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(54) **TRANSFLECTIVE MODE LIQUID CRYSTAL DISPLAY**

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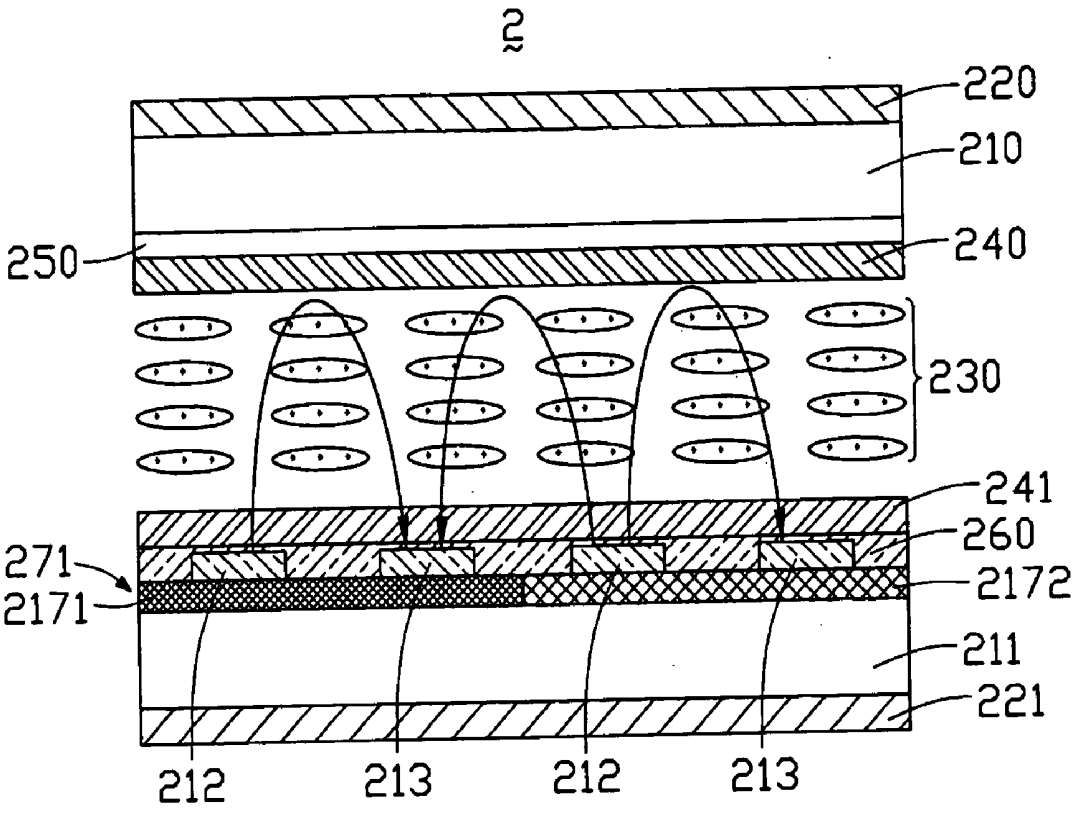
(57) **ABSTRACT**

A transflective mode liquid crystal display (**2**) includes a first substrate (**211**) and a second substrate (**210**), a liquid crystal layer (**230**) interposed between the first substrate and the second substrate, a plurality of pixel electrodes (**213**) and a plurality of counter electrodes (**212**) formed on the first substrate, a color filter (**250**) disposed on an inner surface of the second substrate, and a transflective element (**271**) disposed on the first substrate. The color filter has a color resin layer, which comprises a transmission section and a reflection section. Brightness and color saturation of light beams emitted from the transmission section are substantially the same as those of light beams emitted from the reflection section. Therefore, the transflective mode liquid crystal display has improved color and brightness characteristics.



