US 20050259207A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2005/0259207 A1

Yang et al. (43) Pub. Date: Nov. 24, 2005

(54) REFLECTIVE TYPE FRINGE FIELD SWITCHING LIQUID CRYSTAL DISPLAY

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(21) Appl. No.: **11/135,834**

(22) Filed: **May 23, 2005**

(30) **Foreign Application Priority Data**

May 21, 2004 (TW)..... 93114424

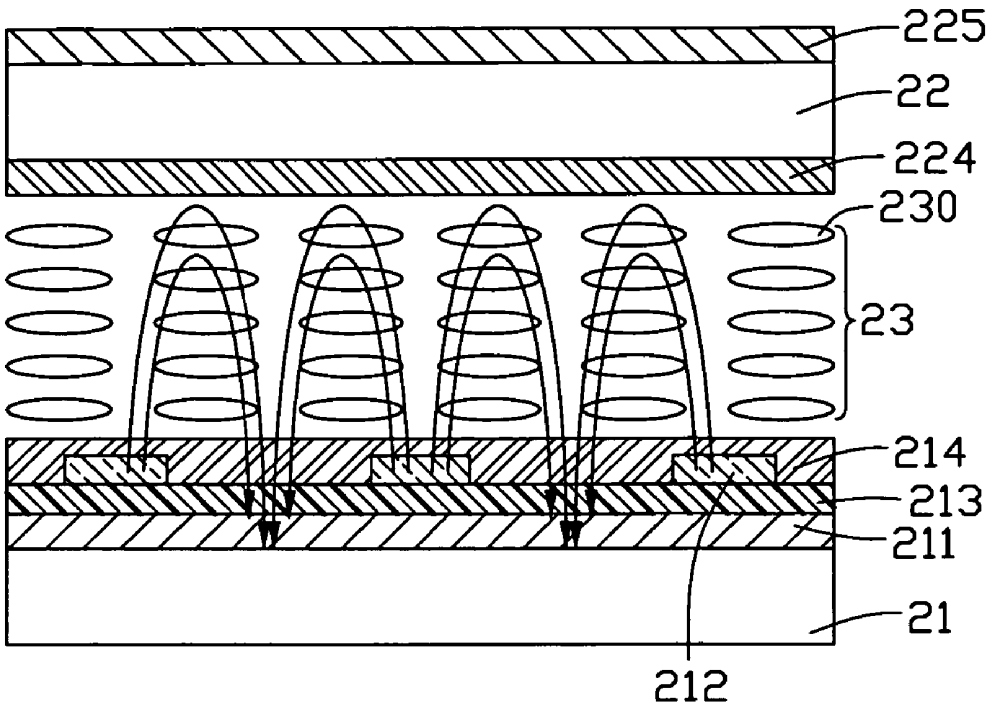
Publication Classification

(51) **Int. Cl.**[7] **G02F 1/1343**; G02F 1/1335

(52) **U.S. Cl.** **349/141**; 349/113

(57) **ABSTRACT**

A reflective type fringe field switching liquid crystal display (FFS LCD) (**2**) includes an upper and a lower substrates (**21, 22**) facing each other, and a liquid crystal layer (**23**) interposed between the upper and lower substrates. A plurality of gate lines (**216**) and a plurality of data lines (**218**) are associated with one of the upper and lower substrates, thereby defining a plurality of pixel regions. A common electrode (**211**) and a plurality of pixel electrodes (**212**) overlying the common electrode are disposed in the pixel regions in order to form at least one fringe electric field. At least one of the pixel electrodes in each pixel region has a bent portion in order to establish an electric field in at least two directions between the pixel electrodes and the common electrode in the pixel region. Accordingly, the reflective FFS LCD has a high quality, reliable display.



