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(54) IN-PLANE SWITCHING LIQUID CRYSTAL DISPLAY DEVICE AND METHOD FOR MANUFACTURING THE SAME

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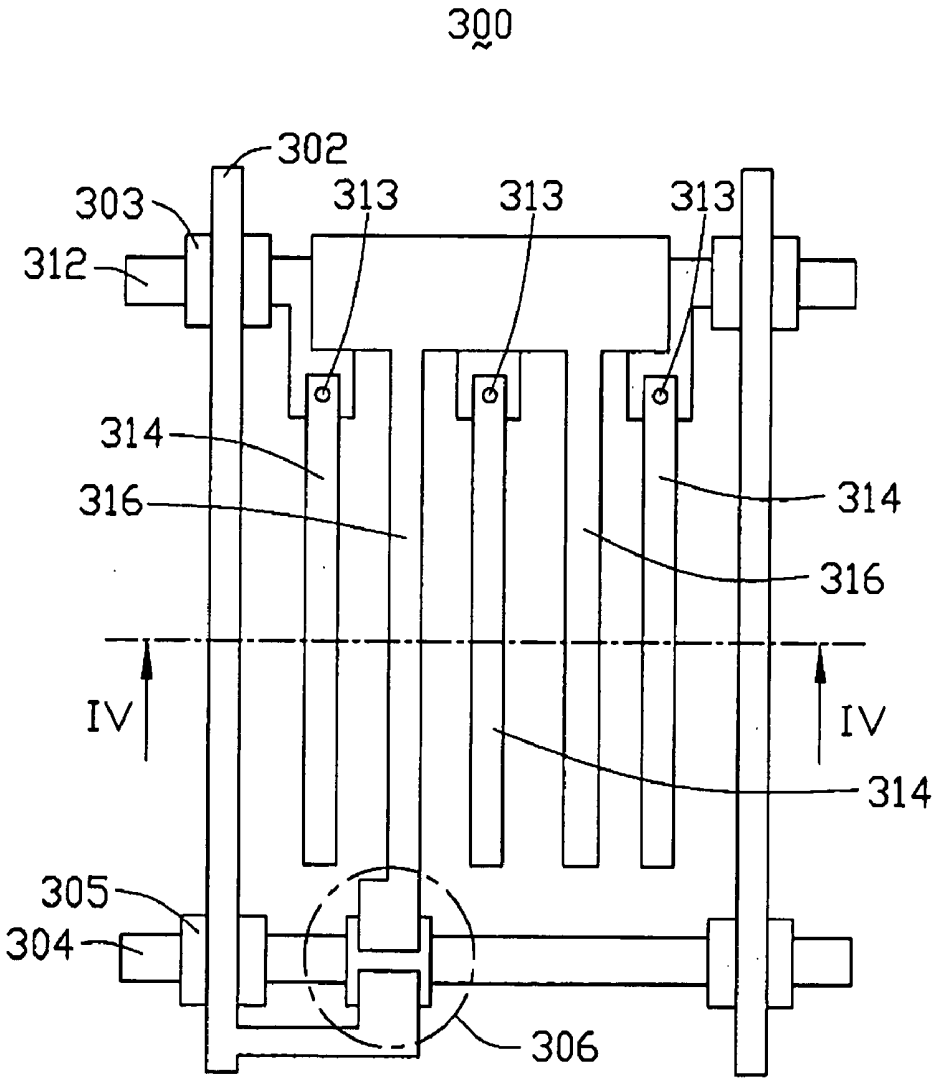
(57) ABSTRACT

The present invention provides an in-plane switching liquid crystal display (IPS-LCD) device that includes a substrate, a protrusive layer having many protrusions on the substrate and a transparent electrode on each of the protrusions. One may dispose a color filter on the protrusions and fill in liquid crystal material between the color filter and the substrate. In contrast to conventional IPS-LCD devices, the IPS-LCD device of the present invention does not require the use of spacers. The present invention may thus largely enhance the light penetration rate and simplify the manufacturing process.



