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(54) **LIQUID CRYSTAL DISPLAYS AND THE VERTICAL ALIGNMENT LIQUID CRYSTAL PANELS THEREOF**

(71) Applicant: **Wuhan China Star Optoelectronics Technology Co.,**, Wuhan, Hubei (CN)

(72) Inventor: **Chang XIE**, Shenzhen, Guangdong (CN)

(73) Assignee: **Wuhan China Star Optoelectronics Technology Co., Ltd.**, Wuhan, Hubei (CN)

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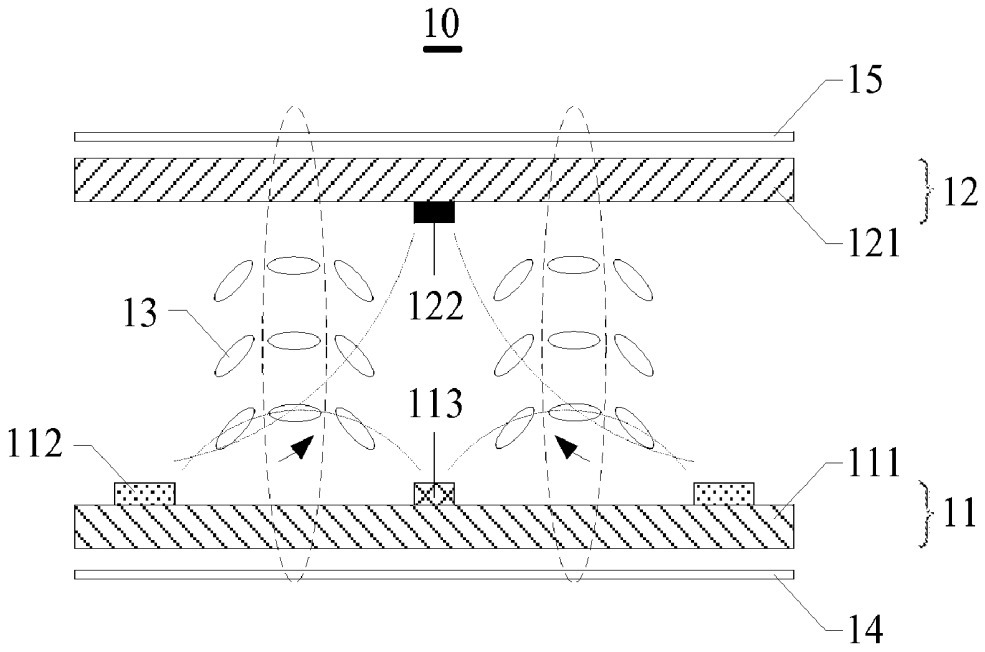
(57) **ABSTRACT**

The present disclosure relates to a liquid crystal display and the vertical alignment liquid crystal panel thereof. The liquid crystal panel includes a first substrate having at least one pixel electrode and at least one common electrode, and a second substrate having at least one twisted electrode. The twisted electrode corresponds to one of the common electrode and the pixel electrodes. When being applied with the voltage, a tilt electrical field is formed between the twisted electrode and the common electrode such that the vertically aligned liquid crystals are controlled to reorientate. In this way, the dark stripes of the liquid crystal panel may be eliminated so as to enhance the transmission rate.



