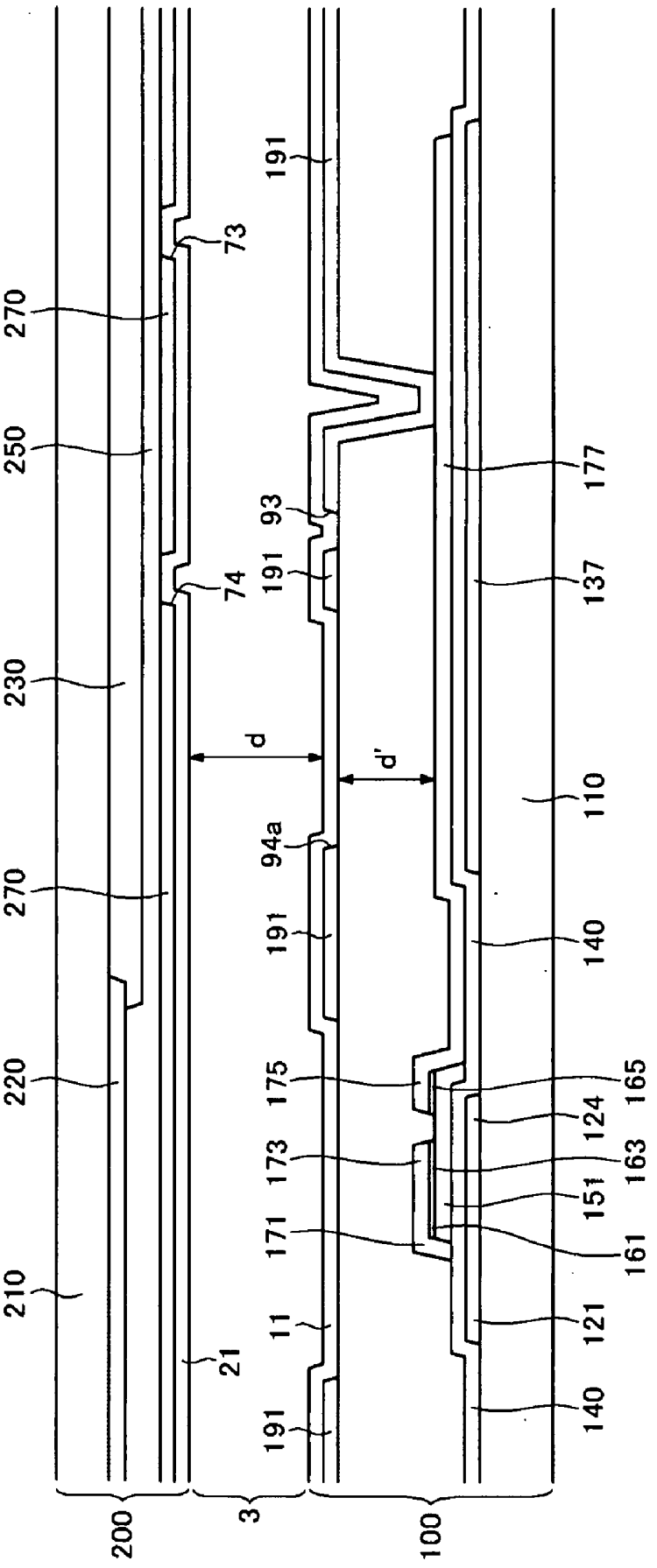
121
76b
75b
151
74
95b
177d
94b
171
171
151
93
137d
185
IV
177c
131
137c
92
177b
73
137b
137a
94a
177a
95a
75a
75a
175
IV
124
191
121
124
173
154

FIG.4


270
250
230
270
220
210
73
74
191
93
191
94a
191
175
173
171
11
21
191
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d'
177
137
110
140
165
124
163
151
161
121
140
200
3
100

