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(19) **United States**(12) **Patent Application Publication**
KIM et al.(10) **Pub. No.: US 2011/0122358 A1**(43) **Pub. Date: May 26, 2011**(54) **LIQUID CRYSTAL DISPLAY AND METHOD
FOR MANUFACTURING THE SAME****C08J 7/18** (2006.01)
B29C 59/02 (2006.01)(76) Inventors: **Jang-Kyum KIM**, Seoul (KR);
Hee-Keun Lee, Suwon-si (KR);
Nak-Cho Choi, Seoul (KR)(52) **U.S. Cl. 349/156; 427/58; 427/510; 264/293**(21) Appl. No.: **12/906,962**(57) **ABSTRACT**(22) Filed: **Oct. 18, 2010**(30) **Foreign Application Priority Data**

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A method of manufacturing a liquid crystal display including a cholesteric liquid crystal and having a first insulation substrate and a second insulation substrate that face each other, the method comprising: forming an organic layer on the first insulation substrate or the second insulation substrate; pressing a mold onto the organic layer; hardening the organic layer; and removing the mold so as to form a cell gap formation pattern in the organic layer, the cell gap formation pattern including first, second, and third portions each having different thicknesses.

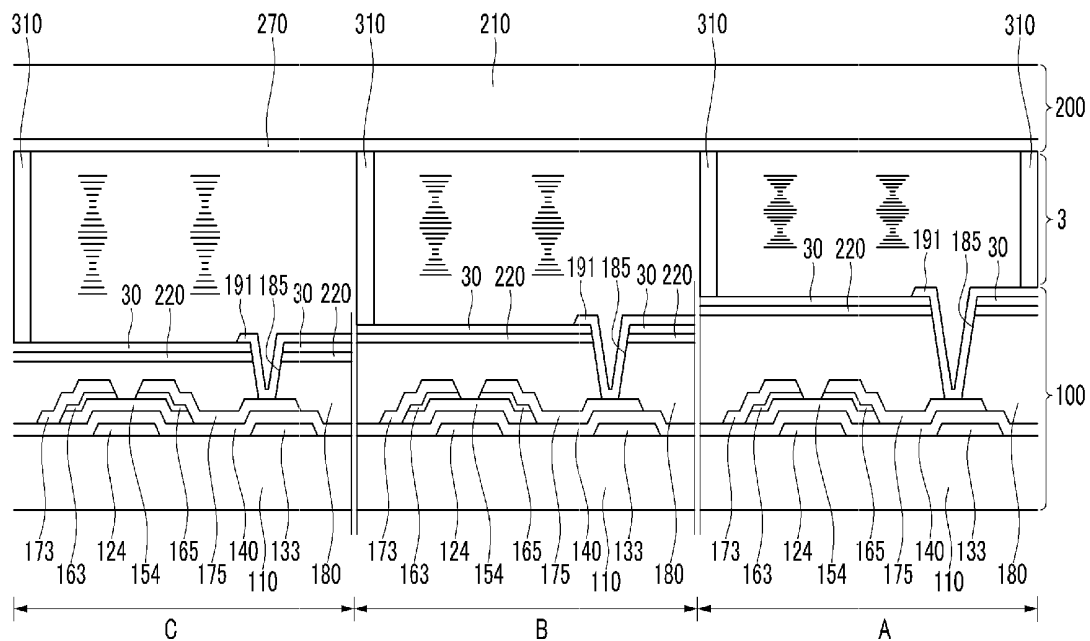


FIG.3

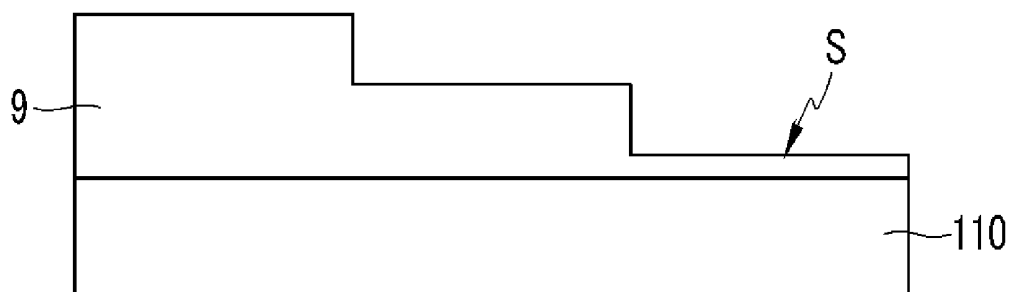


FIG. 4

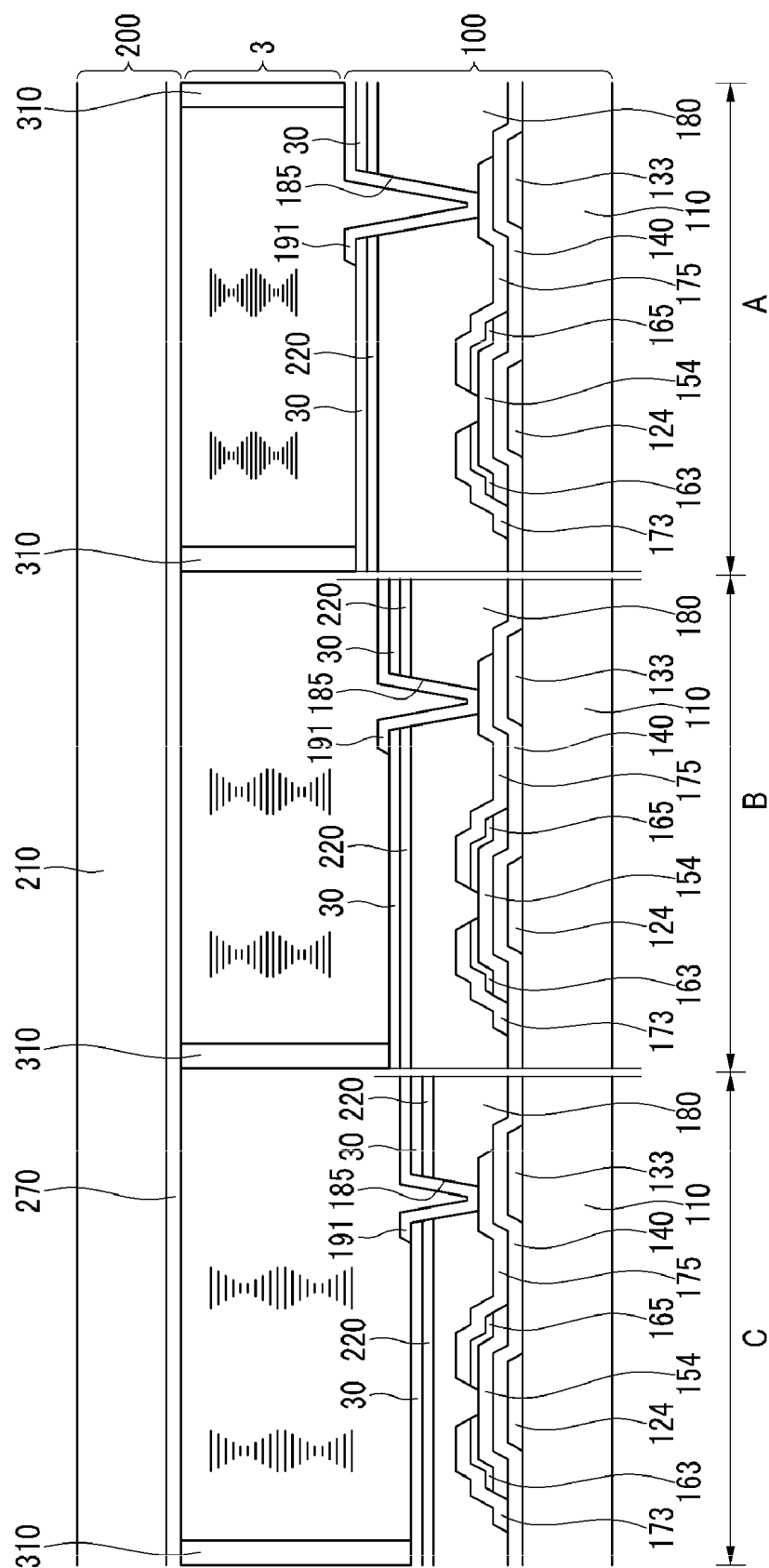
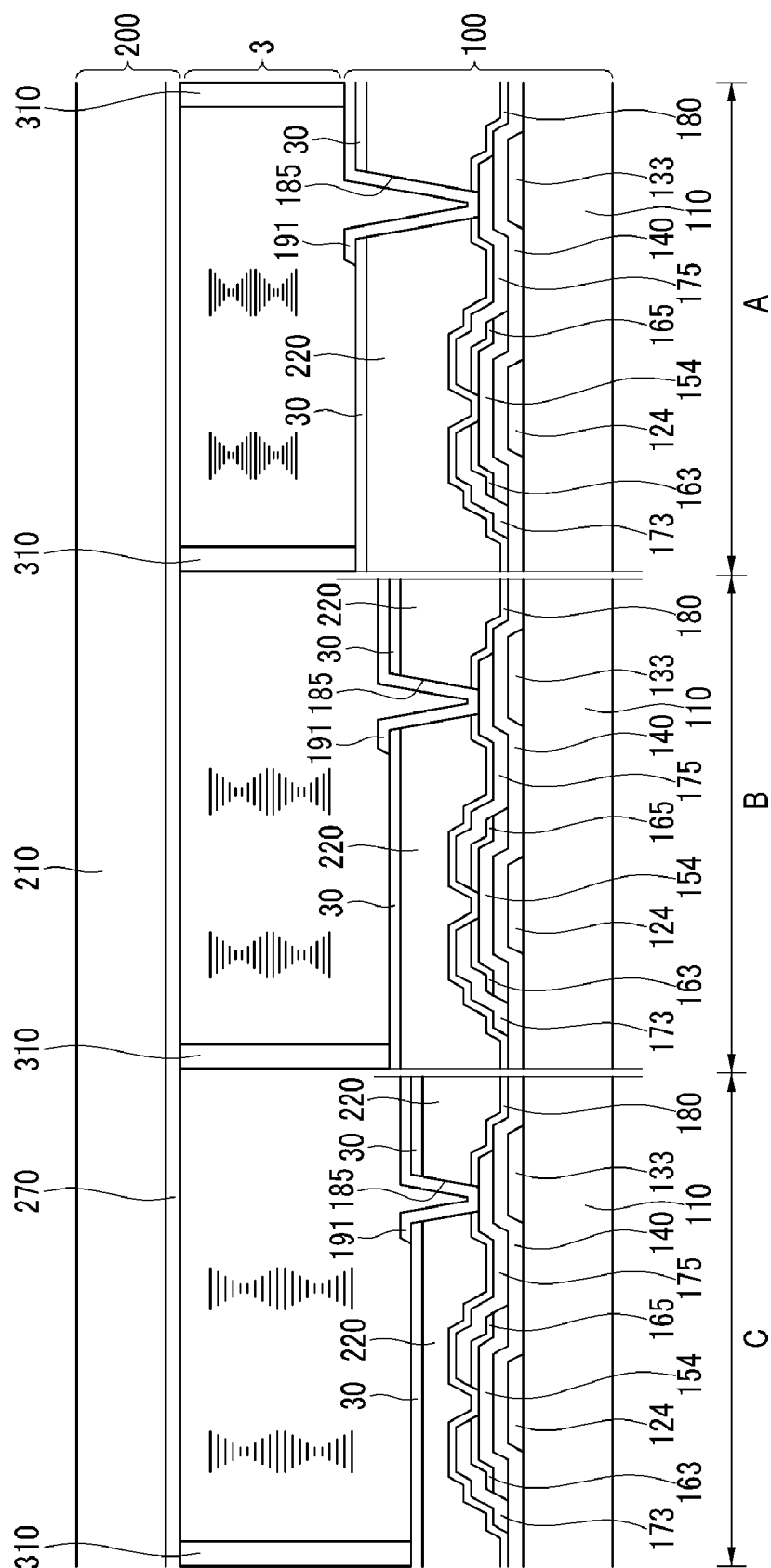