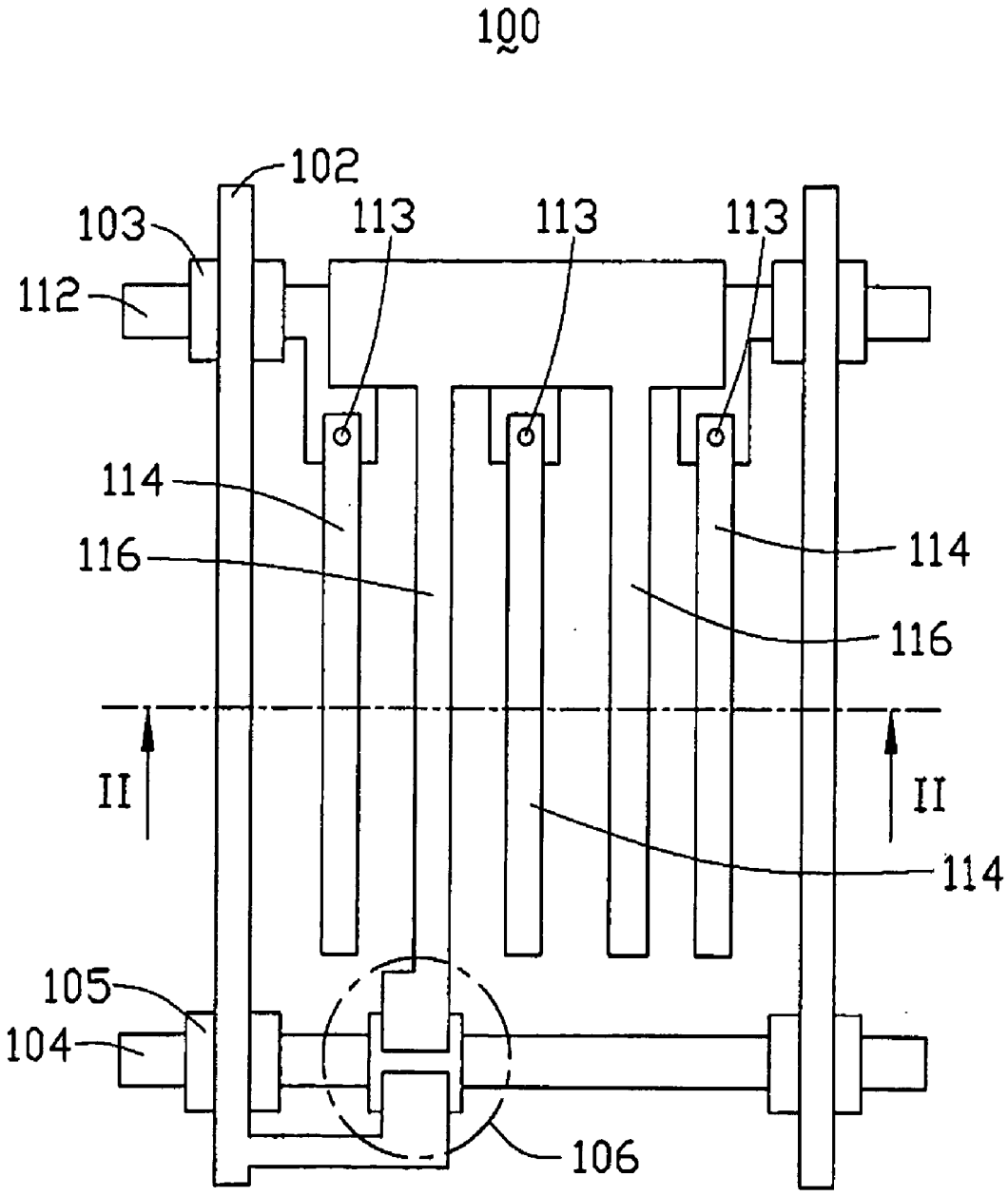


FIG. 1
(PRIOR ART)