FIG.5

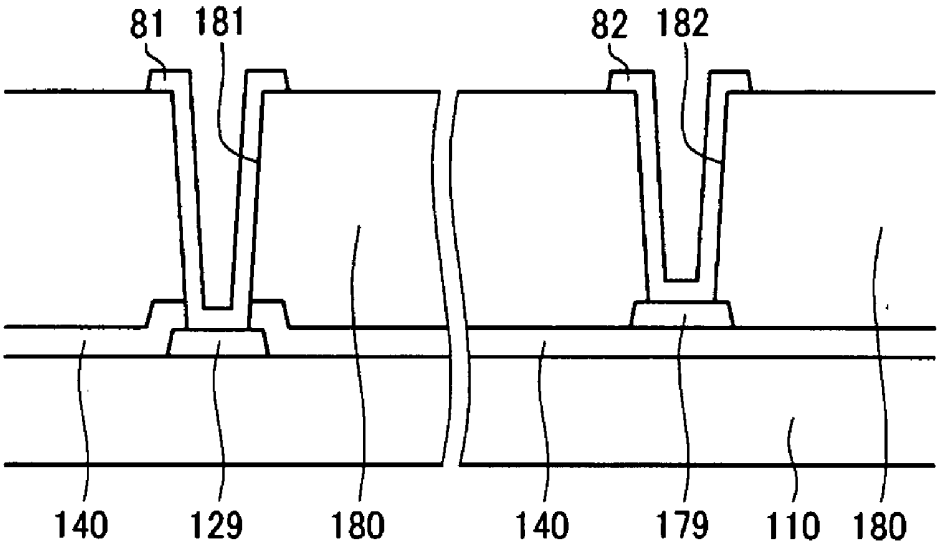
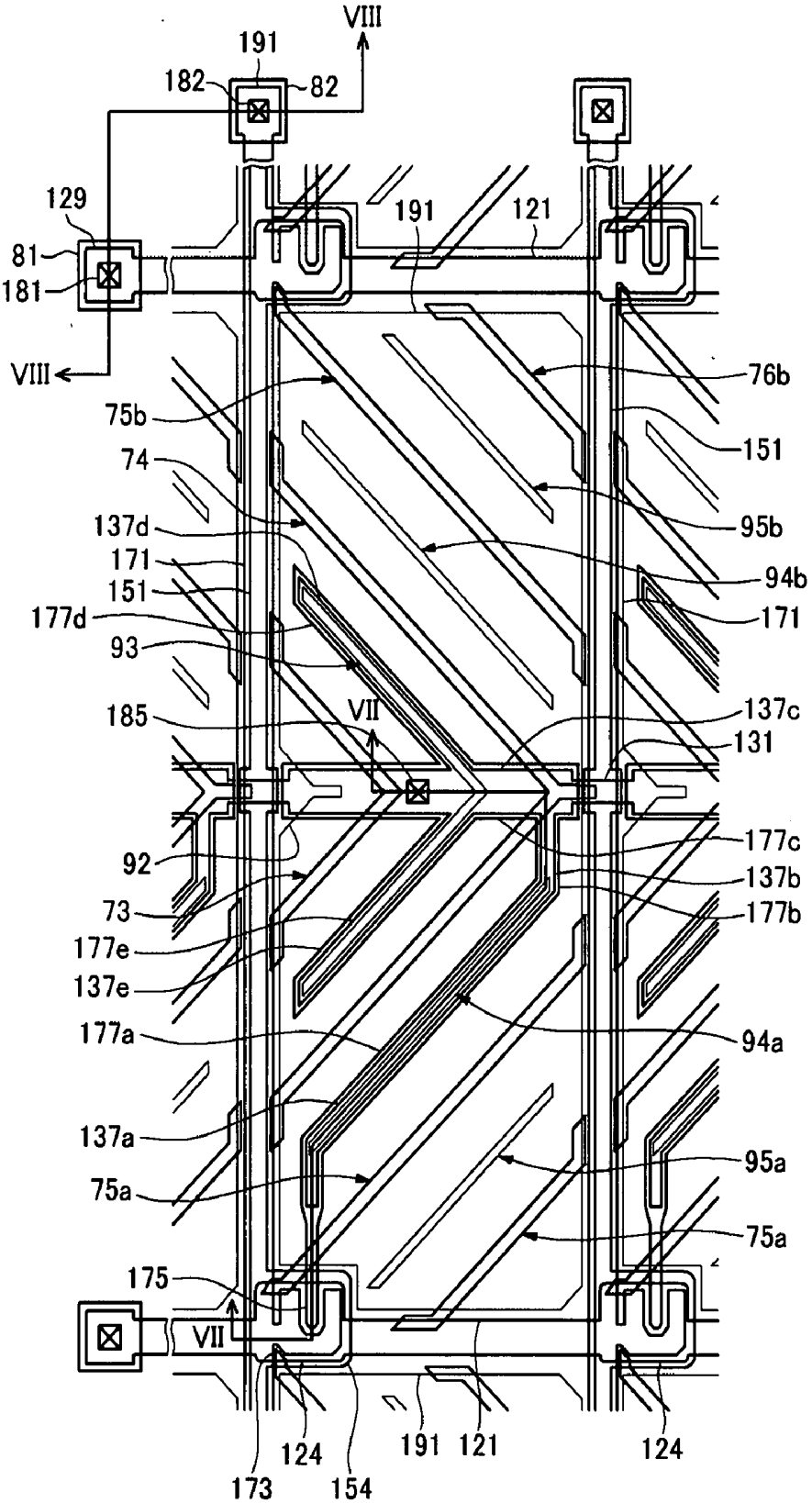


FIG.6


VIII
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182
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129
81
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191
121
VIII
76b
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151
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95b
137d
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171
177d
93
185
VII
137c
131
177c
92
137b
73
177b
177e
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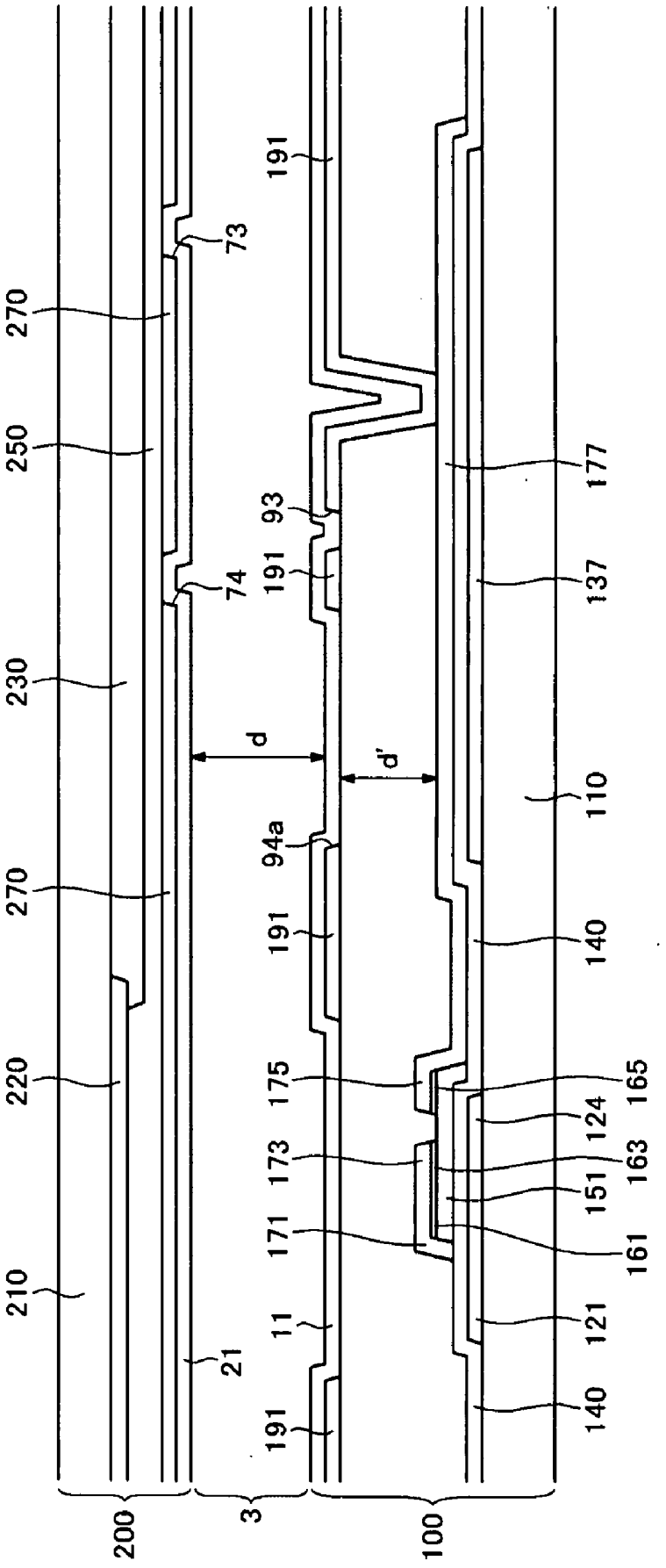
175
VII
124
191
121
124
173
154

