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Kim et al.

- (54) LIQUID CRYSTAL DISPLAY DEVICE AND METHOD OF MANUFACTURING THE SAME

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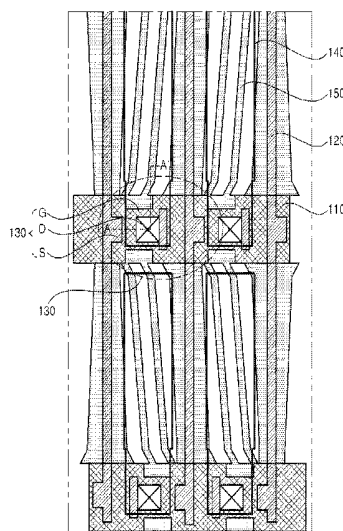
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G02F 1/1343 (2006.01)

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(2013.01); *G02F 1/134363* (2013.01); *G02F*
2201/123 (2013.01)

- (58) **Field of Classification Search**
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See application file for complete search history.



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FIG. 1

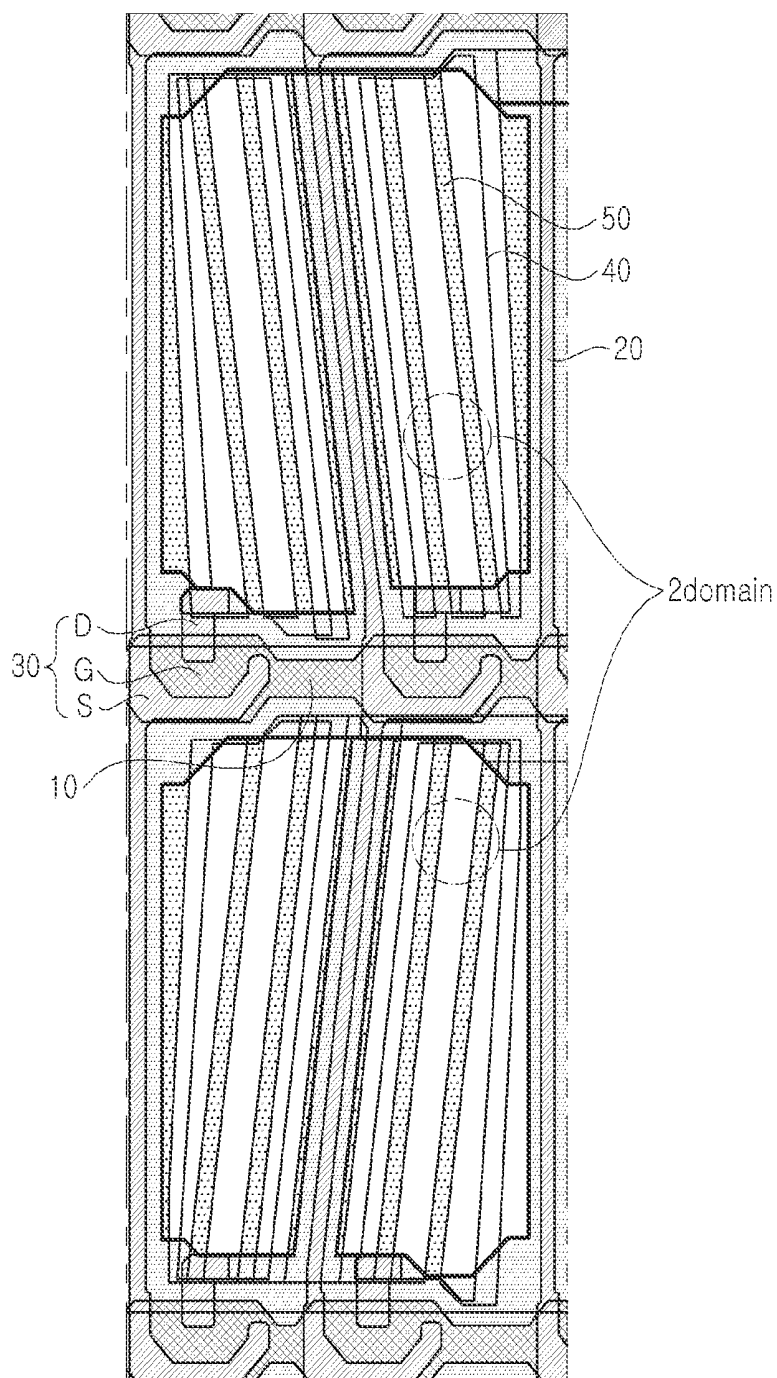


FIG. 2

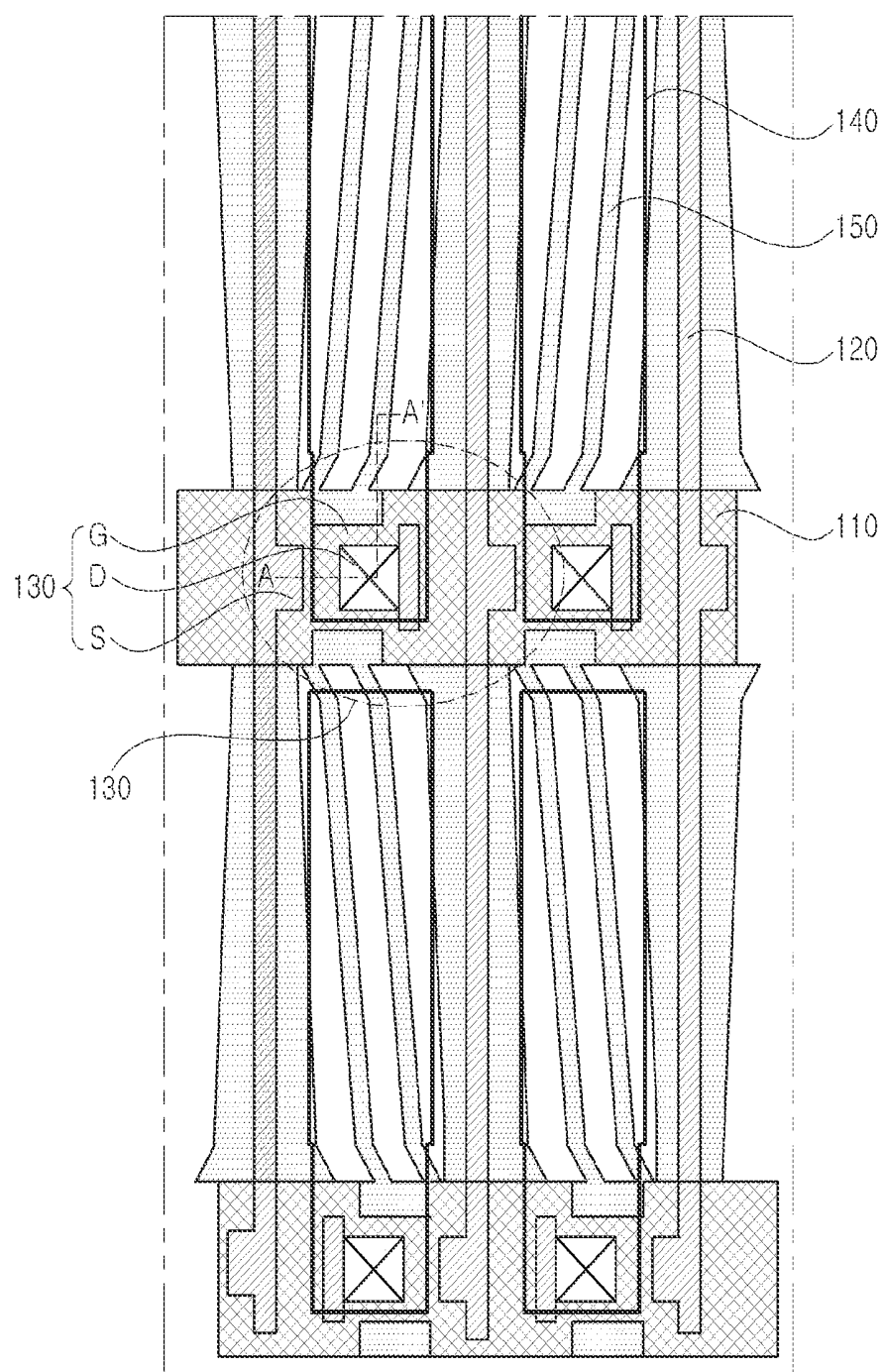


FIG. 3

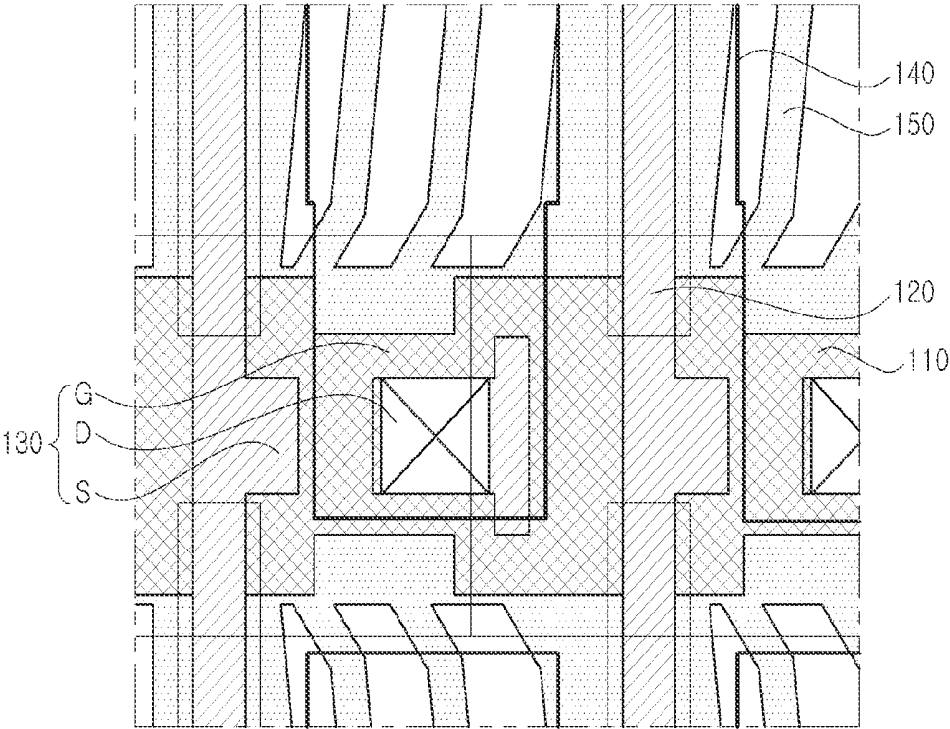


FIG. 4

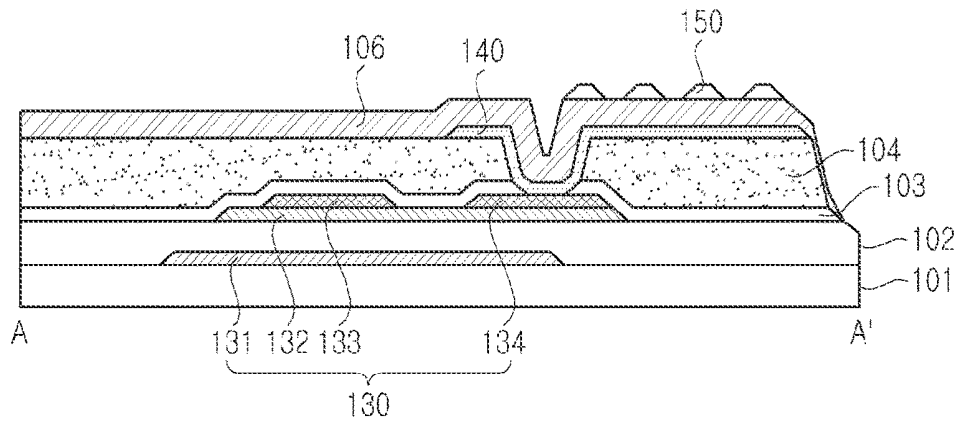


FIG. 5

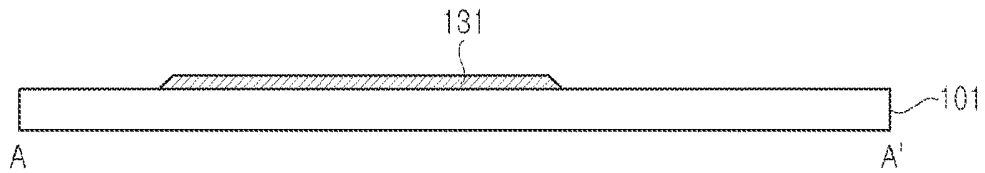
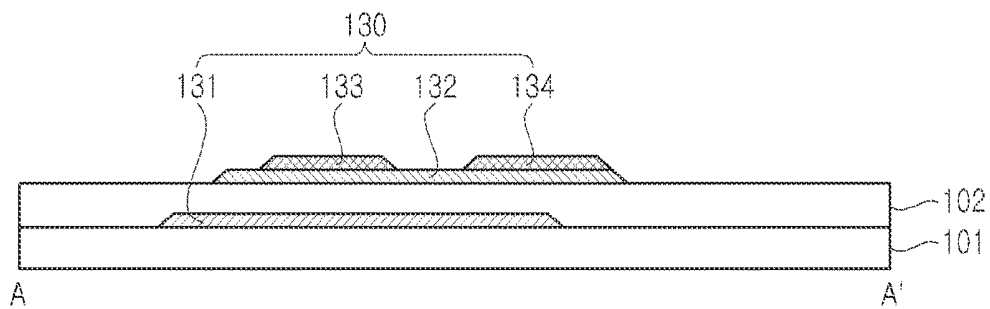
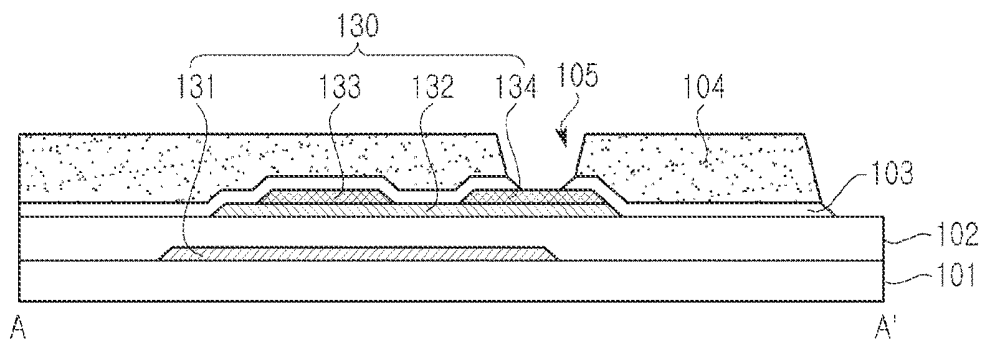