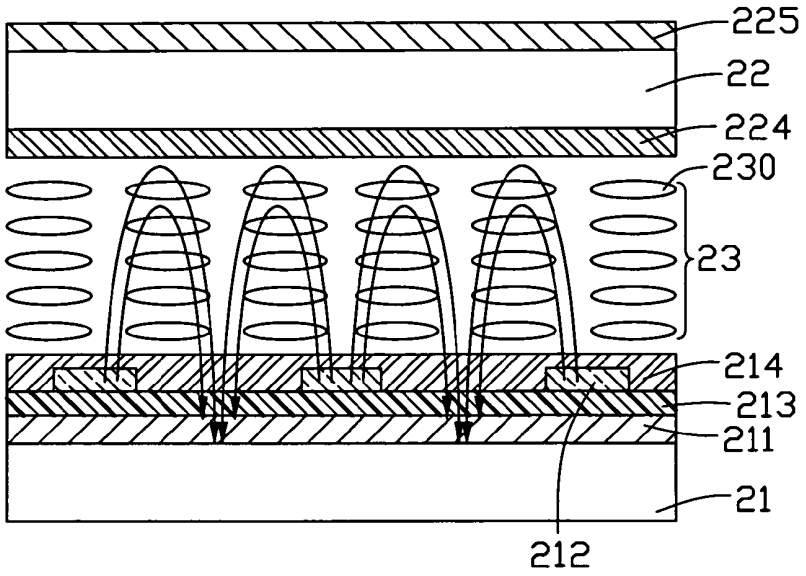


FIG. 1

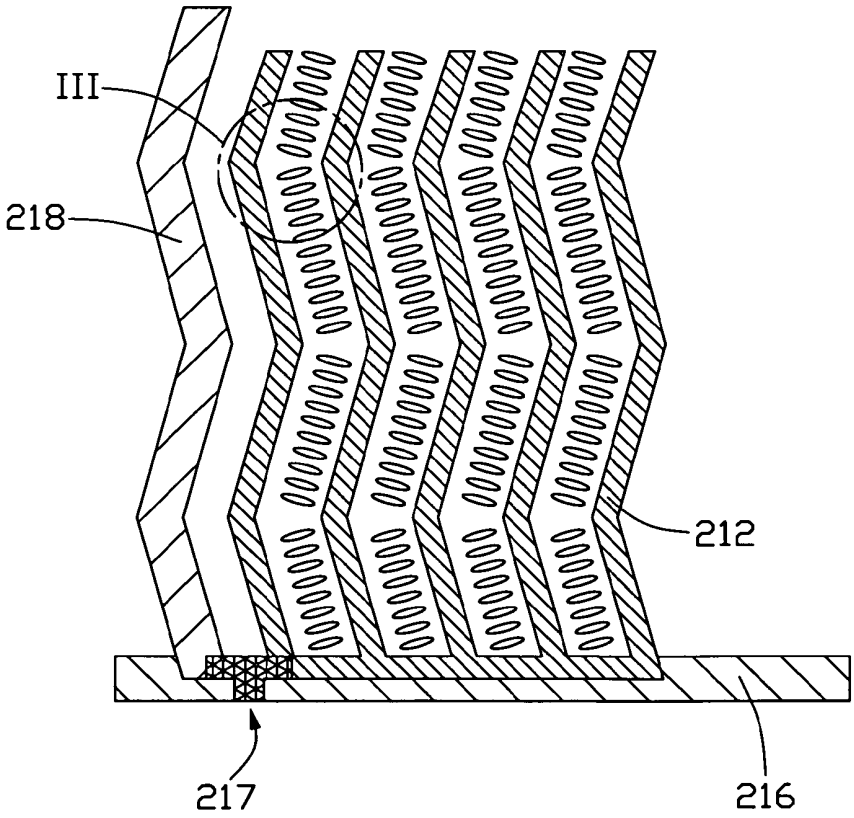


FIG. 2

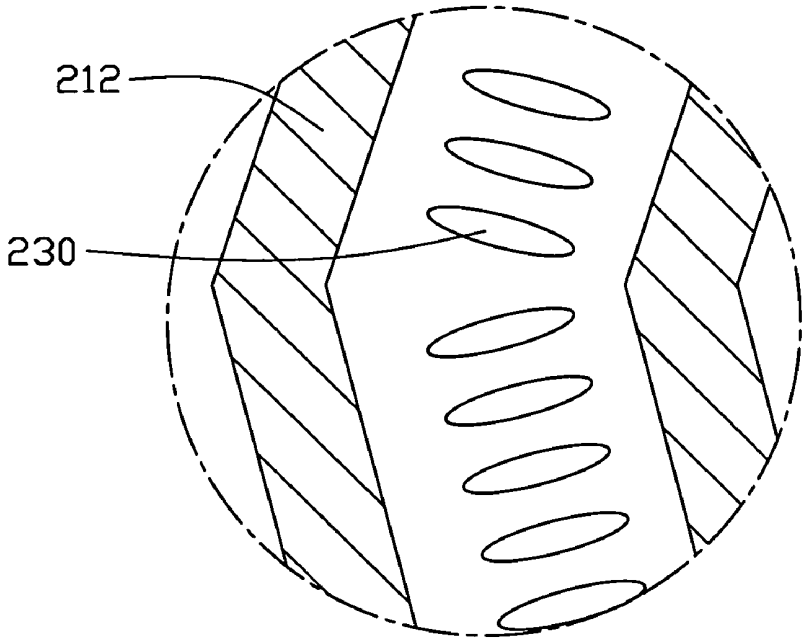


