



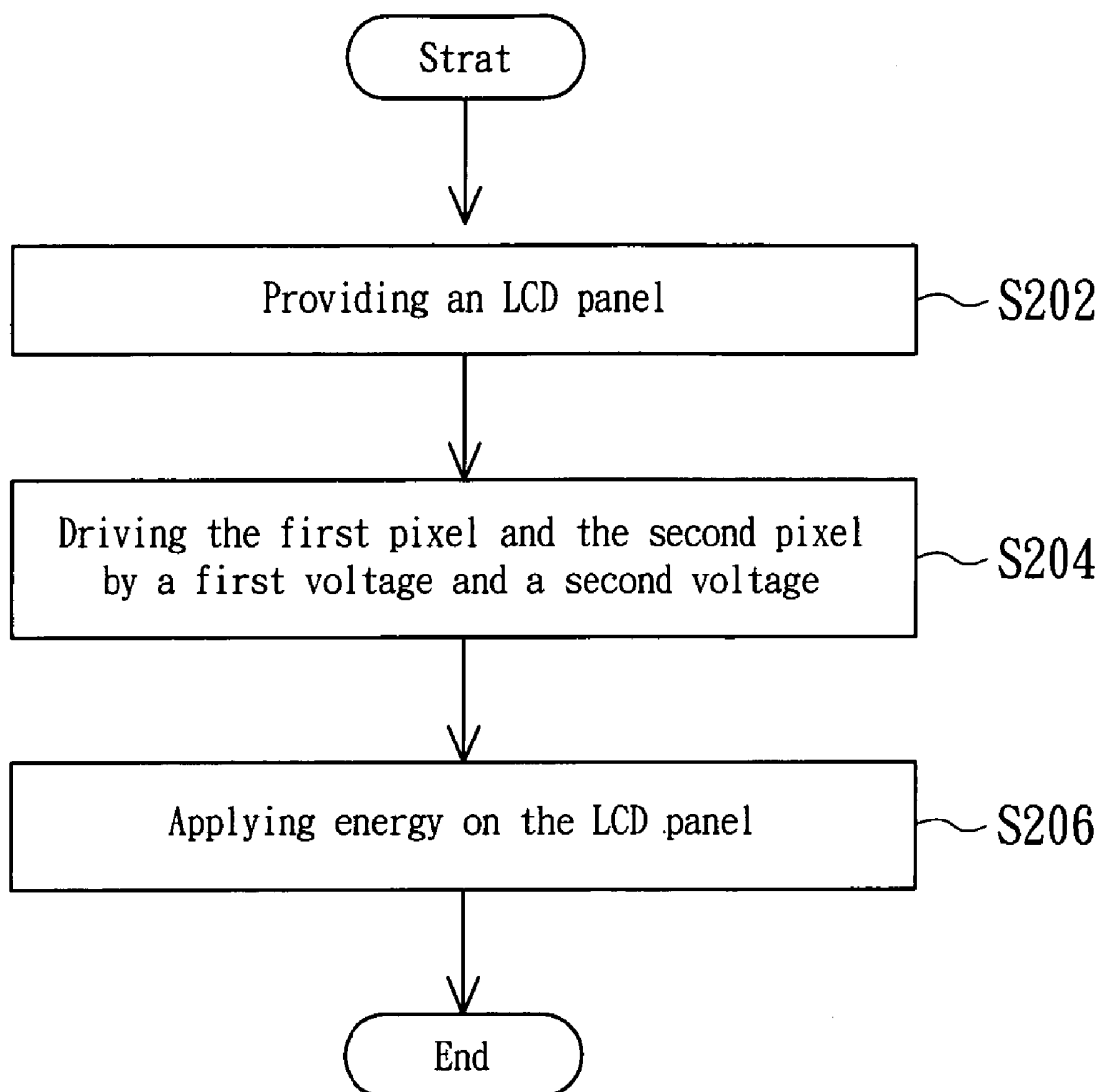
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(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2006/0279502 A1**
Chang (43) **Pub. Date: Dec. 14, 2006**(54) **METHOD FOR FABRICATING LIQUID
CRYSTAL DISPLAY PANEL****Publication Classification**(51) **Int. Cl.**
G09G 3/36 (2006.01)(52) **U.S. Cl.** **345/95**(76) Inventor: **Hao-Yu Chang**, Jhubei City (TW)Correspondence Address:
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WASHINGTON, DC 20005 (US)(57) **ABSTRACT**

A method for fabricating a liquid crystal display (LCD) is provided. The method includes the steps stated below. At first, providing an LCD panel including a first substrate, a second substrate and a liquid crystal layer therebetween. The liquid crystal layer includes several photo-sensitive monomers and several liquid crystal molecules. The LCD panel has at least a first pixel and a second pixel. Afterwards, correspondingly driving the first pixel and the second pixel by the first voltage and the second voltage. At last, applying a ultra-violet source onto the LCD panel to enable several photo-sensitive monomers to polymerize several alignment polymers on the first substrate and the second substrate.

(21) Appl. No.: **11/296,382**(22) Filed: **Dec. 8, 2005**(30) **Foreign Application Priority Data**