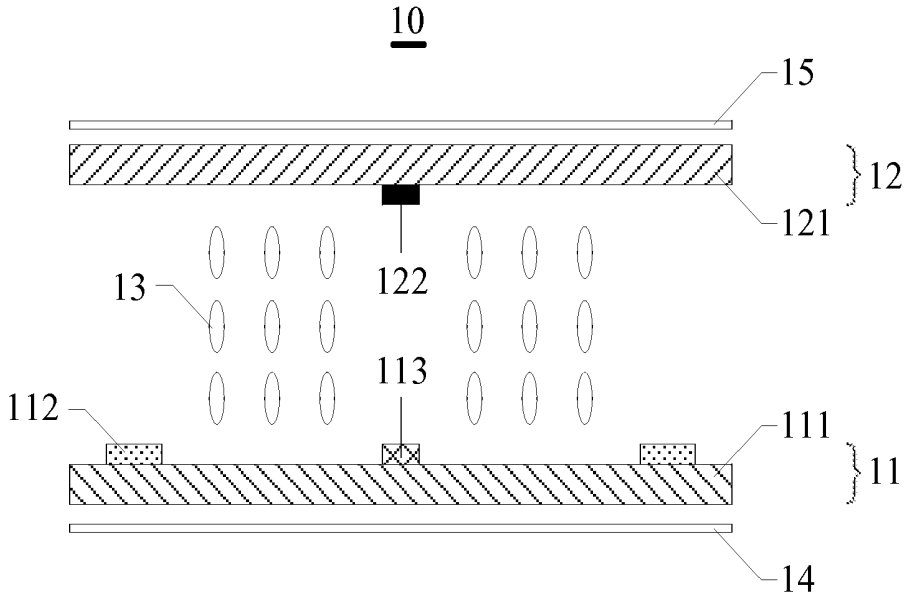

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FIG. 1

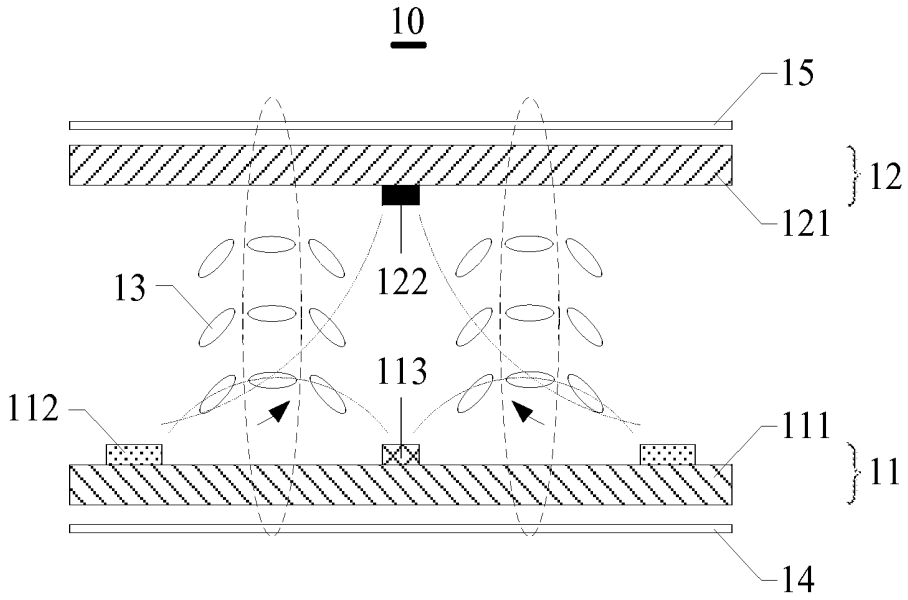
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FIG.2

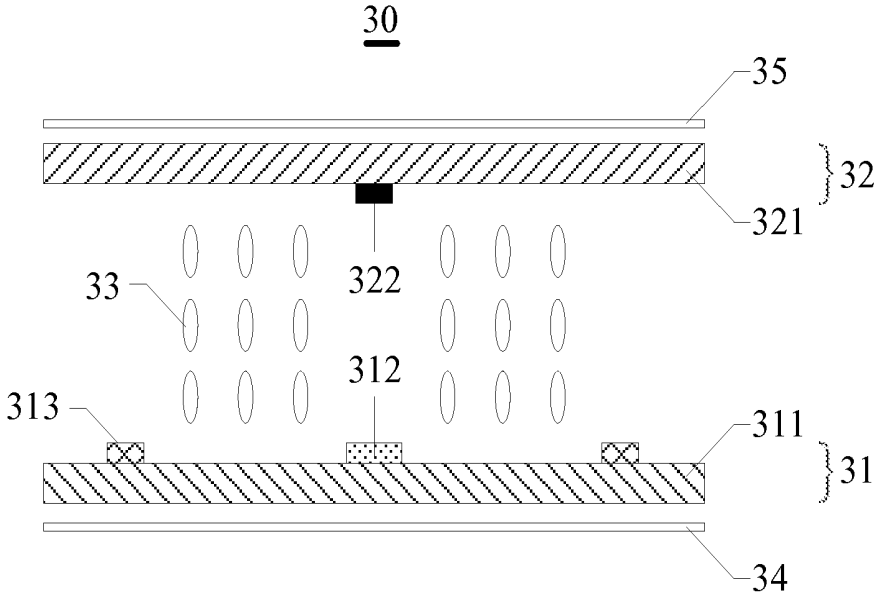
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FIG. 3