FIG. 3

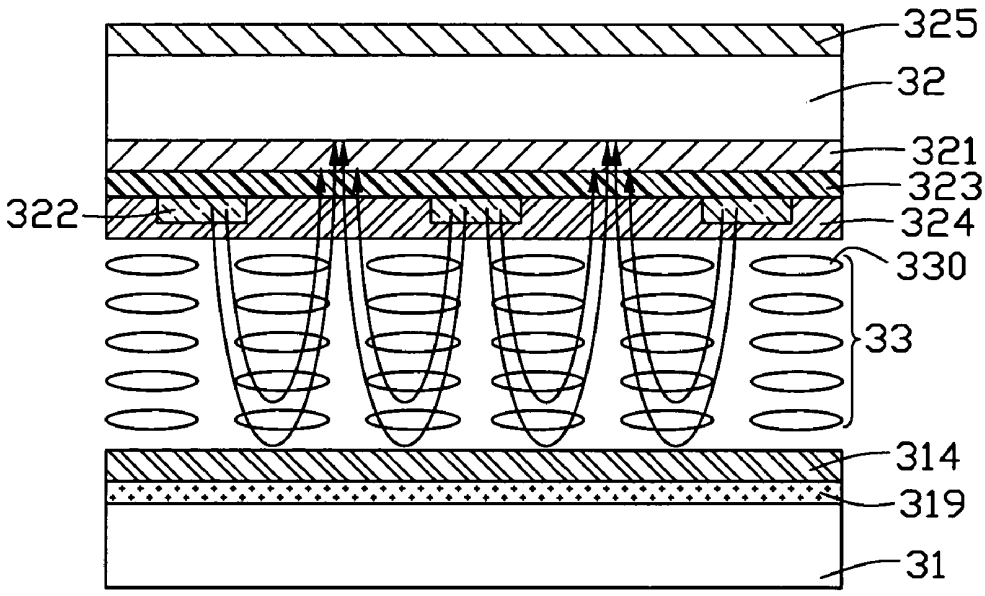


FIG. 4

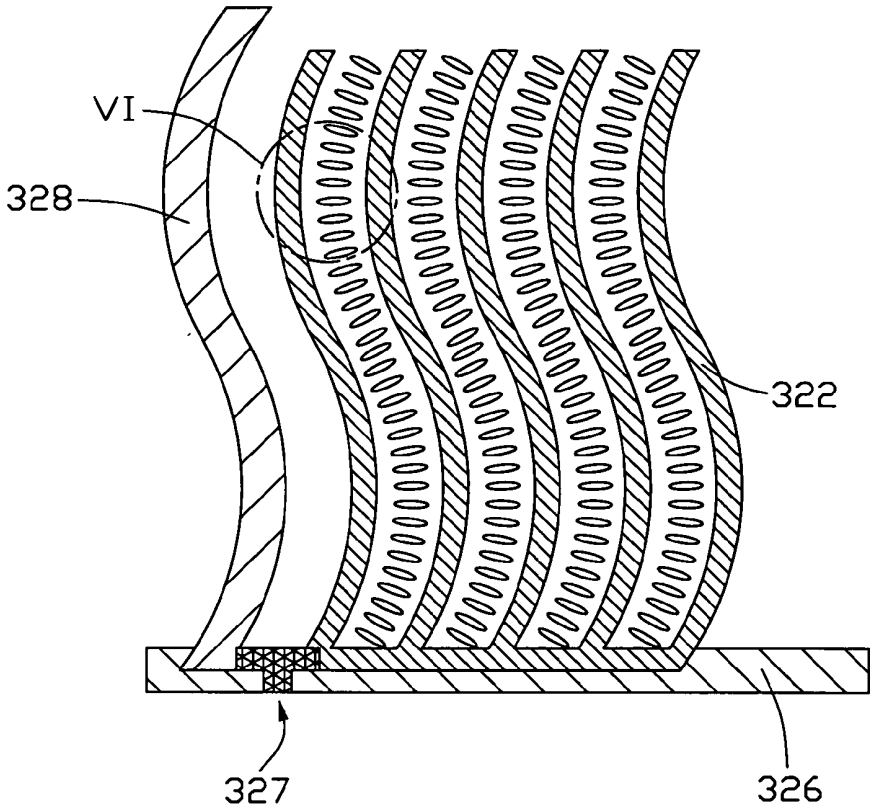


