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Chiu(54) **VERTICAL ALIGNMENT TYPE LIQUID CRYSTAL DISPLAYS****Publication Classification**(75) Inventor: **Chun-Chang Chiu**, Taoyuan County (TW)(51) **Int. Cl.**
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(52) **U.S. Cl.** **349/139; 349/130**

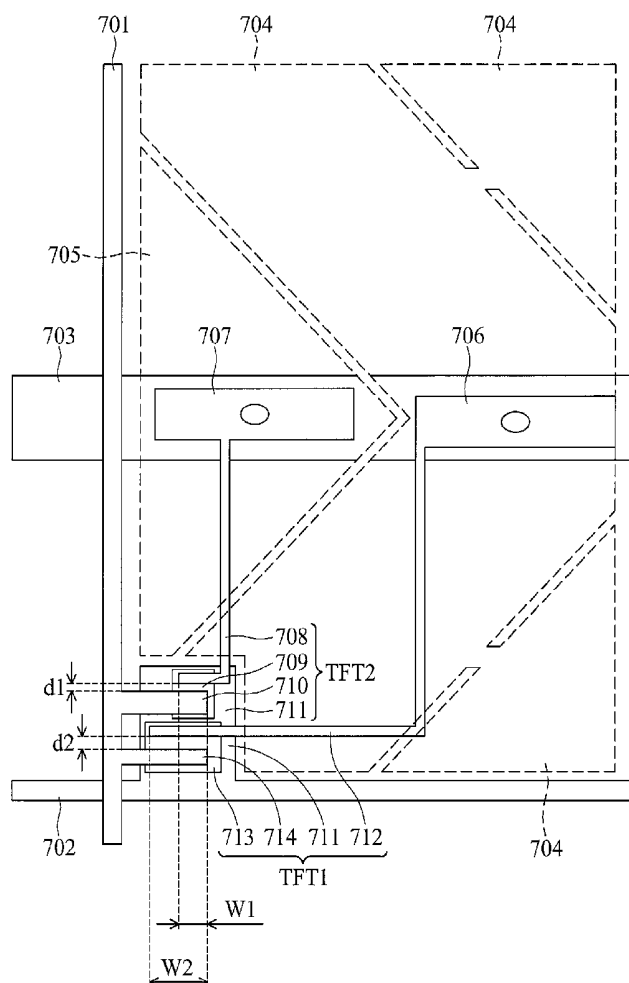
Correspondence Address:

THOMAS, KAYDEN, HORSTEMEYER & RISLEY, LLP
100 GALLERIA PARKWAY, NW
STE 1750
ATLANTA, GA 30339-5948 (US)(73) Assignee: **QUANTA DISPLAY INC.**, Taoyuan County (TW)(21) Appl. No.: **11/420,538**(22) Filed: **May 26, 2006**(30) **Foreign Application Priority Data**

Jun. 17, 2005 (TW)..... 94120158

(57) **ABSTRACT**

A vertical alignment type liquid crystal display comprising a plurality of pixel areas, wherein each pixel area is driven by a source line and a gate line, comprises: a first and a second substrates disposed opposite each other and a liquid crystal layer interposed therebetween; a first pixel driving device and a second pixel driving device are respectively coupled to a first pixel electrode and a second pixel electrode and formed on the first substrate; the first and the second pixel electrodes having a plurality of slits, wherein the first and the second pixel driving devices have mutually different open currents, resulting in the first and the second pixel electrodes having mutually different voltages so that the liquid crystal layer comprises two liquid crystal orientation areas having mutually different orientations; a common electrode having one or more protrusion or slits formed on the interior of the second substrate.



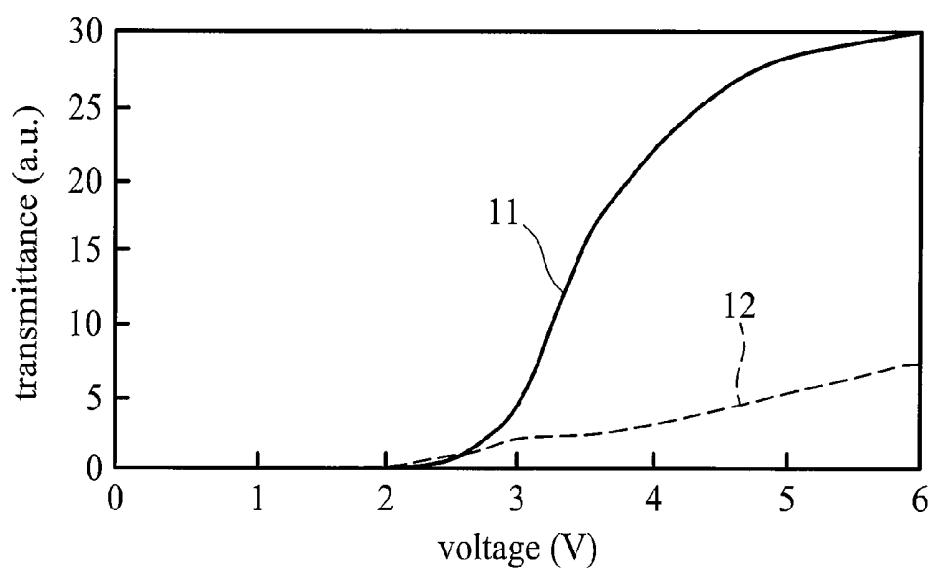


FIG. 1 (RELATED ART)

