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(19) **United States**(12) **Patent Application Publication****Oh et al.**(10) **Pub. No.: US 2005/0117083 A1**(43) **Pub. Date: Jun. 2, 2005**(54) **THIN FILM DIODE PANEL AND
MANUFACTURING METHOD OF THE SAME**(30) **Foreign Application Priority Data**

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BLOOMFIELD, CT 06002**(21) Appl. No.: **10/977,987**(22) Filed: **Oct. 29, 2004**(57) **ABSTRACT**

The present invention provides a liquid crystal display comprising: an insulating substrate; a plurality of color filters formed on the insulating substrate; a plurality of first and second gate lines formed on the color filters; a plurality of pixel electrodes formed on the color filters; a plurality of first MIM diodes formed on the color filters and connecting the first gate line and the pixel electrodes; and a plurality of second MIM diodes formed on the color filters and connecting the second gate line and the pixel electrodes.

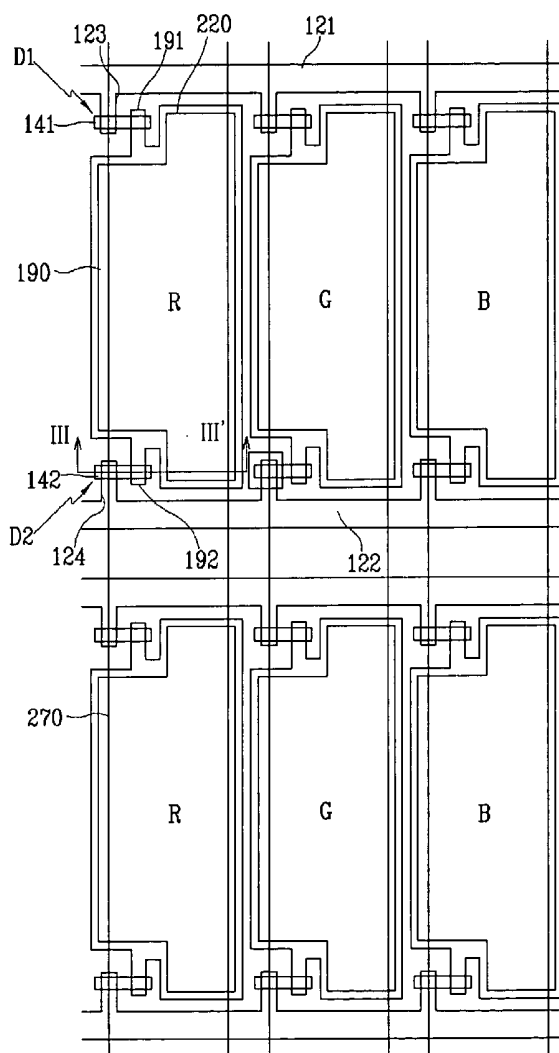


FIG.1

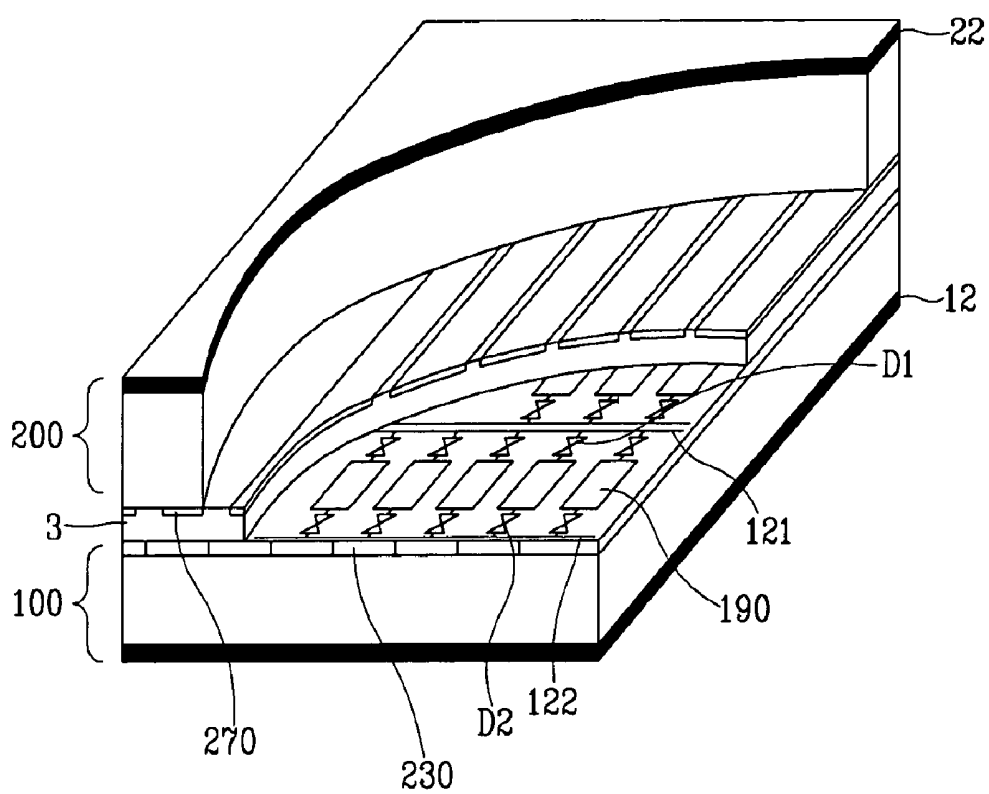


FIG.2

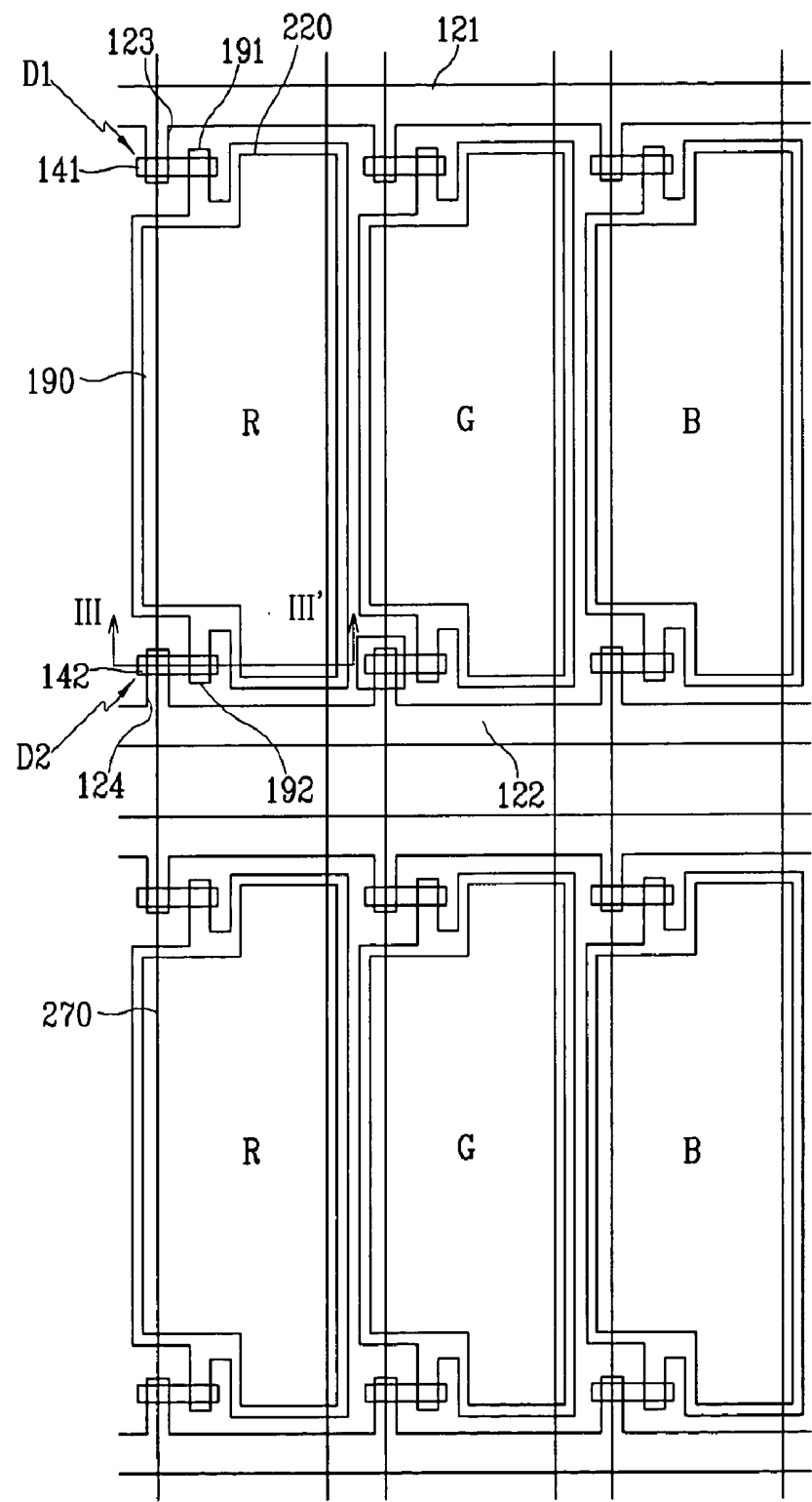


FIG.3

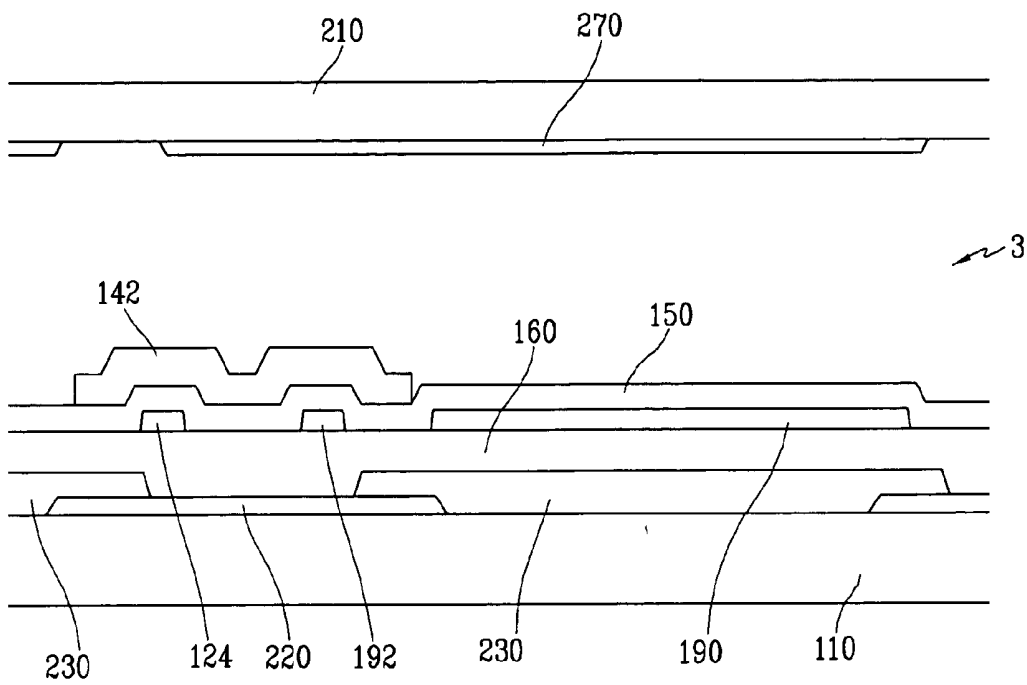
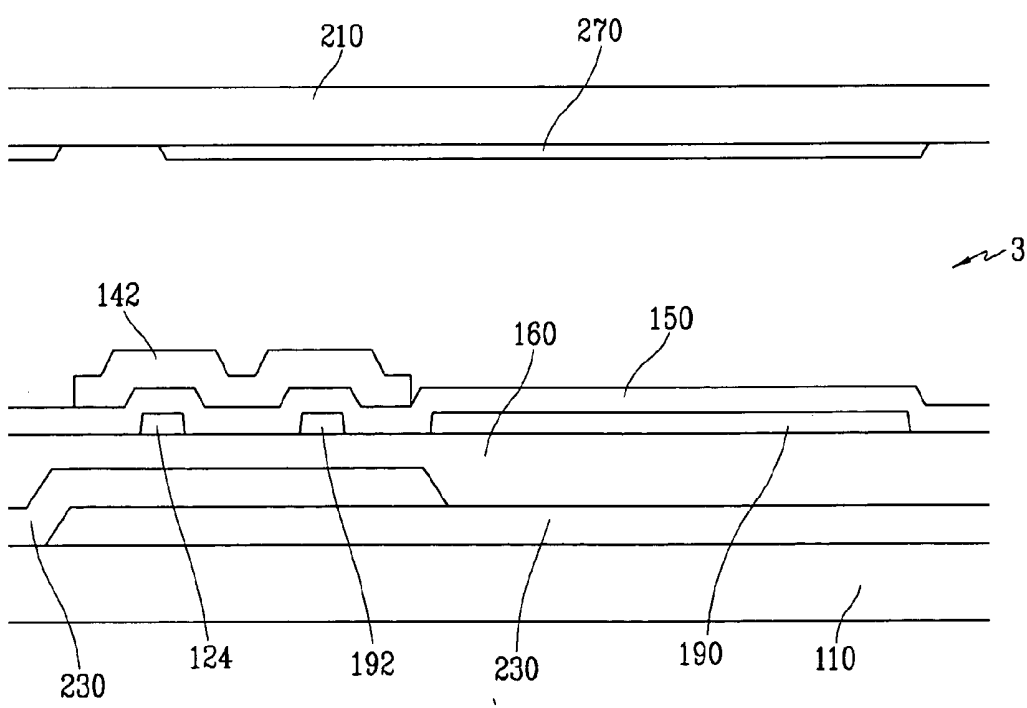