Jun. 8, 2005 (TW)..... 94118964



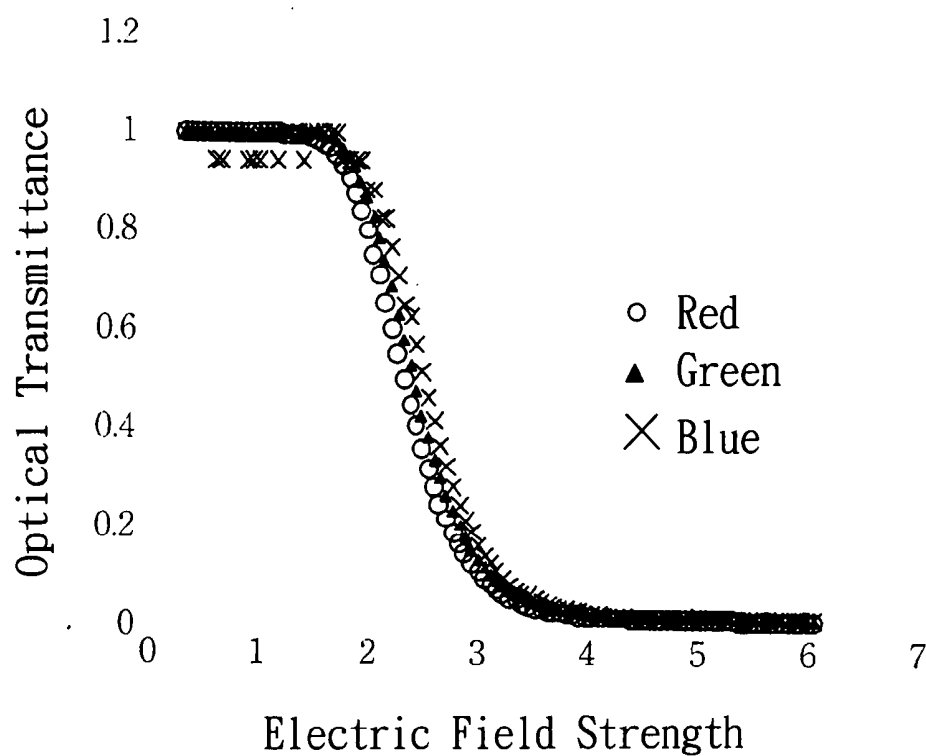


FIG. 1

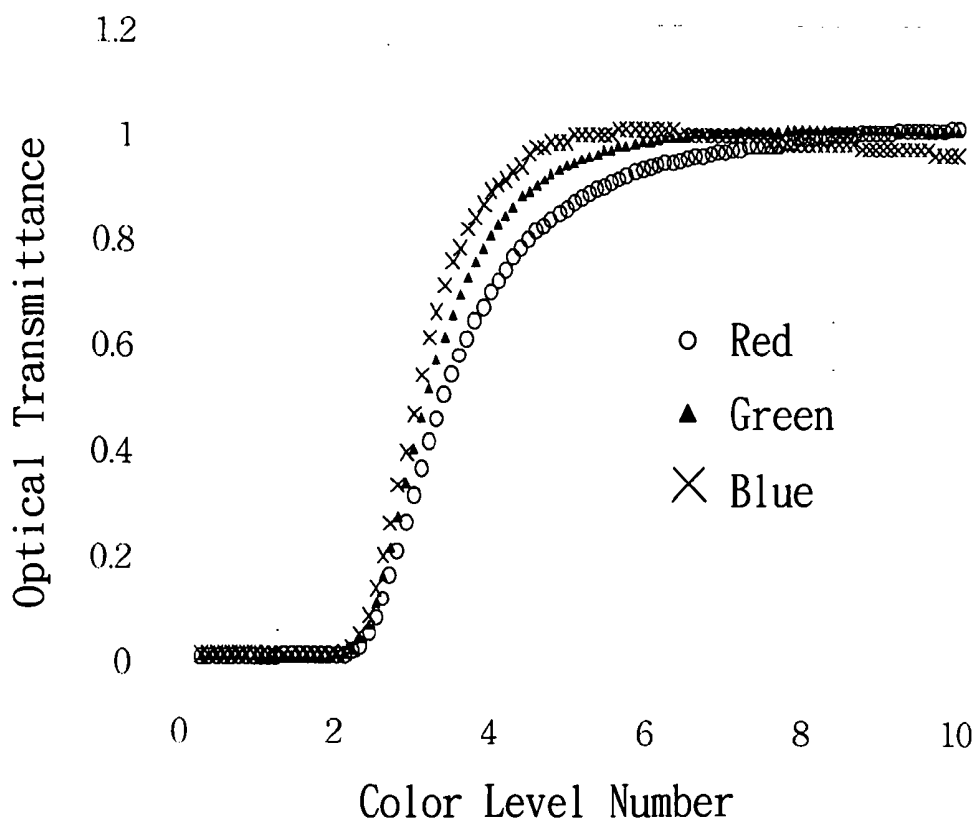


FIG. 2

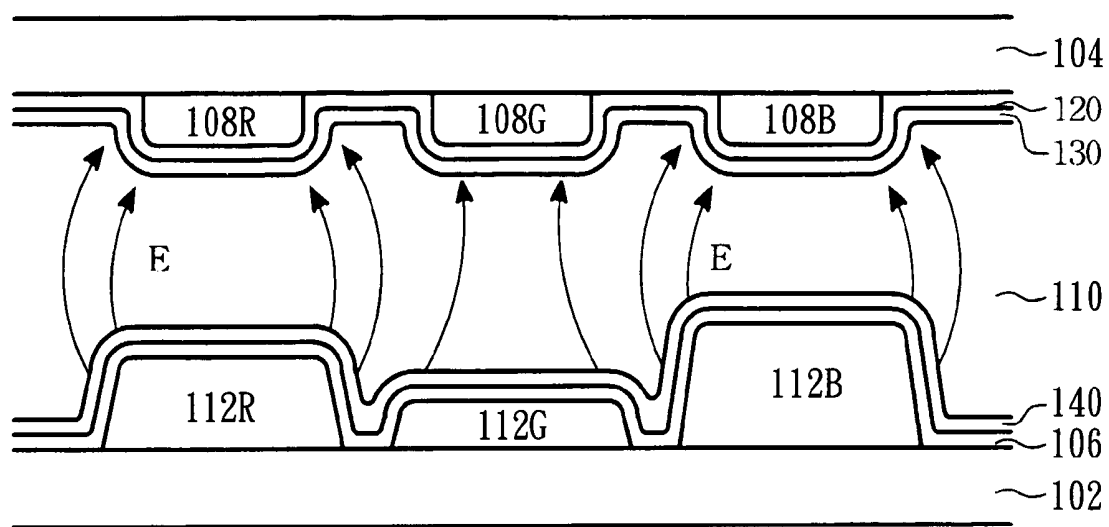


FIG. 3(RELATED ART)