FIG.7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94a
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175
173
171
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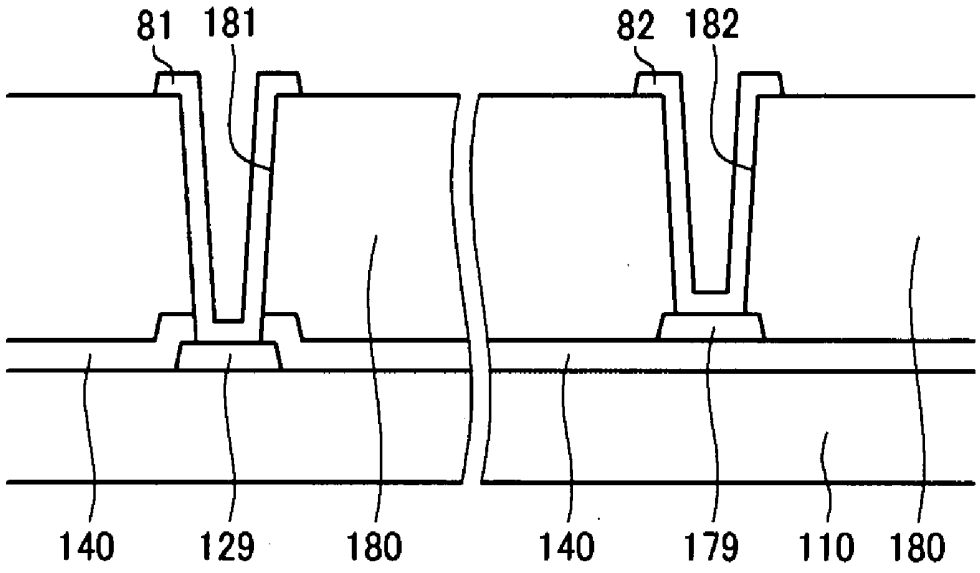
177
137
110
140
165
124
163
151
161
121
140
200
3
100

FIG.8



LIQUID CRYSTAL DISPLAY DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to and the benefit of Korean Patent Application No. 10-2006-0011211 filed in the Korean Intellectual Property Office on Feb. 06, 2006, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a liquid crystal display (LCD) device and, more particularly, to an LCD device having cutout portions.

[0004] 2. Description of the Related Art

[0005] A liquid crystal display (LCD) device, one of the commonly used flat panel displays, includes two panels on which field generating electrodes such as pixel electrodes and a common electrode are formed with a liquid crystal layer interposed between the panels. A voltage is applied to the field generating electrodes to generate an electric field in the liquid crystal layer to determine the alignment of liquid crystal molecules which controls the polarization of incident light so as to display images.

[0006] Of the LCD devices, the vertically aligned (VA) mode LCD device, in which the liquid crystal molecules are arranged with their longer axes perpendicular to the display panels in the absence of an electric field, offers a high contrast ratio and wide reference viewing angle.

[0007] In order to implement a wide viewing angle in the VA mode LCD device, a method for forming cutout portions on the field generating electrodes and a method for forming protrusions on the field generating electrodes are used. The cutout portions or protrusions determine the orientation of the liquid crystal molecules. The reference viewing angle can be widened by locating the cutout portions or the protrusions in several directions to diversify the tilt direction of the liquid crystal molecules.

[0008] However, the larger the cutout portions is, the better the liquid crystal can be controlled, but so doing decreases the aperture ratio of the LCD device decreased.

SUMMARY OF THE INVENTION

[0009] According to an aspect of the invention, an exemplary embodiment is provided which widens the viewing angle without decreasing the aperture ratio the display. A thin film transistor (TFT) array panel comprises a substrate, a gate line including a gate electrode and a storage electrode line including a storage electrode formed on the substrate, a gate insulating layer formed on the gate line, the storage electrode line, and the substrate, a semiconductor layer formed on the gate insulating layer, a data line and a drain electrode formed on the gate insulating layer and the semiconductor layer, a storage conductor formed as the same layer as the data line on the gate insulating layer and connected with the drain electrode, a passivation layer formed on the data line, the drain electrode, and the storage conductor; and a pixel electrode formed on the passivation layer, connected with the drain electrode, and having a plurality of cutout portions. Each storage electrode and each storage conductor has slant portions that overlap with the cutout portions and overlaps with each other with the gate insulating layer interposed therebetween.

[0010] The width of the storage electrode and that of the storage conductor that overlap with each other may be the same, or different.

[0011] The width of the storage electrode that overlaps h the storage conductor may be larger than that of the storage conductor.

[0012] The width of the storage electrode may be larger by about 0.1 μm to about 10 μm than that of the storage conductor.

[0013] The width of the storage conductor that overlaps the storage electrode may be larger than that of the storage electrode.

[0014] The width of the storage conductor may be larger by about 0.1 μm to about 10 μm than that of the storage electrode.

[0015] Another embodiment of the present invention provides a liquid crystal display (LCD) device including a first substrate, a gate line including a gate electrode and a storage electrode line including a storage electrode formed on the first substrate, a gate insulating layer formed on the gate line, the storage line, and the substrate, a semiconductor layer formed on the gate insulating layer, a data line and a drain electrode formed on the gate insulating layer and the semiconductor layer, a storage conductor formed as the same layer as the data line on the gate insulating layer and connected with the drain electrode, a passivation layer formed on the data line, the drain electrode, and the storage conductor, and a pixel electrode formed on the passivation layer, connected with the drain electrode, and having a first cutout portion, a second substrate facing the first substrate, a common electrode formed on the second substrate and having a second cutout portion, and a liquid crystal layer interposed between the first and second substrates. The storage electrode and the storage conductor have slant portions that overlap with the cutout portions and overlap each other with the gate insulating layer interposed therebetween.

[0016] The dielectric constant (ϵ) of the liquid crystal layer, the thickness (d) **10** of the liquid crystal layer, the dielectric constant of the passivation layer (ϵ'), and the thickness (d') of the passivation layer satisfy the relationship; $\epsilon d'/\epsilon' d > 0.1$.

[0017] The second cutout portion and the first cutout portion may be alternately disposed.

[0018] The LCD device may further include a light blocking member formed on the second substrate, and a color filter formed on the second substrate and the light blocking member.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. **1** is a layout view of a thin film transistor (TFT) array panel of a liquid crystal display (LCD) device according to one exemplary embodiment of the present invention.