FIG.4



THIN FILM DIODE PANEL AND MANUFACTURING METHOD OF THE SAME

BACKGROUND OF THE INVENTION

[0001] (a) Field of the Invention

[0002] The present disclosure relates to thin film diode array panels using metal insulator metal (MIM) diodes as switching elements, and a manufacturing method of the same. In more detail, the present disclosure relates to thin film diode array panels of a dual select diode (DSD) type, and a liquid crystal display using the same.

[0003] (b) Description of the Related Art

[0004] A liquid crystal display (LCD) is one of the most widely used flat panel displays. An LCD includes two panels provided with field-generating electrodes, and a liquid crystal (LC) layer interposed therebetween. The LCD displays images by applying voltages to the field-generating electrodes to generate an electric field in the LC layer, which determines orientations of LC molecules in the LC layer to adjust polarization of incident light.

[0005] An LCD may have switching elements to switch voltages of pixels arranged in a matrix form. An LCD can display various images since pixel voltages are individually switched. An LCD having switching elements to switch pixel voltages individually is called an active matrix LCD.

[0006] Thin film transistors or thin film diodes may be used as the switching elements. When thin film diodes are applied, MIM diodes can be used.

[0007] A MIM diode has two metal layers and one insulating layer interposed between the metal layers, and a thickness capable of being measured in micrometers. A MIM diode may act as a switch due to electrical non-linearity of the insulating layer. A MIM diode has two terminals, and as a result, the manufacturing process of the MIM diode is simpler than that of the thin film transistor having three terminals. Accordingly, MIM diodes can be manufactured at a lower cost than thin film transistors.

[0008] However, when diodes are used as switching elements, the uniformity of image quality and contrast ratio may be degraded due to asymmetry of an applied voltage with respect to the polarity.

[0009] In response to the asymmetry, a dual select diode (DSD) panel has been developed. A DSD panel includes two diodes that are symmetrically connected to a pixel electrode and are driven by applying voltages of opposite polarities.

[0010] A DSD LCD shows improved image quality, contrast ratio, gray scale uniformity, and response speed by applying voltages having opposite polarities to two diodes that are connected to the same pixel electrode. Accordingly, a DSD LCD can display images with high resolution like that of an LCD using thin film transistors.

[0011] A thin film diode array panel of a conventional DSD LCD has transmission electrodes made of a transparent conductor such as indium tin oxide (ITO) formed on a substrate as a bottom layer, and signal lines made of a metal and formed on the other layers as a top layer.

[0012] Hence, such a conventional thin film diode array panel structure has the following demerit.

[0013] Off current (I_{off}) of a MIM diode is increased because back light reaches the silicone-rich silicon nitride (Si-rich SiN_x) layer that forms a channel of the MIM diode, and activates the Si-rich SiN_x layer. To solve such a problem, the back light unit is disposed on the color filter panel side and displayed images are seen in front of the thin film diode panel. However, this method also has problems such that characteristics of MIM diodes are affected by external light, and the contrast ratio is degraded due to light reflections by the metal signal lines.