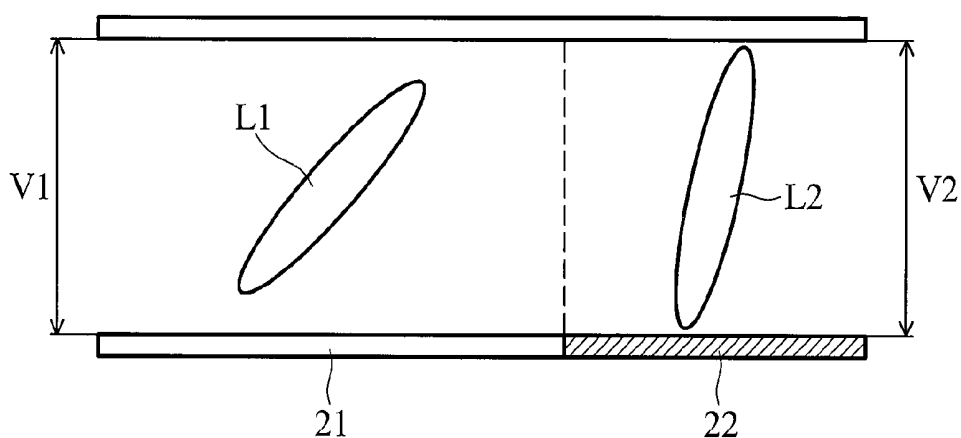


FIG. 2 (RELATED ART)

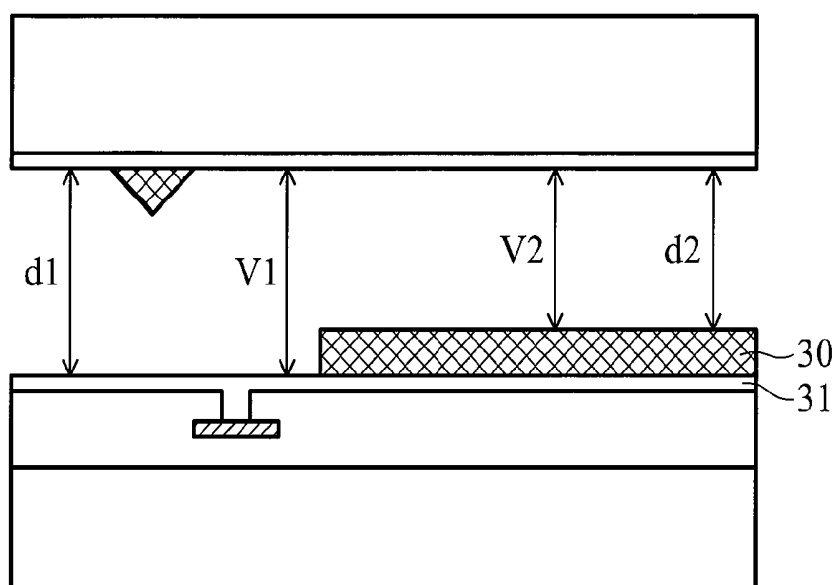


FIG. 3 (RELATED ART)

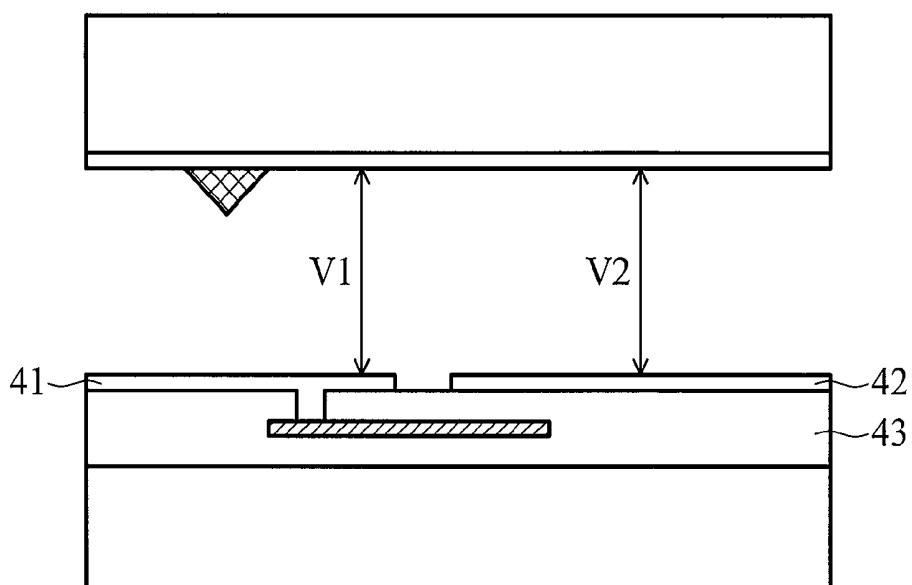


FIG. 4 (RELATED ART)