[0020] FIG. **2** is a layout view of a common electrode panel of the LCD device according to one exemplary embodiment of the present invention.

[0021] FIG. **3** is a layout view of the LCD device according to one exemplary embodiment of the present invention.

[0022] FIG. **4** is a cross-sectional view taken along line IV-IV of the LCD device in FIG. **3**.

[0023] FIG. **5** is a cross-sectional view taken along line V-V of the LCD device in FIG. **3**.

[0024] FIG. **6** is a layout view of an LCD device according to another exemplary embodiment of the present invention.

[0025] FIG. **7** is a cross-sectional view taken along line VII-VII of the LCD device in FIG. **6**.

[0026] FIG. **8** is a cross-sectional view taken along line VIII-VIII of the LCD device in FIG. **6**.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0027] In the drawings, the thickness of layers, films, panels, regions, etc., are exaggerated for clarity. It will be understood that when an element such as a layer, film, region, or substrate is referred to as being "on" another element, it can be directly on the other element or intervening elements may also be present. In contrast, when an element is referred to as being "directly on" another element, there are no intervening elements present.

[0028] A TFT array panel and an LCD device including the TFT array panel according to one exemplary embodiment of the present invention will now be described in detail with reference to FIGS. **1** to **3**.

[0029] FIG. **1** is a layout view of a thin film transistor (TFT) array panel of an LCD device according to one exemplary embodiment of the present invention, FIG. **2** is a layout view of a common electrode panel of the LCD device according to one exemplary embodiment of the present invention, and FIG. **3** is a layout view of the LCD device according to one exemplary embodiment of the present invention.

[0030] The LCD device according to the present exemplary embodiment includes a thin film transistor (TFT) array panel **100** and a common electrode panel **200**, and a liquid crystal layer **3** interposed between the two display panels **100** and **200**.

[0031] First, the TFT array panel will be described with reference to FIGS. **1** and **3**.

[0032] A plurality of gate lines **121** and a plurality of storage electrode lines **131** are formed on an insulation substrate **110** made of transparent glass or plastic.

[0033] The gate lines **121** transfer gate signals and extend mainly in a horizontal direction. Each gate line includes a plurality of gate electrodes **124** that protrude upward and a large end portion **129** for connection with a different layer or an external driving circuit. A gate driving circuit (not shown) for generating gate signals can be mounted on a flexible printed circuit film (not shown) attached on the substrate **110**, directly mounted on the substrate **110**, or integrated on the substrate **110**. When the gate driving circuit is integrated on the substrate **110**, the gate lines **121** can be elongated to be directly connected thereto.

[0034] The storage electrode line **131** receives a predetermined voltage and extends substantially parallel to the gate line **121**. Each storage electrode line **131** is positioned between two adjacent gate lines **121** and is spaced apart from the two gate lines **121** at the same distance.

[0035] The storage electrode line **131** includes upwardly and downwardly extending storage electrodes **137**. The storage electrodes **137** include a horizontal portion **137***c* having such a form that the storage electrode line **131** protrudes up and down, a second and a third slant portions **137***d* and **137***e* extending in upper and lower slant line directions from the horizontal portion **137***c*, a vertical portion **137***b* extending from the right side of the horizontal portion **137***c* in a vertical direction, and a first slant portion **137***a* extending slantingly from the vertical portion **137***b* in a left direction. The shape and disposition of the storage electrode line **131** can be modified in various manners.

[0036] The gate lines **121** and the storage electrode lines **131** can be made of an aluminum-based metal such as aluminum (A) or an aluminum alloy, a silver-based metal such as silver (Ag) or a silver alloy, a copper-based metal such as copper (Cu) or a copper alloy, a molybdenum-based metal such as molybdenum (Mo) or a molybdenum alloy, chromium (Cr), tantalum (Ta), titanium (Ti), etc. Also, the gate lines **121** and the storage electrode lines **131** can have a multi-layered structure including two conductive layers (not shown) each having different physical properties. One of the conductive layers can be made of a metal with low resistivity, such as the aluminum-based metal, the silver-based metal, or the copper-based metal, etc. in order to reduce a signal delay or a voltage drop. The other conductive layer can be made of a material such as the molybdenum-based metal, chromium, tantalum, titanium, etc., that has good physical, chemical, and electrical contact characteristics with a different material, particularly, ITO (indium tin oxide) and IZO (indium zinc oxide). Good examples of such combination may include a combination of a lower chromium layer and an upper aluminum (alloy) layer, and a combination of a lower aluminum (alloy) layer and an upper molybdenum (alloy) layer. In addition, the gate lines **121** and the storage electrode lines **131** can be made of various other metals or conductors.

[0037] The sides of the gate lines **121** and the storage electrode lines **131** are sloped to the surface of the substrate **110**, and preferably, the slope angle is within the range of about **300** to **800**.

[0038] A gate insulating layer **140** made of silicon nitride (SiNx) or silicon oxide (SiOx), etc., is formed on the gate lines **121** and the storage electrode lines **131**.

[0039] A plurality of semiconductor stripes **151** made of hydrogenated amorphous silicon (a-Si) or polycrystalline silicon, etc., are formed on the gate insulating layer **140**. The semiconductor stripes **151** extend mainly in a vertical direction and include a plurality of projections **154** extending toward the gate electrodes **124**. The semiconductor stripes **151** widen near the gate lines **121** and the storage electrode lines **131** to extensively cover them.

[0040] A plurality of ohmic contacts stripes and islands **161** and **165** are formed on the semiconductor stripes **151**.

The ohmic contact stripes and islands **161** and **165** can be made of a material such as n+ hydrogenated amorphous silicon in which an n-type impurity such as phosphor is doped with a high density, or silicide. The ohmic contact stripes **161** have a plurality of projections **163**, and the projections **163** and the ohmic contact islands **165** are disposed as pairs on the projections **154** of the semiconductor stripes **151**.

[**0041**] The sides of the semiconductor stripes **151** and the sides of the ohmic contact stripes and islands **161** and **165** are sloped to the substrate **110**, and the slope angle is within the range of 30° to 80°.

[**0042**] A plurality of data lines **171**, a plurality of drain electrodes **175** and a plurality of storage conductors **177** are formed on the ohmic contact stripes and islands **161** and **165**.