FIG. 5



LIQUID CRYSTAL DISPLAY AND METHOD FOR MANUFACTURING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to, and the benefit of, Korean Patent Application No. 10-2009-000114628 filed in the Korean Intellectual Property Office on Nov. 25, 2009, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] (a) Field of the Invention

[0003] The present invention relates to liquid crystal displays. More particularly, the present invention relates to liquid crystal displays including cholesteric liquid crystals.

[0004] (b) Background

[0005] In general, a cholesteric liquid crystal display is a reflective liquid crystal display with attributes including relatively low power consumption and high screen luminance. In cholesteric liquid crystal displays, cholesteric liquid crystals are mixed with chiral dopants, resulting in a helical structure that selectively reflects light having the same wavelength as a helical pitch of the liquid crystal, so as to control light transmittance for each pixel.

[0006] Here, the reflected light has a wavelength corresponding to the product of the pitch of the liquid crystal and the refractive anisotropy (Δn). The pitch of the liquid crystal may be controlled by the amount of chiral dopant added. When a large amount of chiral dopant is added, the resultant short pitch reflects light having a shorter wavelength, and when a smaller amount of chiral dopant is added, the resultant long pitch reflects light of a longer wavelength.

[0007] This cholesteric liquid crystal display can have different driving voltages for each pixel or sub-pixel color (e.g., red, green, and blue). Thus, for example, if the driving voltage of the blue sub-pixels is also used to drive the red and the green sub-pixels, the red and green sub-pixels are not driven to the proper luminance.

[0008] The above information disclosed in this Background section is only for enhancement of understanding of the background of the invention, and therefore it may contain information not in the prior art.

SUMMARY OF THE INVENTION

[0009] Accordingly, the present invention simplifies the process to form the different cell gaps for each pixel.

[0010] One embodiment concerns a method of manufacturing a liquid crystal display including a cholesteric liquid crystal and having a first insulation substrate and a second insulation substrate that face each other. The method includes: forming an organic layer on the first insulation substrate or the second insulation substrate; pressing a mold onto the organic layer; hardening the organic layer; and removing the mold so as to form a cell gap formation pattern in the organic layer, the cell gap formation pattern including first, second, and third portions each having different thicknesses.

[0011] The first insulation substrate may include a gate line, a data line intersecting the gate line, a thin film transistor connected to the gate line and the data line, and a pixel electrode connected to the thin film transistor.

[0012] The organic layer may include a black color pigment.

[0013] The second insulation substrate may include an overcoat and a common electrode formed on the overcoat, and the organic layer may be the overcoat.

[0014] The organic layer may include a material that is hardened by at least one of heat and ultraviolet radiation.

[0015] A liquid crystal display according to the present invention includes: a first substrate; a cell gap formation pattern formed on the first substrate; a pixel electrode formed on the cell gap formation pattern; a second substrate facing the first substrate; a common electrode formed on the second substrate; a cholesteric liquid crystal layer positioned between the common electrode and the pixel electrode; and a partition dividing the cholesteric liquid crystal layer into regions, wherein the cell gap formation pattern has first, second, and third portions each having different thicknesses.

[0016] The cell gap formation pattern may include an organic material, and the organic material may be hardened by heat or UV.

[0017] The cell gap formation pattern may be an organic material including a black color pigment, and the organic material may be hardened by at least one of heat and ultraviolet radiation.

[0018] The partition may include a same material as the cell gap formation pattern.

[0019] The thickness of the first portion may be greater than the thickness of the second portion, and the thickness of the second portion may be greater than the thickness of the third portion.

[0020] The first portion may correspond to a red region, the second portion may correspond to a green region, and the third portion may correspond to a blue region.

[0021] The liquid crystal display may further include: a gate line formed on the first substrate; a data line intersecting the gate line; and a thin film transistor connected to the gate line and the data line, wherein the pixel electrode is connected to the thin film transistor, and the cell gap formation pattern is formed on the thin film transistor.

[0022] The cell gap formation pattern may include a black color pigment.

[0023] An overcoat formed on the cell gap formation pattern may be further included.

[0024] Accordingly, the different cell gaps per each color may be easily formed through the pressing process (or an embossing stamp) using the mold according to the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] FIG. 1 is a cross-sectional view of a liquid crystal display according to an exemplary embodiment of the present invention.

[0026] FIG. 2 and FIG. 3 are cross-sectional views sequentially showing a method for forming a pattern for a cell gap having varying thicknesses according to the present invention.

[0027] FIG. 4 is a cross-sectional view of a liquid crystal display according to an exemplary embodiment of the present invention.

[0028] FIG. 5 is a cross-sectional view of a liquid crystal display according to another exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0029] The present invention will be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the present invention.

[0030] In the drawings, the thickness of layers, films, panels, regions, etc., are exaggerated for clarity. Like reference numerals designate like elements throughout the specification. It will be understood that when an element such as a layer, film, region, or substrate is referred to as being "on" another element, it can be directly on the other element or intervening elements may also be present. In contrast, when an element is referred to as being "directly on" another element, there are no intervening elements present.