FIG. 5

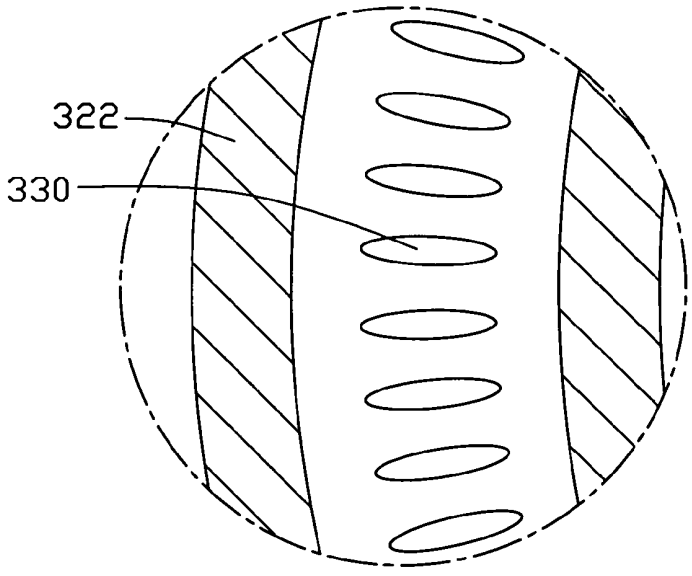


FIG. 6

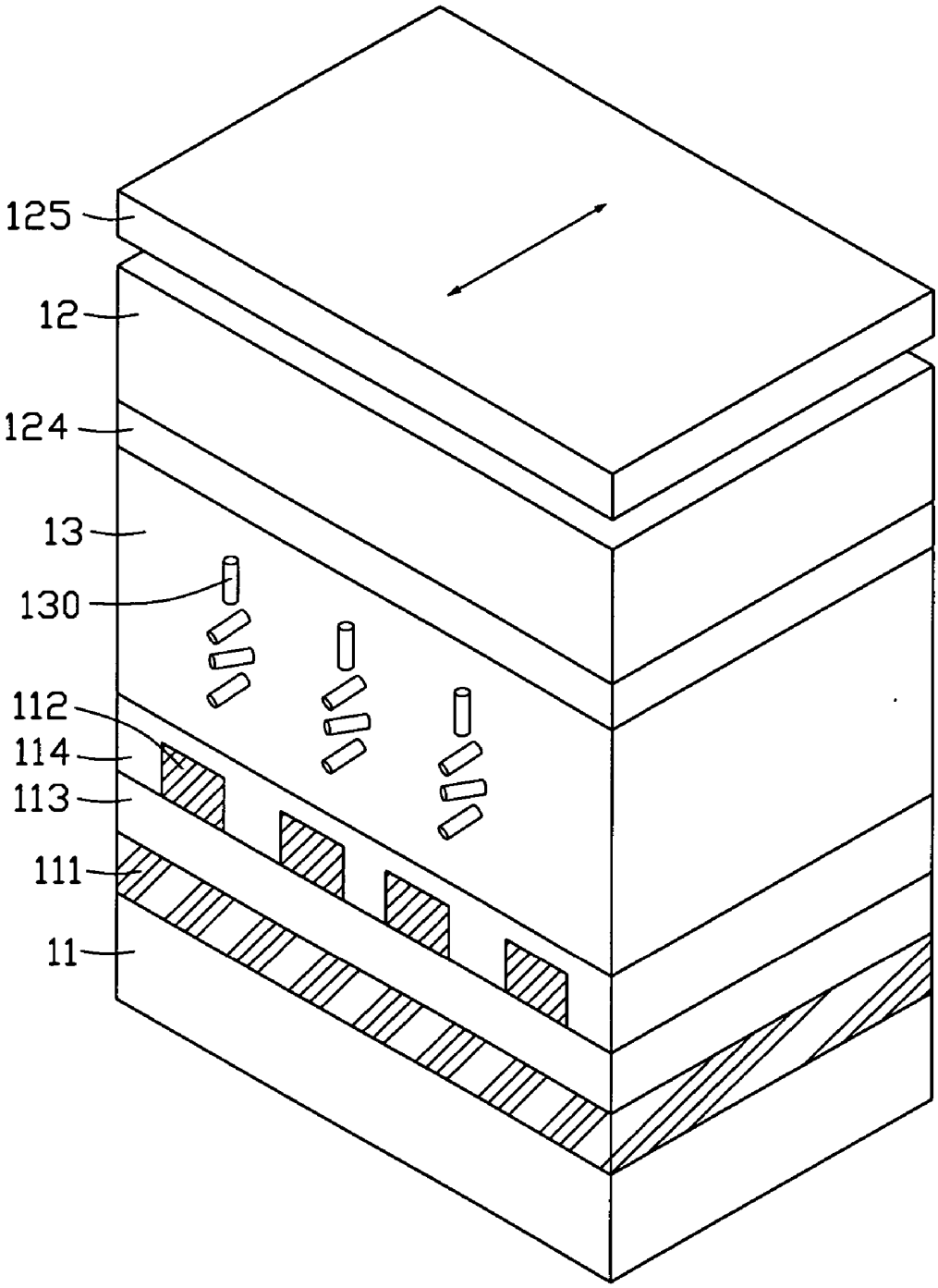


FIG. 7
(PRIOR ART)