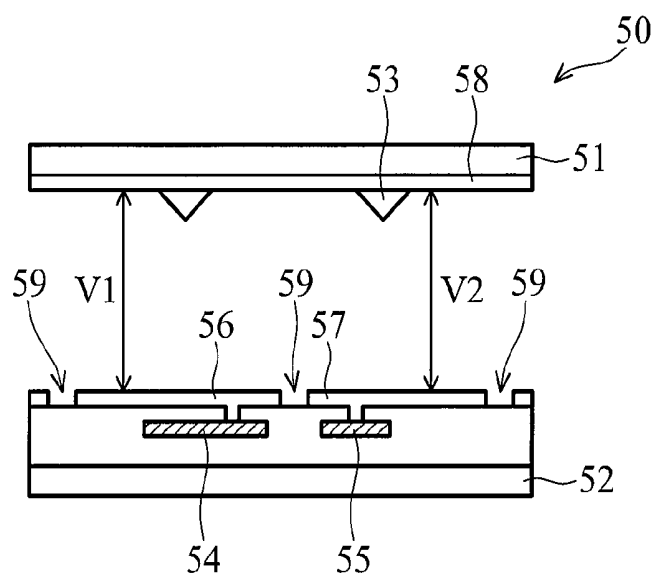


FIG. 5

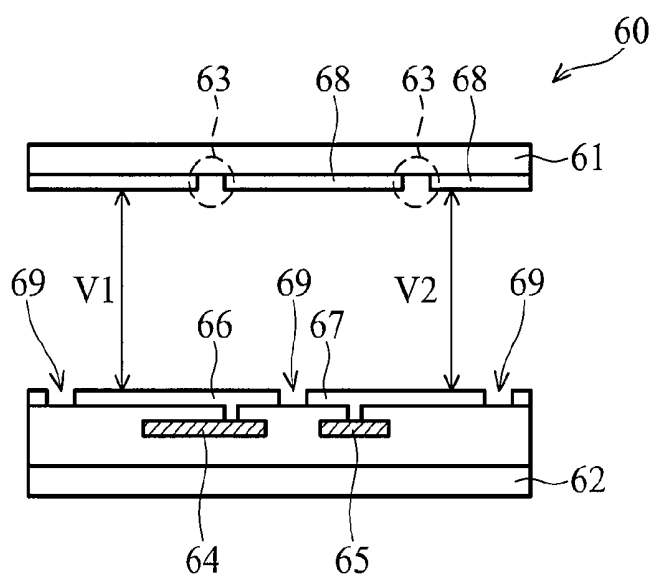


FIG. 6

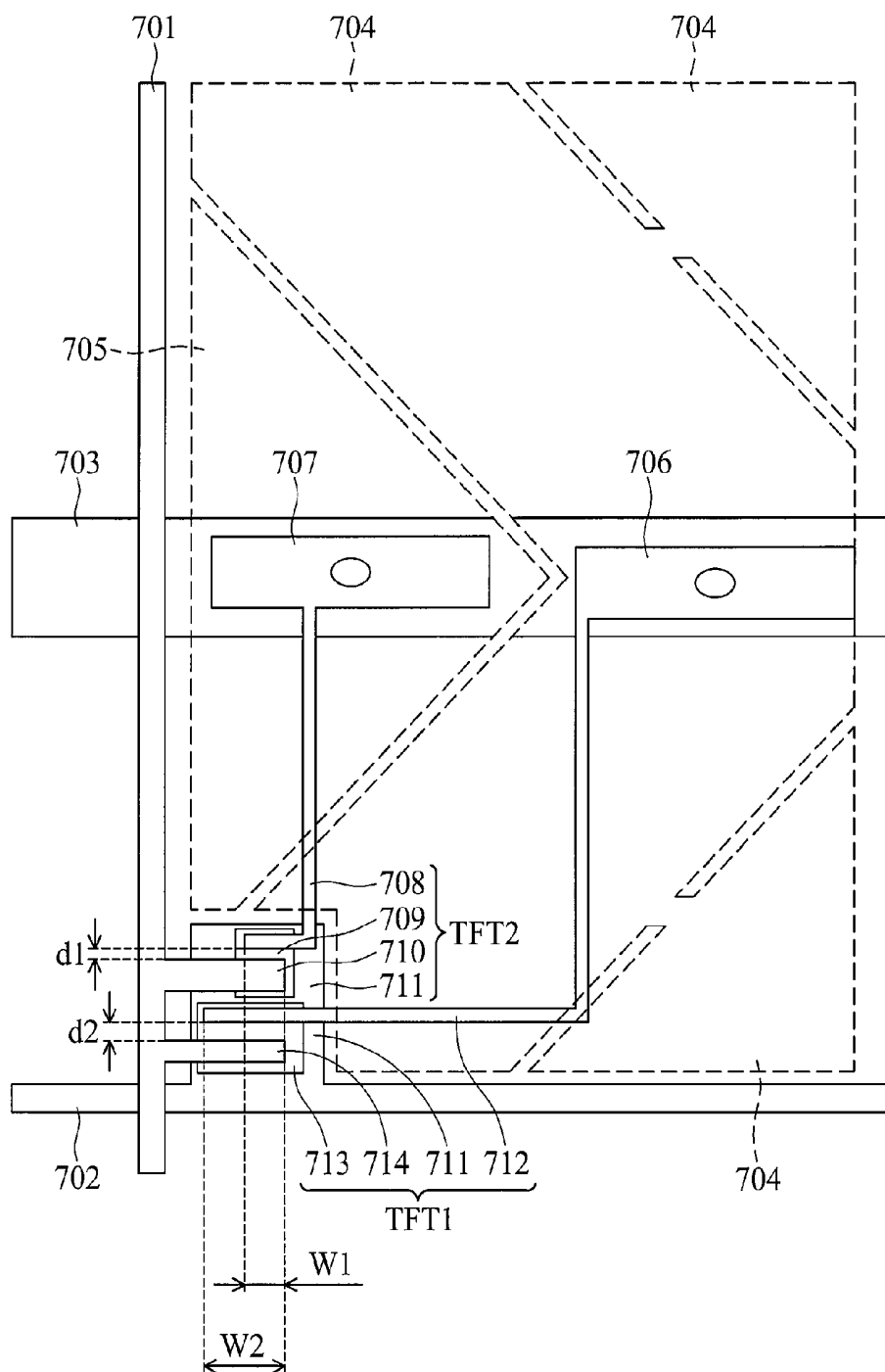


FIG. 7

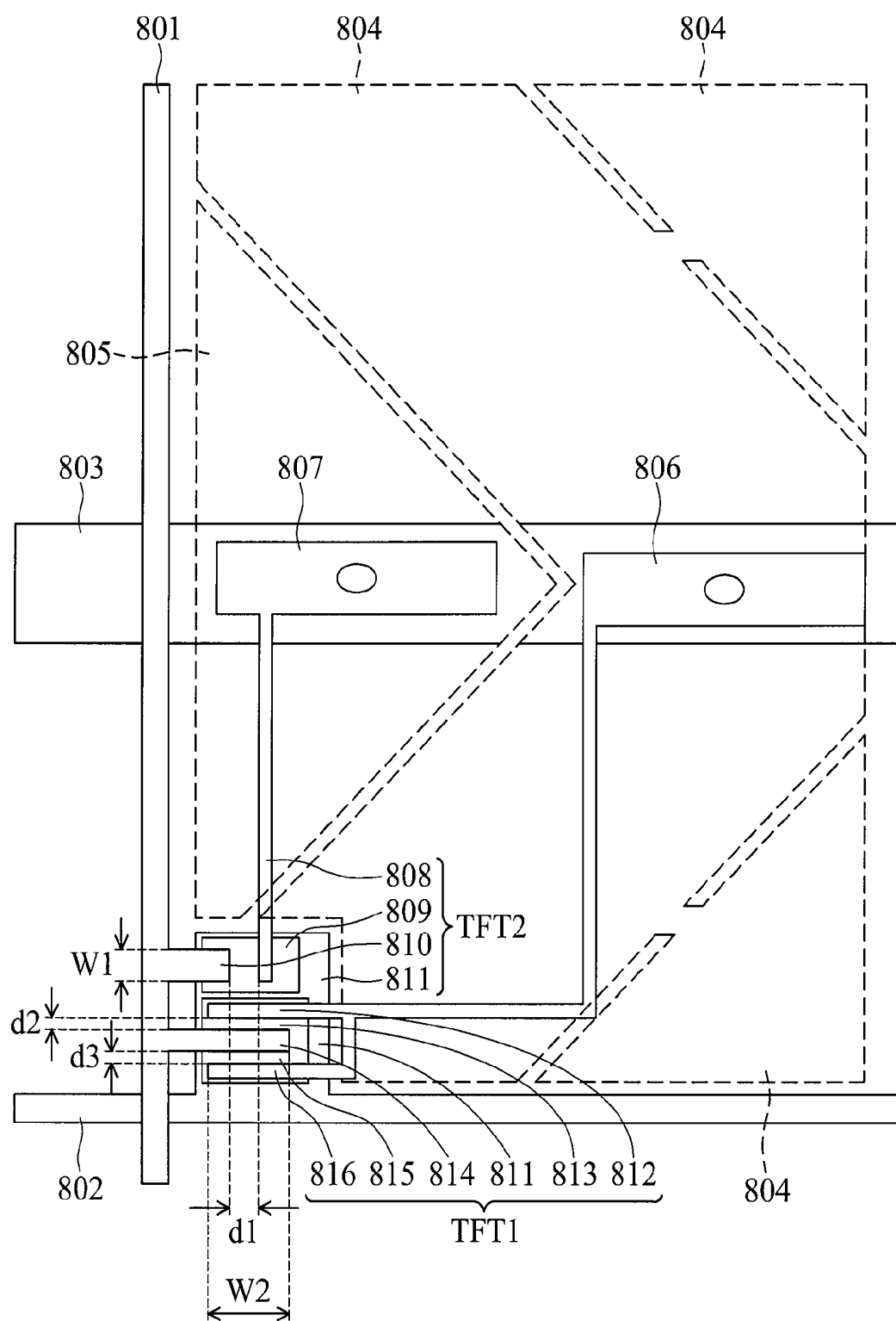


FIG. 8

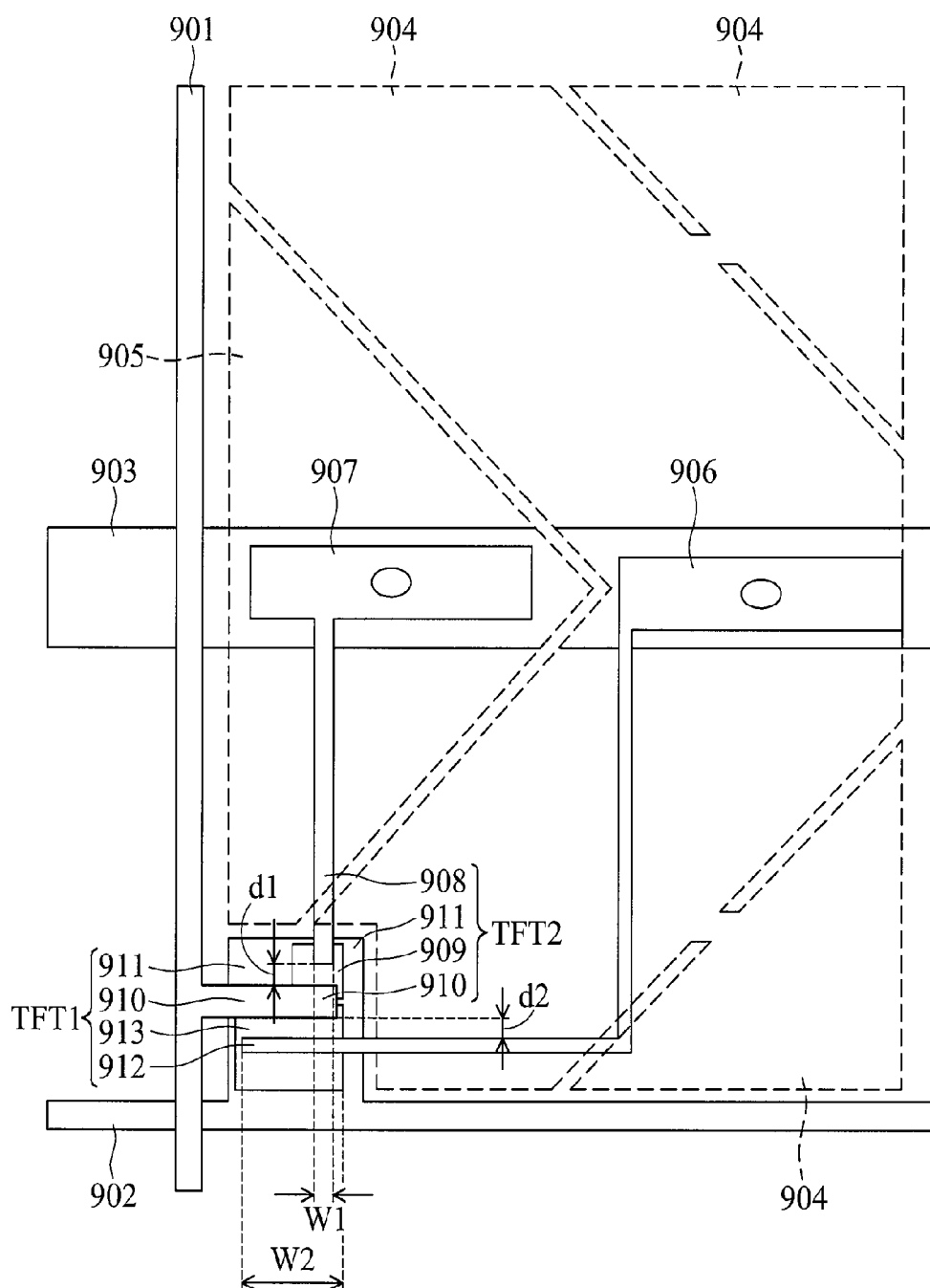


FIG. 9

VERTICAL ALIGNMENT TYPE LIQUID CRYSTAL DISPLAYS

BACKGROUND

[0001] The invention relates to liquid crystal displays, and more particularly to vertical alignment (hereafter called "VA") type liquid crystal displays with widen viewing angle.

[0002] The feature of rapid response time has enhanced the VA type liquid crystal displays to become the dominated liquid crystal displays. However, compared to the In plane Switch (IPS) type liquid crystal displays, the narrow viewing angle of VA type liquid crystal displays has been a problematic to future developing. When viewing a VA type liquid crystal display at an oblique angle, gamma washout phenomenon raised, limiting the view ability. **FIG. 1** is a voltage-transmittance scheme diagram of a VA type liquid crystal display with different viewing angles. In **FIG. 1**, curve **11** is a voltage-transmittance curve of 0 degree normal viewing for the VA type liquid crystal display and curve **12** is of 60 degree oblique viewing. According to the features of VA type liquid crystal displays, the transmittance substantially increases along with increased voltage. If transmittance fails to increase along with the increased voltage, or decreases, color dispersion is generated. Take curve **12** for example, the increased range of transmittance is not as the voltage