SUMMARY OF THE INVENTION

[0014] It is an object of the present invention to provide an DSD LCD without such a problem.

[0015] The present invention provides a liquid crystal display comprising: an insulating substrate; a plurality of color filters formed on the insulating substrate; a plurality of first and second gate lines formed on the color filters; a plurality of pixel electrodes formed on the color filters; a plurality of first MIM diodes formed on the color filters and connecting the first gate line and the pixel electrodes; and a plurality of second MIM diodes formed on the color filters and connecting the second gate line and the pixel electrodes.

[0016] Here, the liquid crystal display may further comprise a black matrix formed between the insulating substrate and the color filters wherein the black matrix includes at least a portion overlapping the first and second MIM diodes, and the black matrix is made of a material mainly including an organic material.

[0017] The color filters may include red, green, and blue color filters and overlap each other at a part wherein the overlapping area of the color filters includes at least a portion overlapping the first and second MIM diodes.

[0018] The liquid crystal display may further comprises an inter-insulating layer formed between the first and second gate lines and the pixel electrodes, wherein the inter-insulating layer is made of an organic insulating material.

[0019] The first MIM diode may include a first input electrode connected to the first gate line, a first contact portion connected to the pixel electrode, a channel insulating layer formed on the first input electrode and the first contact portion, and a first floating electrode formed on the channel insulating layer and intersecting the first input electrode and the first contact portion; and the second MIM diode may include a second input electrode connected to the second gate line, a second contact portion connected to the pixel electrode, the channel insulating layer formed on the second input electrode and the second contact portion, and a second floating electrode formed on the channel insulating layer and intersecting the second input electrode and the second contact portion.

[0020] The liquid crystal display is manufactured by a method comprising: forming a plurality of color filters on an insulating substrate; forming an inter-insulating layer on the color filters; forming a plurality of first and second gate lines and pixel electrodes on the inter-insulating layer; forming a channel insulating layer on the first and second gate lines and pixel electrodes; and forming a plurality of first and second floating electrodes on the channel insulating layer.

[0021] The manufacturing method of a liquid crystal display may further comprise forming a black matrix before the step of forming color filters.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] Preferred embodiments of the present invention can be understood in more detail from the following descriptions taken in conjunction with the accompanying drawings, in which:

[0023] **FIG. 1** is a perspective view of a liquid crystal display according to an embodiment of the present invention;

[0024] **FIG. 2** is a layout view of a liquid crystal display according to an embodiment of the present invention;

[0025] **FIG. 3** is a sectional view of the liquid crystal display taken along the line III-III' of **FIG. 2**; and

[0026] **FIG. 4** is a sectional view of a liquid crystal display according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0027] Preferred embodiments of the present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. The present invention may, however, be embodied in different forms and should not be construed as being limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

[0028] In the drawings, the thickness of layers, films, and regions are exaggerated for clarity. Like numerals refer to like elements throughout. 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.

[0029] **FIG. 1** is a perspective view of a liquid crystal display according to an embodiment of the present invention.

[0030] As shown in **FIG. 1**, the liquid crystal display has a lower panel (a thin film diode array panel) **100**, an upper panel (a color filter array panel) **200** facing the lower panel **100**, and a liquid crystal layer **3** interposed between the two panels **100** and **200** and having liquid crystal molecules aligned in a horizontal direction with respect to the surfaces of the panels **100** and **200**.

[0031] The lower panel **100** has a plurality of red, green, and blue color filters **230**, and a plurality of pixel electrodes **190** which respectively correspond with the red, green, and blue color filters **230**. White pixel areas on which no color filter is formed may also be included. The lower panel **100** has a plurality of pairs of gate lines **121** and **122** transmitting signals having opposite polarities, and a plurality of MIM diodes **D1** and **D2** that are switching elements.

[0032] The upper panel **200** includes a plurality of data electrode lines **230**, forming an electric field along with the pixel electrodes **190** for driving liquid crystal molecules and defining pixel regions by intersecting the pairs of gate lines **121** and **122**.

[0033] Henceforth, a structure of a liquid crystal display according to an embodiment of the present invention will be described in detail.