FIG. 6





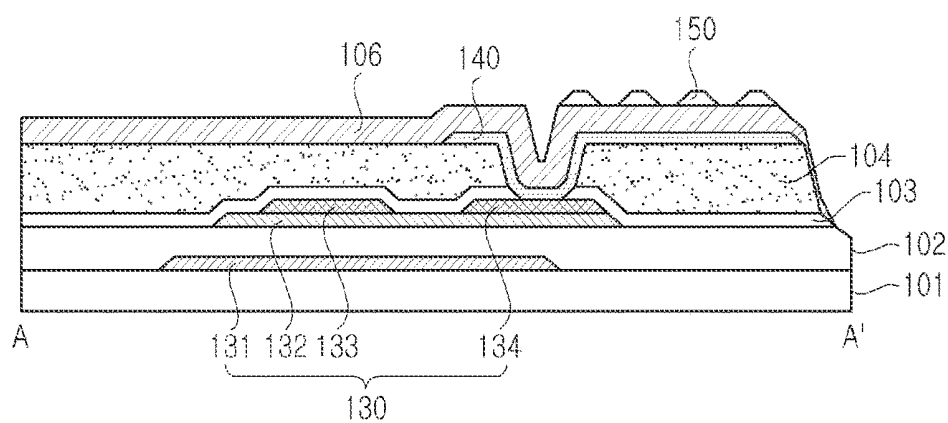
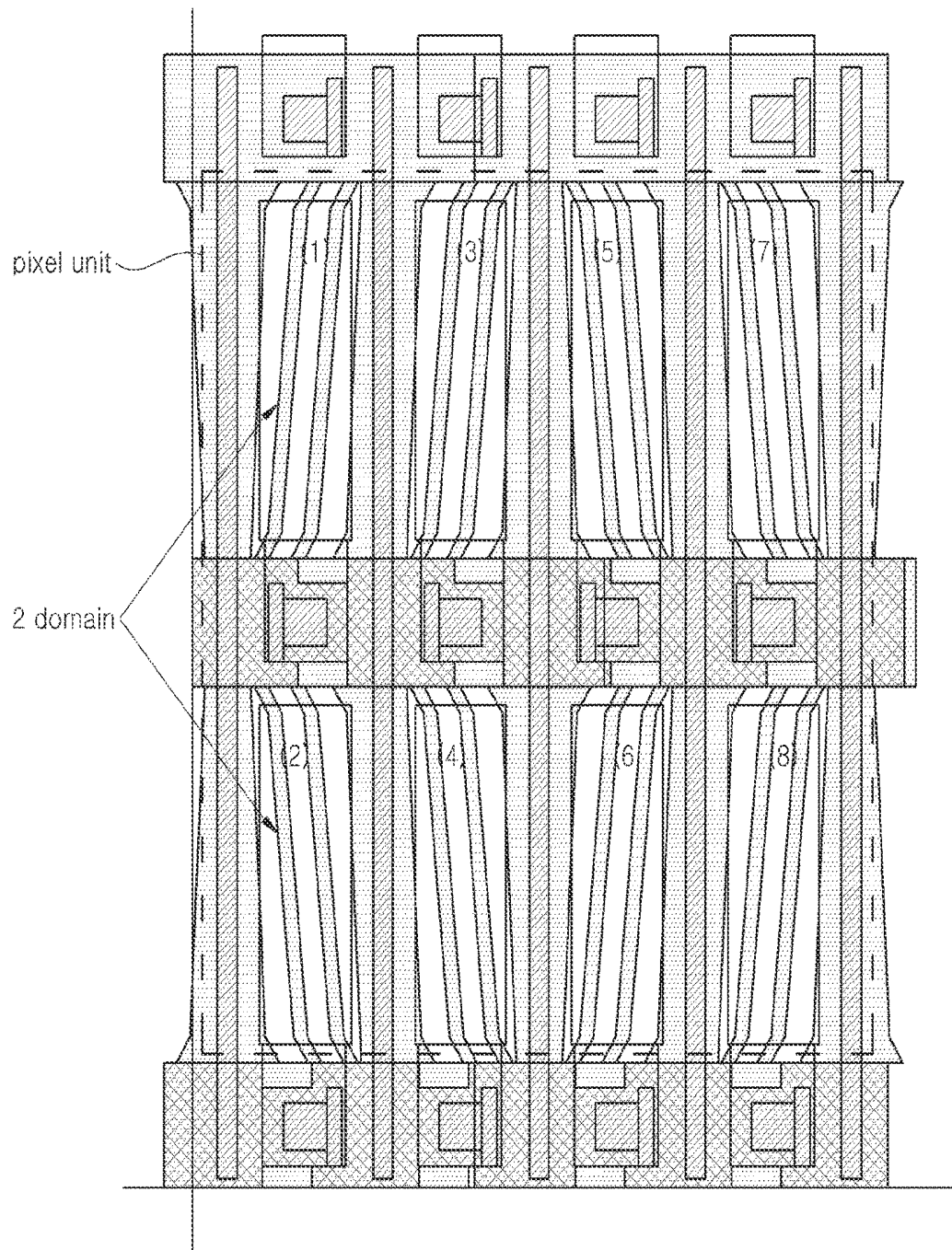


FIG. 13



LIQUID CRYSTAL DISPLAY DEVICE AND METHOD OF MANUFACTURING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of the Korean Patent Application No. 10-2013-0128040 filed on Oct. 25, 2013, which is hereby incorporated by reference as if fully set forth herein.

BACKGROUND

Field of the Invention

The present invention relates to a liquid crystal display (LCD) device, and more particularly, to an LCD device and a method of manufacturing the same, which reduce a capacitance deviation between pixels without any change in a viewing angle and a transmittance.