[0031] As above, a cholesteric liquid crystal display typically requires different driving voltages for each color. One way to drive different color pixels or sub-pixels with the same driving voltage is to form different cell gaps for each color. However, separate etching processes are typically required to form the different cell gaps for each pixel, complicating the fabrication process. Accordingly, embodiments of the invention produce a substrate with a cell gap formation pattern having different thicknesses for each color. The varying heights of this cell gap formation pattern can be fabricated without separate etching steps, yielding a display whose cell gap varies with color, but is still simple to fabricate. In this manner, embodiments of the invention allow for a cholesteric liquid crystal display whose different colors can all be driven with the same voltage, but that remains relatively easy to fabricate.

[0032] An exemplary embodiment of the present invention will hereinafter be described in detail with reference to the accompanying drawings.

[0033] FIG. 1 is a cross-sectional view of a liquid crystal display according to an exemplary embodiment of the present invention.

[0034] Referring to FIG. 1, liquid crystal display includes a lower panel with a pixel electrode 191 formed on a substrate 110, an upper panel including a common electrode 270 formed on a substrate 210, and a liquid crystal layer 3 between the two display panels. The liquid crystal layer 3 is made of a cholesteric liquid crystal and includes a chiral dopant.

[0035] The liquid crystal display of this embodiment has different cell gaps for each pixel color. In particular, the lower panel includes a cell gap formation pattern 9, and the pattern 9 includes first to third portions A-C each having different thicknesses.

[0036] Any suitable thicknesses are contemplated. However, in the embodiment shown, the thicknesses of the first to third portions A-C have a relationship of $A > B > C$, and accordingly the cell gap has a relationship of $A < B < C$. Here, the pitch of the liquid crystal is controlled in the first portion A for display of blue, in the second portion B for green, and in the third portion C for red.

[0037] Next, a method for differentiating the cell gap of the liquid crystal display will be described with reference to

FIGS. 2-3. FIG. 2 and FIG. 3 are cross-sectional views sequentially showing a method for forming a pattern for a cell gap having the different thicknesses according to the present invention.

[0038] First, as shown in FIG. 2, a cell gap formation material layer 90 is coated on a substrate 110. The cell gap formation material layer 90 may be made of any suitable material, such as an organic material to be hardened by heat or UV.

[0039] Next, a mold M is disposed on the cell gap formation material layer 90, and pressure is applied to shape the layer 90 according to the mold. The mold M has heights opposite to the height of the pattern, so that the mold M presses the layer 90 to the correct heights.

[0040] Here, as shown in FIG. 3, the cell gap formation material layer 90 is hardened by UV or heat. Next, the mold is removed to form a cell gap formation pattern 9.

[0041] The cell gap formation pattern 9 is used to form the different cell gaps in the first to third portions A to C. Depending on the application, the cell gap formation material may be removed entirely from the third portion C. To accomplish this, the remaining layer S of the third portion may be removed through ashing. In other applications, the remaining layer S may be kept, i.e. not removed.

[0042] The above-described process yields a cell gap formation pattern with different thicknesses, that may be relatively easily formed without using a separate etching process.

[0043] FIG. 4 illustrates a liquid crystal display incorporating the cell gap formation pattern 9 of FIG. 1. More specifically, FIG. 4 is a cross-sectional view of a liquid crystal display according to an exemplary embodiment of the present invention. The liquid crystal display of FIG. 4 includes a lower panel 100 and upper panel 200, with a liquid crystal layer 3 placed therebetween.

[0044] Referring to the lower panel 100, a gate line and a storage electrode line are formed on an insulation substrate 110 made of transparent glass or plastic. The gate line transmits a gate signal, and extends in a substantially transverse direction. The gate line includes a gate electrode 124 which protrudes from the gate line.

[0045] The storage electrode line receives a predetermined voltage and extends substantially in the transverse direction. Each storage electrode line includes a storage electrode 133 that extends from the storage electrode line.

[0046] A gate insulating layer 140 is formed on the gate electrode 124 and the storage electrode 133. The gate insulating layer 140 may be made of any suitable insulating material, such as silicon oxide or silicon nitride.

[0047] A semiconductor 154 made of hydrogenated amorphous silicon or crystallized silicon is formed on the gate insulating layer 140. A pair of ohmic contacts 163 and 165 are then formed on the semiconductor 154, and face each other.

[0048] A data line, including a source electrode 173 and a drain electrode 175, is formed on the ohmic contacts 163 and 165 and the gate insulating layer 140.