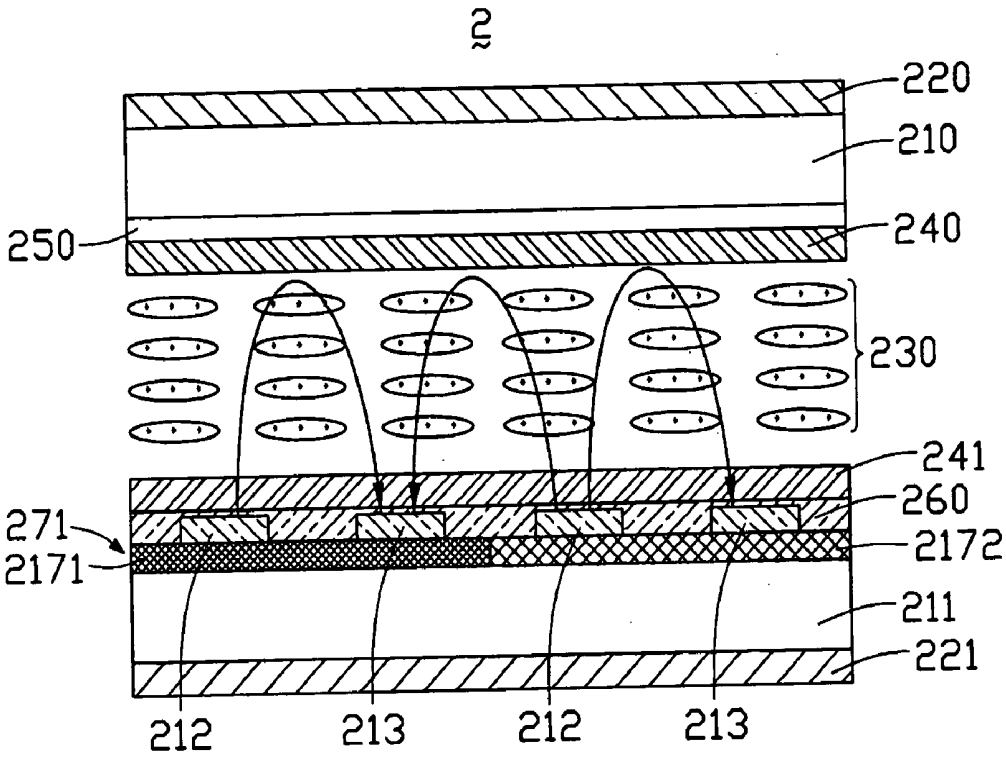

2
220
210
250
240
230
241
260
271
2171
2172
211
221
212
213
212
213

FIG. 1

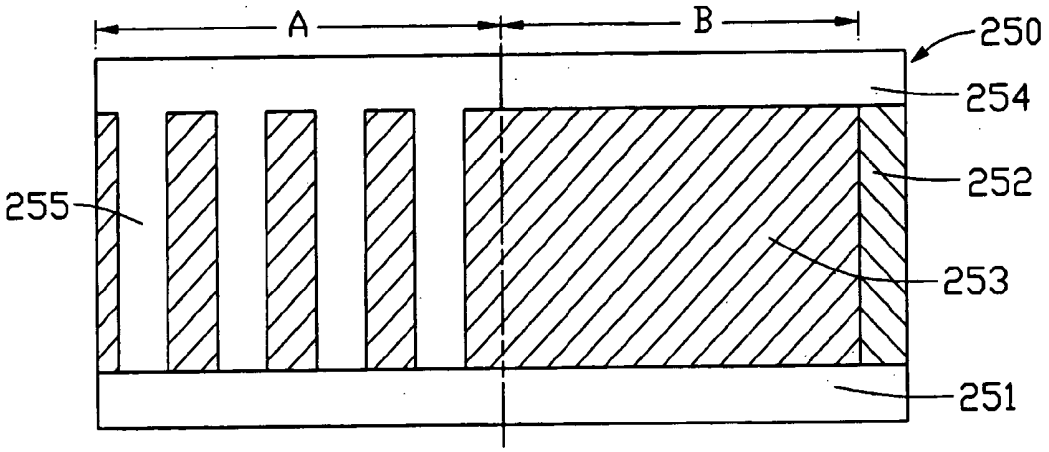


FIG. 2

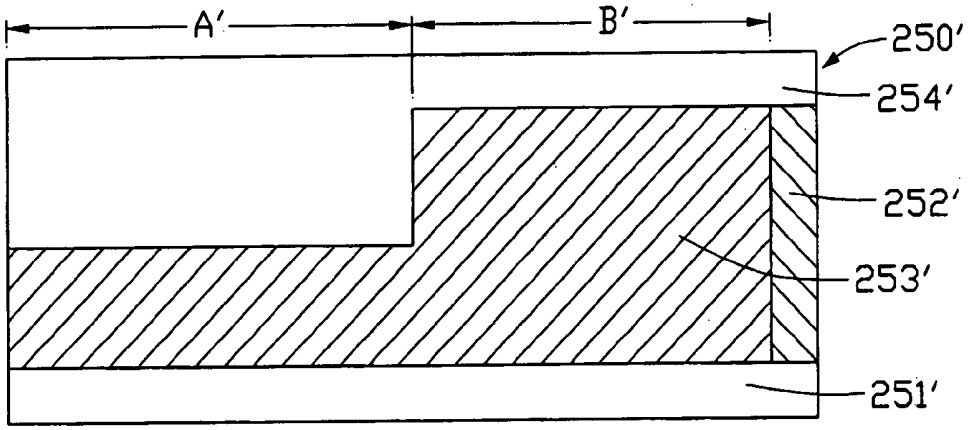


FIG. 3