Discussion of the Related Art

With the advance of various portable electronic devices such as mobile communication terminals, smart phones, tablet computers, notebook computers, etc., the demand for flat panel display (FPD) devices applicable to the portable electronic devices is increasing.

Liquid crystal display (LCD) devices, plasma display panels (PDPs), field emission display (FED) devices, organic light emitting display devices, etc. have been developed as the FPD devices.

In such FPD devices, applications of the LCD devices have expanded because the LCD devices can be easily manufactured due to the advance of manufacturing technology, ease of implementation, low power consumption, a high-quality image, and a large screen.

FIG. 1 is a diagram illustrating a pixel structure of a related art LCD device. FIG. 1 illustrates a portion of a plurality of pixels which are formed in a liquid crystal panel, and illustrates a pixel structure of a thin film transistor (TFT) array substrate (a lower substrate) in an in-plane switching (IPS) mode. In FIG. 1, a color filter array substrate (an upper substrate), a backlight unit, and a driving circuit unit are not illustrated.

Referring to FIG. 1, a plurality of pixels are formed on the TFT array substrate of the liquid crystal panel, and are defined by a plurality of gate lines 10 and a plurality of data lines 20 which are formed to intersect.

A TFT 30 is formed in each of a plurality of areas defined by intersections between the gate lines 10 and the data lines 20.

The TFT 30 is formed in a bottom gate type, and includes a gate electrode G of which an area extends from the gate line 10, a source electrode S which extends from the data line 20, an active layer formed of a semiconductor material, and a drain electrode D.

A pixel electrode 40 for supplying a data voltage based on image data input from the outside is formed in each of the plurality of pixels, and a common electrode 50 is formed on the pixel electrode 40.

The drain electrode D of the TFT 30 is connected to the pixel electrode 40 through a contact hole. In order to prevent a loss of an aperture ratio of each pixel, the contact hole is formed in a storage capacitor (Cst) area. The common electrode 50 is patterned to have a finger shape in each pixel, and is formed in common in all the pixels.

A finger pattern of the common electrode 50 is formed to be inclined at a certain angle, and the pixel electrode 40 is formed to be inclined at a substantially same angle as that of the finger pattern.

The pixels of the related art LCD device illustrated in FIG. 1 are formed in a 2-domain structure where upper and lower pixels are formed in different forms. Therefore, in comparison with a 1-domain structure, the 2-domain structure improves a viewing angle, and solves a drawback of a color shift.

However, the data lines are alternately formed to be inclined at a certain angle. Therefore, a profile of each pixel is formed in a trapezoid shape, and two pixels which are adjacent in a horizontal direction are formed in a connected form.

As described above, when the pixels are formed in a trapezoid shape, in a manufacturing process, a plurality of metal layers may be formed to be distorted without properly overlapping each other.

Therefore, areas in which the metal layers overlap each other differ in each pixel, and thus, capacitances of the pixels differ. For this reason, line dim in a height direction and a width direction, and flicker may occur, causing the degradation in a quality of an image.

SUMMARY

Accordingly, the present invention is directed to provide an LCD device and a method of manufacturing the same that substantially obviate one or more problems due to limitations and disadvantages of the related art.

An aspect of the present invention is directed to provide an LCD device and a method of manufacturing the same, which can prevent a capacitance deviation between pixels from occurring.

Another aspect of the present invention is directed to provide an LCD device and a method of manufacturing the same, which can prevent a quality of an image from being degraded by line dim in a horizontal and vertical direction, and flicker.

In addition to the aforesaid objects of the present invention, other features and advantages of the present invention will be described below, but will be clearly understood by those skilled in the art from descriptions below.

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

To achieve these and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, there is provided an LCD device including: a plurality of gate lines disposed in a first direction on a substrate; a plurality of data lines disposed in a second direction to intersect the plurality of gate lines; a thin film transistor (TFT) disposed in each of a plurality of pixel areas defined by the plurality of gate lines and the plurality of data lines; a pixel electrode disposed in a tetragonal shape in each of the plurality of pixel areas; and a common electrode disposed on the pixel electrode, and configured to include a plurality of finger patterns, wherein each of the plurality of pixel areas is disposed in a tetragonal shape.

In another aspect of the present invention, there is provided a method of manufacturing a liquid crystal display

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(LCD) device including: forming a plurality of gate lines in a first direction on a substrate, and forming a gate electrode of a thin film transistor (TFT); forming a gate insulator to cover the plurality of gate lines and the gate electrode; forming an active layer on the gate insulator in an area which overlaps the gate electrode; forming a plurality of data lines in a second direction on the substrate, and forming a source electrode and a drain electrode of the TFT; forming a first passivation layer and a planarizing layer to cover the plurality of data lines and the TFT, and forming a contact hole to expose a top of the drain electrode; forming a pixel electrode in a tetragonal shape in each of a plurality of pixel areas defined by intersections between the plurality of gate lines and the plurality of data lines; forming a second passivation layer to cover the pixel electrode; and forming a common electrode, which includes a plurality of finger patterns, on the second passivation layer, wherein each of the plurality of pixel areas is formed in a tetragonal shape.

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

BRIEF DESCRIPTION OF THE DRAWINGS

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

FIG. 1 is a diagram illustrating a pixel structure of a related art LCD device;

FIG. 2 is a diagram illustrating a pixel structure of an LCD device according to an embodiment of the present invention;

FIG. 3 is a diagram illustrating an enlarged portion in which a TFT of FIG. 2 is formed;

FIG. 4 is a cross-sectional view taken along line A-A' of FIG. 2;

FIG. 5 is a diagram illustrating an LCD device in a first state of manufacturing process, according to an embodiment of the present invention;

FIG. 6 is a diagram illustrating an LCD device in a second state of manufacturing process, according to an embodiment of the present invention;

FIG. 7 is a diagram illustrating an LCD device in a third state of manufacturing process, according to an embodiment of the present invention;

FIG. 8 is a diagram illustrating an LCD device in a fourth state of manufacturing process, according to an embodiment of the present invention;

FIG. 9 is a diagram illustrating an LCD device in a fifth state of manufacturing process, according to an embodiment of the present invention;

FIG. 10 is a diagram illustrating an LCD device in a sixth state of manufacturing process, according to an embodiment of the present invention;

FIG. 11 is a diagram illustrating an LCD device in a seventh state of manufacturing process, according to an embodiment of the present invention;

FIG. 12 is a diagram illustrating an LCD device in an eighth state of manufacturing process, according to an embodiment of the present invention; and

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FIG. 13 is a diagram illustrating a structure of pixels of an LCD device according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to the exemplary embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

Hereinafter, an LCD device and a method of manufacturing the same according to embodiments of the present invention will be described in detail with reference to the accompanying drawings.

In description of embodiments of the present invention, when a structure (for example, an electrode, a line, a wiring, a layer, or a contact) is described as being formed at an upper portion/lower portion of another structure or on/under the other structure, this description should be construed as including a case where the structures contact each other and moreover a case where a third structure is disposed therebetween.