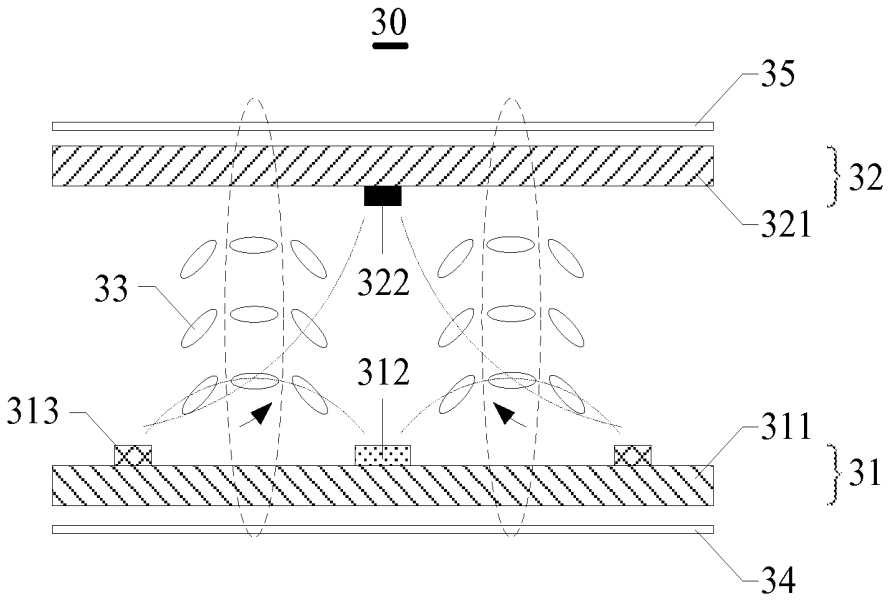
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FIG. 4

LIQUID CRYSTAL DISPLAYS AND THE VERTICAL ALIGNMENT LIQUID CRYSTAL PANELS THEREOF

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present disclosure relates to liquid crystal display technology, and more particularly to a liquid crystal display (LCD) and the vertical alignment liquid crystal panel thereof.

[0003] 2. Discussion of the Related Art

[0004] Vertical alignment liquid crystal molecules may not reorientate when the liquid crystal panel has not applied a voltage. Light beams passing through the liquid crystal molecules cannot pass through the liquid crystal panel such that the liquid crystal panel is in a normal black mode. When being applied with the voltage, the vertical alignment liquid crystal molecules reorientate so as to be gradually horizontal due to the horizontal electrical field, and thus the light beams may pass through the liquid crystal panel and the liquid crystal panel may display images. However, the liquid crystal molecules located between pixel electrodes and common electrodes may be clasped by the liquid crystal molecules located in two sides, and thus are vertically aligned. Under the circumstance, the light beams cannot pass through the middle area, and thus dark strips may occur in the liquid crystal panel such that the transmission rate has been affected.

SUMMARY

[0005] The present disclosure relates to a liquid crystal display and the vertical alignment liquid crystal panel thereof. With the configuration, the dark stripes of the liquid crystal panel may be eliminated so as to enhance the transmission rate.

[0006] In one aspect, a vertical alignment liquid crystal panel includes: a first substrate, a second substrate opposite to the first substrate, and positive liquid crystals between the first substrate and the second substrate, the first substrate comprising at least one pixel electrode and at least one common electrode, the common electrode and the pixel electrode are stripe-like structures arranged along a surface of the first substrate, and the common electrode and the pixel electrode are spaced apart from each other, the second substrate comprising at least one stripe-like twisted electrodes arranged along the surface of the second substrate, and the twisted electrodes being spaced apart from each, the twisted electrode being configured to be corresponding to the common electrode, when the common electrode, the pixel electrode, and the twisted electrode being applied with a voltage, a horizontal electrical field being formed between the common electrode and the pixel electrode and a tilt electrical field being formed between the twisted electrode and the common electrode such that the vertically aligned liquid crystals are controlled to reorientate by the horizontal electrical field and the tilt electrical field.