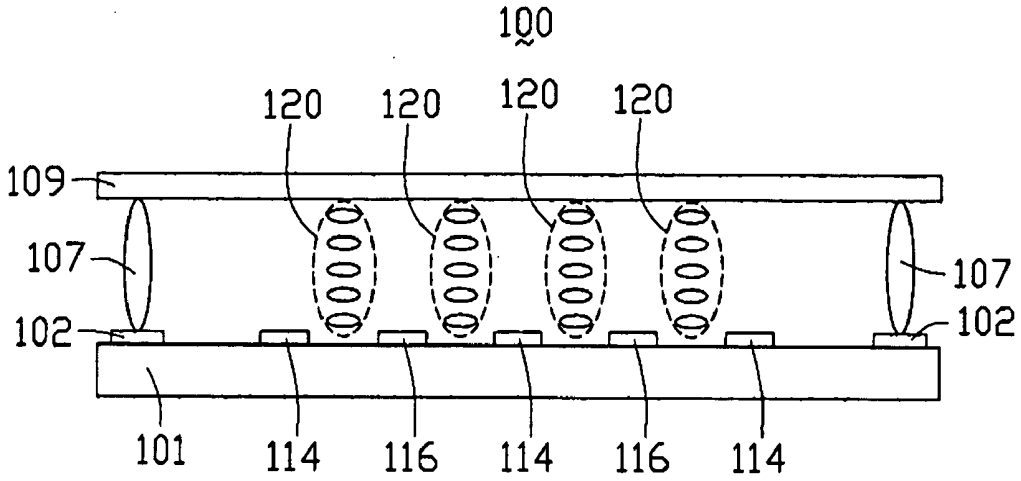


FIG. 2A
(PRIOR ART)

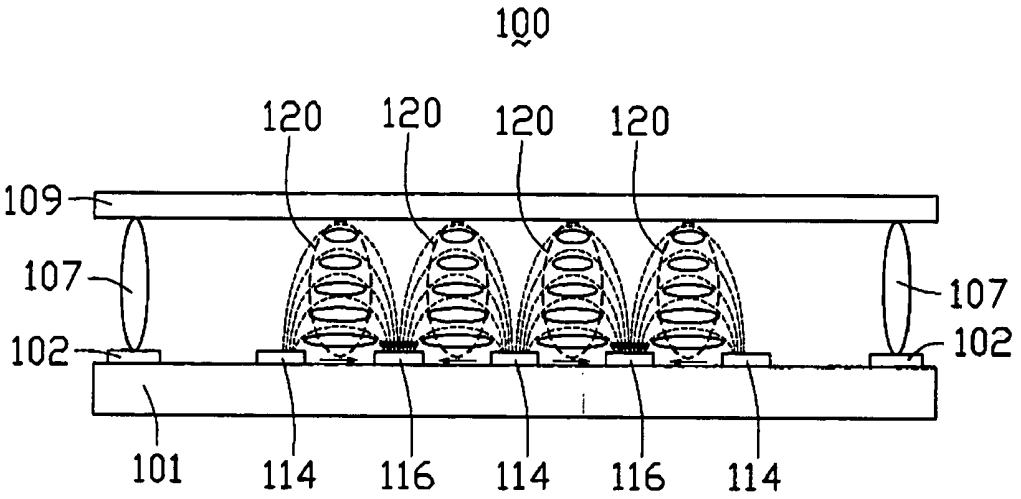


FIG. 2B
(PRIOR ART)