Terms "upper portion/lower portion" and "on/under" are for describing a configuration of an LCD device with a built-in touch sensor and a method of manufacturing the same according to an embodiment of the present invention with reference to the drawings. Therefore, the terms "upper portion/lower portion" and "on/under" may differ in structure during a manufacturing process and after manufacturing is completed.

LCD devices have been variously developed in a twisted nematic (TN) mode, a vertical alignment (VA) mode, an in-plane switching (IPS) mode, and a fringe field switching (FFS) mode according to a scheme of adjusting the alignment of liquid crystal.

Among different modes, the IPS mode and the FFS mode have a plurality of pixel electrodes and common electrodes arranged on a lower substrate, and thus, the alignment of liquid crystal is adjusted with electric fields between the pixel electrodes and the common electrodes.

FIG. 2 is a diagram illustrating a pixel structure of an LCD device according to an embodiment of the present invention, and FIG. 3 is a diagram illustrating an enlarged portion in which a TFT of FIG. 2 is formed.

FIGS. 2 and 3 illustrate a pixel structure of a TFT array substrate (a lower substrate) which is driven in an FFS mode, and illustrate a portion of a plurality of pixels. A color filter array substrate (an upper substrate), a backlight unit, and a driving circuit unit are not illustrated.

The driving circuit unit includes a timing controller (T-con), a data driver (D-IC), a gate driver (G-IC), a backlight driver, and a power supply that supplies driving power to a plurality of driving circuits.

Here, all or some of the driving circuit unit may be provided on a liquid crystal panel in a chip-on glass (COG) type or a chip-on film (COF, chip-on flexible printed circuit) type.

Referring to FIGS. 2 and 3, a plurality of pixels are formed on the TFT array substrate of the liquid crystal panel, and are defined by a plurality of gate lines 110 and a plurality of data lines 120 which are formed to intersect each other.

The gate lines 110 are formed in a first direction (for example, an X axis direction, and the data lines 120 are

formed in a second direction (for example, a Y axis direction). The gate lines **110** and the data lines **120** are formed in a long bar shape.

In the LCD device according to an embodiment of the present invention, the gate lines **110** and the data lines **120** are formed so that a profile of an opening of each of the pixels has a tetragonal shape. That is, a data line of a related art LCD device is formed to be inclined at a certain angle in a diagonal direction, but the data lines of the LCD device according to an embodiment of the present invention are formed in a straight line in a vertical direction.

A pixel electrode **140** and a common electrode **150** are formed in a pixel area formed by intersection between the gate line **110** and the data line **120**. The pixel electrode **140** and the common electrode **150** are formed on different layers.

The pixel electrode **140** is formed to have a tetragonal shape in an opening of each pixel. That is, the pixel electrode **140** is formed in a tetragonal shape along a profile of the pixel area. The common electrode **150** is formed to have a plurality of finger patterns, and is formed to be inclined at a certain angle in each pixel.

The common electrode **150** is electrically connected to a common electrode line (not shown) through a contact hole (not shown) which is formed at one side of each pixel, and is supplied with a common voltage (Vcom).

A TFT **130** is formed in each of a plurality of areas defined by intersections between the plurality of gate lines **110** and the plurality of data lines **120**. A drain electrode D of the TFT **130** is electrically connected to the pixel electrode **140** through a contact hole. The contact hole which connects the drain electrode D of the TFT **130** to the pixel electrode **140** is formed on the gate line **110**, for reducing a loss of an aperture ratio. Here, the contact hole may be formed to have a 4 $\mu\text{m} \times 4 \mu\text{m}$ to 14 $\mu\text{m} \times 10 \mu\text{m}$ size.

FIG. 4 is a cross-sectional view taken along line A-A' of FIG. 2.

A pixel structure of an LCD device according to an embodiment of the present invention will be described in more detail with reference to FIG. 4.

A substrate **101** may use a glass substrate or a flexible plastic substrate. A gate electrode **131** of the TFT **130** is formed in a TFT area on the substrate **101**. An area of the gate line **110** which is formed in a horizontal direction extends from the TFT area, and thus, the gate electrode **131** of the TFT **130** is formed.

The gate lines **110** and the gate electrode **131** may be formed of a metal material such as aluminum (Al), molybdenum (Mo), titanium (Ti), silver (Ag), gold (Au), nickel (Ni), cadmium (Cd), hafnium (Hf), tungsten (W), tantalum (Ta), chromium (Cr), zirconium (Zr), or copper (Cu) to have a thickness of 2,500 Å.

As another example, the gate lines **110** and the gate electrode **131** may be formed of an alloy containing a metal material such as aluminum (Al), molybdenum (Mo), titanium (Ti), silver (Ag), gold (Au), nickel (Ni), cadmium (Cd), hafnium (Hf), tungsten (W), tantalum (Ta), chromium (Cr), zirconium (Zr), or copper (Cu).

Although not shown, a buffer layer may be formed on a substrate, and the gate line **110**, the gate electrode **131**, and a common electrode line (not shown) may be formed on the buffer layer. The buffer layer may be formed of an inorganic material (for example, SiO_2 or SiNx), and may have a thickness of 2,000 Å to 3,000 Å.

A gate insulator **102** is formed to cover the gate line **110** and the gate electrode **131**. The gate insulator **102** may be formed of SiO_2 or SiNx , and may have a thickness of 4,000 Å.

As another example, the gate insulator **102** may be formed to have a thickness of 4,000 Å by depositing tetra ethyl ortho silicate (TEOS) or middle temperature oxide (MTO) in a chemical vapor deposition (CVD) process.

An active layer **132** of the TFT **130** is formed on the gate insulator **102** to overlap the gate electrode **131**. The active layer **132** may be formed of a semiconductor material to have a thickness of 2,200 Å. In this case, the semiconductor material of the active layer **132** may use poly silicon (P—Si), amorphous silicon (a-Si), low temperature poly silicon (LTPS), or oxide.

A source electrode **133** of the TFT **130** is formed at one side on the active layer **132**, and a drain electrode **134** is formed at the other side. The data line **120** extends into a pixel area to form the source electrode **133**. The drain electrode **134** is formed to have an island pattern.

The data line **120**, the source electrode **133**, and the drain electrode **134** may be formed of a metal material such as aluminum (Al), molybdenum (Mo), titanium (Ti), silver (Ag), gold (Au), nickel (Ni), cadmium (Cd), hafnium (Hf), tungsten (W), tantalum (Ta), chromium (Cr), zirconium (Zr), or copper (Cu) to have a thickness of 2,500 Å.

As another example, the data line **120**, the source electrode **133**, and the drain electrode **134** may be formed of an alloy containing a metal material such as aluminum (Al), molybdenum (Mo), titanium (Ti), silver (Ag), gold (Au), nickel (Ni), cadmium (Cd), hafnium (Hf), tungsten (W), tantalum (Ta), chromium (Cr), zirconium (Zr), or copper (Cu) to have a thickness of 2,500 Å.