[**0043**] The data lines **171** transfer data signals and extend mainly in a vertical direction to cross the gate lines **121**. Each data line **171** includes a plurality of source electrodes **173** extending toward the gate electrode **124** and a large end portion **179** for a connection with a different layer or an external driving circuit. A data driving circuit (not shown) can be mounted on a flexible printed circuit film (not shown) attached on the substrate **110**, directly mounted on the substrate **110**, or integrated on the substrate **110**. When the data driving circuit is integrated on the substrate **110**, the data line **171** can be elongated to be connected thereto.

[**0044**] The drain electrode **175** is separated from the data line **171** and faces the source electrode **173** centering on the gate electrode **124**. Each drain electrode **175** includes one bar type end portion and a storage conductor **177**, and the bar type end portion is partially surrounded by a U-shaped source electrode **173**.

[**0045**] One gate electrode **124**, one source electrode **173**, and one drain electrode **175** constitute a single thin film transistor (TFT) together with the projection **154** of the semiconductor stripe **151**, and a channel of the TFT is formed at the projection **154** between the source electrode **173** and the drain electrode **175**.

[**0046**] The storage conductor **177** includes a first slant portion **177***a* extending in a slant line direction from the bar type end portion surrounded by the source electrode **173** of the drain electrode **175**, a vertical portion **177***b* extending from the first slant portion **177***a* in a vertical direction, a horizontal portion **177***c* extending from the vertical portion **177***b* in a horizontal direction, and second and third slant portions **177***d* and **177***e* extending in upper and lower slant line directions. Each portion of the storage conductor **177** overlaps a corresponding the storage electrode **137**. In the present exemplary embodiment of the present invention, a width of the storage conductor **177** of the TFT array panel may be the same as or narrower than that of the storage electrode **137**, and the width of the storage electrode **137** can be wider than that of the storage conductor **177** by about 0 μm to about 10 μm.

[**0047**] Preferably, the data lines **171**, the drain electrodes **175**, and the storage conductors **177** are made of a refractory metal (not shown) such as molybdenum, chromium, tantalum, titanium, etc., or their alloys, and can have a multi-layered structure including the refractory metal layer (not shown) and a low-resistance conductive layer (not shown). Examples of the multi-layered structure may include a dual-layer of a lower chromium or molybdenum (alloy) layer and an upper aluminum (alloy) layer, and a triple-layer of a lower molybdenum (alloy) layer, an intermediate aluminum (alloy) layer, and an upper molybdenum (alloy) layer. Also, the data line **171** and the drain electrode **175** can be made of various other metals or conductors.

[**0048**] Preferably, the sides of the data lines **171**, the sides of the drain electrodes **175**, and the sides of the drain electrodes **175** are also sloped to the surface of the substrate **110** at a slope angle within the range of about 30° to 80°.

[**0049**] The ohmic contact stripes and islands **161** and **165** exist only between the lower semiconductor stripes **151** and the upper data lines **171** and the drain electrodes **175**, in order to lower contact resistance therebetween. In most portions, the semiconductor stripes **151** are narrower than the data lines **171**, but as mentioned above, the semiconductor stripes **151** widen at a portion that they meet the gate lines **121** and the storage electrode lines **131** to smooth a profile of the surface to thus prevent a disconnection of the data lines **171**. Some portions of the semiconductor stripes **151** including a portion between the source electrode **173** and the drain electrode **175** are exposed without being covered by the data line **171** and the drain electrode **175**.

[**0050**] A passivation layer **180** is formed on the data lines **171** and the drain electrodes **175**, and on the exposed portions of the semiconductor stripe **151**. The passivation layer **180** is made of an inorganic insulator or an organic insulator, etc., and may have a planarized surface. The organic insulator may be, for example, silicon nitride or silicon oxide. The organic insulator may have photosensitivity, and its dielectric constant is preferably 4.0 or less. In this respect, the passivation layer **180** may have a dual-layered structure of a lower inorganic layer and an upper organic layer so that it may not do harm to the exposed portion of the semiconductor island **154** while still sustaining the excellent insulation characteristics of the organic layer.

[**0051**] On the passivation layer **180**, there are formed a plurality of contact holes **182** and **185** exposing the end portions **179** of the data lines **171**, and the drain electrodes **175**, and on the passivation layer **180** and the gate insulating layer **140**, there are formed a plurality of contact holes **181** exposing the end portions **129** of the gate lines **121**.

[**0052**] A plurality of pixel electrodes **191** and a plurality of contact assistants **81** and **82** are formed on the passivation layer **180**. The pixel electrodes **191** and the contact assistants **81** and **82** can be made of a transparent conductive material such as ITO or IZO, or a reflective metal such as aluminum, silver, chromium, or their alloys.

[**0053**] The pixel electrode **191** is physically and electrically connected with the drain electrode **175** via the contact hole **185** and receives a data voltage from the drain electrode **175**. The pixel electrode **191**, to which the data voltage has been applied, generates an electric field together with a common electrode **270** of the common electrode panel **200** which receives a common voltage, to thereby determine the orientation direction of the liquid crystal molecules (not shown) of the liquid crystal layer **3**. The polarization of light transmitted through the liquid crystal layer **3** differs depending on the orientation direction of the liquid crystal mol-

ecules. The pixel electrode **191** and the common electrode **270** form a capacitor (referred to hereinafter as a 'liquid crystal capacitor') to sustain the applied voltage even after the TFT is turned off.

[**0054**] As mentioned, the storage conductor **177** overlaps the storage electrode line **131** including the storage electrode **137**. A capacitor formed as the storage conductor **177** electrically connected with the pixel electrode **191** overlaps with the storage electrode line **131** is called a storage capacitor, which strengthens voltage storage capability of the liquid crystal capacitor. In the exemplary embodiment of the present invention, the storage electrode **137** and the storage conductor **177** overlap each other to form the storage capacitor of the TFT array panel. Slant portions **137***a*, **137***d*, **137***e*, **177***a*, **177***d*, and **177***e* are disposed below cutout portions **92**, **93**, **94***a*, **94***b*, **95***a*, and **95***b* of the pixel electrode. The width of the slant portions **137***a*, **137***d*, **137***e*, **177***a*, **177***d*, and **177***e* is preferably the same as that of the cutout portions **92**, **93**, **94***a*, **94***b*, **95***a*, and **95***b* of the pixel electrode.