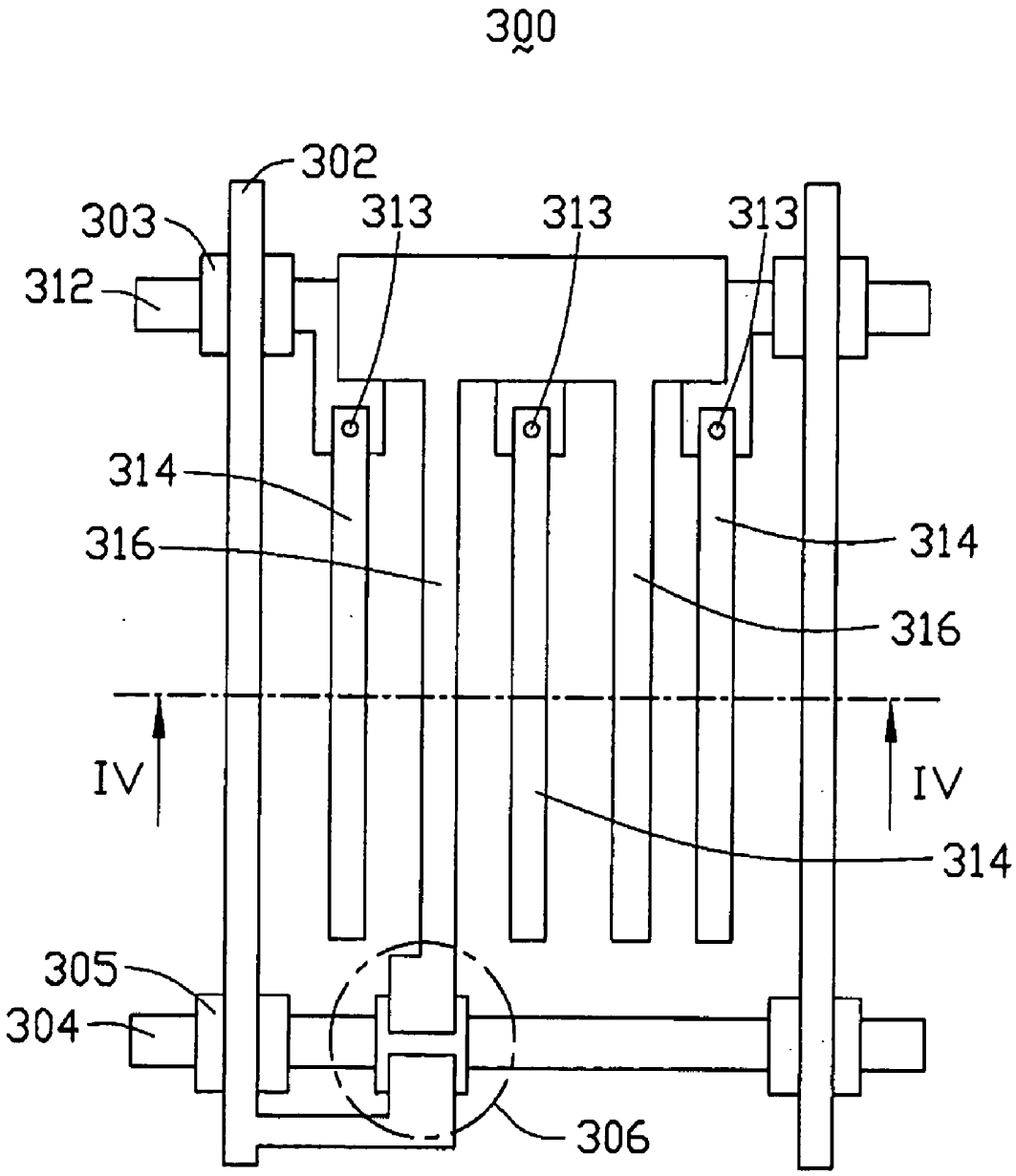


FIG. 3

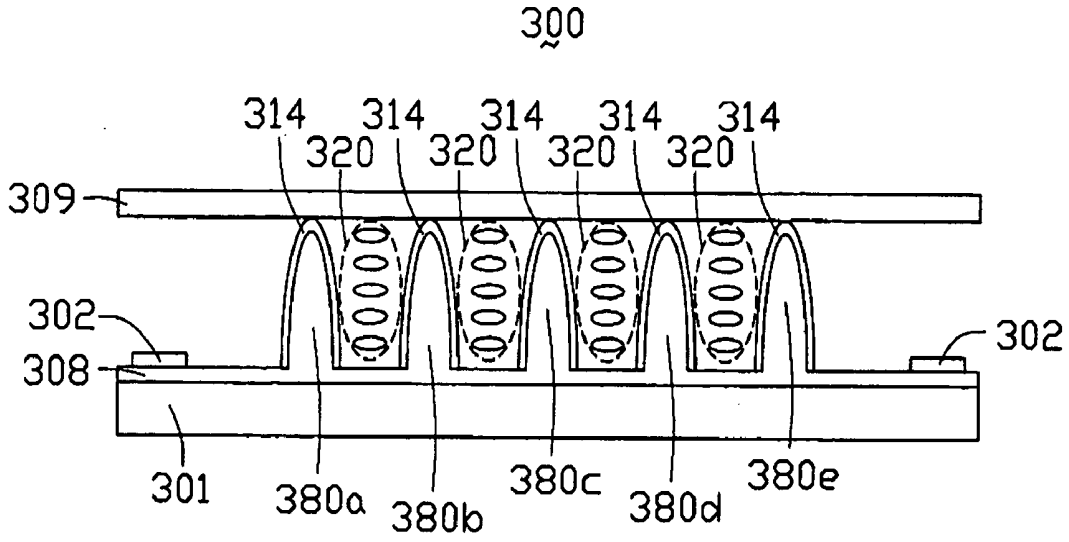
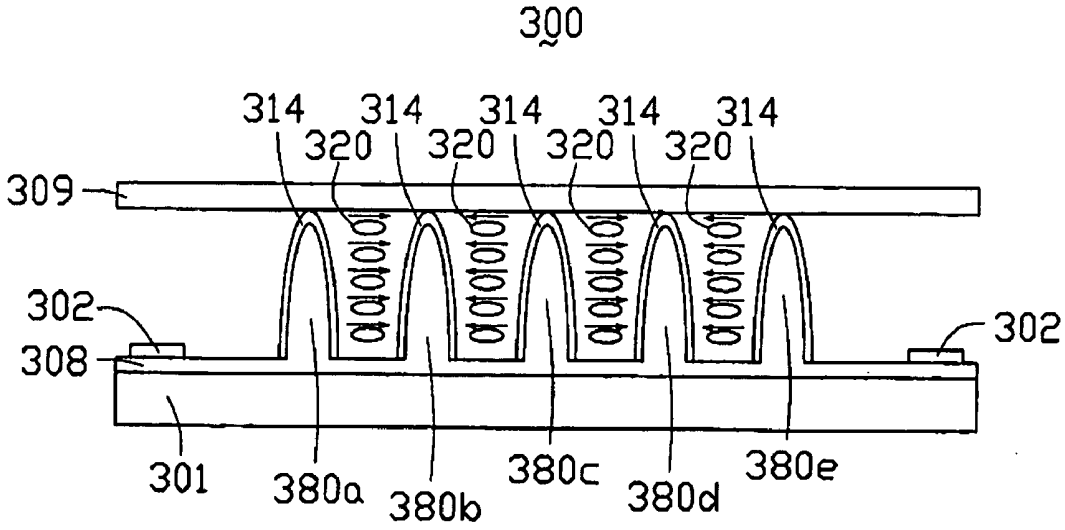

300
314
314
314
314
314
320
320
320
320
309
302
308
302
301
380a
380b
380c
380d
380e

FIG. 4A


300
314
314
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320
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309
302
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380a
380b
380c
380d
380e

FIG. 4B

IN-PLANE SWITCHING LIQUID CRYSTAL DISPLAY DEVICE AND METHOD FOR MANUFACTURING THE SAME

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates generally to a liquid crystal display (LCD) device and a method for manufacturing the same, and more particularly to an in-plane switching liquid crystal display (IPS-LCD) device and a method for manufacturing the same.