[0007] Wherein the voltage being applied to the twisted electrode and the common electrode are the same.

[0008] Wherein the voltage being applied to the twisted electrode and the common electrode are different.

[0009] In another aspect, a vertical alignment liquid crystal panel includes: a first substrate, a second substrate opposite to the first substrate, and positive liquid crystals between the first substrate and the second substrate, the first substrate comprising at least one pixel electrode and at least one common electrode, the second substrate comprising at least one twisted electrodes arranged along the surface of the second substrate, the twisted electrode being configured to be corresponding to one of the common electrode and the pixel electrode, and when the common electrode, the pixel electrode, and the twisted electrode being applied with a voltage, a tilt electrical field being formed between the twisted electrode and the corresponding common electrode or the corresponding pixel electrodes such that the vertically aligned liquid crystals are controlled to reorientate.

[0010] Wherein the twisted electrode is configured to be corresponding to the common electrode, when the common electrode, the pixel electrode, and the twisted electrode being applied with the voltage, a horizontal electrical field is formed between the common electrode and the pixel electrode and a tilt electrical field is formed between the twisted electrode and the common electrode such that the vertically aligned liquid crystals are controlled to reorientate by the horizontal electrical field and the tilt electrical field.

[0011] Wherein the voltage being applied to the twisted electrode and the common electrode are the same.

[0012] Wherein the voltage being applied to the twisted electrode and the common electrode are different.

[0013] Wherein the twisted electrode is configured to be corresponding to the pixel electrode, when the common electrode, the pixel electrode, and the twisted electrode being applied with the voltage, a horizontal electrical field is formed between the common electrode and the pixel electrode and a tilt electrical field is formed between the twisted electrode and the pixel electrode such that the vertically aligned liquid crystals are controlled to reorientate by the horizontal electrical field and the tilt electrical field.

[0014] Wherein the voltage being applied to the twisted electrode and the common electrode are the same.

[0015] Wherein the voltage being applied to the twisted electrode and the common electrode are different.

[0016] Wherein the common electrode and the pixel electrode are stripe-like structures arranged along a surface of the first substrate, and the common electrode and the pixel electrode are spaced apart from each other, and the second substrate comprises at least one stripe-like twisted electrodes arranged along the surface of the second substrate.

[0017] Wherein the liquid crystals are positive liquid crystals.

[0018] In another aspect, a liquid crystal display (LCD) includes: a first substrate, a second substrate opposite to the first substrate, and positive liquid crystals between the first substrate and the second substrate, the first substrate comprising at least one pixel electrode and at least one common electrode, the second substrate comprising at least one twisted electrodes, the twisted electrode being configured to be corresponding to one of the common electrode and the pixel electrode, and when the common electrode, the pixel electrode, and the twisted electrode being applied with a voltage, a tilt electrical field being formed between the twisted electrode and the corresponding common electrode or the corresponding pixel electrodes such that the vertically aligned liquid crystals are controlled to reorientate.

[0019] Wherein the twisted electrode is configured to be corresponding to the common electrode, when the common electrode, the pixel electrode, and the twisted electrode being applied with the voltage, a horizontal electrical field is

formed between the common electrode and the pixel electrode and a tilt electrical field is formed between the twisted electrode and the common electrode such that the vertically aligned liquid crystals are controlled to reorientate by the horizontal electrical field and the tilt electrical field.

[0020] Wherein the twisted electrode is configured to be corresponding to the pixel electrode, when the common electrode, the pixel electrode, and the twisted electrode being applied with the voltage, a horizontal electrical field is formed between the common electrode and the pixel electrode and a tilt electrical field is formed between the twisted electrode and the common electrode such that the vertically aligned liquid crystals are controlled to reorientate by the horizontal electrical field and the tilt electrical field.