[**0055**] Each pixel electrode **191** has four major edges substantially parallel to the gate lines **121** and the data lines **171**, and has a substantially rectangular shape with chamfered corners. The chamfered hypotenuse of the pixel electrode **191** makes an angle of about 45° with the gate line **121**.

[**0056**] The cutout portions of the pixel electrodes **191** includes central cutout portions **92** and **93**, the lower cutout portions **94***a* and **95***a*, and upper cutout portions **94***b* and **95***b*. The pixel electrodes **191** are divided into a plurality of partitions by these cutout portions **92~95***b*. The cutout portions **92~95***b* are substantially symmetrical to a virtual horizontal central line that divides each pixel electrode **191**.

[**0057**] The upper and lower cutout portions **94***a*~**95***b* extend substantially from the right and upper hypotenuses of the pixel electrode **191** to the right hypotenuse slantingly, and are positioned at the upper and lower portions of the pixel electrode **191** based on the horizontal central line of the pixel electrode **191**. The upper and lower cutout portions **94***a*~**95***b* extend vertically at an angel of about 45° to the gate lines **121**.

[**0058**] The central cutout portion **92** is disposed at the center of the pixel electrode **191** and has an entrance positioned at the left side thereof. The entrance of the central cutout portion **92** has a pair of hypotenuses substantially parallel to the lower and upper cutout portions **94***a*, **95***a*, **94***b*, and **95***b*. The central cutout portion **93** includes a pair of slant portions extending slantingly from the horizontal central line of the pixel electrode **191** to the left side of the pixel electrode **191**.

[**0059**] Accordingly, the lower portion of the pixel electrode **191** is divided into four parts by the central cutout portion **93** and the lower cutout portions **94***a* and **95***a*, and the upper portion of the pixel electrode **191** is divided into four parts by the central cutout portion **93** and the lower cutout portions **94***a* and **95***a*.

[**0060**] The number of regions or the number of cutout portions may vary depending on the designing factors such as the ratio of the length of the horizontal side and vertical side of the pixel electrode **191** and type or characteristics of the liquid crystal layer **3**.

[**0061**] Among the cutout portions **92***a*~**95***b*, the central cutout portion **93** and the lower cutout portion **94***a* overlap the first to third slant portions **177***a*, **177***d*, and **177***e* of the storage conductor **177** and the slant portions of the storage electrode **137**.

[**0062**] In this manner, by forming the storage electrode **137** and the storage **15** conductor **177** such that they overlap the cutout portions **92**, **93**, **94***a*, **94***b*, **95***a*, and **95***b*, the aperture ratio of the LCD device can be improved.

[**0063**] The contact assistants **81** and **82** are connected with the end portions **129** of the gate lines **121** and the end portions **179** of the data lines **171** via the contact holes **181** and **182**. The contact assistants **81** and **82** assist the adhesion of the end portions **129** of the gate lines **121** and the end portions **179** of the data lines **171** with an external device, and protect them.

[**0064**] In the LCD device according to the exemplary embodiment of the present invention, when the dielectric constant of liquid crystal is "ϵ", the cell gap of the LCD device is "d", the dielectric constant of the passivation layer **180** is "ϵ"", and the thickness of the passivation layer **180** is "d"", it is preferred that the relationship ϵd'/ϵ'd>0.1 be satisfied.

[**0065**] The common electrode panel **200** will now be described with reference to FIGS. **2** to **4**.

[**0066**] A light blocking member **220** is formed on the insulation substrate **210** made of transparent glass or plastic. The light blocking member **220** is also called a black matrix and prevents light leakage. The light blocking member **220** faces the pixel electrode **191**, has a plurality of openings **225** with substantially the same shape as the pixel electrode **191**, and blocks light leakage between pixel electrodes **191**. The light blocking member **220** may include a portion corresponding to the gate line **121** and the data line **171** and a portion corresponding to the TFT.

[**0067**] A plurality of color filters **230** are also formed on the substrate **210**. The color filters **230** exist mostly within regions surrounded by the light blocking member **230**, and may extend long in a vertical direction along the rows of pixel electrodes **191**. Each color filter **230** can display one of three primary colors of red green, and blue.

[**0068**] An overcoat **250** is formed on the color filters **230** and the light blocking members **220**. The overcoat **250** can be made of an (organic) insulator to protect the color filters **230**, to prevent the color filters **230** from being exposed, and to provide a planarized surface.

[**0069**] A common electrode **270** made of a transparent conductor such as ITO or IZO is formed on the overcoat **250**.

[**0070**] The common electrode **270** has sets of a plurality of cutout portions **73**, **74**, **75***a*, **75***b*, **76***a*, and **76**b.

[**0071**] One set of cutout portions **73~75***b* face a single pixel electrode **191** and include central cutout portions **73** and **74**, lower cutout portions **75***a* and **76***a* and upper cutout portions **75***b* and **76***b*. The cutout portions **73**, **74**, **75***a*, **76***a*, **75***b*, and **76***b* are disposed between adjacent cutout portions **92~95***b* or between cutout portions **94***a*~**95***b* and the chamfered hypotenuse. The cutout portions **73~75***b* include at least one slant portion extending parallel to the lower cutout portions **94***a* and **95***a* or the upper cutout portions **94***b* and

95*b* of the pixel electrode **191**, and each slant portion includes a concave notch. The notches of the cutout portions **73**~**75***b* of the common electrode **270** determine a slant direction of liquid crystal molecules positioned at the cutout portions **73**~**75***b*. The notches can be formed at the cutout portions **92**~**95***b* of the pixel electrode **191** or omitted.

[**0072**] The lower and upper cutout portions **75***a*, **75***b*, **76***a*, and **76***b* include a slant portion, a horizontal portion, and a vertical portion. The slant portion extends substantially from the upper or lower side of the pixel electrode **191** to the right side. The horizontal and vertical portions overlap with the sides of the pixel electrode **191** and extend from each end of slant portions, and form an obtuse angle to the slant portions.

[**0073**] The central cutout portions **73** and **74** include a central horizontal portion, a pair of slant portions, and a pair of end vertical portions. The central horizontal portion extends substantially from the right side or the center of the pixel electrode **191** to the left side along the horizontal central line of the pixel electrode **191**, and the pair of slant portions extend substantially from an end of the central horizontal portion toward the left side of the pixel electrode **191** so as to be substantially parallel to the lower and upper cutout portions **75***a* and **75***b*. The end vertical portions extend from ends of the corresponding slant portions while overlapping with the right side along the right side of the pixel electrode **191**, and form an obtuse angle to the slant portion.