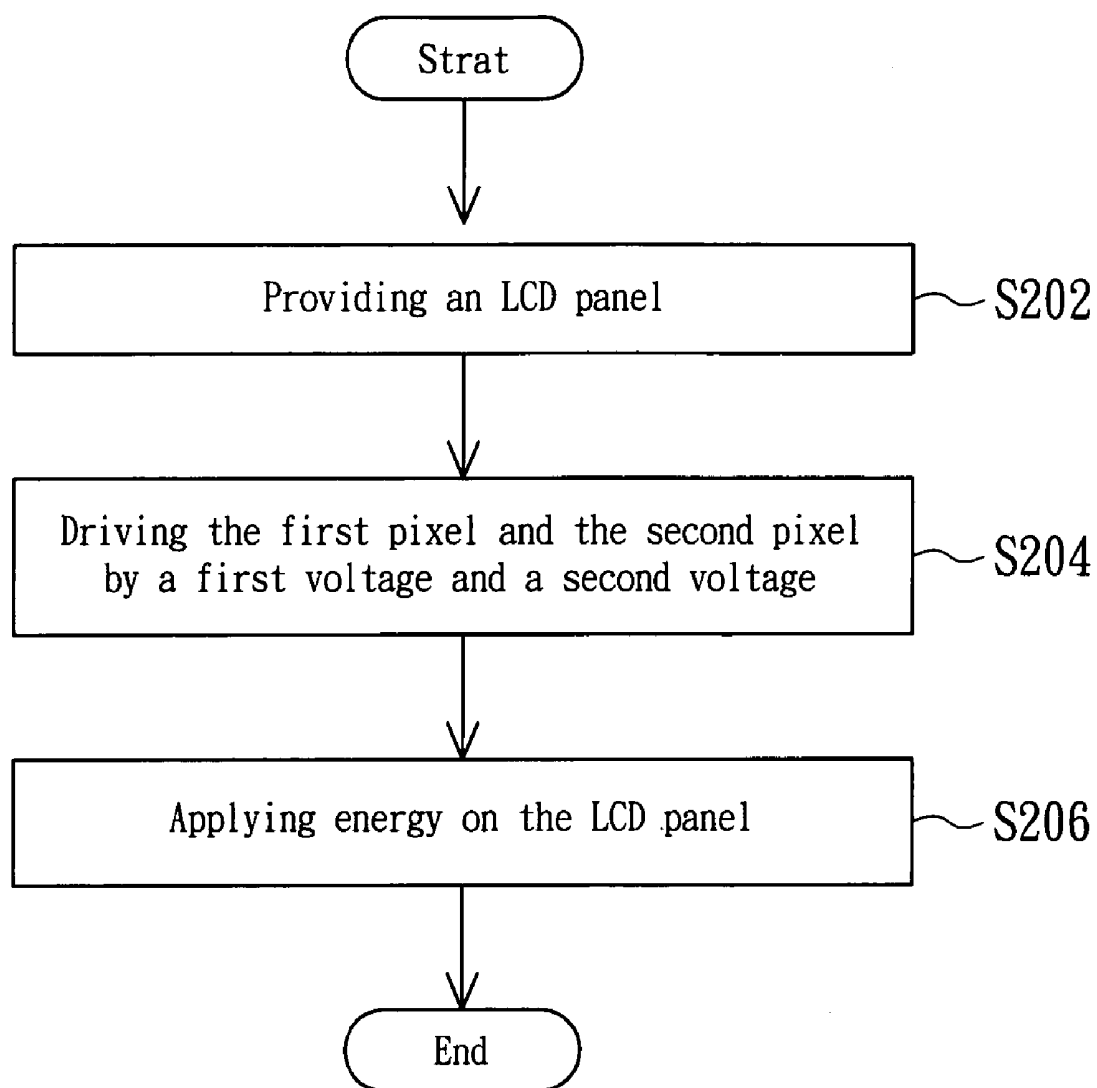


FIG. 4

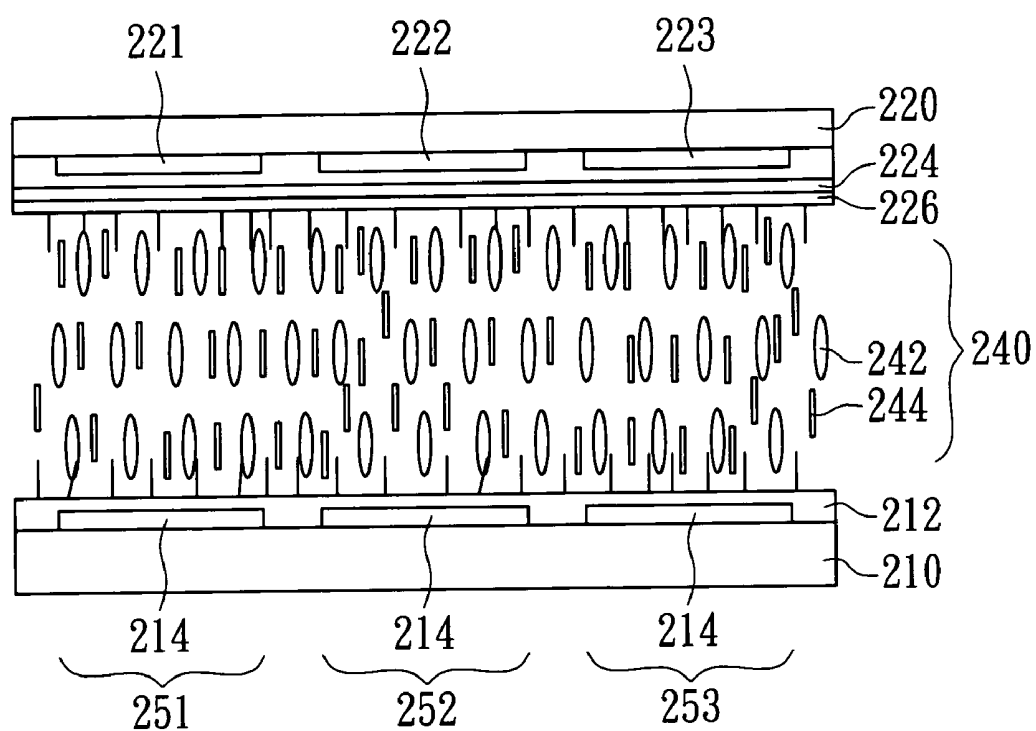


FIG. 5A

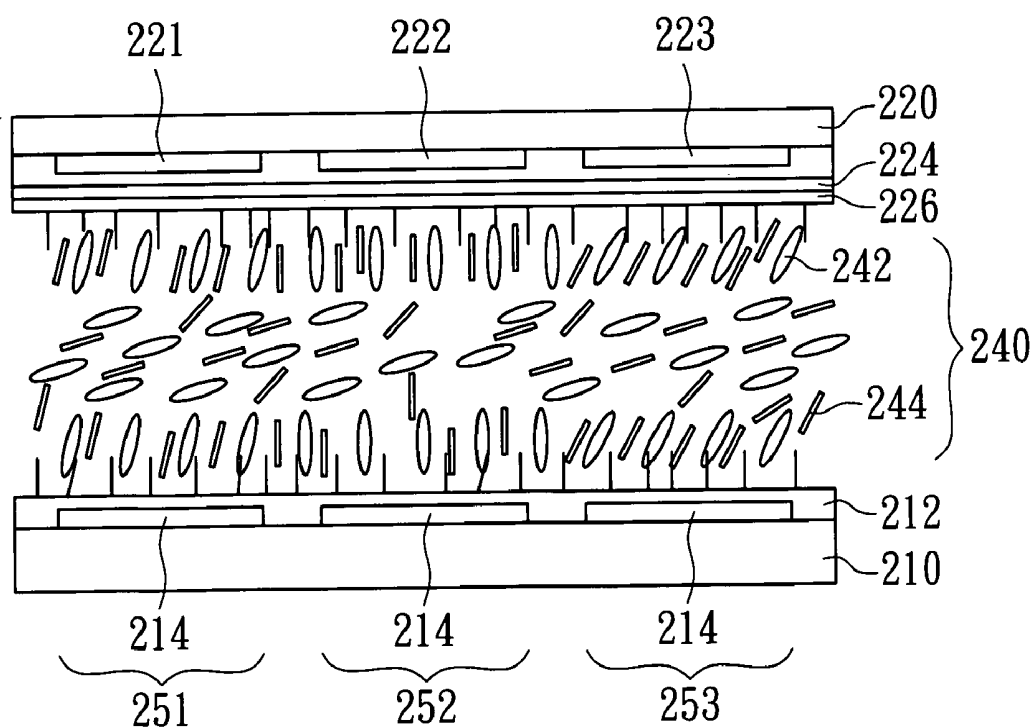


FIG. 5B

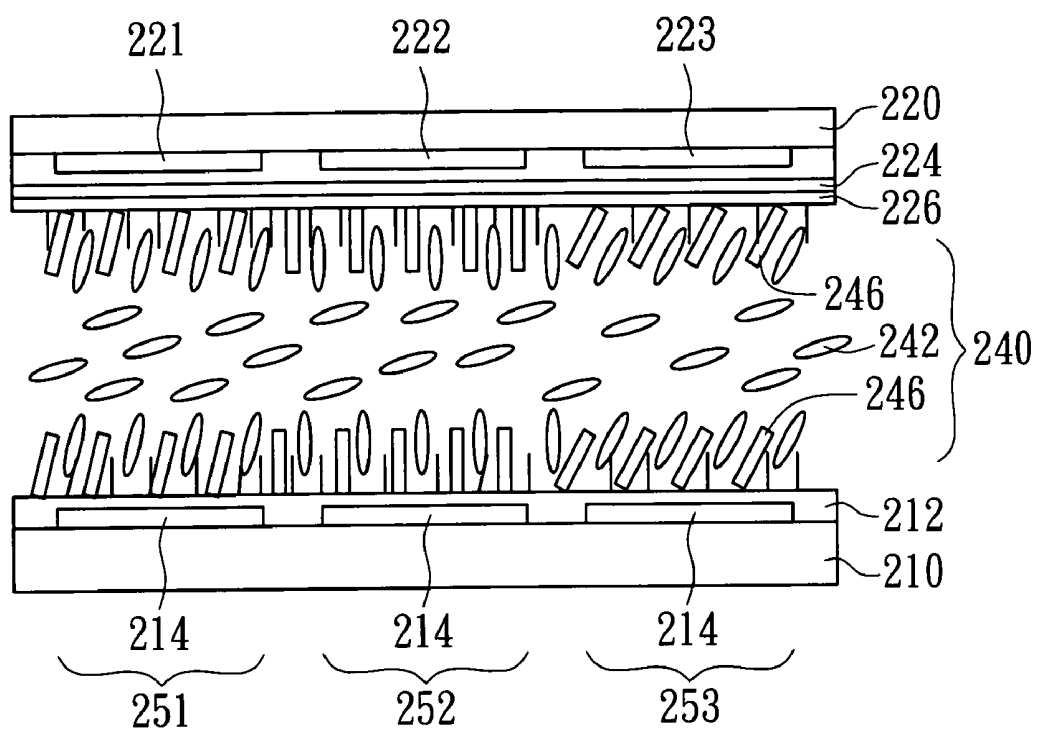


FIG. 5C

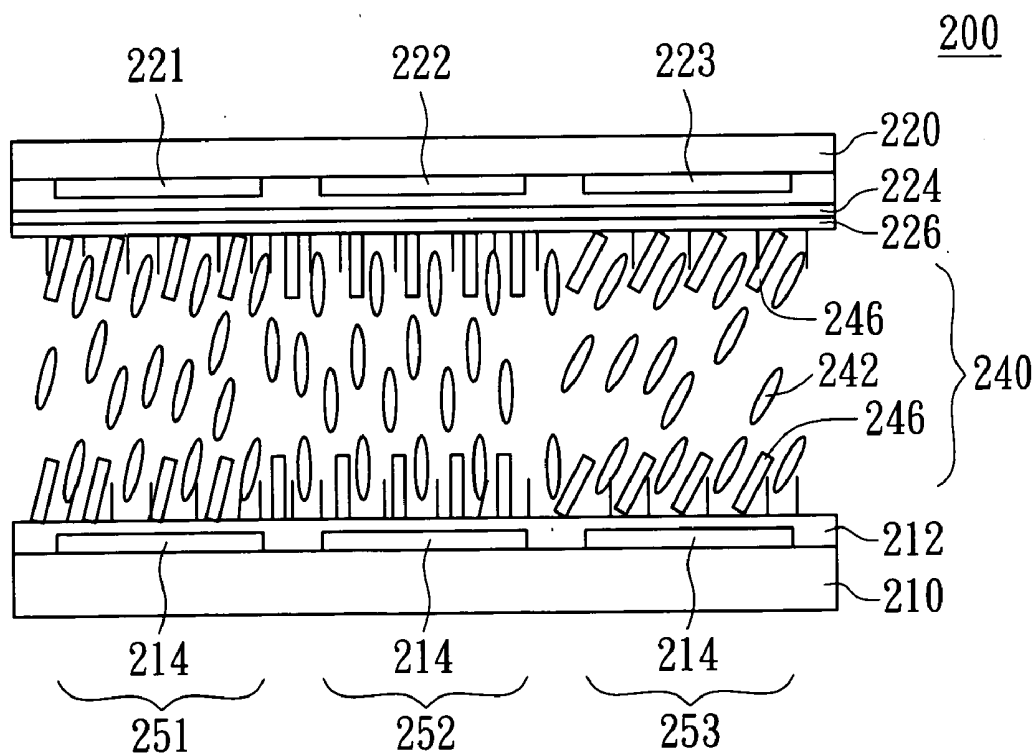


FIG. 5D

METHOD FOR FABRICATING LIQUID CRYSTAL DISPLAY PANEL

[0001] This application claims the benefit of Taiwan Application Serial No. 094118964, filed Jun. 08, 2005, the subject matter of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates in general to a method for fabricating a liquid crystal display (LCD) panel, and more particularly to a method for fabricating an LCD panel with Gamma correction function.

[0004] 2. Description of the Related Art

[0005] Referring to **FIG. 1**, a diagram showing the optical transmittance of conventional pixel components corresponding to RGB illuminators under different drive electrical fields is shown. The horizontal coordinate corresponds to the electrical field strength, and the vertical coordinate corresponds to the optical transmittance. The liquid crystal molecules have different degrees of refractivity and retardation towards visible light of different wavelengths. Therefore, when driven by the same strength of electrical field, the conventional pixel components have different transparencies corresponding to RGB illuminators.

[0006] Normally, Gamma curve is used to quantify a viewer's visual perception in the design of LCD monitor circuit. Gamma curve describes the relationship between the photo-transparency of a liquid crystal layer and the corresponding luminance perceived by the viewer. The luminance perceived by the viewer is inferred from the driving electrical field strength of the liquid crystal layer. **FIG. 2** is a diagram showing the Gamma curves of a LCD monitor corresponding to the relationship between the electric field and the transmittance in **FIG. 1**. The horizontal coordinate corresponds to color level number, while the vertical coordinate corresponds to the optical transmittance. As shown in **FIG. 2**, the Gamma curves for the red light, the green light and the blue light are different and separate. This implies that when the electrical fields of the same strength are provided to the liquid crystal layer, the luminance of the red light, the luminance of the green light and the luminance of the blue light cannot maintain a constant ratio, and would deviate from the predetermined white balance of the LCD monitor. Consequently, bias would occur between the display colors as viewed by the viewer and the display signal as inputted.

[0007] The method to resolve the above problem can be categorized into two aspects: the circuit and the structure. In terms of structure, the typical method is to change the electric field strength applied to the liquid crystal layers of different color pixels by directly adjusting the thickness of the liquid crystal layer which is disposed inside the LCD monitor and corresponds to the display of the RGB pixels. Referring to **FIG. 3**, a cross-sectional view of a conventional LCD monitor is shown. In **FIG. 3**, a liquid crystal layer **110** is formed between a first substrate **102** and a second substrate **104**. Moreover, three transparent organic layers **112R**, **112G** and **112B** of various thicknesses corresponding to pixels of different colors are respectively disposed on the top surface of the first substrate **102**, while three color filters **108R**, **108G** and **108B** corresponding to pixels of different colors are disposed on the bottom surface of the second

substrate **104**. The pixel electrode **106** of the RGB pixels is disposed on the top surface of the above transparent organic layers **112R**, **112G** and **112B**, and a common electrode **120** is disposed on the bottom surface of the color filters **108R**, **108G** and **108B**, so as to generate a driving electric field **E** in the liquid crystal layer **110**. Besides, two alignment films **130** and **140** are respectively disposed on the surface of the common electrode **120** and that of the pixel electrode **106** for the alignment of the liquid crystal layer **110**.