As described above, the gate electrode **131**, the gate insulator **102**, the active layer **132**, the source electrode **133**, and the drain electrode **134** are formed to configure the TFT **130**.

A first passivation layer (PAS1) **103** is formed to cover the TFT **130**. The first passivation layer **103** may be formed of SiO_2 or SiNx to have a thickness of 1,000 Å.

A planarizing layer **104** is formed to cover an entire surface of the substrate. The planarizing layer **104** is formed of photoacryl to have a thickness of 2.0 μm to 3.0 μm , and planarizes the entire surface of the substrate.

The pixel electrode **140** is formed in an opening of the planarizing layer **104**. A contact hole is formed to expose a portion of a top of the drain electrode **134**. The pixel electrode **140** is formed in the contact hole, and is electrically connected to the drain electrode **134** of the TFT **130** and the pixel electrode **140**.

A second passivation layer (PAS2) **106** is formed to cover the pixel electrode **140**. The second passivation layer **106** may be formed of SiO_2 or SiNx to have a thickness of 2,000 Å.

The common electrode **150** is formed on the second passivation layer **106**. The common electrode **150** is formed to have a plurality of finger patterns. The common electrode **150** is formed to be inclined at a certain angle relative to data lines **120** in each pixel. The common electrode **150** is electrically connected to the common electrode line (not shown) through the contact hole (not shown) which is formed at one side of each pixel, and is supplied with the common voltage (Vcom).

As described above, the pixel electrode **140** and the common electrode **150** are formed on different layers, and a fringe field is generated between the pixel electrode **140** and the common electrode **150**.

The pixel electrode **140** and the common electrode **150** are formed of a transparent conductive material such as indium tin oxide (ITO), indium zinc oxide (IZO), or indium tin zinc oxide (ITZO) to have a thickness of 400 Å.

Although not shown, in order for a space to be formed between the lower substrate (the TFT array substrate) and the upper substrate (the color filter array substrate), a column spacer CS is formed on the lower substrate (the TFT array substrate). Liquid crystal is injected into the space formed between the lower substrate (the TFT array substrate) and the upper substrate (the color filter array substrate).

A black matrix BM for dividing the plurality of pixels is formed on the upper substrate (the color filter array substrate) in which a color filter is formed. The black matrix is formed to overlap the gate lines **110** and the data line **120**, for reducing a loss of an opening of each pixel. In this case, except for a portion for covering the column spacer, the black matrix is formed in a tetragonal shape.

In the LCD device according to an embodiment of the present invention including the above-described elements, the gate lines and the data lines are formed so that a profile of an opening of each pixel has a tetragonal shape. The pixel electrode is formed in a tetragonal shape in the opening of each pixel. That is, the data line **120** and pixel electrode **140** of each of pixels which are adjacent in an up and down direction or in a left and right direction are formed in a substantially same shape.

Therefore, even when an overlap of metals is distorted in a manufacturing process, an area in which metals of the pixels overlap each other is substantially same as a distorted area, and thus, a defect caused by capacitance differences of the pixels can be prevented. Accordingly, the capacitances of the pixels are equal, and thus, line dim in a height direction and a width direction and flicker can be prevented.

FIGS. **5** to **12** are diagrams illustrating a method of manufacturing an LCD device according to an embodiment of the present invention.

Hereinafter, a method of manufacturing an LCD device according to an embodiment of the present invention will be described in detail with reference to FIGS. **5** to **12**.

Referring to FIG. **5**, a metal material is coated on the substrate **101**, and then a plurality of gate lines, a plurality of common electrode lines, and the gate electrode **131** of each pixel area are formed by performing a photolithography process, an etching process, and an ashing process which use a first mask (Mask 1). In this case, the plurality of gate lines are formed in a first direction (for example, an X axis direction). An area of the gate line which is formed in the first direction (for example, a horizontal direction) extends from a TFT area, and thus, the gate electrode **131** of a TFT is formed. The substrate **101** may use a glass substrate or a flexible plastic substrate.

Although not shown, a buffer layer may be formed on a substrate, and the gate line, the gate electrode **131**, and the common electrode line (not shown) may be formed on the buffer layer. The buffer layer may be formed of an inorganic material (for example, SiO₂ or SiNx), and may have a thickness of 2,000 Å to 3,000 Å.

The gate lines and the gate electrode **131** may be formed on the same layer, and may be formed of a metal material such as aluminum (Al), molybdenum (Mo), titanium (Ti), silver (Ag), gold (Au), nickel (Ni), cadmium (Cd), hafnium (Hf), tungsten (W), tantalum (Ta), chromium (Cr), zirconium (Zr), or copper (Cu) to have a thickness of 2,500 Å.

As another example, the gate lines and the gate electrode **131** may be formed of an alloy containing a metal material such as aluminum (Al), molybdenum (Mo), titanium (Ti),

silver (Ag), gold (Au), nickel (Ni), cadmium (Cd), hafnium (Hf), tungsten (W), tantalum (Ta), chromium (Cr), zirconium (Zr), or copper (Cu) to have a thickness of 2,500 Å.

Subsequently, referring to FIG. **6**, the gate insulator **102** is formed to cover the gate line and the gate electrode **131**. The gate insulator **102** may be formed of SiO₂ or SiNx, and may have a thickness of 4,000 Å.

As another example, the gate insulator **102** may be formed to a thickness of 4,000 Å by depositing tetra ethyl ortho silicate (TEOS) or middle temperature oxide (MTO) in a chemical vapor deposition (CVD) process.

Subsequently, a semiconductor material is deposited on the gate insulator **102**, and a metal material is coated on the semiconductor material.

Subsequently, the active layer **132** is formed to a thickness of 2,200 Å to overlap the gate electrode **131** by performing a photolithography process, an etching process, and an ashing process which use a second mask (Mask 2). Furthermore, when forming the active layer **132**, the data line **120**, the source electrode **133**, and the drain electrode **134** are simultaneously formed to a thickness of 2,500 Å. At this time, a half tone mask is used as the second mask so as to simultaneously form the active layer **132** and a source/drain layer.

A photoresist is coated, and then, the active layer **132** and the source/drain layer are simultaneously formed by performing a photolithography process, an etching process, and an ashing process which use the half tone mask.

Here, the photoresist may use a negative photoresist in which an exposed area remains. The half tone mask includes a full tone area, a half tone area, and a blocking area.

Substantially all of a photoresist corresponding to the full tone area remain. Thus, the photoresist corresponding to the full tone area becomes thick. In a photoresist corresponding to the half tone area, an amount of remaining photoresist (an amount of removed photoresist) is adjusted according to an amount of transmitted light, namely, an amount of exposure, and thus, the photoresist corresponding to the half tone area becomes thinner than the photoresist corresponding to the full tone area. Also, a photoresist corresponding to the blocking area is not exposed, and thus substantially all of the photoresist corresponding to the blocking area is removed.