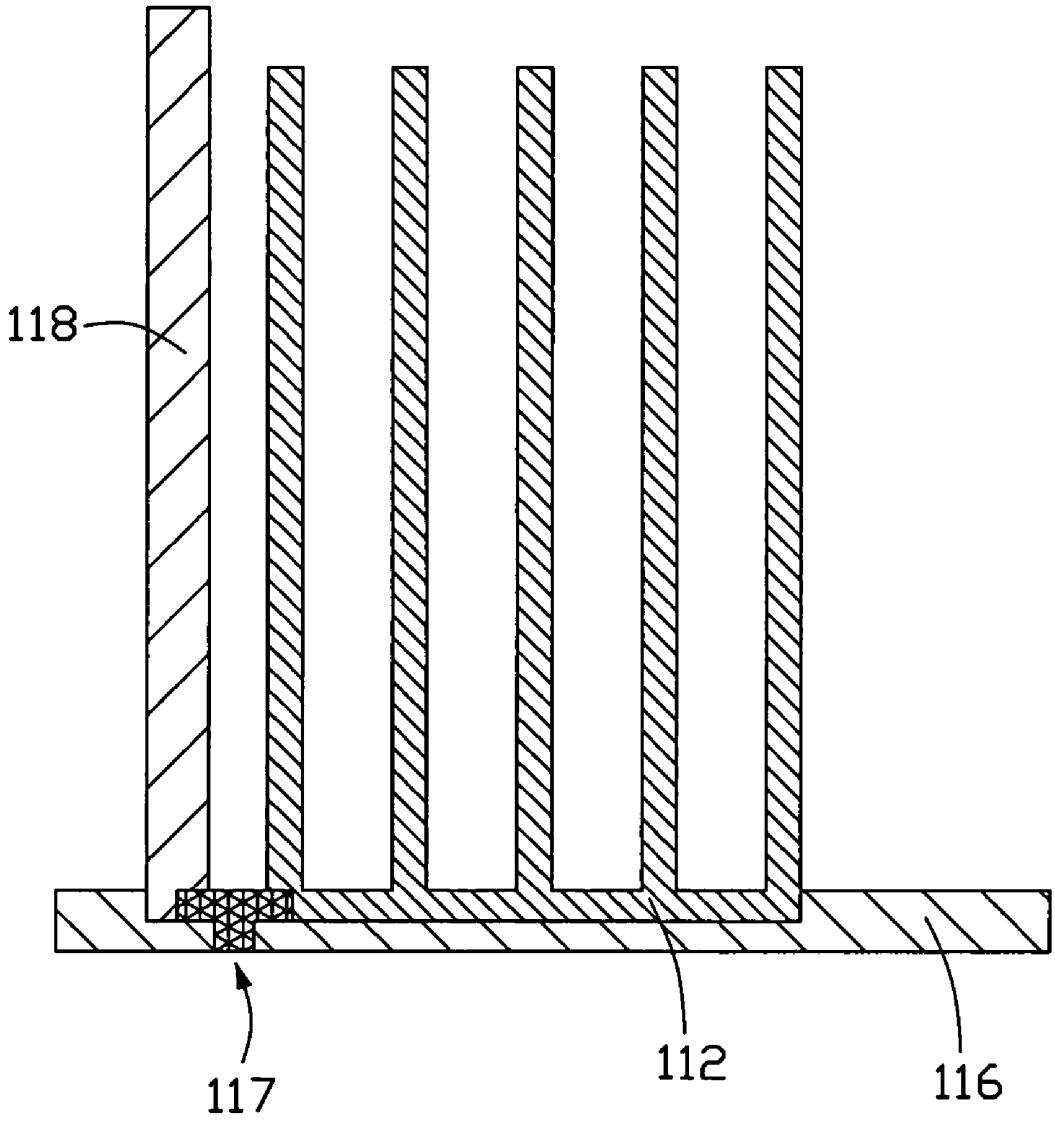


FIG. 8
(PRIOR ART)

REFLECTIVE TYPE FRINGE FIELD SWITCHING LIQUID CRYSTAL DISPLAY

FIELD OF THE INVENTION

[0001] The present invention relates to reflective type liquid crystal displays (LCDs), and more particularly to a reflective type fringe field switching (FFS) LCD.

BACKGROUND

[0002] An LCD utilizes the optical and electrical anisotropy of liquid crystal molecules thereof in order to produce an image. The liquid crystal molecules have a particular passive orientation when no voltage is applied thereto. However, when a voltage is applied and the LCD is in a driven state, the liquid crystal molecules change their orientation according to the strength and direction of the driving electric field. A polarization state of incident light changes when the light transmits through the liquid crystal molecules, due to the optical anisotropy of the liquid crystal molecules. The extent of the change depends on the orientation of the liquid crystal molecules. Thus, by properly controlling the driving electric field, an orientation of the liquid crystal molecules is changed and a desired image can be produced.