[0034] **FIG. 2** is a layout view of a liquid crystal display according to an embodiment of the present invention.

[0035] Referring to **FIG. 2**, the liquid crystal display has a plurality of red, green, and blue pixels **R**, **G**, and **B** that are arranged in a matrix form. A pixel column consists of the same colored pixels. For example, red pixels **R**, green pixels **G**, and blue pixels **B** are sequentially and alternately arranged along a pixel row, but a pixel column only includes one color of the red, green, and blue pixels. That is, each color of the red, green, and blue pixels **R**, **G**, and **B** forms a stripe. However, the arrangement of the red, green, and blue pixels **R**, **G**, and **B** may have various modifications. White pixels may be included.

[0036] In the above described LCD, a set of the red, green, and blue pixels forms a dot which is a basic unit of images. The size of each pixel is uniform.

[0037] Henceforth, a structure of a thin film diode array panel **100** according to an embodiment of the present invention will be described in detail.

[0038] **FIG. 3** is a sectional view of the liquid crystal display taken along the line III-III' of **FIG. 2**;

[0039] As shown in **FIGS. 2 and 3**, a black matrix **220** formed of a chromium (Cr) single layer or Cr and chromium oxide (CrO₂) double layers is formed on the insulating substrate **110**. The black matrix **220** may be formed of an organic material. When the black matrix **220** is made of an organic material, the stress that the substrate **210** receives is reduced. An organic black matrix is useful for a flexible display.

[0040] The black matrix **220** is disposed under the MIM diodes and the boundary of the pixels.

[0041] The red, green, and blue color filters **230** are formed on the black matrix **220** to form stripes.

[0042] An inter-insulating layer **160** made of an organic material is formed on the color filters **230**. The inter-insulating layer **160** may be made of an inorganic material such as silicon nitride or silicon oxide. However, it is preferable for flattening that the inter-insulating layer **160** is made of an organic material.

[0043] A plurality of pixel electrodes **190** made of a transparent conductor such as indium tin oxide (ITO) and indium zinc oxide (IZO) are formed on the inter-insulating layer **160**. Each pixel electrode **190** is electrically connected to the first and second gate lines **121** and **122** which extend in a transverse direction through MIM diodes **D1** and **D2**.

[0044] The pixel electrodes **190** may be made of a conductor having good light reflectivity such as aluminum (Al) and silver (Ag) for a reflection type of LCD.

[0045] In more detail, each pixel electrode **190** is formed in a pixel region on the inter-insulating layer **160**. The pixel electrode **190** includes a first contact portion **191** and a second contact portion **192**.

[0046] The first and second gate lines **121** and **122** transmitting scanning signals are respectively disposed at upper and lower sides of the pixel region on the inter-insulating layer **160**. First and second input electrodes **123** and **124** respectively connected to the first and second gate lines **121** and **122** extend toward each other. The first and second input

electrodes **123** and **124** are respectively adjacent to the first and second contact portions **191** and **192** of the pixel electrode **190** with a predetermined gap therebetween.

[0047] It is preferable that the first and second gate lines **121** and **122** are made of the same material as the pixel electrode **190**, for simplifying manufacturing processes. However, when another purpose such as reducing resistance is more important, the first and second gate lines **121** and **122** may be made of a different material from the pixel electrode **190**. In this case, the first and second gate lines **121** and **122** may be made of one of aluminum (Al), chromium (Cr), thallium (Ta), molybdenum (Mo), and their alloys.

[0048] A channel insulating layer **150** is formed on the first and second gate lines **121** and **122**. A channel insulating layer **150** is made of silicon nitride (SiN_x). The channel insulating layer **150** may be regionally formed on the first input electrode **123** and the first contact portion **191** and the second input electrode **124** and the second contact portion **192**.

[0049] A first floating electrodes **141** is formed on the channel insulating layer **150** to intersect the first input electrode **123** and the first contact portion **191**. A second floating electrode **142** is formed on the channel insulating layer **150** to intersect the second input electrode **124** and the second contact portion **192**.

[0050] The upper panel **200** includes an insulating substrate **210** and a plurality of data electrode lines **270** formed on the insulating substrate **210**. The data electrode line **270** is made of a transparent conductor such as ITO and IZO. The data electrode line **270** overlaps the pixel electrodes **190** and a liquid crystal layer **3** is interposed between the data electrode line **270** and the pixel electrodes **190** to form liquid crystal capacitors.