[0003] 2. Prior Art

[0004] The invention of liquid crystal display (LCD) devices has revolutionized the way information is displayed. Its overwhelming application in almost all aspects of electronic products guaranteed its success in the market. However, for many years, LCD devices have suffered from its narrow viewing angles. This drawback is solved by many techniques. Among them, the most popular one is the so-called in-plane switching (IPS) technique, which is disclosed in U.S. Pat. No. 5,600,464, for example.

[0005] As shown in **FIG. 1**, a conventional IPS-LCD device **100** is illustrated. The IPS-LCD device **100** comprises a source line **102**, a gate line **104**, a common line **112**, at least a counter electrode **114**, at least a pixel electrode **116** and a thin film transistor (TFT) **106**. The IPS-LCD device **100** further comprises an insulating layer **103** electrically separating the common line **112** and the source line **102**, an insulating layer **105** electrically separating the gate line **104** and the source line **102**, and at least a via **113** electrically connecting the counter electrode **114** with the common line **112**.

[0006] Referring to **FIG. 2A** and **FIG. 2B**, wherein the cross-sectional views of line II-II of **FIG. 1** are illustrated. As shown in **FIG. 2A** and **FIG. 2B**, the IPS-LCD device **100** comprises a substrate **101**, a source line **102**, at least a counter electrode **114**, at least a pixel electrode **116**, a spacer **107**, a color filter **109** and liquid crystal material **120**. The source line **102**, the counter electrode **114** and the pixel electrode **114** are disposed on the substrate **101**. The presence of the spacer **107** provides room between the color filter **109** and the substrate **101** so as to fill in the liquid crystal material **120**. The IPS-LCD device **100** shown in **FIG. 2A** does not supply electric field to the liquid crystal material **120**. Referring to **FIG. 2B**, electric field is now supplied to the liquid crystal material **120**. The liquid crystal material **120** is thus rotated and aligned in response to the electric field supplied. The curved lines each having an arrow at one end, as shown in **FIG. 2B**, represent the electric field lines.

[0007] It is clearly seen from **FIG. 2B** that the electric field supplied to the liquid crystal material **120** near the substrate **101** is stronger than that supplied to the liquid crystal material **120** near the color filter **109**. Therefore, the rotation angle of the liquid crystal material **120** adjacent the color filter **109** is less than that of the liquid crystal material **120** adjacent the substrate **101**. These inhomogeneous rotation angles of the liquid crystal material **120**, resulted from the inhomogeneous electric field distribution, may reduce the light penetration rate, hence lowering the display quality.

SUMMARY OF THE INVENTION

[0008] In accordance with the above and other reasons, one objective of the present invention is to provide an in-plane switching liquid crystal display (IPS-LCD) device and a manufacturing method thereof so as to supply a homogeneous electric field distribution.

[0009] Another objection of the present invention is to provide an IPS-LCD device and a manufacturing method thereof that do not require the use of spacers.

[0010] In order to achieve the above objectives, the present invention of an IPS-LCD device comprises a substrate, a protrusive layer having a plurality of protrusions and a transparent electrode on each of the protrusions of the protrusive layer. The transparent electrode on each of the protrusions is either a pixel electrode or a counter electrode. By covering a color filter on the protrusions, liquid crystal material may be filled in between the color filter and the substrate. Once the IPS-LCD device is switched on, a homogeneous electric field distribution is generated between the pixel electrode and the counter electrode. The liquid crystal material thus rotates to approximately the same angle due to the homogeneous electric field distribution. Therefore, the IPS-LCD device of the present invention has a higher light penetration rate. Furthermore, the IPS-LCD device of the present invention employs a plurality of protrusions to replace the conventional spacers. The manufacturing process is thus integrated to the fabrication of the protrusion layers, and therefore is reduced.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The present invention is better understood by referring to the detailed description of the preferred embodiment taken in conjunction with the drawings, wherein:

[0012] **FIG. 1** illustrates a top view of a conventional IPS-LCD device;

[0013] **FIG. 2A and 2B** illustrate cross-sectional views taken along line II-II of **FIG. 1**;

[0014] **FIG. 3** illustrates a top view of an IPS-LCD device according to the present invention; and

[0015] **FIG. 4A and 4B** illustrate cross-sectional views taken along line IV-IV of **FIG. 3**.

DETAILED DESCRIPTION OF THE INVENTION

[0016] Hereinafter, the present invention is described in detail by incorporating with the accompanied drawings. For the convenience of explanation, it is appreciated that these drawings are not drawn to scale, but are schematic only.

[0017] Referring to **FIG. 3**, an IPS-LCD device **300** of the present invention is illustrated. The IPS-LCD device **300** comprises a source line **302**, a gate line **304**, a common line **312**, at least a counter electrode **314**, at lease a pixel electrode **316** and a thin film transistor (TFT) **306**. The source line **302** crosses the gate line **304** and the common line **312**, thus defining a unit pixel as shown in the drawing. The IPS-LCD device **300** further comprises an insulating layer **303** electrically separating the common line **312** and the source line **302**, an insulating layer **305** electrically separating the gate line **304** and the source line **302**, and at least a via **313** electrically connecting the counter electrode **314** with the common line **312**. The counter electrode **314** and the pixel electrode **316** are parallel to each other. In addition, the neighboring electrode of each pixel electrode is

a counter electrode, and vice versa. Furthermore, the TFT **306** of the IPS-LCD device **300** acts as a switch for turning on-and-off of the IPS-LCD device **300**.

[**0018**] In order to further describe the particular features of the present invention, attention is now directed to **FIG. 4A** and **FIG. 4B**, wherein cross-sectional views taken along line IV-IV of **FIG. 3** are illustrated. As shown in **FIG. 4A** and **FIG. 4B**, the IPS-LCD device **300** comprises a substrate **301**, a protrusive layer **308** having a plurality of protrusions **308***a*, **308***b*, **308***c*, **308***d* and **308***e*, at least a counter electrode **314**, at least a pixel electrode **316**, a color filter **309** and liquid crystal material **320**. In **FIG. 4A**, no electric field is supplied to the liquid crystal material **320**. The substrate **301** is made of transparent solid materials such as glass and plastic material. The protrusive layer **308** is formed on the substrate **301**, which is made of organic materials such as a transparent negative photoresist material. The protrusions **308***a*, **308***b*, **308***c*, **308***d* and **308***e* of the protrusive layer **308** are thus formed by means of photolithography techniques. In this particular embodiment, the source line **302** is deposited on protrusive layer **308** not on any of the protrusions **308***a*, **308***b*, **308***c*, **308***d* and **308***e*, while the counter electrode **314** is deposited on the protrusions **308***a*, **308***c* and **308***e*, and the pixel electrode **316** is deposited on the protrusions **308***b* and **308***d*. The deposition of the source line **302**, the counter electrode **314** and the pixel electrode **316** are accomplished by sputtering a transparent conductive material, such as indium-tin-oxide (ITO). The color filter **309** is disposed on and supported by the protrusions **308***a*, **308***b*, **308***c*, **308***d* and **308***e* of the protrusive layer **308**. In contrast to the spacer **107** of the conventional IPS-LCD device **100** as shown in **FIG. 2A** and **FIG. 2***b*, the protrusions **308***a*, **308***b*, **308***c*, **308***d* and **308***e* of the present invention provides room between the color filter **309** and the substrate **301** so as to fill in the liquid crystal material **320**.