[0003] The twisted nematic (TN) mode LCD was the first main type of LCD developed. Even though TN mode LCDs have been put into use in many applications, they have an inherent drawback that cannot be eliminated; namely, a very narrow viewing angle. By adding compensation films on TN mode LCDs, this problem can be mitigated to some extent. However, the cost of the TN mode LCD is increased. Therefore, an LCD with a totally different driving means has been developed. The LCD is called a fringe field switching (FFS) LCD. The FFS LCD has pixel and common electrodes usually arranged on two different layers of a same substrate. The distance between the electrodes is narrow, in order to form a fringe electric field about the electrodes.

[0004] Usually an LCD needs a planar light source, such as a backlight module, to display images. This kind of LCD is called a transmissive type LCD. In general, the backlight module is the main power consuming component of the transmissive type LCD. In order to reduce power consumption, reflective type LCDs have been developed. A reflective type LCD generally utilizes natural ambient light beams to provide a planar light source.

[0005] **FIG. 7** is a perspective view showing orientations of liquid crystal molecules **130** in a conventional reflective type FFS LCD **1** when a voltage is applied thereto. The reflective FFS LCD **1** includes a lower substrate **11**, an upper substrate **12** facing the lower substrate **11**, and a liquid crystal layer **13** interposed between the substrates **11**, **12**. A common electrode **111**, an insulating layer **113**, a plurality of parallel pixel electrodes **112**, and a lower alignment layer **114** are sequentially arranged on an inner surface of the lower substrate **11**. An upper alignment layer **124** is arranged on an inner surface of the upper substrate **12**. An upper polarizer **125** is arranged on an outer surface of the upper substrate **12**.

[0006] As shown in **FIG. 7**, when a voltage is applied to the FFS LCD **1**, the pixel electrodes **112** and the common electrode **111** form a fringe electric field to drive the liquid crystal molecules **130** of the liquid crystal layer **13**, and to thus make the FFS LCD **1** display desired images.

[0007] Also referring to **FIG. 8**, this is a schematic, cross-sectional top view of pixel electrodes **112** and other components of the FFS LCD **1**. A gate line **116** and a data line **118** are arranged on the lower substrate **11**, and cross each other. A thin film transistor (TFT) **117** is disposed in the vicinity of the crossing of the gate line **116** and the data line **118**. The gate line **116** is utilized to control the electrical switching of the TFT **117**. The data line **118** provides electrical signals to the pixel electrodes **112**. Each pixel electrode **112** is a linear electrode that is aligned along a single direction.

[0008] Because each pixel electrode **112** is a linear electrode that is aligned along a single direction, when a voltage is applied, a single direction electric field is established between the pixel and common electrodes **112** and **111**. The liquid crystal molecules **130** are twisted so as to align according to the electric field. That is, long axes of the liquid crystal molecules **130** are oriented in a single direction only. This means that an associated display screen exhibits color shift when the display screen is obliquely viewed while displaying white.

[0009] What is needed, therefore, is a reflective type FFS LCD which has better viewing angle characteristics.

SUMMARY

[0010] In a preferred embodiment, a reflective type fringe field switching liquid crystal display comprises an upper and a lower substrates facing each other, and a liquid crystal layer interposed between the upper and lower substrates. A plurality of gate lines and a plurality of data lines are associated with one of the upper and lower substrates, thereby defining a plurality of pixel regions. A common electrode and a plurality of pixel electrodes overlying the common electrode are disposed in the pixel regions in order to form at least one fringe electric field. At least one of the pixel electrodes in each pixel region has a bent portion in order to establish an electric field in at least two directions between the pixel electrodes and the common electrode in the pixel region.

[0011] In a second embodiment, a reflective type FFS LCD comprises an upper and lower substrates facing each other, and a liquid crystal layer interposed between the first and second substrates. A common electrode and a plurality of pixel electrodes overlying the common electrode are disposed on one of the upper and lower substrates in order to form one or more fringe electric fields. One of the pixel electrodes has a bent portion.

[0012] Thus, in each pixel region of the reflective FFS LCD, an electric field in at least two directions is generated between the pixel and common electrodes so as to form at least two domains. Accordingly, the reflective FFS LCD has a high quality, reliable display.