[0051] The first floating electrode **141**, the first input electrode **123**, the first contact portion **191**, and the channel insulating layer **150** interposed between them form a first MIM diode D1. The second floating electrode **142**, the second input electrode **124**, the second contact portion **192**, and the channel insulating layer **150** interposed between them form a second MIM diode D2.

[0052] Due to the nonlinearity of voltage-current characteristics of the channel insulating layer **150**, the first and second MIM diodes D1 and D2 permit the pixel electrode **190** to be charged only when a voltage over the critical voltage of the channel insulating layer **150** is applied. On the contrary, when no signal voltage is applied to the MIM diodes D1 and D2, the charged voltage is preserved in a liquid crystal capacitor formed between the pixel electrode **190** and a data electrode line **270**, since the channel of the MIM diodes M1 and M2 are closed.

[0053] When an LCD is manufactured to have the above-described structure, even though a back light is disposed under the thin film diode panel **100**, the light of the back light does not reach the channel insulating layer **150** due to interception of the black matrix **220**. As a result, off current (loff) of the MIM diodes is not increased.

[0054] Since the color filters **230** are formed on the same substrate **110** with the pixel electrode **190**, the alignment step for assembling the upper and lower panels **100** and **200** is easy. Further, the width of the black matrix **220** that has

redundancy for covering misalignment of the upper and lower panels **100** and **200** can be reduced to enhance the aperture ratio of an LCD.

[0055] Henceforth, a manufacturing method of a thin film diode array panel according to an embodiment of the present invention will be described with reference to FIG. 3.

[0056] One of the Cr single layer, the Cr and CrO₂ double layers, and a black organic thin film is deposited on the insulating substrate **110** and is photo-etched to form the black matrix **220**.

[0057] When the black matrix **220** is made of a photosensitive organic material, the black matrix **220** may be formed by an exposure and development process.

[0058] Next, a photoresist including red pigments is coated, exposed to a light, and developed to form the red color filter **230**. The same processes are performed to photoresists respectively including green and blue pigments to form the green and blue color filters.

[0059] One of an organic insulating material, silicon nitride, and silicon oxide is deposited to form the inter-insulating layer **160**.

[0060] A transparent conductive layer such as indium tin oxide (ITO) and indium zinc oxide (IZO) is deposited on the inter-insulating layer **160** and is photo-etched to form the first and second gate lines **121** and **122** and the pixel electrode **190**.

[0061] When the pixel electrode **190** is formed of a different material from the first and second gate lines **121** and **122**, the pixel electrode **190** is patterned by a separate photo-etching process from that of the first and second gate lines **121** and **122**.

[0062] When a thin film diode array panel for a reflection type of LCD is manufactured, the first and second gate lines **121** and **122** and the pixel electrode **190** may be formed of a conductor having good light reflectivity such as aluminum (Al) or silver (Ag).

[0063] Silicon nitride is deposited on the first and second gate lines **121** and **122** and the pixel electrode **190** to form the channel insulating layer **150**. The channel insulating layer **150** may be photo-etched to form regional channel insulating layers disposed on the first input electrode **123** and the first contact portion **191** and the second input electrode **124** and the second contact portion **192**.

[0064] A metal such as Mo is deposited and photo-etched to form the first and second floating electrodes **141** and **142**.

[0065] Henceforth, another embodiment of the present invention will be described.

[0066] FIG. 4 is a sectional view of a liquid crystal display according to another embodiment of the present invention.

[0067] The LCD of FIG. 4 will be compared with the LCD of FIGS. 2 and 3, and only differences that are peculiar to the LCD of FIG. 4 will be described.

[0068] The LCD of FIG. 4 has color filters **230** formed directly on an insulating substrate **110** without a black matrix.

[0069] The color filters **230** overlap each other at adjacent parts thereof. Almost no light transmits through the over-

lapping areas of the color filters **230** due to light absorption of the color filters **230**. Accordingly, the overlapping areas of the color filters **230** play a role of a black matrix.

[0070] The most peculiar thing of the LCD of **FIG. 4** is that the black matrix **220** of the LCD of **FIGS. 2 and 3** is replaced with the overlapping area of the color filters **230**.