A plurality of data lines are formed in a second direction (for example, a Y axis direction).

When forming the data line, the source electrode **133** and the drain electrode **134** are formed in each pixel. The source electrode **133** is formed at one side on the active layer **132**, and the drain electrode **134** is formed at the other side. The data line extends into a pixel area to form the source electrode **133**. The drain electrode **134** is formed to have an island pattern.

Here, the semiconductor material of the active layer **132** may use poly silicon (P—Si), amorphous silicon (a-Si), low temperature poly silicon (LTPS), or oxide.

The data line, the source electrode **133**, and the drain electrode **134** may be formed on the same layer, and may be formed of a metal material such as aluminum (Al), molybdenum (Mo), titanium (Ti), silver (Ag), gold (Au), nickel (Ni), cadmium (Cd), hafnium (Hf), tungsten (W), tantalum (Ta), chromium (Cr), zirconium (Zr), or copper (Cu) to have a thickness of 2,500 Å.

As another example, the data line, the source electrode **133**, and the drain electrode **134** may be formed on the same layer, and may be formed of an alloy containing a metal material such as aluminum (Al), molybdenum (Mo), titanium (Ti), silver (Ag), gold (Au), nickel (Ni), cadmium

(Cd), hafnium (Hf), tungsten (W), tantalum (Ta), chromium (Cr), zirconium (Zr), or copper (Cu) to have a thickness of 2,500 Å.

As described above, the gate electrode **131**, the gate insulator **102**, the active layer **132**, the source electrode **133**, and the drain electrode **134** are formed to configure the TFT **130**.

Subsequently, referring to FIG. 7, the TFT **130** is formed, and then, SiO₂ or SiNx is coated over the substrate to a thickness of 1,000 Å, and the first passivation layer **103** is formed to cover the TFT **130**.

Subsequently, referring to FIG. 8, the planarizing layer **104** is formed by coating photoacryl on the entire surface of the substrate **101** to cover the first passivation layer **103**. In this case, the planarizing layer **104** is formed to a thickness of 2.0 μm to 3.0 μm, and planarizes the entire surface of the substrate.

Subsequently, a portion **104a** of the planarizing layer **104** in an area overlapping the drain electrode **134** is removed by performing an etching process and an ashing process which use a third mask (Mask 3). The first passivation layer **103** in the area overlapping the drain electrode **134** is exposed by removing the portion **104a** of the planarizing layer **104**.

Subsequently, referring to FIG. 9, the first passivation layer **103** in the area overlapping the drain electrode **134** is removed by performing a dry etching process. A contact hole **105** which exposes the drain electrode **134** is formed by removing the first passivation layer **103** in the area overlapping the drain electrode **134**.

Here, the contact hole **105** connects the drain electrode D of the TFT **130** to the pixel electrode **140**, and is formed on the gate line **110**, for reducing a loss of an aperture ratio. Here, the contact hole **105** may be formed to have a 4 μm×4 μm to 14 μm×10 μm size.

Subsequently, referring to FIG. 10, a transparent conductive material such as indium tin oxide (ITO), indium zinc oxide (IZO), or indium tin zinc oxide (ITZO) is coated over the substrate **101** to a thickness of 400 Å.

Subsequently, the pixel electrode **140** is formed in a pixel area (an opening) by performing a photolithography process, an etching process, and an ashing process which use a fourth mask (Mask 4).

The pixel electrode **140** is formed to have a tetragonal shape in an opening of each pixel. The pixel electrode **140** is also formed in the contact hole **105**, and is electrically connected to the drain electrode D of the TFT **130** through the contact hole **105**.

Subsequently, referring to FIG. 11, the second passivation layer (PAS2) **106** is formed to cover the pixel electrode **140**. The second passivation layer **106** may be formed of SiO₂ or SiNx to have a thickness of 2,000 Å.

Here, although not shown, a gate pad, a data pad, a gate link, and a data link are provided in a pad area outside an active area. In this case, the second passivation layer **106** is also formed on the gate pad, the data pad, the gate link, and the data link.

By performing a photolithography process, an etching process, and an ashing process which use a fifth mask (Mask 5), a plurality of contact holes are formed by removing a portion of the second passivation layer **106** formed in a pad area so that the gate pad, the data pad, the gate link, and the data link are exposed.

Subsequently, referring to FIG. 12, a transparent conductive material such as indium tin oxide (ITO), indium zinc oxide (IZO), or indium tin zinc oxide (ITZO) is coated on the second passivation layer **106** to a thickness of 400 Å.

Subsequently, the common electrode **150** having a plurality of finger patterns is formed by performing a photolithography process, an etching process, and an ashing process which use a sixth mask (Mask 6).

The common electrode **150** is formed to be inclined at a certain angle relative to data lines **120** in each pixel. The common electrode **150** is electrically connected to the common electrode line (not shown) through the contact hole (not shown) which is formed at one side of each pixel, and is supplied with the common voltage (Vcom).

As described above, the pixel electrode **140** and the common electrode **150** are formed on different layers, and a fringe field is generated between the pixel electrode **140** and the common electrode **150**.

The pixel electrode **140** and the common electrode **150** are formed of a transparent conductive material such as indium tin oxide (ITO), indium zinc oxide (IZO), or indium tin zinc oxide (ITZO) to have a thickness of 400 Å.

Although not shown, in order for a space to be formed between the lower substrate (the TFT array substrate) and the upper substrate (the color filter array substrate), the column spacer CS is formed on the lower substrate (the TFT array substrate).

Subsequently, when the lower substrate (the TFT array substrate) is coupled to the upper substrate (the color filter array substrate), the space is provided between the lower substrate (the TFT array substrate) and the upper substrate (the color filter array substrate) by the column spacer.

Subsequently, liquid crystal is injected into the space formed between the lower substrate (the TFT array substrate) and the upper substrate (the color filter array substrate), and then, sides of the lower substrate (the TFT array substrate) and the upper substrate (the color filter array substrate) are sealed in order to prevent the liquid crystal from flowing out.

A red color filter, a green color filter, and a blue color filter are formed on the upper substrate (the color filter array substrate) in correspondence with a pixel area, and the black matrix BM for dividing the plurality of pixels is formed on the upper substrate (the color filter array substrate).

The black matrix is formed to overlap the gate lines **110** and the data line **120**, for reducing a loss of an opening of each pixel. In this case, except for a portion for covering the column spacer, the black matrix is formed in a tetragonal shape. By using the method of manufacturing the LCD device according to an embodiment of the present invention, the gate lines and the data lines are formed so that a profile of an opening of each pixel has a tetragonal shape. The pixel electrode is formed in a tetragonal shape in the opening of each pixel. That is, the data line **120** and pixel electrode **140** of each of pixels which are adjacent in an up and down direction or in a left and right direction are formed in a substantially same shape.