increases from 3V to 4V, thus color dispersion of curve **12** is worse than the color dispersion of curve **11**. One kind of technologies used to resolve the above-mentioned issue, the pixel division technology is preferred. **FIG. 2** is a schematic diagram of pixel division. In **FIG. 2**, a pixel is divided into two pixel areas, first pixel area **21** with voltage V_1 and second pixel area **22** with voltage V_2 , wherein $V_1 \neq V_2$. When charging, liquid crystal elements **L1** and **L2** have mutually different orientation directions due to the first and second pixel areas having mutually different voltages, thus, the issue of color dispersion can be improved. **FIG. 3** is a schematic diagram of a pixel of a conventional display according to the **FIG. 2**. In **FIG. 3**, a dielectric layer **30** is provided above the pixel electrode to generate mutually different voltages V_1 and V_2 . Forming the dielectric layer on the pixel electrode could improve the color dispersion issue, but the Mura and after-images problems raised due to the non-uniform cell gap. **FIG. 4** is a scheme diagram of another conventional display according to the **FIG. 2**. To improve detrimental effects caused by the non-uniform cell gaps of **FIG. 3**, a coupling capacitor formed by a dielectric layer **43** floating connects to the pixel electrode **42** so that the first and second pixel electrode have different voltages V_1 and V_2 . Although problems arising from the non-uniform cell gap can be solved, the liquid crystal has after-images due to the denseless property of dielectric layer.

SUMMARY

[0003] An object of the present invention is to improve and resolve gamma washout phenomenon of a VA type liquid crystal display.

[0004] Another object of the present invention is to improve and resolve gamma washout phenomenon of a VA type liquid crystal display by utilizing two thin film transistors with different open currents to drive two different pixel electrodes in a pixel electrode unit.

[0005] VA type liquid crystal displays with widen viewing angle are provided. In an exemplary embodiment, a VA type

liquid crystal display comprising a plurality of pixel areas, wherein each pixel area is driven by a source line and a gate line, comprises the following: a first substrate disposed opposite a second substrate with a liquid crystal layer interposed therebetween; a first pixel driving device and a second pixel driving device coupled to a first pixel electrode and a second pixel electrode respectively formed on the first substrate. The first and the second pixel electrode have a plurality of slits, wherein the first and second pixel driving devices have mutually different open currents, resulting in the first and the second pixel electrodes having mutually different voltages so that the liquid crystal layer comprises two liquid crystal orientation areas having mutually different orientation directions. A common electrode having one or more protrusions or slits is formed on the interior of the second substrate.

[0006] Further, in the embodiment, the first and the second pixel driving devices can be two thin film transistors.