[0021] Wherein the voltage being applied to the twisted electrode and the common electrode are the same.

[0022] Wherein the voltage being applied to the twisted electrode and the common electrode are different.

[0023] Wherein the common electrode and the pixel electrode are stripe-like structures arranged along a surface of the first substrate, and the common electrode and the pixel electrode are spaced apart from each other, the second substrate comprising at least one stripe-like twisted electrodes arranged along the surface of the second substrate, and the twisted electrodes being spaced apart from each.

[0024] Wherein the liquid crystals are positive liquid crystals.

[0025] In view of the above, the twisted electrode has been configured to be corresponding to the common electrode and the pixel electrodes. In addition, the tilt electrical field formed between the common electrode and the pixel electrodes may control the vertically aligned liquid crystals located in the middle area between the pixel electrodes and the common electrode to reorientate. As such, the light beams may pass through the area to eliminate the dark strips, which enhances the transmission rate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] FIG. **1** is a cross-sectional view of the liquid crystal panel in accordance with a first embodiment when no voltage has been applied to the liquid crystal panel.

[0027] FIG. **2** is a schematic view of the liquid crystal panel of FIG. **1** when being applied with the voltage.

[0028] FIG. **3** is a cross-sectional view of the liquid crystal panel in accordance with a second embodiment when no voltage has been applied to the liquid crystal panel.

[0029] FIG. **4** is a schematic view of the liquid crystal panel of FIG. **3** when being applied with the voltage.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0030] Embodiments of the invention will now be described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the invention are shown.

[0031] FIG. **1** is a cross-sectional view of the liquid crystal panel in accordance with a first embodiment when no voltage has been applied to the liquid crystal panel. As shown, the liquid crystal panel **10** includes a first substrate **11**, a second substrate **12**, and a liquid crystal layer **13** between the first substrate **11** and the second substrate **12**. The first substrate **11** and the second substrate **12** are opposite to each other, and are arranged at a certain distance. The first substrate **11** is an array substrate, such as a thin film transistor (TFT) substrate. The first substrate **11** includes a transparent body **111**, at least one pixel electrode **112**, at least one common electrode **113** and a variety of wiring arranged on the transparent body **111**. As the pixel electrode **112** and the common electrode **113** are arranged on the same substrate, the liquid crystal panel **10** may be driven by the horizontal electrical field, which may also be deemed as IPS liquid crystal panel. The second substrate **12** is a color film (CF) substrate. The second substrate **12** includes a transparent body **121** and a twisted electrode **122** on the transparent body **121**.

[0032] In the embodiment, the transparent body **111** and the transparent body **121** may be glass substrates, quartz substrates, plastic substrates, or other kinds of hard or flexible substrate. The material of the transparent body **111** and the pixel electrode **112** may be the same or may be different. In addition, the twisted electrode **122** is arranged to be corresponding to the common electrode **113**. For instance, the pixel electrode **112** and the common electrode **113** may be stripe-like structure arranged along the surface of the first substrate **11**, and the pixel electrode **112** and the common electrode **113** are spaced apart from each other. Correspondingly, the twisted electrode **122** may be stripe-like structure arranged along the surface of the second substrate **12**, and the twisted electrode **122** and the common electrode **113** are spaced apart from each other.

[0033] In the embodiment, the liquid crystal panel **10** is the vertical alignment liquid crystal panel. That is, when no voltage has been applied to the liquid crystal panel **10**, the liquid crystal molecules are vertically aligned, as shown in FIG. **1**. In addition, the liquid crystal panel **10** further includes a first polarizer **14** arranged at a farther surface of the first substrate **11** with respect to the liquid crystal layer **13**. The liquid crystal panel **10** further includes a second polarizer **15** arranged at a farther surface of the second substrate **12** with respect to the liquid crystal layer **13**. The polarized direction of the first polarizer **14** and the second polarizer **15** are perpendicular to each other.