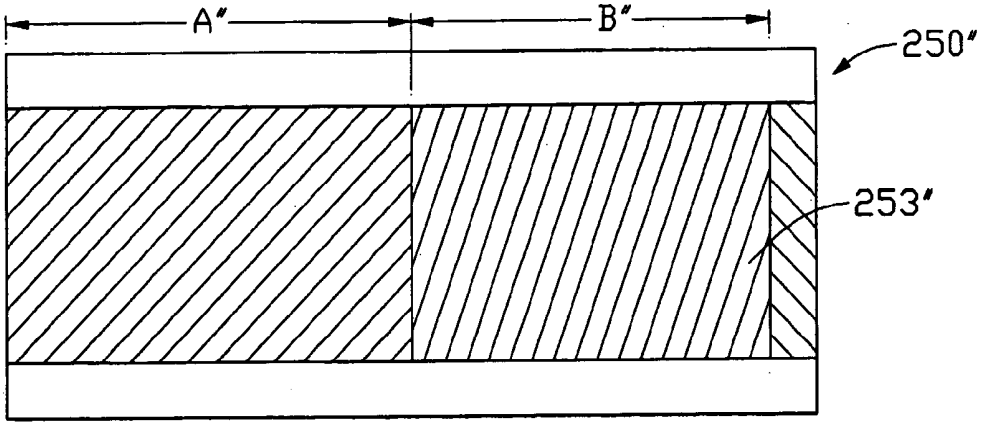


FIG. 4

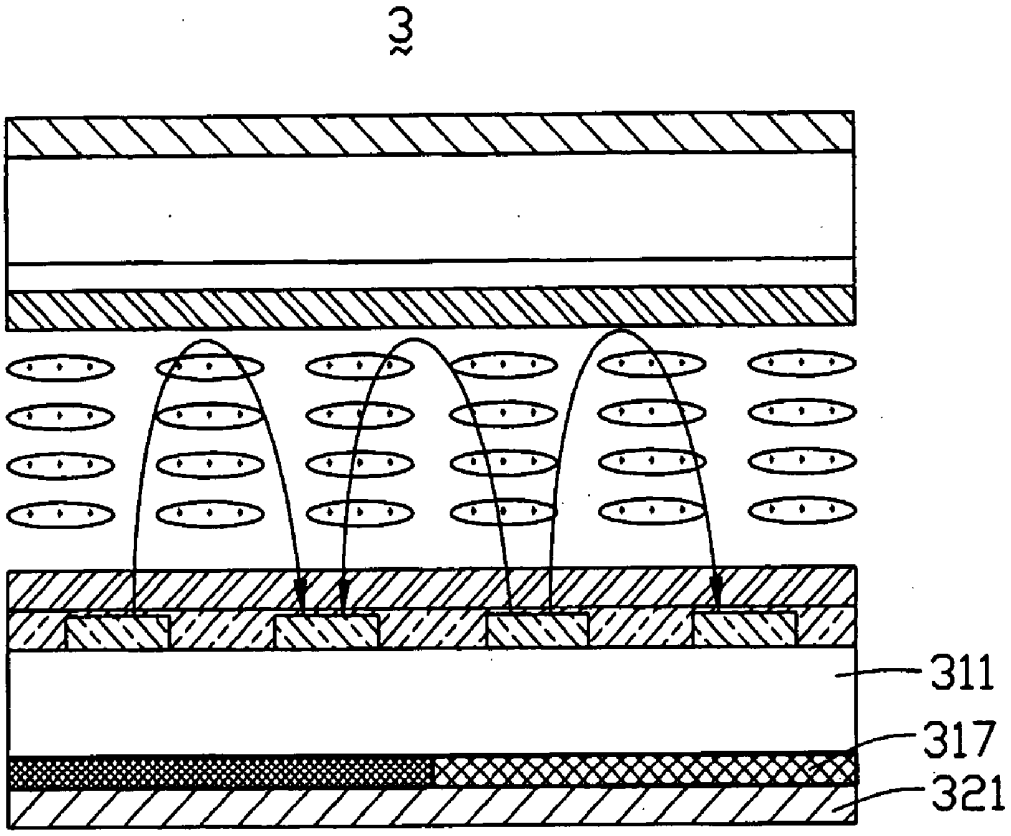


FIG. 5

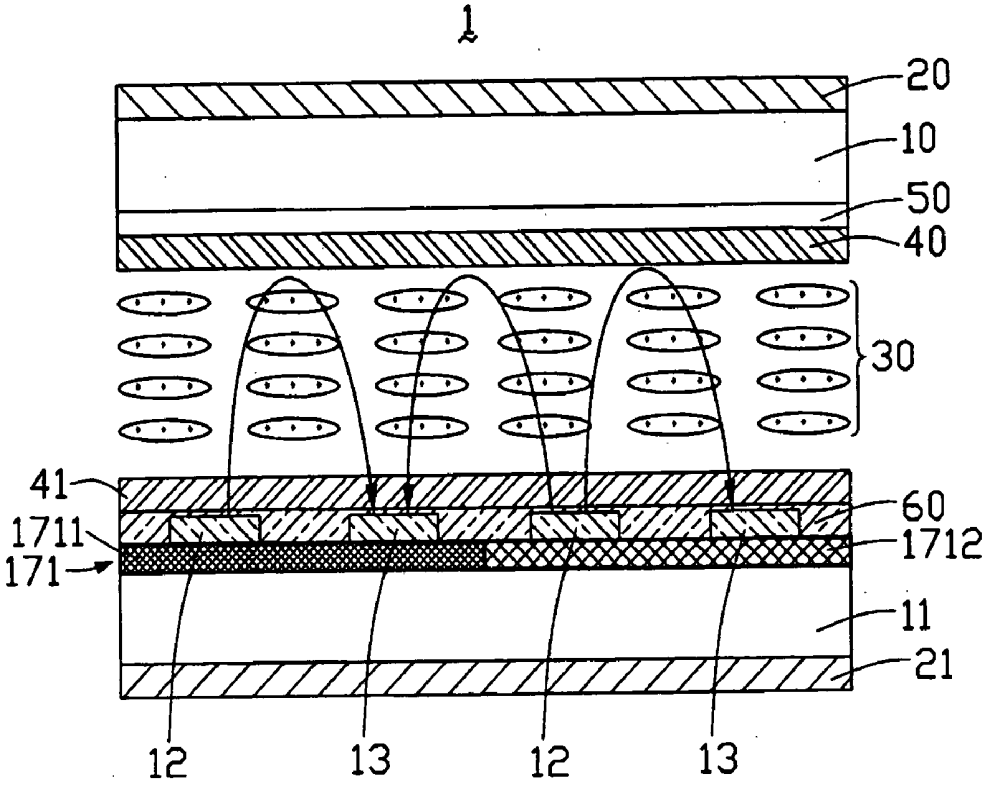


FIG. 6
(PRIOR ART)

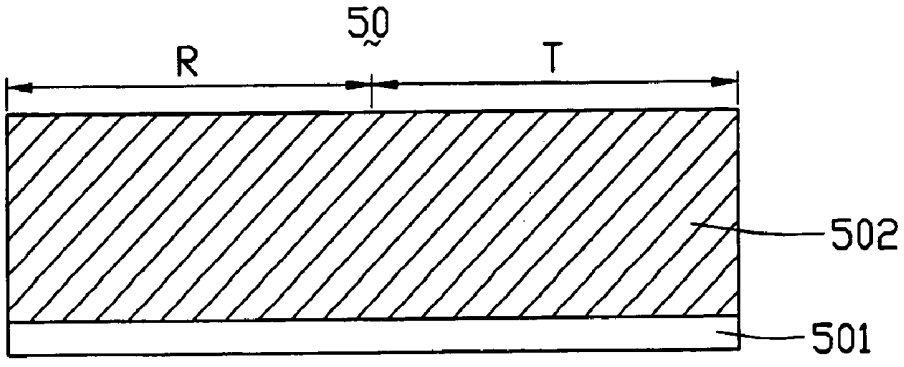


FIG. 7
(PRIOR ART)

TRANSFLECTIVE MODE LIQUID CRYSTAL DISPLAY

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to transflective mode liquid crystal displays, and particularly to a transflective mode liquid crystal display with improved color and brightness characteristics.