[0008] It is noteworthy that the transparent organic layers **112R**, **112G** and **112B** are different in thickness, causing the corresponding liquid crystal layer **110** to have different thickness and the corresponding driving electrical field to have different strength in consequence. It can be seen from the above disclosure that by adjusting the thicknesses of the above transparent organic layers **112R**, **112G** and **112B**, the strength of the driving electric field is changed, the alignment of the liquid crystal molecules in the liquid crystal layer **110** is adjusted, the optical transmittance of the liquid crystal layer **110** is changed, and finally the object of calibrating and separating the RGB Gamma curves is achieved.

[0009] However, the above solution still has the following disadvantages:

[0010] 1. An extra manufacturing process of fabricating the transparent organic layers **112R**, **112G** and **112B** is required prior to fabricating the pixel electrode, resulting in an increase in terms of manufacturing cost and manufacturing time.

[0011] 2. The transparent organic layers **112R**, **112G** and **112B** have different thicknesses in respective positions corresponding to the pixels of different colors, resulting in a bumpy surface of the transparent organic layers, making it more difficult in forming the alignment film **140** on the surface of the pixel electrode **106** in subsequent liquid crystal alignment process.

[0012] 3. The pixel electrode **106** covers the bumpy surface of the transparent organic layer **112R**, **112G** and **112B**. Since the transparent organic layers **112R**, **112G** and **112B** of different colors have different thicknesses, a horizontal electric field occurs between adjacent pixels electrodes **106** of different colors, and the alignment of the liquid crystal molecules and the normal operation of the liquid crystal layer **110** would be affected.