[**0074**] The number of the cutout portions **73**~**75***b* can vary depending on design factors, and the light blocking member **220** and the cutout portions **73**~**75***b* can overlap with each other to prevent light leakage at or around the cutout portions **73**~**75***b*.

[**0075**] Alignment layers **11** and **21** are coated on an inner surface of the display panels **100** and **200**, and can be vertical alignment layers. Polarizers (not shown) are provided on an outer surface of the display panels **100** and **200**, and polarization axes of the two polarizers are perpendicular to each other, and preferably, one of the two polarization axes is parallel to the gate lines **121**. In the case of a reflective LCD device, one of the two polarizers can be omitted.

[**0076**] The LCD device according to the present exemplary embodiment of the present invention may further include a phase retardation film (not shown) for compensating delay of the liquid crystal layer. The LCD device may further include a backlight unit (not shown) for providing light to the polarizers, the phase retardation film, the display panels **100** and **200**, and the liquid crystal layer **3**.

[**0077**] The liquid crystal layer **3** has negative dielectric anisotropy, and liquid crystal molecules of the liquid crystal layer **3** are aligned such that their longer axes are substantially perpendicular to the surfaces of the two display panels **100** and **200** in a state when there is no electric field. Accordingly, incident light is blocked, rather than passing through the crossed polarizers.

[**0078**] When a common voltage is applied to the common electrode and a data voltage is applied to the pixel electrode **191**, an electric field substantially perpendicular to the surface of the display panels **100** and **200** is generated. Then, the longer axis of the liquid crystal molecules is changed to be perpendicular to the direction of the electric field in response to the electric field. Hereinafter, the pixel electrode **191** and the common electrode **270** will be called field generating electrodes.

[**0079**] The cutout portions **73**~**75***b* and **92**~**95***b* of the field generating electrodes **191** and **270** and the sides of the pixel electrode **191** distort the electric field to create a horizontal component for determining a slant direction of the liquid crystal molecules. The horizontal component of the **20** electric field is substantially perpendicular to the sides of the cutout portions **73**~**75***b* and **92**~**95***b* and the sides of the pixel electrode **191**.

[**0080**] With reference to FIG. **3**, a set of cutout portions **73**~**75***b* and **92**~**95***b* divide the pixel electrode **191** into a plurality of sub-regions, and each region has two major edges making an oblique angle to a major edge of the pixel electrode **191**.

[**0081**] Liquid crystal molecules on each sub-region mostly incline to be perpendicular to the major edges, namely, substantially in four directions. By varying the directions in which the liquid crystal molecules incline, a reference viewing angle of the LCD device can increase.

[**0082**] At least one or more cutout portions **73**~**75***b* and **92**~**95***b* can be substituted by protrusions (not shown) or depressions (not shown). The protrusions can be made of an organic material or an inorganic material, and can be disposed on an upper or lower portion of the field generating electrodes **191** and **270**.

[**0083**] In the present exemplary embodiment of the present invention, a storage conductor **177**, to which the same voltage as that of the pixel electrode is applied, is disposed at lower portions of some of the sets of cutout portions **92**~**95***b* of the pixel electrode **191** of the TFT array panel.

[**0084**] Where the storage conductor **177** to which a voltage is applied is located at the lower portions of the sets of cutout portions **92**~**95***b* of the pixel electrode **191**, the following relational expression should be satisfied in order to create an electric field horizontal component having a magnitude that can control the direction in which the liquid crystal molecules incline:

$$V_{SC}<V_P(1+\epsilon d''/\epsilon' d),$$

where, V_{SC} is the voltage applied to the storage conductor **177**, V_P is the voltage applied to the pixel electrode **191**, "ϵ" and "d" are a dielectric constants of the liquid crystal and the cell gap, respectively, and "ϵ"' and "d"' are the dielectric constant and thickness of the passivation layer **180**.

[**0085**] A TFT array panel according to the present exemplary embodiment of the present invention applies the same data voltage to the storage conductor **177** and the pixel electrode **191**, so that V_{SC} and V_P are the same and $\epsilon d'/\epsilon' d>0.1$, and thus, the above formula is satisfied.

[**0086**] In the TFT array panel according to the present exemplary embodiment, the storage electrode **137** and the storage conductor **177** have the slant portions with the same width as the cutout portions and are disposed below the cutout portions **92**~**95***b* Accordingly, the aperture ratio of the LCD device is increased. The horizontal component of the electric field allows the sets of cutout portions **92**~**95***b* of the pixel electrode **191** to control the direction in which the

liquid crystal molecules are oriented compared with a conventional LCD device in which the storage electrode **137** and the storage conductor **177** are not disposed below the cutout portions **92**~**95***b*.

[**0087**] The LCD device according to another exemplary embodiment of the present invention will now be described in detail with reference to FIGS. **6** to **8**.

[**0088**] FIG. **6** is a layout view of an LCD device according to another exemplary embodiment of the present invention, FIG. **7** is a cross-sectional view taken along line VII-VII of the LCD device in FIG. **6**, and FIG. **8** is a cross-sectional view taken along line VIII-VIII of the LCD device in FIG. **6**.

[**0089**] The LCD device according to the present exemplary embodiment includes a TFT array panel **100**, a common electrode panel **200**, and a liquid crystal layer **3** interposed between the two display panels **100** and **200**.

[**0090**] The layered structures of the display panels **100** and **200** are substantially the same as those shown in FIGS. **1** to **5**.

[**0091**] In the TFT array panel, a plurality of gate lines **121** including gate electrodes **124** and a plurality of storage electrode lines **131** including storage electrodes are formed on a substrate **110**, on which a gate insulating layer **140**, a plurality of semiconductor stripes **151** including projections **154**, a plurality of ohmic contact stripes **161** including projections **163**, and a plurality of ohmic contact islands **165** are sequentially formed.

[**0092**] A plurality of data lines **171** including source electrodes **173** and a plurality of drain electrodes **175** are formed on the ohmic contact stripes and islands **161** and **165**, a storage conductor **177** is formed as the same layer as the data lines **171** and connected with the drain electrode **175**, and a passivation layer **180** is formed thereon. A plurality of contact holes **181**, **182**, and **185** are formed at the passivation layer **180**, on which a plurality of pixel electrodes **191**, a plurality of contact assistants **81** and **82**, and an alignment layer **11** are formed.