[0003] 2. Description of Prior Art

[0004] The in-plane switching liquid crystal display (IPS-LCD) has been developed in order to improve the narrow viewing angle of the more traditional twisted nematic liquid crystal display (TN-LCD). The IPS-LCD has a plurality of counter electrodes and a plurality of pixel electrodes all disposed on a same substrate of two opposite substrates, for driving liquid crystal molecules in a liquid crystal layer between the two substrates. The resulting electric field is substantially planar and parallel to surfaces of both substrates. This configuration provides an improved viewing angle.

[0005] Referring to **FIG. 6**, this is a cross-sectional view of a conventional transflective mode IPS-LCD **1**. The IPS-LCD **1** comprises an upper substrate **10** and a lower substrate **11** disposed opposite to each other and spaced apart a predetermined distance, with a liquid crystal layer (not labeled) having a plurality of liquid crystal molecules **30** disposed therebetween. A transflective element **171** having a reflection section **1711** and a transmission section **1712** is disposed on an inner side of the lower substrate **11**. A plurality of counter electrodes **12** and a plurality of pixel electrodes **13** are disposed on the transflective element **171**, with an insulating layer **60** and an alignment film **41** disposed on the counter and pixel electrodes **12**, **13**, in that order from bottom to top. A lower polarizer **21** is formed on an undersurface of the lower substrate **11**, and an upper polarizer **20** is formed on a top surface of the upper substrate **10**. A color filter **50** and an alignment film **40** are disposed on an undersurface of the upper substrate **10**, in that order from top to bottom.

[0006] Referring to **FIG. 7**, this is an enlarged, inverted view of part of a color filter **250** of the conventional transflective mode IPS LCD **1**. The color filter **50** comprises a transparent substrate **501**, a black matrix (not shown), and a color resin layer **502** having Red, Green and Blue segments. The color resin layer **502** has a transmission section T corresponding to the transmission section **1712** of the transflective element **171**, and a reflection section R corresponding to the reflection section **1711** of the transflective element **171**. The transmission section T and the reflection section R have a same thickness.

[0007] When the IPS-LCD **1** is driven, an electric field having a component parallel to two main surfaces of the substrates **10**, **11** is formed at upper portions of the counter electrodes **12** and the pixel electrodes **13**. In the transmission section T of the color filter **50**, light beams emitted from a backlight (not shown) pass through the color resin layer **502** and the transparent substrate **501** to display color images. In the reflection section R of the color filter **50**, light beams incident from an exterior of the IPS-LCD **1** pass through the transparent substrate **501** and the color resin layer **502**, and are then reflected by the reflection section **1711** of the transflective element **171**. The reflected light beams pass back through the color resin layer **502** and the transparent substrate **501** again to display color images.

[0008] As described above, light beams pass through the color resin layer **502** twice in the reflection section R and once only in the transmission section T. Therefore, when the reflection section R and the transmission section T have the same thickness, the light beams emitted from the reflection section R have a lower brightness than those of the transmission section T, because the distance traveled by the light beams passing through the color resin layer **502** in the reflection section R is longer than that in the transmission section T. That is, much more light energy is lost in the reflection section R than in the transmission section T.

[0009] Furthermore, the color characteristics of the light beams emitted from the reflection section R are different from the color characteristics of the of light beams emitted from the transmission section T. In particular, the color saturation of the light beams emitting from the reflection section R is more than the color saturation of the light beams emitting from the transmission section T.

[0010] It is desired to provide a transflective mode liquid crystal display that can solve the above-mentioned brightness and color problems.

SUMMARY OF THE INVENTION

[0011] An object of the present invention is to provide a transflective mode liquid crystal display which has enhanced brightness and color characteristics.

[0012] Another object of the present invention is to provide a transflective mode liquid crystal display having a wide viewing angle.

[0013] To achieve the above objects, a transflective mode liquid crystal display comprises a first substrate and a second substrate disposed opposite each other and spaced apart a predetermined distance, a liquid crystal layer interposed between the first substrate and the second substrate, a plurality of pixel electrodes and a plurality of counter electrodes formed on the first substrate, a color filter disposed on an inner surface of the second substrate, and a transflective element disposed on the first substrate. The color filter has a color resin layer, which comprises a transmission section and a reflection section. Brightness and color saturation of light beams emitted from the transmission section are substantially the same as those of light beams emitted from the reflection section. Therefore, the transflective mode liquid crystal display has improved color and brightness characteristics.