[0071] The thin film transistor array panel of **FIG. 4** may be manufactured by omitting formation of the black matrix from the manufacturing method of the thin film diode array panel of **FIGS. 2 and 3**, and forming color filters **230** to partially overlap each other.

[0072] When a thin film diode panel for an LCD is manufactured to have the structure of **FIG. 4**, the process of forming the black matrix can be omitted to simplify the manufacturing method.

[0073] When an LCD is manufactured to have the above-described structures, even though a back light is disposed under the thin film diode panel **100**, the light of the back light does not reach the channel insulating layer **150** due to interception of the black matrix **220** or the overlapping areas of the color filters **230**. As a result, off current (loff) of the MIM diodes is not increased.

[0074] Since the color filters **230** are formed on the same substrate **110** as the pixel electrode **190**, work for aligning the upper and lower panels **100** and **200** can be saved.

[0075] Further, the width of the black matrix **220** that has redundancy for covering misalignment of the upper and lower panel **100** and **200** can be reduced to enhance the aperture ratio of an LCD.

[0076] Although illustrative embodiments have been described herein with reference to the accompanying drawings, it is to be understood that the present invention is not limited to those precise embodiments, and that various changes and modifications may be affected therein by one of ordinary skill in the related art without departing from the scope or spirit of the invention. All such changes and modifications are intended to be included within the scope of the invention as defined by the appended claims.

What is claimed is:

1. A liquid crystal display comprising:

- an insulating substrate;
- a plurality of color filters formed on the insulating substrate;
- a plurality of first and second gate lines formed on the color filters;
- a plurality of pixel electrodes formed on the color filters;
- a plurality of first MIM diodes formed on the color filters and connecting the first gate lines and the pixel electrodes; and
- a plurality of second MIM diodes formed on the color filters and connecting the second gate lines and the pixel electrodes.

2. The liquid crystal display of claim 1, further comprising a black matrix formed between the insulating substrate and the color filters.

3. The liquid crystal display of claim 2, wherein the black matrix includes at least a portion overlapping the first and second MIM diodes.

4. The liquid crystal display of claim 2, wherein the black matrix is made of a material mainly including an organic material.

5. The liquid crystal display of claim 1, wherein the color filters include red, green, and blue color filters that overlap each other in part.

6. The liquid crystal display of claim 5, wherein the overlapping area of the color filters includes at least a portion overlapping the first and second MIM diodes.

7. The liquid crystal display of claim 1, further comprising an inter-insulating layer formed between the first and second gate lines and the pixel electrodes.

8. The liquid crystal display of claim 7, wherein the inter-insulating layer is made of an organic insulating material.

9. The liquid crystal display of claim 1, wherein the first MIM diode includes a first input electrode connected to the first gate line, a first contact portion connected to the pixel electrode, a channel insulating layer formed on the first input electrode and the first contact portion, and a first floating electrode formed on the channel insulating layer and intersecting the first input electrode and the first contact portion; and

the second MIM diode includes a second input electrode connected to the second gate line, a second contact portion connected to the pixel electrode, the channel insulating layer formed on the second input electrode and the second contact portion, and a second floating electrode formed on the channel insulating layer and intersecting the second input electrode and the second contact portion.

10. A manufacturing method of a liquid crystal display, comprising:

- forming a plurality of color filters on an insulating substrate;
- forming an inter-insulating layer on the color filters;
- forming a plurality of first and second gate lines and pixel electrodes on the inter-insulating layer;
- forming a channel insulating layer on the first and second gate lines and pixel electrodes; and
- forming a plurality of first and second floating electrodes on the channel insulating layer.

11. The manufacturing method of the liquid crystal display of claim 10, further comprising forming a black matrix before the step of forming the color filters.

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专利名称(译)	薄膜二极管面板及其制造方法		
公开(公告)号	US20050117083A1	公开(公告)日	2005-06-02
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摘要(译)

本发明提供一种液晶显示器，包括：绝缘基板；多个滤色器形成在绝缘基板上；多个第一和第二栅极线形成在滤色器上；多个像素电极形成在滤色器上；多个第一MIM二极管，形成在滤色器上并连接第一栅极线和像素电极；多个第二MIM二极管形成在滤色器上并连接第二栅极线和像素电极。