[**0093**] In the common electrode panel **200**, a light blocking member **220**, a plurality of color filers **230**, a common electrode, and an alignment layer **21** are sequentially formed on an insulation substrate **210**.

[**0094**] However, unlike the LCD device shown in FIGS. **1** to **5**, in the LCD device according to another exemplary embodiment of the present invention, the width of the storage electrode **137** may be the same as or narrower than that of the storage conductor **177** and the width of the storage conductor **177** may be larger than that of the storage electrode **137** by about 0 μm to about 10 μm.

[**0095**] In the LCD device according to the present exemplary embodiment, the storage electrode **137** and the storage conductor **177** also have slant portions overlapping cutout portions **92**~**95***b*. When the dielectric constant of the liquid crystal is "E", the cell gap of the LCD device is "d", the dielectric constant of the passivation layer **180** is "ϵ'", and the thickness of the passivation layer **180** is "d'", the relationship $\epsilon d'/\epsilon' d > 0.1$ is satisfied.

[**0096**] Accordingly, because the storage electrode **137** and the storage conductor **177** have the slant portions that overlap the cutout portions **92**~**95***b* of the pixel electrode **191**, the aperture ratio of the LCD device is increased and the electric field horizontal component allows the sets of cutout portions **92**~**95***b* of the pixel electrode **191** to control the direction in which the liquid crystal molecules are inclined, compared with the conventional LCD device in which the storage electrode **137** and the storage conductor **177** are not disposed below the cutout portions **92**~**95***b*.

[**0097**] As described above, because the TFT array panel of the LCD device according to the exemplary embodiments of the present invention includes the storage electrode and the storage conductor having the slant portions that overlap the cutout portions of the pixel electrode, the aperture ratio of the LCD device is increased compared with the conventional LCD device in which the storage electrode and the storage conductor do not have the slant portions.

[**0098**] While this invention has been described in connection with what is presently considered to be practical exemplary embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

What is claimed is:

1. A thin film transistor (TFT) array panel comprising:

a substrate;

a gate line including a gate electrode and a storage electrode line including a storage electrode formed on the substrate;

a gate insulating layer formed on the gate line, the storage electrode line, and the substrate;

a semiconductor layer formed on the gate insulating layer;

a data line and a drain electrode formed on the gate insulating layer and the semiconductor layer;

a storage conductor formed as the same layer as the data line on the gate insulating layer and connected with the drain electrode;

a passivation layer formed on the data line, the drain electrode, and the storage conductor; and

a pixel electrode formed on the passivation layer, connected with the drain electrode, and having a plurality of cutout portions,

wherein the storage electrode and the storage conductor have slant portions that overlap the cutout portions and overlap each other with the gate insulating layer interposed therebetween.

2. The panel of claim 1, wherein a width of the storage electrode and that of the storage conductor that overlap each other are substantially the same.

3. The panel of claim 1, wherein the width of the storage electrode and that of the storage conductor that overlap each other are different.

4. The panel of claim 3, wherein the width of the storage electrode that overlaps the storage conductor is larger than the width of the storage conductor.

5. The panel of claim 4, wherein the width of the storage electrode is wider by about 0.1 μm to about 10 μm than the width of the storage conductor.

6. The panel of claim 3, wherein the width of the storage conductor that overlaps the storage electrode is wider than the width of the storage electrode.

7. The panel of claim 6, wherein the width of the storage conductor is wider by about 0.1 μm to about 10 μm than the width of the storage electrode.

8. A liquid crystal display (LCD) device comprising:

a first substrate,

a gate line including a gate electrode and a storage electrode line including a storage electrode formed on the first substrate;

a gate insulating layer formed on the gate line, the storage electrode line, and the substrate;

a semiconductor layer formed on the gate insulating layer;

a data line and a drain electrode formed on the gate insulating layer and the semiconductor layer;

a storage conductor formed as the same layer as the data line on the gate insulating layer and connected with the drain electrode;

a passivation layer formed on the data line, the drain electrode, and the storage conductor; and

a pixel electrode formed on the passivation layer, connected with the drain electrode, and having a first cutout portion;

a second substrate facing the first substrate;

a common electrode formed on the second substrate and having a second cutout portion; and

a liquid crystal layer interposed between the first and second substrates,

wherein the storage electrode and the storage conductor have slant portions that overlap the cutout portions and overlap each other, with the gate insulating layer interposed therebetween.

9. The device of claim 8, wherein the dielectric constant (ϵ) of the liquid crystal layer, the thickness (d) of the liquid crystal layer, the dielectric constant of the passivation layer (ϵ'), and the thickness (d') of the passivation layer satisfy the relationship: $\epsilon d'/\epsilon' d > 0.1$.

10. The device of claim 8, wherein the widths of the storage electrode and that of the storage conductor that overlap each other are the same.

11. The device of claim 8, wherein the widths of the storage electrode and that of the storage conductor that overlap each other are different.

12. The device of claim 11, wherein the width of the storage electrode is wider by about 0.1 μm to about 10 μm than the width of the storage conductor.

13. The device of claim 11, wherein the width of the storage conductor is wider by about 0.1 μm to about 10 μm than the width of the storage electrode.

14. The device of claim 8, wherein the second cutout portion and the first cutout portion are alternately disposed.

15. The device of claim 8, further comprising:

a light blocking member formed on the second substrate; and

a color filter formed on the second substrate and the light blocking member.

* * * * *

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公开(公告)号	US20070206125A1	公开(公告)日	2007-09-06
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[标]申请(专利权)人(译)	LEE BAEK WOON		
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摘要(译)

薄膜晶体管（TFT）阵列面板包括：基板;栅极线包括栅电极和包括存储电极的存储电极线，栅极线和存储电极线形成在基板上;形成在基板上的栅极绝缘层;形成在栅极绝缘层上的半导体层;数据线和漏电极形成在栅极绝缘层和半导体层上;存储导体与栅极绝缘层上的数据线一起形成并与漏极连接;形成在数据线，漏电极和存储导体上的钝化层;形成在钝化层上，与漏极连接，并具有多个切口部分的像素电极，其中每个存储电极和每个存储导体具有与切口部分重叠并与栅极绝缘层相互重叠的倾斜部分夹在其间。存储电极和存储导体具有与像素电极的切口部分重叠的倾斜部分，从而提供增大的孔径比。与其中存储电极和存储导体不具有倾斜部分的传统LCD装置相比，电场的水平分量允许像素电极的多组切口部分控制液晶分子的方向。