SUMMARY OF THE INVENTION

[0013] It is therefore the object of the invention to provide a method for fabricating a liquid crystal display (LCD) panel.

[0014] According to an object of the invention, a method for fabricating a liquid crystal display (LCD) panel is provided. The method includes the steps stated below. At first, an LCD panel assembly including a first substrate, a second substrate and a liquid crystal layer therebetween is provided. The liquid crystal layer includes several photo-sensitive monomers and several liquid crystal molecules. The LCD panel assembly has at least a first pixel and a second pixel. Afterwards, the first pixel and the second pixel are respectively driven by the first voltage and the second voltage. At last, energy, a ultra-violet (UV) for example, is applied onto the LCD panel assembly to enable several

photo-sensitive monomers to polymerize several alignment polymers on the first substrate or the second substrate.

[0015] According to another object of the invention, a method for fabricating a liquid crystal display (LCD) panel is provided. The method includes the steps stated below. At first, a first substrate and a second substrate are provided. Next, a liquid crystal layer is formed between the first substrate and the second substrate to form an LCD panel assembly. The liquid crystal layer has several liquid crystal molecules and several photo-sensitive monomers. The LCD panel assembly has a first pixel, a second pixel and a third pixel. Then, the first pixel, the second pixel and the third pixel are respectively driven by a first voltage, a second voltage and a third voltage. Afterwards, energy is applied to the LCD panel assembly to enable several photo-sensitive monomers to polymerize several alignment polymers on the first substrate or the second substrate. At last, the first voltage, the second voltage and third voltage are removed.

[0016] Other objects, features, and advantages of the invention will become apparent from the following detailed description of the preferred but non-limiting embodiments. The following description is made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] **FIG. 1** is a diagram showing the optical transmittance of conventional pixel components corresponding to RGB illuminators under different drive electrical fields is shown;

[0018] **FIG. 1** is a diagram showing the optical transmittance of conventional pixel components corresponding to RGB illuminators under different driving electric fields;

[0019] **FIG. 2** is a diagram showing the Gamma curves of an LCD monitor corresponding to the relationship between the electric field and the transmittance in **FIG. 1**;

[0020] **FIG. 3** (Related Art) is a cross-sectional view of a conventional LCD monitor;

[0021] **FIG. 4** is a method flowchart for fabricating an LCD panel according to an embodiment of the invention; and

[0022] **FIGS. 5A-5D** are diagrams showing a method for fabricating an LCD according to an embodiment of the invention.

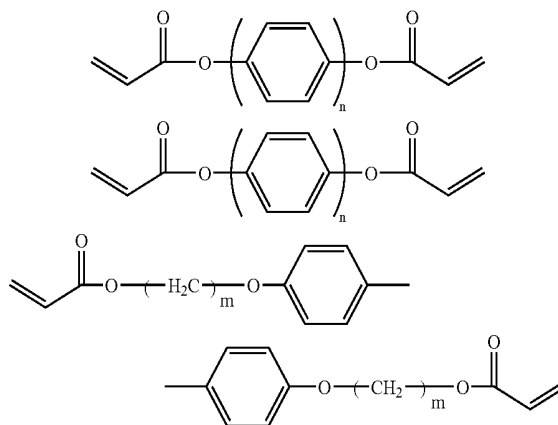
DETAILED DESCRIPTION OF THE INVENTION

[0023] The photo-alignment method is applying a ultra-violet (UV) light with a predetermined polarization direction onto a photo-sensitive material. The photo-sensitive material absorbs the energy of the UV light by a specific functional group and generates molecular re-arrangement to achieve an alignment similar to that achieved in a conventional rubbing manufacturing process. The photo-sensitive material possesses the feature of photo-alignment through a UV light exposure response. Therefore, relevant exposure parameters such as duration, intensity of light source, and incident angle of light source all affect the result of photo-alignment.

[0024] **FIG. 4** is a flowchart illustrating a method for fabricating an LCD panel according to a preferred embodi-

ment of the invention. **FIG. 5A-5D** are diagrams showing a method for fabricating an LCD panel according to a preferred embodiment of the invention. Referring to **FIG. 4-5D** at the same time, the method for fabricating a liquid crystal display (LCD) panel **200** of the preferred embodiment includes steps **S202-S206** stated below.

[0025] At first, as shown in step **S202** and **FIG. 5A**, an LCD panel assembly is provided with the detailed steps stated below. Firstly, a first substrate **210** and a second substrate **220** are provided. The first substrate **210** has a pixel array and an alignment film **212**. The pixel array includes several pixel electrodes **214**; several scan lines, several data lines and several thin film transistors (TFTs). Several pixel regions are defined by several scan lines and several data lines. Each pixel region, defined by a pair of adjacent scan lines and a pair of adjacent data lines, has a TFT (not shown here) and a pixel electrode **216** disposed therein. The TFT is used for selectively conducting the pixel electrode **214**. The alignment film **212**, disposed between the first substrate **210** and the liquid crystal layer **240**, is used for controlling the liquid crystal molecules **242** to achieve single-directional alignment so that a uniform image display is obtained. Meanwhile, the alignment film **212** improves the display quality of the LCD panel assembly by providing a pre-inclination to the liquid crystal molecules **242** and controlling the liquid crystal molecules **242** to have prompt single-directional response towards external-electromagnetic field. The alignment film **212** is mainly made of polymer resin such as polyimide (PI). The second substrate **220** has a first color film **221**, a second color film **222**, a common electrode **224** and an alignment film **226**. The alignment film **226**, disposed between the second substrate **220** and the liquid crystal layer **240**, is used for controlling the liquid crystal molecules **242** to achieve single-directional alignment and provide a pre-inclination. Next, the liquid crystal layer **240** is disposed between the first substrate **210** and the second substrate **220** to form an LCD panel assembly. The liquid crystal layer **240** has several liquid crystal molecules **242** and several photo-sensitive monomers **244**. The chemical structure of the photo-sensitive monomers is formulated as:



[0026] In above formula, n and m are positive integers. In the embodiment, n and m are set to be $n=1$ or 2 ; $m=2$.