[0034] When no voltage has been applied to the liquid crystal panel **10**, the pixel electrode **112**, the common electrode **113**, and the twisted electrode **122** have not been applied with the voltage. There is no electrical field being generated between any two of the pixel electrode **112**, the common electrode **113**, and the twisted electrode **122**. Thus, the vertical alignment liquid crystal molecules may not reorientate. At this moment, the light beams pass through the first polarizer **14**, the liquid crystal layer **13** and then arrive the second polarizer **15**. As the polarized direction of the first polarizer **14** and the second polarizer **15** are perpendicular to each other, the light beams are not capable of passing through the second polarizer **15**. That is, the second polarizer **15** blocks the light beams passing through the first polarizer **14** and the liquid crystal layer **13**, which results in that the liquid crystal panel is in the normal black mode.

[0035] When the liquid crystal panel **10** has been applied with the voltage, the pixel electrode **112**, the common electrode **113**, and the twisted electrode **122** have been applied with the voltage. The horizontal electrical field has been formed between the common electrode **113** and the pixel electrode **112** as shown in FIG. **2**. A tilt electrical field has been formed between the twisted electrode **122** and the pixel electrode **112**, as shown in FIG. **2**. The horizontal electrical field and tilt electrical field cooperatively control

the liquid crystal molecules **13** to reorientate. The tilt electrical field may understood by referring to the dashed area of FIG. **2**, i.e., a middle area between the pixel electrode **112** and the common electrode **113**. The liquid crystal molecules **13** may reorientate due to the horizontal electrical field, and then reorientate along with directions of the arrows due to the tilt electrical field. The liquid crystal molecules **13** located in the middle area between the pixel electrode **112** and the common electrode **113** reorientate toward the horizontal direction due to the tilt electrical field such that the light beams may pass through the first polarizer **14** within the middle area and the liquid crystal molecules **13** within the liquid crystal layer. Afterward, the polarized direction of the light beams has changed, and thus the light beams may pass through the second polarizer **15**, which eliminates the dark stripes occurred in the middle area.

[0036] In an example, the voltage applied to the twisted electrode **122** and the common electrode **113** may be the same or different. The force of the tilt electrical field may be controlled by configuring the voltage being applied to the twisted electrode **122** and the common electrode **113**. In this way, the amount of light beams passing through the liquid crystal panel **10** (the second polarizer **15**) may be controlled, which enhances the transmission rate of the liquid crystal panel **10**.

[0037] FIG. **3** is a cross-sectional view of the liquid crystal panel in accordance with a second embodiment when no voltage has been applied to the liquid crystal panel. In the embodiment, the liquid crystal panel **30** includes a first substrate **31**, a second substrate **32**, and a liquid crystal layer **33** between the first substrate **31** and the second substrate **32**. The first substrate **11** is an array substrate. The first substrate **11** includes a transparent body **311**, at least one pixel electrode **312**, at least one common electrode **313** and a variety of wiring arranged on the transparent body **311**. The second substrate **32** is a color film (CF) substrate. The second substrate **32** includes a transparent body **321** and a twisted electrode **322** on the transparent body **321**.

[0038] The difference between the first embodiment in FIG. **1** and the second embodiment resides in that the twisted electrode **322** is a stripe-like structure being configured to be corresponding to the common electrode **313**.

[0039] Before the liquid crystal panel **30** has been applied with the voltage, referring to FIG. **3**, the light beams passing through the first polarizer **34** and liquid crystal molecules **33** within the liquid crystal layer are not capable of passing through the second polarizer **35**. At this moment, the liquid crystal panel **30** is in the normal black mode.

[0040] When the liquid crystal panel **30** has been applied with the voltage, the horizontal electrical field has been formed between the common electrode **313** and the pixel electrode **312**. The tilt electrical field has been formed between the twisted electrode **322** and the common electrode **313**. The horizontal electrical field and tilt electrical field cooperatively control the liquid crystal molecules **33** to reorientate.

[0041] The tilt electrical field may understood by referring to the dashed area of FIG. **4**, i.e., a middle area between the pixel electrode **312** and the common electrode **313**. The liquid crystal molecules **33** may reorientate due to the horizontal electrical field, and then reorientate along with directions of the arrows. The liquid crystal molecules **33** located in the middle area between the pixel electrode **312** and the common electrode **313** reorientate toward the horizontal direction due to the tilt electrical field such that the light beams may pass through the first polarizer **34** within the middle area and the liquid crystal molecules **33** within the liquid crystal layer. Afterward, the polarized direction of the light beams has changed, and thus the light beams may pass through the second polarizer **35**, which eliminates the dark stripes occurred in the middle area.