[0007] In another exemplary embodiment, a VA type liquid crystal display comprises a plurality of pixel areas, wherein each pixel area comprises a transversely extending gate line and a longitudinally extending source line formed on a first substrate. A first thin film transistor formed on the first substrate has a first source and a first drain. A second thin film transistor formed on the first substrate has a second source and a second drain, in which the first and the second thin film transistors have mutually different open currents. A first pixel electrode having a plurality of slits is electrically connected to the first source through the first drain so that the first pixel electrode has a first voltage. A second pixel electrode having a plurality of slits is electrically connected to the second source through the second drain so that the second pixel electrode has a second voltage distinct from the first voltage, in which there is a voltage difference between the first and the second voltages. A second substrate is disposed opposite the first substrate. A liquid crystal layer is interposed between the first and the second substrates. A common electrode having a plurality of slits or protrusions formed on an interior of the second substrate generates different voltage differences with the first and the second pixel electrodes respectively so that the liquid crystal layer has two different liquid crystal orientations.

[0008] In another exemplary embodiment, a VA type liquid crystal display comprises a plurality of pixel areas, wherein each pixel area comprises a transversely extending gate line and a longitudinally extending source line formed on a first substrate. A first thin film transistor formed on the first substrate has a first source and a first drain. A second thin film transistor formed on the first substrate has the first source and a second drain, wherein the first and second thin film transistors have mutually different open currents. A first pixel electrode having a plurality of slits is electrically connected to the first source through the first drain so that the first pixel electrode has a first voltage. A second pixel electrode having a plurality of slits is electrically connected to the first source through the second drain so that the second pixel electrode has a second voltage distinct from the first voltage, in which a voltage difference exists between the first and second voltages. A second substrate disposed opposite the first substrate with a liquid crystal layer interposed therebetween. A common electrode having a plurality of slits or protrusions formed on an interior of the second substrate generates different voltage differences with the first and the

second pixel electrodes respectively so that the liquid crystal layer has two different liquid crystal orientation directions.

[0009] Further scope of applicability of the disclosure will become apparent from the detailed description given hereinafter. It should be understood that the detailed description and specific examples are given by way of illustration only, since various changes and modifications within the spirit and scope of the disclosure will become apparent to those skilled in the art from this detailed description.

DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is a diagram of voltage-transmittance of a VA type liquid crystal display with different viewing angles.

[0011] FIG. 2 is a schematic diagram of pixel division.

[0012] FIG. 3 is a schematic diagram of a conventional liquid crystal display according to the FIG. 2.

[0013] FIG. 4 is a schematic diagram of another conventional liquid crystal display according to the FIG. 2.

[0014] FIG. 5 is a schematic diagram of a VA type liquid crystal display embodiment of the invention.

[0015] FIG. 6 is a schematic diagram of another VA type liquid crystal display embodiment of the invention.

[0016] FIG. 7 is a diagram of a pixel layout of the first VA type liquid crystal display embodiment of the invention.

[0017] FIG. 8 is a diagram of a pixel layout of the second VA type liquid crystal display embodiment of the invention.

[0018] FIG. 9 is a diagram of a pixel layout of the third VA type liquid crystal display embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0019] FIG. 5 is a schematic diagram of an embodiment of the invention. A MVA (multi-domain vertical alignment) type liquid crystal display 50 has an upper substrate 51 and a lower substrate 52 opposite to the upper substrate 51, wherein liquid crystal (not shown in FIG. 5) is interposed therebetween. A common electrode 58, such as indium tin oxide (ITO) or indium zinc oxide (IZO) layers, is disposed on an interior of the upper substrate 51. The common electrode 58 has a plurality of protrusions 53, such as dielectric or photoresist materials, to change the orientation of liquid crystal elements. The lower substrate 52 has a first driving device 54 and a second driving device 55 respectively electrical connected to a first pixel electrode 56 and a second pixel electrode 57, wherein the first pixel electrode 56 is not coupled to the second pixel electrode 57. The first pixel electrode 56 and the second pixel electrode 57 have one or more silts 59. The first driving device 54 and the second driving device 55, such as a thin film transistor, have different open circuits to ensure that the first pixel electrode 56 and the second pixel electrode 57 have different voltage, V1 and V2, so that liquid crystal elements have different orientations. In this embodiment of present invention, the first pixel driving device 54 and second pixel driving device 55 can be two thin film transistors.

[0020] FIG. 6 is a schematic diagram of another embodiment of the invention. A patterned vertical alignment (PVA) type liquid crystal display 60 has an upper substrate 61 and

a lower substrate 62 opposite to the upper substrate 61, wherein liquid crystal (not shown in FIG. 6) is interposed therebetween. A common electrode 68, such as indium tin oxide (ITO) or indium zinc oxide (IZO) layers, is disposed on an interior of the upper substrate 61. The common electrode 68 has a plurality of silts 63 to change the direction of orientation of liquid crystal elements. The lower substrate 62 has a first driving device 64 and a second driving device 65 respectively electrically connected to a first pixel electrode 66 and a second pixel electrode 67, wherein the first pixel electrode 66 is not coupled to the second pixel electrode 67. The first pixel electrode 66 and the second pixel electrode 67 have a plurality of silts 69. The first driving device 64 and the second driving device 65, such as a thin film transistors, have different open circuits to ensure that the first pixel electrode 66 and the second pixel electrode 67 have different voltages, V1 and V2, so that liquid crystal elements have different orientations.