Therefore, even when an overlap of metals is distorted in a manufacturing process, an area in which metals of the pixels overlap each other is substantially same as a distorted area, and thus, a defect caused by capacitance differences of the pixels can be prevented. Accordingly, the capacitances of the pixels are equal, and thus, line dim in a height direction and a width direction and flicker can be prevented.

TABLE 1

	The Related Art	The Present Invention
C _{gs}	Upper and lower pixel difference: 47.8%	Upper and lower pixel difference: 0%

TABLE 1-continued

	The Related Art	The Present Invention
Cst	Left and right pixel difference: 0%	Left and right pixel difference: 0%
	Upper and lower pixel difference: 2.05%	Upper and lower pixel difference: 0%
	Left and right pixel difference: 3.18%	Left and right pixel difference: 0%
Cdp	Upper and lower pixel difference: 0%	Upper and lower pixel difference: 0%
	Left and right pixel difference: 13.86%	Left and right pixel difference: 0%

As listed in Table 1, in the relate art, since an overlap of metals is distorted in a manufacturing process, capacitances of pixels differ. On the other hand, an area in which metals of the pixels overlap each other is substantially same as a distorted area, and thus, capacitances of the pixels are substantially same. FIG. 13 is a diagram illustrating an arrangement structure of pixels of an LCD device according to an embodiment of the present invention.

Referring to FIG. 13, in the LCD device according to an embodiment of the present invention, two domains may be formed by two pixels which are adjacent upward and downward.

Moreover, one pixel unit may be composed of eight pixels which are adjacent in an up and down direction and a left and right direction. The pixel unit may be repeatedly disposed. An angle of a common electrode of a pixel in the up direction relative to the data lines may be different from an angle of a common electrode of a pixel in the down direction relative to the data lines.

The LCD device and the method of manufacturing the same according to the embodiments of the present invention can prevent a capacitance deviation between pixels from occurring.

The LCD device and the method of manufacturing the same according to the embodiments of the present invention can prevent a quality of an image from being degraded by line dim in a horizontal and vertical direction and flicker.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the inventions. Thus, it is intended that the present invention covers 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 liquid crystal display (LCD) device comprising:
 - a plurality of gate lines disposed in a first direction on a substrate;
 - a plurality of data lines disposed in a second direction to intersect the plurality of gate lines;
 - a thin film transistor (TFT) disposed in each of a plurality of pixel areas defined by the plurality of gate lines and the plurality of data lines;
 - a pixel electrode disposed in a tetragonal shape in each of the plurality of pixel areas, the pixel electrode disposed in the tetragonal shape extending over a gate line of the plurality of gate lines, the pixel electrode disposed in the tetragonal shape coupled to the TFT through a contact hole, the contact hole formed in a region at which the gate line, the pixel electrode, and the TFT overlap with each other; and
 - a common electrode disposed on the pixel electrode, and configured to include a plurality of finger patterns,

wherein each of the plurality of pixel areas is disposed in a tetragonal shape.

2. The LCD device of claim 1, wherein, the pixel electrode is disposed in the tetragonal shape along a profile of a corresponding pixel area, and the common electrode is disposed to be inclined at a certain angle relative to the plurality of data lines.

3. The LCD device of claim 1, wherein the plurality of data lines are disposed in straight lines.

4. The LCD device of claim 1, wherein pixel electrodes of pixels which are adjacent in an up and down direction and a left and right direction are disposed in a substantially same shape.

5. The LCD device of claim 1, wherein, a black matrix which defines an opening of each of the plurality of pixel areas is disposed on another substrate above the substrate, and the black matrix is disposed in a tetragonal shape.

6. The LCD device of claim 1, wherein two domains are disposed by two pixels which are adjacent upward and downward.

7. The LCD device of claim 6, wherein an angle of a common electrode of a pixel in a first domain of the two domains relative to the plurality of data lines is different from an angle of a common electrode of a pixel in a second domain of the two domains relative to the plurality of data lines.

8. The LCD device of claim 1, wherein, one pixel unit is composed of eight pixels, and the one pixel unit is repeatedly disposed.

9. A method of manufacturing a liquid crystal display (LCD) device, the method comprising:

forming a plurality of gate lines in a first direction on a substrate, and forming a gate electrode of a thin film transistor (TFT);

forming a gate insulator to cover the plurality of gate lines and the gate electrode;

forming an active layer on the gate insulator in an area which overlaps the gate electrode;

forming a plurality of data lines in a second direction on the substrate, and forming a source electrode and a drain electrode of the TFT;

forming a first passivation layer and a planarizing layer to cover the plurality of data lines and the TFT, and forming a contact hole to expose a top of the drain electrode;

forming a pixel electrode in a tetragonal shape in each of a plurality of pixel areas defined by intersections between the plurality of gate lines and the plurality of data lines, the pixel electrode formed in the tetragonal shape extending over a gate line of the plurality of gate lines, the pixel electrode disposed in the tetragonal shape coupled to the TFT through the contact hole, the contact hole formed in a region at which the gate line, the pixel electrode, and the TFT overlap with each other;

forming a second passivation layer to cover the pixel electrode; and

forming a common electrode, which includes a plurality of finger patterns, on the second passivation layer, wherein each of the plurality of pixel areas is formed in a tetragonal shape.

10. The method of claim 9, wherein, the pixel electrode is formed in the tetragonal shape along a profile of a corresponding pixel area, and the common electrode is formed to be inclined at a certain angle relative to the plurality of data lines.

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11. The method of claim 9, wherein the plurality of data lines are formed in straight lines.

12. The method of claim 9, wherein pixel electrodes of pixels which are adjacent are formed in a substantially same shape. 5

13. The method of claim 9, further comprising forming a black matrix, which defines an opening of each of the plurality of pixel areas, on another substrate above the substrate, wherein the black matrix is disposed in a tetrago-
nal shape. 10

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专利名称(译)	液晶显示装置及其制造方法		
公开(公告)号	US9608018	公开(公告)日	2017-03-28
申请号	US14/522553	申请日	2014-10-23
[标]申请(专利权)人(译)	乐金显示有限公司		
申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
当前申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
[标]发明人	KIM KYOUNG WOOK SHIN KI TAEG LEE HEE WON		
发明人	KIM, KYOUNG-WOOK SHIN, KI TAEG LEE, HEE WON		
IPC分类号	G02F1/1362 H01L27/12 G02F1/1343		
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优先权	1020130128040 2013-10-25 KR		
其他公开文献	US20150116622A1		
外部链接	Espacenet USPTO		

摘要(译)

公开了一种LCD装置及其制造方法，其减小了像素之间的电容偏差而没有任何视角变化和高透射率。LCD装置包括在基板上沿第一方向形成的多条栅极线，沿第二方向形成以与多条栅极线交叉的多条数据线，形成在多个栅极线中的每一个中的薄膜晶体管（TFT）由多条栅极线和多条数据线限定的像素区域，在多个像素区域的每一个中形成为四边形的像素电极，以及形成在像素电极上的公共电极，并且被配置为包括多个手指模式。多个像素区域中的每一个形成为四边形形状。