[0042] Referring to FIGS. **2** and **4**, the twisted electrode has been configured in different locations in the first and the second embodiment. The generated tilt electrical field may result in opposite polarized direction for the liquid crystal molecules **33** located in the middle area between the pixel electrode **312** and the common electrode **313**.

[0043] According to the present disclosure, a liquid crystal display may include the liquid crystal panel **10** in FIGS. **1** and **2** or the liquid crystal panel **30** in FIGS. **3** and **4**.

[0044] In view of the above, the twisted electrode is configured to be spaced apart with the common electrode or the pixel electrode correspondingly. In addition, the vertically aligned liquid crystal molecules located in the middle area between the pixel electrode and the common electrode are controlled to reorientate toward the horizontal direction due to the tilt electrical field formed due to the twisted electrode and the common electrode or the pixel electrode. In this way, the light beams may pass through the middle area so as to avoid the dark stripes in the area, which enhances the transmission rate of the liquid crystal panel.

[0045] It is believed that the present embodiments and their advantages will be understood from the foregoing description, and it will be apparent that various changes may be made thereto without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the examples hereinbefore described merely being preferred or exemplary embodiments of the invention.

What is claimed is:

1. A vertical alignment liquid crystal panel, comprising:

a first substrate, a second substrate opposite to the first substrate, and positive liquid crystals between the first substrate and the second substrate, the first substrate comprising at least one pixel electrode and at least one common electrode, the common electrode and the pixel electrode are stripe-like structures arranged along a surface of the first substrate, and the common electrode and the pixel electrode are spaced apart from each other, the second substrate comprising at least one stripe-like twisted electrodes arranged along the surface of the second substrate, and the twisted electrodes being spaced apart from each, the twisted electrode being configured to be corresponding to the common electrode, when the common electrode, the pixel electrode, and the twisted electrode being applied with a voltage, a horizontal electrical field being formed between the common electrode and the pixel electrode and a tilt electrical field being formed between the twisted electrode and the common electrode such that the vertically aligned liquid crystals are controlled to reorientate by the horizontal electrical field and the tilt electrical field.

2. The liquid crystal panel as claimed in claim **1**, wherein the voltage being applied to the twisted electrode and the common electrode are the same.

3. The liquid crystal panel as claimed in claim **1**, wherein the voltage being applied to the twisted electrode and the common electrode are different.

4. A vertical alignment liquid crystal panel, comprising:
a first substrate, a second substrate opposite to the first substrate, and positive liquid crystals between the first substrate and the second substrate, the first substrate comprising at least one pixel electrode and at least one common electrode, the second substrate comprising at least one twisted electrodes arranged along the surface of the second substrate, the twisted electrode being configured to be corresponding to one of the common electrode and the pixel electrode, and when the common electrode, the pixel electrode, and the twisted electrode being applied with a voltage, a tilt electrical field being formed between the twisted electrode and the corresponding common electrode or the corresponding pixel electrodes such that the vertically aligned liquid crystals are controlled to reorientate.

5. The liquid crystal panel as claimed in claim 4, wherein the twisted electrode is configured to be corresponding to the common electrode, when the common electrode, the pixel electrode, and the twisted electrode being applied with the voltage, a horizontal electrical field is formed between the common electrode and the pixel electrode and a tilt electrical field is formed between the twisted electrode and the common electrode such that the vertically aligned liquid crystals are controlled to reorientate by the horizontal electrical field and the tilt electrical field.

6. The liquid crystal panel as claimed in claim 5, wherein the voltage being applied to the twisted electrode and the common electrode are the same.

7. The liquid crystal panel as claimed in claim 5, wherein the voltage being applied to the twisted electrode and the common electrode are different.