[0049] The data line transmits a data signal and extends substantially in the longitudinal direction, thereby intersecting the gate line.

[0050] The drain electrode 175 faces the source electrode 173 with respect to the gate electrode 124.

[0051] A gate electrode 124, a source electrode 173, and a drain electrode 175 form a thin film transistor (TFT) along with the semiconductor 154. The channel of the thin film transistor is formed in the semiconductor 154 between the source electrode 173 and the drain electrode 175.

[0052] A passivation layer **180** is formed on the drain electrode **175**, the source electrode **173**, and the exposed semiconductor **154**. The passivation layer **180** may be made of any suitable material, such as an inorganic insulator such as silicon nitride, silicon oxide, or an organic insulator and an insulating material having a dielectric ratio of less than 4.0.

[0053] The passivation layer **180** (made of organic material) may be used as the cell gap formation pattern, and may be pressed so as to have first through third portions A-C with different thicknesses. The passivation layer **180** formed into different thicknesses through the method shown in FIG. 2 and FIG. 3.

[0054] An absorption layer **220** is formed on the passivation layer **180**. The absorption layer **220** may be made of an organic material including pigments such as black color pigments.

[0055] Among the ambient light incident to the liquid crystal layer, the light of wavelength corresponding to the liquid crystal pitch is reflected, and the remaining unreflected light is absorbed by the absorption layer **220**. For black, the liquid crystal pitch is controlled so that all light is transmitted, i.e. none is reflected. All light is thus absorbed by the absorption layer **220**, so that black is displayed.

[0056] An overcoat **30** is formed on the absorption layer **220**. The overcoat **30** prevents impurities outgassed from the absorption layer **220** from flowing into the liquid crystal, and may reduce the influence of the dielectric ratio due to the absorption layer **220**.

[0057] In the example of FIG. 4, passivation layer **180** is used as the cell gap formation pattern. However, the invention contemplates use of any layer as the cell gap formation pattern. In particular, the invention contemplates use of any suitable pattern that can be imprinted with different heights, creating varying cell gaps. In the example of FIG. 5, the absorption layer **220** may be used as the cell gap formation pattern and the overcoat **30** may be formed thereover. Although not shown in the figures, further embodiments may also include use of the overcoat **30** as the cell gap formation pattern.

[0058] In FIG. 5, the overcoat **30** and the absorption layer **220** have a contact hole **185** exposing the drain electrode **175**.

[0059] A pixel electrode **191** and a partition **310** are formed on the overcoat **30**. The pixel electrode **191** is made of a transparent conductive material such as ITO and IZO, and is electrically connected to the drain electrode **175** through the contact hole **185**.

[0060] The partition **310** may be made of an organic insulating material, and may be made of the same material as the absorption layer **220**. Also, one of ordinary skill in the art will observe that the partition **310** can be formed using the mold M shown in FIG. 2 and FIG. 3, thereby simplifying the process.

[0061] The liquid crystal of the liquid crystal display of the present invention represents a special color according to its pitch, so that neighboring colors can require differently-pitched liquid crystal. Accordingly, the partition **310** prevents the mixture of the neighboring colors. The shape of the partition **310** may be changed according to the arrangement of the colors. For example, the partition **310** may be extended along the pixel row or the pixel column, or may be formed with a shape enclosing each pixel.

[0062] When forming the partition **310** to be extended, the liquid crystal may be injected through vacuum injection. Alternatively, when forming a shape enclosing the pixel, the liquid crystal layer may be formed through an Inkjet method

or a dripping method. The partition **310** may also be used as a spacer to maintain the interval of the upper substrate.

[0063] An alignment layer (not shown) may be formed on the pixel electrode **191**.

[0064] Next, upper panel **200** is described. The upper panel **200** includes a substrate **210**, and a common electrode **270** formed on the substrate **210**. An alignment layer (not shown) may also be formed on the common electrode **270**.

[0065] As above, the invention includes embodiments in which the passivation layer is used as the cell gap formation pattern. However, the invention also includes embodiments in which any other suitable layer, such as an overcoat layer, is instead used as the cell gap formation pattern. Additionally, the invention contemplates formation of the partition **310** in either the lower panel **100** or the upper panel **200**.

[0066] A cholesteric liquid crystal layer is formed between the two display panels **100** and **200**, and has a helical structure. Also, the first portion A is used in the blue pixel (or sub-pixel), the second portion B is used in the green pixel (or sub-pixel), and the third portion C is used in the red pixel (or sub-pixel).