[0027] It is noteworthy that the LCD panel assembly with the first substrate **210** and the second substrate **220** being

assembled includes a first pixel 251 and a second pixel 252. By adjusting the voltage applied to the pixel electrode 214 and the common electrode 224, the alignment in the liquid crystal molecules 242 of the liquid crystal layer 240 will be changed, and so will the polarization direction of the light passing through the liquid crystal layer 240 be changed accordingly. After the light passing through the liquid crystal layer 240 penetrates the first color film 221 and the second color film 222 respectively, a first color and a second color are displayed. Preferably, the LCD panel assembly further includes a third pixel 253 and the second substrate 220 further includes a third color film 223, so that the light passing through the liquid crystal layer 240 penetrates the third color film 223 to display a third color. The first color, the second color, and the third color respectively can be the red color, the green color and the blue color. By mixing the red light, the green light and the blue light, the light of whatever colors can be obtained. In the present embodiment, FIG. 5A is exemplified by the LCD panel assembly has the first pixel 251, the second pixel 252 and the third pixel 253.

[0028] Next, as shown in step S204 and FIG. 5B, the first pixel 251 and the second pixel 252 are respectively driven by the first voltage and second voltage. Preferably, the first voltage and the second voltage are different, and approximately range from 0V to 17V. Besides, the LCD panel assembly further includes a third pixel 253, so the present step further includes the step of driving third pixel 253 by the third voltage. Preferably, the first voltage, the second voltage and the third voltage are different, and approximately range from 0V to 40V. When a voltage is applied to a pixel, the liquid crystal molecules 242 corresponding to the pixel region would rotate a certain angle due to the influence of the field. When the first voltage is applied to the first pixel 251, the liquid crystal molecules 242 would rotate a certain angle due to the influence of the field. Meanwhile, the photo-sensitive monomers 244 corresponding to the first pixel would be affected by the liquid crystal molecules and thus aligned in the same angle. Similarly, when the second voltage and the third voltage are respectively applied to the second pixel 252 and the third pixel 253, the photo-sensitive monomers 244 corresponding to the second pixel 252 and the third pixel 253 would be affected by the liquid crystal molecules and thus aligned in the same angle. The first voltage, the second voltage and the third voltage are different, so the rotation angle of the liquid crystal molecules and the photo-sensitive monomers in respect to the first pixel 251, the second pixel 252 and the third pixel 253 would also be distinct.

[0029] The first, second, and third voltage approximately range from 0V to 25V, and preferably from 0V to 17V. Preferably, the driving voltages can be pre-determined according to the original Gamma voltage curves of the first pixel 251, the second pixel 252 and the third pixel 253. For example, if the first pixel 251 is a red pixel (R), that is, the first color film 221 is a red film layer, then the first voltage between the common electrode 224 and the pixel electrode 214 approximately ranges from 0.5V to 45V, preferably from 0.5V to 33V. If the first pixel 251 is a green pixel (G), then the first voltage approximately ranges from 1V to 47V, preferably from 1V to 35V. If the first pixel is a blue pixel (B), then the first voltage approximately ranges from 1.5V to 49V, preferably from 1.5V to 37V.

[0030] It is noteworthy that the steps of driving first pixel 251 by the first voltage, driving second pixel 252 by the second voltage, and driving third pixel 253 by the third voltage can be performed either simultaneously or sequentially.

[0031] At last, as shown in step S206 and FIG. 5C, energy, a ultra-violet light for example, is applied onto the LCD panel assembly, enabling the photo-sensitive monomers 244 to polymerize several alignment polymers 246 on the first substrate 210 or the second substrate 220. In the FIG. 5C, the alignment polymers are formed on the first substrate 210 and the second substrate 220. The alignment polymers 246 preferably have the thickness of about 1000Å. When the first voltage, the second voltage and the third voltage are applied, the photo-sensitive monomers 244 and the liquid crystal molecules 242 are arranged according to a pre-determined angle. The photo-sensitive monomers 244, which are gradually moved towards the surface of the first substrate 210 and that of the second substrate 220, polymerize the alignment polymers 246 under the irradiation of the UV light. Preferably, the first voltage, the second voltage and the third voltage are removed. Under the influence of the alignment polymers 246, the liquid crystal molecules 242 manifest different pre-inclinations in respect to the first pixel 251, the second pixel 252 and the third pixel 253. At last, the LCD panel 200 is completed as shown in FIG. 5D. By doing so, the alignment polymers 246 polymerized under a pre-determined voltage would have a fixed molecular direction first and then facilitate the liquid crystal molecules 242 to be aligned, enabling the liquid crystal molecules 242 of the pixel to have a predetermined pre-inclination. Particularly in the previous step of applying different predetermined voltages to different color pixels, the liquid crystal molecules of different color pixels have different pre-inclinations. When applying the same voltage to different color pixels, each color pixel possesses the same transparency. That is, the voltage-transparency (V-T) curve of each color pixel is the same. Thus, the LCD panel of the present embodiment is equipped with Gamma correction function and is free of color distortion when digital data are converted into image data.

[0032] According to the LCD panel and the manufacturing method thereof disclosed in above embodiment of the invention, the liquid crystal layer includes several alignment polymers polymerized by several photo-sensitive monomers, equipping the LCD panel of the embodiment with Gamma correction function. By doing so, the V-T curve of each color pixel is the same and is free of color distortion when digital data are converted into image data. In the manufacturing process of the present manufacturing method, several photo-sensitive monomers are added to the liquid crystal layer, different voltages are applied to different color pixels, and then energy is applied to the panel. The manufacturing process is simple and incurs no increase in manufacturing cost.

[0033] While the invention has been described by way of example and in terms of a preferred embodiment, it is to be understood that the invention is not limited thereto. On the contrary, it is intended to cover various modifications and similar arrangements and procedures, and the scope of the appended claims therefore should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements and procedures.