[0021] FIG. 7 is a diagram of a pixel layout of the first embodiment of the invention. A pixel electrode is divided into a first pixel electrode 704 and a second pixel electrode 705, wherein the first pixel electrode 704 is not connected to the second pixel electrode 705. The first pixel electrode 704 is driven by a first thin film transistor TFT-1 and the second pixel electrode is driven by a second thin film transistor TFT-2, wherein the TFT-1 and TFT-2 have different open currents. The TFT-1 comprises a first source 714 formed of an extension of source line 701, a first drain 712, a gate 711 formed by an extension of gate line 702 and a channel layer 713. The first drain 712 is formed of an extension of a first extension 706 formed on a storage capacitance electrode line (Cs) 703. When the TFT-1 is switched on, the first source 714 generates a potential difference with the first drain 712 through the channel layer 713, and then generates a voltage V1 on the first extension 706 through the first drain 712 to drive the first pixel electrode 704. The TFT-2 comprises a second source 710 formed by an extension of source 701, a second drain 708, the gate 711 formed by an extension of gate line 702 and a channel layer 709. The second drain 708 is an extension of a second extension 707 formed on the storage capacitance electrode line 703. When TFT-2 is switched on, a potential difference is generated between the second source 710 and second drain 708 through the channel layer 709, and then a voltage V2 is generated on the second extension 707 through the second drain 708 to drive the second pixel electrode 705. To ensure that the TFT-1 and TFT-2 have different open currents, the channel 709 of TFT-2 and the channel layer 713 of TFT-1 satisfy the equation, $W1/d1 \neq W2/d2$.

[0022] FIG. 8 is a diagram of a pixel layout of the second embodiment of the invention. A pixel electrode is divided into a first pixel electrode 804 and a second pixel electrode 805, wherein the first pixel electrode 804 is not connected to the second pixel electrode 805. The first pixel electrode 804 is driven by a first thin film transistor TFT-1 and the second pixel electrode is driven by a second thin film transistor TFT-2, wherein the TFT-1 and the TFT-2 have different open currents. FIG. 8 shows the dual drain design of TFT-1. The TFT-1 comprises a first source 814 formed of an extension of a source line 801, a first drain 812, a second drain 816, a first channel layer 813, a second channel layer 815 and a gate 811 formed of an extension of gate line 802. The first drain 812 and second drain 816 are an extension of a first extension 806 formed on a storage capacitance electrode line

803. When TFT-1 is switched on, the first source **814** generates potential differences with the first drain **812** and second drain **816** respectively through the first channel layer **813** and second channel layer **815**, and then a voltage V1 is generated on the first extension **806** through the first drain **812** and second drain **816** to drive the first pixel electrode **804**. The TFT-2 comprises a second source **810** formed of an extension of source line **801**, a third drain **808**, a gate **811** formed of an extension of the gate line **802** and a third channel layer **809**. The third drain **808** is an extension of a second extension **807** formed on the storage capacitance electrode line **803**. When TFT-2 is switched on, a potential difference is generated between the second source **810** and the third drain **808** through third channel layer **809**, and then a voltage V2 is generated on the second extension **807** through the third drain **808** to drive the second pixel electrode **805**. To ensure that the TFT-1 and TFT-2 have different open currents, the first channel layer **813** and second channel layer **815** of TFT-1 and the third channel layer **809** of TFT-2 satisfy $W1/d1 \neq W2/d2 + W3/d3$.

[0023] **FIG. 9** is a diagram of a pixel layout of the third embodiment of the invention. A pixel electrode is divided into a first pixel electrode **904** and a second pixel electrode **905**, wherein the first pixel electrode **904** is not connected to the second pixel electrode **905**. The first pixel electrode **904** is driven by a first thin film transistor TFT-1 and the second pixel electrode **905** is driven by a second thin film transistor TFT-2, wherein the TFT-1 and TFT-2 have different open currents. The design of the embodiment illustrated in **FIG. 9** employs a common source for TFT-1 and TFT-2. The TFT-1 comprises a source **910** formed of an extension of source line **901**, a first drain **912**, a first channel layer **913** and a gate **911** formed of an extension of a gate line **902**. The first drain **912** is an extension of a first extension **906** formed on a storage capacitance electrode line **903**. When TFT-1 is switched on, the source **910** generates a potential difference with the first drain **912** through the first channel layer **913**, and then a voltage V1 is generated on the first extension **906** through the first drain **912** to drive the first pixel electrode **904**. The TFT-2 comprises the source **910** formed of an extension of the source line **901**, a second drain **908**, a second channel layer **909** and the gate **911** formed of an extension of a gate line **902**. The second drain **908** is an extension of the second extension **907** formed on the storage capacitance electrode line **903**. When TFT-2 is switched on, the source **910** generates a potential difference with the second drain **908** through the second channel layer **909**, and then a voltage V2 is generated on the second extension **907** to drive the second pixel electrode **905**. To ensure that the TFT-1 and the TFT-2 have different open currents, the second channel **909** of TFT-2 and the first channel layer **713** of TFT-1 satisfy the equation, $W1/d1 \neq W2/d2$.

[0024] While the invention has been described by way of example and in terms of the preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments. To the contrary, it is intended to cover various modifications and similar arrangements (as would be apparent to those skilled in the art). Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

What is claimed is:

1. A vertical alignment type liquid crystal display comprising a plurality of pixel areas, each pixel area being driven by a source line and a gate line, comprising:

- a first substrate;
- a second substrate disposed opposite the first substrate;
- a liquid crystal layer interposed between the first substrate and the second substrate;

a first pixel electrode and a second pixel electrode formed on the first substrate, wherein the second pixel electrode is not coupled to the first pixel electrode and the first and the second pixel electrodes comprise a plurality of silts;

a first pixel driving device coupled to the first pixel electrode formed on the first substrate;

a second pixel driving device coupled to the second pixel electrode formed on the first substrate, wherein the first and the second pixel driving devices have different open currents so that the first pixel electrode and the second pixel electrode have different voltages; and

a common electrode having a plurality of silts or protrusions formed on an interior of the second substrate, wherein different voltage differences are generated between the common electrode and the first pixel electrode and between the common electrode and the second pixel electrode respectively so that the liquid crystal layer having mutually has two different liquid crystal orientations.