[0013] Other objects, advantages, and novel features will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] **FIG. 1** is a schematic, side cross-sectional view of part of a reflective FFS LCD according to a first embodiment of the present invention;

[0015] **FIG. 2** is a schematic, cross-sectional top elevation of parts of a pixel region of the reflective FFS LCD of **FIG. 1**, showing a configuration of pixel electrodes;

[0016] **FIG. 3** is an enlarged view of a circled portion III of **FIG. 2**;

[0017] **FIG. 4** is a schematic, side cross-sectional view of part of a reflective FFS LCD according to a second embodiment of the present invention;

[0018] **FIG. 5** is a schematic, cross-sectional top elevation of parts of a pixel region of the reflective FFS LCD of **FIG. 4**, showing a configuration of pixel electrodes;

[0019] **FIG. 6** is an enlarged view of a circled portion VI of **FIG. 5**;

[0020] **FIG. 7** is a perspective view of a conventional reflective FFS LCD; and;

[0021] **FIG. 8** is a schematic, cross-sectional top elevation of parts of a pixel region of the reflective FFS LCD of **FIG. 7**, showing a configuration of pixel electrodes.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0022] Referring to **FIG. 1**, a reflective FFS LCD **2** according to a first embodiment of the present invention includes a lower substrate **21**, an upper substrate **22** facing the lower substrate **21**, and a liquid crystal layer **23** interposed between the substrates **21**, **22**. A common electrode **211** made of reflective electrically conductive material, an insulating layer **213**, a plurality of parallel pixel electrodes **212**, and a lower alignment layer **214** are sequentially arranged on an inner surface of the lower substrate **21**. An upper alignment layer **224** is arranged on an inner surface of the upper substrate **22**. An upper polarizer **225** is arranged on an outer surface of the upper substrate **22**.

[0023] Referring to **FIG. 2** and **FIG. 3**, a gate line **216** and a data line **218** are arranged on the lower substrate **21**, and cross each other. A thin film transistor (TFT) **217** is disposed in the vicinity of the crossing of the gate line **216** and the data line **218**. The gate line **216** is utilized to control the electrical switching of the TFT **217**. The data line **218** provides electrical signals to the pixel electrodes **212**. Each pixel electrode **212** has a generally zigzagged configuration, with the pixel electrodes **212** being parallel to each other. The data line **218** may also have a zigzagged configuration, whereby the data line **218** is parallel to the pixel electrodes **212**.

[0024] When a voltage is applied to the reflective FFS LCD **2**, the reflective FFS LCD **100** is in an on state. A fringe electric field distributing in at least two directions is generated between the pixel electrodes **212** and the common electrode **211** so as to form at least two domains. Liquid crystal molecules **230** are twisted so as to align according to the fringe electric field. That is, long axes of the liquid crystal molecules **230** are oriented in at least two directions. Accordingly, the FFS LCD **2** has a high quality, reliable display.

[0025] In addition, in the first embodiment, the common electrode **211** may be a transparent electrode. And a reflective layer may be interposed between the lower substrate **21** and the common electrode **211**. Alternatively, the reflective layer may be also disposed on the outer surface of the lower substrate **21**. Furthermore, in order to improve the reflective effect, a plurality of reflective bumps may be arranged on an inner surface of the reflective layer or the common electrode **211** made of reflective material.

[0026] Referring to **FIG. 4**, a reflective FFS LCD **3** according to a second embodiment of the present invention includes a lower substrate **31**, an upper substrate **32** facing the lower substrate **31**, and a liquid crystal layer **33** interposed between the substrates **31**, **32**. A common electrode **321**, an insulating layer **323**, a plurality of parallel pixel electrodes **322**, and an upper alignment layer **324** are sequentially arranged on an inner surface of the upper substrate **31**. A lower alignment layer **314** and a reflective layer **319** are sequentially arranged on an inner surface of the lower substrate **31**. An upper polarizer **325** is arranged on an outer surface of the upper substrate **32**.

[0027] Referring to **FIG. 5** and **FIG. 6**, a gate line **326** and a data line **328** are arranged on the upper substrate **32**, and cross each other. A thin film transistor (TFT) **327** is disposed in the vicinity of the crossing of the gate line **326** and the data line **328**. The gate line **326** is utilized to control the electrical switching of the TFT **327**. The data line **328** provides electrical signals to the pixel electrodes **322**. Each pixel electrode **322** has a wave-shaped configuration, with the pixel electrodes **322** being parallel to each other. The data line **328** may also have a wave-shaped configuration, whereby the data line **328** is parallel to the pixel electrodes **322**.

[0028] When a voltage is applied to the reflective FFS LCD **3**, the reflective FFS LCD **3** is in an on state. A fringe electric field distributing in multi-directions is generated between the pixel electrodes **322** and the common electrode **321** so as to form multi-domains. Liquid crystal molecules **330** are twisted so as to align according to the fringe electric field. That is, long axes of the liquid crystal molecules **330** are oriented in multi directions. Accordingly, the reflective FFS LCD **3** has a high quality, reliable display.

[0029] In summary, all the above-described configurations of an FFS LCD provide the following structure, function and advantages. In each pixel region, electric fields in at least two directions are generated between the pixel and common electrodes so as to form at least two domains. Accordingly, the FFS LCD has a high quality, reliable display.