[0067] While this invention has been described in connection with what is presently considered to be practical exemplary embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

What is claimed is:

1. A method of manufacturing a liquid crystal display including a cholesteric liquid crystal and having a first insulation substrate and a second insulation substrate that face each other, the method comprising:

forming an organic layer on the first insulation substrate or the second insulation substrate;

pressing a mold onto the organic layer;

hardening the organic layer; and

removing the mold so as to form a cell gap formation pattern in the organic layer, the cell gap formation pattern including first, second, and third portions each having different thicknesses.

2. The method of claim 1, wherein

the first insulation substrate includes a gate line, a data line intersecting the gate line, a thin film transistor connected to the gate line and the data line, and a pixel electrode connected to the thin film transistor, and

the organic layer is formed on the thin film transistor.

3. The method of claim 2, wherein

the organic layer includes a black color pigment.

4. The method of claim 1, wherein

the second insulation substrate includes an overcoat and a common electrode formed on the overcoat, and the organic layer is the overcoat.

5. The method of claim 1, wherein

the organic layer includes a material that is hardened by at least one of heat and ultraviolet radiation.

6. A liquid crystal display comprising:

a first substrate;

a cell gap formation pattern formed on the first substrate;

a pixel electrode formed on the cell gap formation pattern;

a second substrate facing the first substrate;

a common electrode formed on the second substrate;

a cholesteric liquid crystal layer positioned between the common electrode and the pixel electrode; and

a partition dividing the cholesteric liquid crystal layer into regions,

wherein the cell gap formation pattern has first, second, and third portions each having different thicknesses.

7. The liquid crystal display of claim 6, wherein the cell gap formation pattern includes an organic material.

8. The liquid crystal display of claim 7, wherein the organic material is hardened by at least one of heat and ultraviolet radiation.

9. The liquid crystal display of claim 6, wherein the cell gap formation pattern includes an organic material, the organic material including a black color pigment.

10. The liquid crystal display of claim 9, wherein the organic material is hardened by at least one of heat and ultraviolet radiation.

11. The liquid crystal display of claim 9, wherein the partition includes a same material as the cell gap formation pattern.

12. The liquid crystal display of claim 6, wherein the thickness of the first portion is greater than the thickness of the second portion, and the thickness of the second portion is greater than the thickness of the third portion.

13. The liquid crystal display of claim 12, wherein a cell gap of the third portion is greater than a cell gap of the second portion, and the cell gap of the second portion is greater than a cell gap of the first portion.

14. The liquid crystal display of claim 13, wherein the first portion corresponds to a red region, the second portion corresponds to a green region, and the third portion corresponds to a blue region.

15. The liquid crystal display of claim 6, further comprising:

a gate line formed on the first substrate;

a data line intersecting the gate line; and

a thin film transistor connected to the gate line and the data line,

wherein the pixel electrode is connected to the thin film transistor, and

the cell gap formation pattern is formed on the thin film transistor.

16. The liquid crystal display of claim 15, wherein the cell gap formation pattern includes a black color pigment.

17. The liquid crystal display of claim 15, further comprising an overcoat formed on the cell gap formation pattern.

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专利名称(译)	液晶显示器及其制造方法		
公开(公告)号	US20110122358A1	公开(公告)日	2011-05-26
申请号	US12/906962	申请日	2010-10-18
[标]申请(专利权)人(译)	金章KYUM 李姬瑾 CHOI NAK CHO		
申请(专利权)人(译)	金章KYUM LEE HEE-瑾 崔NAK-CHO		
当前申请(专利权)人(译)	金章KYUM LEE HEE-瑾 崔NAK-CHO		
[标]发明人	KIM JANG KYUM LEE HEE KEUN CHOI NAK CHO		
发明人	KIM, JANG-KYUM LEE, HEE-KEUN CHOI, NAK-CHO		
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CPC分类号	G02F1/13718 G02F1/133371		
优先权	1020090114628 2009-11-25 KR		
外部链接	Espacenet USPTO		

摘要(译)

一种制造液晶显示器的方法，包括胆甾型液晶并具有彼此面对的第一绝缘基板和第二绝缘基板，该方法包括：在第一绝缘基板或第二绝缘基板上形成有机层；将模具压在有机层上；硬化有机层；并且去除模具以在有机层中形成单元间隙形成图案，单元间隙形成图案包括各自具有不同厚度的第一，第二和第三部分。