What is claimed is:

1. A method for fabricating a liquid crystal display (LCD) panel, comprising:

providing an LCD panel assembly, which comprises a first substrate, a second substrate and a liquid crystal layer therebetween, wherein the liquid crystal layer comprises a plurality of photo-sensitive monomers and a plurality of liquid crystal molecules, and the LCD panel assembly further comprises a first pixel and a second pixel;

driving the first and the second pixel by a first voltage and a second voltage, respectively; and

applying energy on the LCD panel assembly to enable the photo-sensitive monomers to polymerize a plurality of alignment polymers on the first substrate or the second substrate.

2. The method for fabricating an LCD panel according to claim 1, further comprising:

driving a third pixel of the LCD panel by a third voltage.

3. The method for fabricating an LCD panel according to claim 2, wherein the first voltage, the second voltage and the third voltage are different.

4. The method for fabricating an LCD panel according to claim 2, wherein the first voltage, the second voltage and the third voltage approximately range from 0V to 50V.

5. The method for fabricating an LCD panel according to claim 4, wherein the first voltage, the second voltage and the third voltage are different.

6. The method for fabricating an LCD panel according to claim 2, wherein the first voltage, the second voltage and the third voltage approximately range from 0V to 40V.

7. The method for fabricating an LCD panel according to claim 1, wherein driving the first pixel by the first voltage and driving the second pixel by the second voltage are performed simultaneously.

8. The method for fabricating an LCD panel according to claim 1, wherein driving the first pixel by the first voltage and driving the second pixel by the second voltage are performed sequentially.

9. The method for fabricating an LCD panel according to claim 1, wherein the first pixel is a red pixel, and the first voltage approximately ranges from 0.5V to 45V.

10. The method for fabricating an LCD panel according to claim 1, wherein the first pixel is a red pixel, and the first voltage approximately ranges from 0.5V to 33V.

11. The method for fabricating an LCD panel according to claim 1, wherein the first pixel is a green pixel, and the first voltage approximately ranges from 1V to 47V.

12. The method for fabricating an LCD panel according to claim 1, wherein the first pixel is a green pixel, and the first voltage approximately ranges from 1V to 35V.

13. The method for fabricating an LCD panel according to claim 1, wherein the first pixel is a blue pixel, and the first voltage approximately ranges from 1.5V to 49V.

14. The method for fabricating an LCD panel according to claim 1, wherein the first pixel is a blue pixel, and the first voltage approximately ranges from 1.5V to 37V.

15. The method for fabricating an LCD panel according to claim 1, wherein the first voltage and the second voltage are different.

16. The method for fabricating an LCD panel according to claim 1, wherein the first voltage and the second voltage approximately range from 0V to 25V.

17. The method for fabricating an LCD panel according to claim 1, wherein the first voltage and the second voltage approximately range from 0V to 17V.

18. The method for fabricating an LCD panel according to claim 17, wherein the first voltage and the second voltage are different.

19. A method for fabricating a liquid crystal display (LCD) panel, comprising:

providing a first substrate and a second substrate;

forming a liquid crystal layer between the first substrate and the second substrate to form an LCD panel assembly, wherein the liquid crystal layer comprises a plurality of liquid crystal molecules and a plurality of photo-sensitive monomers, while the LCD panel assembly has a first pixel, a second pixel and a third pixel;

driving the first pixel, the second pixel and the third pixel by a first voltage, a second voltage and a third voltage, respectively;

applying energy to the LCD panel assembly to enable the photo-sensitive monomers to polymerize a plurality of alignment polymers on the first substrate or the second substrate; and

removing the first voltage, the second voltage and the third voltage.

20. The method for fabricating an LCD panel according to claim 19, wherein driving the first pixel by the first voltage, driving the second pixel by the second voltage and driving the third pixel by the third voltage are performed simultaneously.

21. The method for fabricating an LCD panel according to claim 19, wherein driving the first pixel by the first voltage, driving the second pixel by the second voltage and driving the third pixel by the third voltage are performed sequentially.

22. The method for fabricating an LCD panel according to claim 19, wherein the first pixel is a red pixel, and the first voltage approximately ranges from 0.5V to 45V.

23. The method for fabricating an LCD panel according to claim 19, wherein the first pixel is a red pixel, and the first voltage approximately ranges from 0.5V to 33V.

24. The method for fabricating an LCD panel according to claim 19, wherein the first pixel is a green pixel, and the first voltage approximately ranges from 1.0V to 47V.

25. The method for fabricating an LCD panel according to claim 19, wherein the first pixel is a green pixel, and the first voltage approximately ranges from 1.0V to 35V.

26. The method for fabricating an LCD panel according to claim 19, wherein the first pixel is a blue pixel, and the first voltage approximately ranges from 1.5V to 49V.

27. The method for fabricating an LCD panel according to claim 19, wherein the first pixel is a blue pixel, and the first voltage approximately ranges from 1.5V to 37V.

28. The method for fabricating an LCD panel according to claim 19, wherein the first voltage, the second voltage and the third voltage approximately range from 0V to 25V.

29. The method for fabricating an LCD panel according to claim 19, wherein the first voltage, the second voltage and the third voltage approximately range from 0V to 17V.

专利名称(译)	制造液晶显示板的方法		
公开(公告)号	US20060279502A1	公开(公告)日	2006-12-14
申请号	US11/296382	申请日	2005-12-08
[标]申请(专利权)人(译)	昌豪YU		
申请(专利权)人(译)	常昊宇		
当前申请(专利权)人(译)	友达光电.		
[标]发明人	CHANG HAO YU		
发明人	CHANG, HAO-YU		
IPC分类号	G09G3/36		
CPC分类号	G02F1/133788 G09G3/36 Y10T428/1005 Y10T428/10 G09G2320/0276		
优先权	094118964 2005-06-08 TW		
其他公开文献	US7728934		
外部链接	Espacenet USPTO		

摘要(译)

提供一种制造液晶显示器 (LCD) 的方法。该方法包括下述步骤。首先, 提供包括第一基板, 第二基板和其间的液晶层的LCD面板。液晶层包括几种光敏单体和几种液晶分子。 LCD面板至少具有第一像素和第二像素。之后, 相应地通过第一电压和第二电压驱动第一像素和第二像素。最后, 将紫外光源施加到LCD面板上, 使几种光敏单体能够聚合第一基板和第二基板上的几种取向聚合物。