[**0019**] **FIG. 4B** illustrates a cross-sectional view taken along line IV-IV of **FIG. 3**, wherein electric field is supplied to the liquid crystal material **320**. As shown in **FIG. 4B**, the electric field supplied to the liquid crystal material **320** adjacent the substrate **301** is approximately equal to that supplied to the liquid crystal material **320** adjacent the color filter **309**. Consequently, the present invention provides a homogeneous electric field distribution on the liquid crystal material **320**, which is advantageous in that the light penetration rate is increased. In addition, the employment of the protrusions **308***a*, **308***b*, **308***c*, **308***d* and **308***e* does not require the employment of the spacer **107**, as shown in **FIG. 2A** and **FIG. 2B**.

[**0020**] In summary, the method for manufacturing an in-plane switching liquid crystal display device of the present invention comprises the steps of: providing a substrate; forming an organic material layer on the substrate; etching the organic material layer by means of a photolithography technique so as to obtain a plurality of protrusions; and depositing a transparent electrode on each of the protrusions. The method further comprises the step of: covering a color filter on the protrusions; and filling in liquid crystal material between the color filter and the substrate.

[**0021**] It is appreciated that the above discussion discloses only a preferred embodiment of the present invention. Any person having ordinary skill in the art may easily find various other embodiments equivalent to the present invention. Therefore, the scope of the present invention is covered by the appended claims as set forth in the following.

What is claimed is:

1. An in-plane switching liquid crystal display device, comprising:

a substrate;

a protrusive layer on said substrate, which includes a plurality of protrusions; and

a transparent electrode deposited on each of the protrusions.

2. The liquid crystal display device of claim 1, wherein said transparent electrode is either a pixel electrode or a counter electrode.

3. The liquid crystal display device of claim 1, wherein said protrusive layer is made of an organic material such as a transparent negative photoresist material.

4. The liquid crystal display device of claim 1, further comprising: a color filter covering said protrusions

5. The liquid crystal display device of claim 4, wherein liquid crystal material is filled in between said substrate and said color filter.

6. A method for manufacturing an in-plane switching liquid crystal display device, comprising the steps of:

(a) providing a substrate;

(b) forming an protrusive layer having a plurality of protrusions on said substrate; and

(c) depositing a transparent electrode on each protrusion of said protrusive layer.

7. The method of claim 6, wherein the step (b) further comprising:

(d) forming an organic material layer on said substrate;

(e) etching the organic material layer by means of a photolithography technique to obtain a plurality of protrusions.

* * * * *

专利名称(译)	面内切换液晶显示装置及其制造方法		
公开(公告)号	US20040196426A1	公开(公告)日	2004-10-07
申请号	US10/818905	申请日	2004-04-05
[标]申请(专利权)人(译)	HSIEH TSAU华 庞贾庞 陈CHEUH JU		
申请(专利权)人(译)	HSIEH TSAU-HUA 庞贾鹏 陈CHEUH-JU		
当前申请(专利权)人(译)	群创光电		
[标]发明人	HSIEH TSAU HUA PANG JIA PANG CHEN CHEUH JU		
发明人	HSIEH, TSAU-HUA PANG, JIA-PANG CHEN, CHEUH-JU		
IPC分类号	G02F1/1335 G02F1/1339 G02F1/1343		
CPC分类号	G02F1/133514 G02F1/134363 G02F1/13394		
优先权	092107707 2003-04-04 TW		
其他公开文献	US7136129		
外部链接	Espacenet USPTO		

摘要(译)

本发明提供一种面内切换液晶显示器（IPS-LCD）装置，其包括基板，在基板上具有许多突起的突出层和在每个突起上的透明电极。可以在突起上设置滤色器并在滤色器和基板之间填充液晶材料。与传统的IPS-LCD设备相比，本发明的IPS-LCD设备不需要使用间隔物。因此，本发明可以在很大程度上提高光穿透率并简化制造工艺。