2. The liquid crystal display of claim 1, further comprising a storage capacitance electrode line parallel to the gate line formed on the first substrate.

3. The liquid crystal display of claim 1, wherein the first and the second pixel electrodes are indium tin oxide (ITO) or indium zinc oxide (IZO) layers.

4. The liquid crystal display of claim 1, wherein the common electrode is an ITO or IZO layer.

5. The liquid crystal display of claim 1, wherein the first pixel driving device is a first thin film transistor and the second pixel driving device is a second thin film transistor.

6. The liquid crystal display of claim 5, wherein the first and the second thin film transistors have mutually different ratios of width to length (W/L).

7. A vertical alignment type liquid crystal display comprising a plurality of pixel areas, each pixel area comprising:

a transversely extending gate line and a longitudinally extending source line formed on a first substrate;

a first thin film transistor formed on the first substrate having a first source and a first drain;

a second thin film transistor formed on the first substrate having a second source and a second drain, wherein the first and second thin film transistors have mutually different open currents;

a first pixel electrode having a plurality of silts being electrically connected to the first source through by the first drain so that the first pixel electrode has a first voltage;

a second pixel electrode having a plurality of silts being electrically connected to the second source through by

the second drain so that the second pixel electrode has a second voltage distinct from the first voltage, wherein there is a voltage difference between the first and the second voltages;

a second substrate opposite the first substrate;

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

a common electrode having a plurality of silts or protrusions formed on an interior of the second substrate, wherein different voltage drop existing differences are generated between the common electrode and the first pixel electrode and between the common electrode and second pixel electrode respectively so that the liquid crystal layer having mutually has two different liquid crystal orientations.

8. The liquid crystal display of claim 7, further comprising a storage capacitance electrode line parallel to the gate line formed on the first substrate.

9. The liquid crystal display of claim 7, wherein the first and second thin film transistors have a disposition order, first drain, first source, second drain and second source.

10. The liquid crystal display of claim 7, wherein the first and the second pixel electrodes are indium tin oxide (ITO) or indium zinc oxide (IZO) layers.

11. The liquid crystal display of claim 7, wherein the common electrode is an ITO or IZO layer.

12. The liquid crystal display of claim 7, wherein the first and the second thin film transistors have the same gate.

13. The liquid crystal display of claim 7, wherein the first and the second thin film transistors have mutually different ratio of width to length (W/L).

14. A vertical alignment type liquid crystal display comprising a plurality of pixel areas, each pixel area comprising:

a transversely extending gate line and a longitudinally extending source line formed on a first substrate;

a first thin film transistor formed on the first substrate having a first source and a first drain;

a second thin film transistor formed on the first substrate having the first source and a second drain, wherein the

first and second thin film transistors have mutually different open currents;

a first pixel electrode having a plurality of silts being electrically connected to the first source through by the first drain so that the first pixel electrode has a first voltage;

a second pixel electrode having a plurality of silts being electrically connected to the first source through by the second drain so that the second pixel electrode has a second voltage distinct from the first voltage, wherein there is a voltage difference between the first and second voltages;

a second substrate opposite the first substrate;

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

a common electrode having a plurality of silts or protrusions formed on an interior of the second substrate, wherein different voltage drop existing differences are generated between the common electrode and the first pixel electrode and between the common electrode and second pixel electrode respectively so that the liquid crystal layer having mutually has two different liquid crystal orientations.

15. The liquid crystal display of claim 14, further comprising a storage capacitance electrode line parallel to the gate line formed on the first substrate.

16. The liquid crystal display of claim 14, wherein the first and the second pixel electrodes are indium tin oxide (ITO) or indium zinc oxide (IZO) layers.

17. The liquid crystal display of claim 14, wherein the common electrode is an ITO or IZO layer.

18. The liquid crystal display of claim 14, wherein the first and the second thin film transistors have the same gate.

19. The liquid crystal display of claim 14, wherein the first and the second thin film transistor have mutually different ratios of width to length (W/L).

* * * * *

专利名称(译)	垂直对准型液晶显示器		
公开(公告)号	US20060285047A1	公开(公告)日	2006-12-21
申请号	US11/420538	申请日	2006-05-26
[标]申请(专利权)人(译)	广辉电子股份有限公司		
申请(专利权)人(译)	广辉INC.		
当前申请(专利权)人(译)	友达光电.		
[标]发明人	CHIU CHUN CHANG		
发明人	CHIU, CHUN-CHANG		
IPC分类号	G02F1/1343 G02F1/1337		
CPC分类号	G02F1/134309 G02F1/13624 G02F2001/134345 G02F2001/133776 G02F1/1393		
优先权	094120158 2005-06-17 TW		
外部链接	Espacenet USPTO		

摘要(译)

一种垂直取向型液晶显示器，包括多个像素区域，其中每个像素区域由源极线和栅极线驱动，包括：彼此相对设置的第一和第二基板，以及插入其间的液晶层；第一像素驱动装置和第二像素驱动装置分别耦接第一像素电极和第二像素电极，并形成于第一基板上；第一像素电极和第二像素电极具有多个狭缝，其中第一和第二像素驱动装置具有相互不同的开路电流，导致第一和第二像素电极具有相互不同的电压，使得液晶层包括两个液体具有相互不同取向的晶体取向区域；公共电极具有形成在第二基板内部的一个或多个突起或狭缝。