[0030] It is to be understood, however, that even though numerous characteristics and advantages of embodiments of the present invention have been set forth in the foregoing description, together with details of the structure and function of the embodiments, the disclosure is illustrative only, and changes may be made in detail to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. A reflective type fringe field switching liquid crystal display, comprising:

an upper and a lower substrates facing each other;

a liquid crystal layer interposed between the upper and lower substrates;

a plurality of gate lines and a plurality of data lines associated with one of the upper and lower substrates, thereby defining a plurality of pixel regions; and

a common electrode and a plurality of pixel electrodes overlying the common electrode disposed in the pixel regions in order to form at least one fringe electric field, at least one of the pixel electrodes in each pixel region having a bent portion in order to establish an electric field in at least two directions between the pixel electrodes and the common electrode in the pixel region.

2. The reflective type fringe field switching liquid crystal display of claim 1, wherein the bent portion of each of the pixel electrodes has a generally zigzagged configuration.

3. The reflective type fringe field switching liquid crystal display of claim 1, wherein the bent portion of each of the pixel electrodes is wave-shaped.

4. The reflective type fringe field switching liquid crystal display of claim 1, wherein the gate lines and the data lines are associated with the lower substrate.

5. The reflective type fringe field switching liquid crystal display of claim 4, wherein the common electrode is made of reflective material.

6. The reflective type fringe field switching liquid crystal display of claim 5, wherein the common electrode has a plurality of reflective bumps disposed at an inner surface thereof.

7. The reflective type fringe field switching liquid crystal display of claim 4, further comprising a reflective layer disposed between the lower substrate and the common electrode.

8. The reflective type fringe field switching liquid crystal display of claim 7, wherein the reflective layer has a plurality of reflective bumps disposed at an inner surface thereof.

9. The reflective type fringe field switching liquid crystal display of claim 1, wherein the gate lines and the data lines are associated with the upper substrate.

10. The reflective type fringe field switching liquid crystal display of claim 9, further comprising a reflective layer disposed between the lower substrate and the liquid crystal layer.

11. The reflective type fringe field switching liquid crystal display of claim 10, wherein the reflective layer has a plurality of reflective bumps disposed at an inner surface thereof.

12. A reflective type fringe field switching liquid crystal display, comprising:

a first and a second substrates facing each other;

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

a common electrode and a plurality of pixel electrodes overlying the common electrode disposed at one of the first and second substrates in order to form one or more fringe electric fields, at least one of the pixel electrodes having a bent portion.

13. The reflective type fringe field switching liquid crystal display of claim 12, wherein the bent portion has a generally zigzagged configuration.

14. The reflective type fringe field switching liquid crystal display of claim 12, wherein the bent portion is wave-shaped.

15. The reflective type fringe field switching liquid crystal display of claim 12, wherein the common electrode is disposed at the second substrate.

16. The reflective type fringe field switching liquid crystal display of claim 15, wherein the common electrode is made of reflective material.

17. The reflective type fringe field switching liquid crystal display of claim 16, wherein the common electrode has a plurality of reflective bumps disposed at an inner surface thereof.

18. The reflective type fringe field switching liquid crystal display of claim 15, further comprising a reflective layer disposed between the second substrate and the common electrode.

19. The reflective type fringe field switching liquid crystal display of claim 18, wherein the reflective layer has a plurality of reflective bumps disposed at an inner surface thereof.

* * * * *

专利名称(译)	反射型边缘场切换液晶显示器		
公开(公告)号	US20050259207A1	公开(公告)日	2005-11-24
申请号	US11/135834	申请日	2005-05-23
[标]申请(专利权)人(译)	群创光电股份有限公司		
申请(专利权)人(译)	群创光电股份有限公司.		
当前申请(专利权)人(译)	群创光电		
[标]发明人	YANG CHIU LIEN PANG JIA PANG		
发明人	YANG, CHIU-LIEN PANG, JIA-PANG		
IPC分类号	G02F1/1335 G02F1/1343		
CPC分类号	G02F1/134363		
优先权	093114424 2004-05-21 TW		
外部链接	Espacenet USPTO		

摘要(译)

反射型边缘场切换液晶显示器（FFS LCD）（2）包括彼此面对的上基板和下基板（21,22），以及插入在上基板和下基板之间的液晶层（23）。多条栅极线（216）和多条数据线（218）与上基板和下基板中的一个相关联，从而限定多个像素区域。公共电极（211）和覆盖公共电极的多个像素电极（212）设置在像素区域中，以形成至少一个边缘电场。每个像素区域中的至少一个像素电极具有弯曲部分，以便在像素电极和像素区域中的公共电极之间的至少两个方向上建立电场。因此，反射FFS LCD具有高质量，可靠的显示。