8. The liquid crystal panel as claimed in claim 4, wherein the twisted electrode is configured to be corresponding to the pixel electrode, when the common electrode, the pixel electrode, and the twisted electrode being applied with the voltage, a horizontal electrical field is formed between the common electrode and the pixel electrode and a tilt electrical field is formed between the twisted electrode and the pixel electrode such that the vertically aligned liquid crystals are controlled to reorientate by the horizontal electrical field and the tilt electrical field.

9. The liquid crystal panel as claimed in claim 8, wherein the voltage being applied to the twisted electrode and the common electrode are the same.

10. The liquid crystal panel as claimed in claim 8, wherein the voltage being applied to the twisted electrode and the common electrode are different.

11. The liquid crystal panel as claimed in claim 4, wherein the common electrode and the pixel electrode are stripe-like structures arranged along a surface of the first substrate, and the common electrode and the pixel electrode are spaced apart from each other, and the second substrate comprises at least one stripe-like twisted electrodes arranged along the surface of the second substrate.

12. The liquid crystal panel as claimed in claim 4, wherein the liquid crystals are positive liquid crystals.

13. A liquid crystal display (LCD), comprising:
a first substrate, a second substrate opposite to the first substrate, and positive liquid crystals between the first substrate and the second substrate, the first substrate comprising at least one pixel electrode and at least one common electrode, the second substrate comprising at least one twisted electrodes, the twisted electrode being configured to be corresponding to one of the common electrode and the pixel electrode, and when the common electrode, the pixel electrode, and the twisted electrode being applied with a voltage, a tilt electrical field being formed between the twisted electrode and the corresponding common electrode or the corresponding pixel electrodes such that the vertically aligned liquid crystals are controlled to reorientate.

14. The LCD as claimed in claim 13, wherein the twisted electrode is configured to be corresponding to the common electrode, when the common electrode, the pixel electrode, and the twisted electrode being applied with the voltage, a horizontal electrical field is formed between the common electrode and the pixel electrode and a tilt electrical field is formed between the twisted electrode and the common electrode such that the vertically aligned liquid crystals are controlled to reorientate by the horizontal electrical field and the tilt electrical field.

15. The LCD as claimed in claim 13, wherein the twisted electrode is configured to be corresponding to the pixel electrode, when the common electrode, the pixel electrode, and the twisted electrode being applied with the voltage, a horizontal electrical field is formed between the common electrode and the pixel electrode and a tilt electrical field is formed between the twisted electrode and the common electrode such that the vertically aligned liquid crystals are controlled to reorientate by the horizontal electrical field and the tilt electrical field.

16. The LCD as claimed in claim 13, wherein the voltage being applied to the twisted electrode and the common electrode are the same.

17. The LCD as claimed in claim 13, wherein the voltage being applied to the twisted electrode and the common electrode are different.

18. The LCD as claimed in claim 13, wherein the common electrode and the pixel electrode are stripe-like structures arranged along a surface of the first substrate, and the common electrode and the pixel electrode are spaced apart from each other, the second substrate comprising at least one stripe-like twisted electrodes arranged along the surface of the second substrate, and the twisted electrodes being spaced apart from each.

19. The LCD as claimed in claim 13, wherein the liquid crystals are positive liquid crystals.

* * * * *

专利名称(译)	液晶显示器及其垂直配向液晶面板		
公开(公告)号	US20160363827A1	公开(公告)日	2016-12-15
申请号	US14/761114	申请日	2015-06-17
当前申请(专利权)人(译)	中国武汉恒星光电科技有限公司		
[标]发明人	XIE CHANG		
发明人	XIE, CHANG		
IPC分类号	G02F1/1343		
CPC分类号	G02F1/134363 G02F2201/123 G02F2201/121 G02F1/134309 G02F2001/134318 G02F2001/134381		
优先权	201510329794.0 2015-06-15 CN		
外部链接	Espacenet USPTO		

摘要(译)

本发明涉及一种液晶显示器及其垂直配向液晶面板。液晶面板包括具有至少一个像素电极和至少一个公共电极的第一基板，以及具有至少一个扭曲电极的第二基板。扭曲电极对应于公共电极和像素电极中的一个。当施加电压时，在扭曲电极和公共电极之间形成倾斜电场，使得控制垂直排列的液晶以重新定向。这样，可以消除液晶面板的暗条纹，从而提高传输速率。