[0014] Other objects, advantages, and novel features of the present invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] **FIG. 1** is a schematic, cross-sectional view of part of a transflective mode liquid crystal display according to a first embodiment of the present invention;

[0016] **FIG. 2** is an enlarged, inverted view of part of a color filter of the transflective mode liquid crystal display of **FIG. 1**;

[0017] **FIG. 3** is similar to **FIG. 2**, but showing an alternative color filter according to the present invention;

[0018] **FIG. 4** is similar to **FIG. 2**, but showing a further alternative color filter according to the present invention;

[0019] **FIG. 5** is a schematic, cross-sectional view of part of a transflective mode liquid crystal display according to a second embodiment of the present invention;

[0020] **FIG. 6** is a schematic, cross-sectional view of part of a conventional transflective mode IPS LCD; and

[0021] **FIG. 7** is an enlarged, inverted view of part of a color filter of the conventional transflective mode IPS LCD of **FIG. 6**.

DETAILED DESCRIPTION OF THE INVENTION

[0022] **FIG. 1** is a schematic, cross-sectional view of a transflective mode liquid crystal display **2** according to the first embodiment of the present invention. The transflective mode liquid crystal display **2** comprises a first substrate **211**, a second substrate **210**, and a liquid crystal layer **230** having a plurality of liquid crystal molecules. The first substrate **211** and the second substrate **210** are spaced apart from each other, and the liquid crystal layer **230** is disposed therebetween.

[0023] A plurality of gate bus lines (not shown) and a plurality of data bus lines (not shown) are cross-arranged on an inner surface of the first substrate **211**. A plurality of thin film transistors (not shown) is disposed at intersections of the gate bus lines and the data bus lines. A plurality of counter electrodes **212** and a plurality of pixel electrodes **213** are disposed on the first substrate **211**, with a transparent insulating layer **260** and an alignment film **241** disposed on the counter and pixel electrodes **212**, **213** in that order from bottom to top. A transflective element **271** is interposed between the counter and pixel electrodes **212**, **213** and the first substrate **211**. A color filer **250** and an alignment film **240** are formed on an underside of the second substrate **210**, in that order from top to bottom. Two polarizers **221**, **220** are formed on two outer surfaces of the first substrate **211** and the second substrate **210**, respectively.

[0024] The alignment films **241**, **240** are horizontal alignment layers. Alignment directions of the alignment films **241**, **240** are parallel to each other, or alternatively an angle of 180 degrees may be defined between the alignment directions. Polarization axes of the polarizers **221**, **220** are perpendicular to each other.

[0025] The counter electrodes **212** and the pixel electrodes **213** are strip-shaped, and are arranged parallel to each other in alternating fashion on the transflective element **271**. The counter electrodes **212** and the pixel electrodes **213** are made of a transparent conductor, such as indium tin oxide (ITO) or indium zinc oxide (IZO). The transflective element **271** is made of a dielectric material. When a voltage is applied to the counter electrodes **212** and the pixel electrodes **213**, an electric field having horizontal components is produced therebetween. Long axes of the liquid crystal molecules are aligned parallel to the direction of the electric field. Alternatively, the counter electrodes **212** and the pixel electrodes **213** may be zigzag-shaped, or wave-shaped.

[0026] The transflective element **271** has a reflection section **2171** and a transmission section **2172**. The combination of the reflection section and transmission sections **2171**, **2172** corresponds to a single pixel. The reflection section **2171** is made of a plurality of layers of high-reflectivity dielectric materials stacked one on the other, for reflecting light beams incident from an exterior of the transflective mode liquid crystal display **2**. The transmission section **2172** is made of a plurality of layers of high-transmission dielectric materials stacked one on the other, for transmitting light beams emitted from a backlight (not shown) disposed under the first substrate **211**.

[0027] Referring to **FIG. 2**, the color filter **250** includes a transparent substrate **251**, and a black matrix **252**, a color resin layer **253** and a transparent protection layer **254** that are all formed on the transparent substrate **251**.

[0028] The color resin layer **253** comprises a plurality of RGB (Red Green Blue) segments. Each RGB segment comprises a Red (R) segment, a Green (G) segment, and a Blue (B) segment. The RGB segments are arranged in a regular repeating array on the transparent substrate **251**. The black matrix **252** is disposed between the RGB segments, for preventing light beams from leaking and for protecting the thin film transistors from damage. The transparent protection layer **254** is coated on the color resin layer **253** and the black matrix **252**, and is made of SiO_2 (silicon dioxide) or SiNx (silicon nitride). Each RGB segment of the color resin layer **253** is divided into a reflection section/area A and a transmission section/area B, corresponding to the reflection section **2171** and the transmission section **2172** of the transflective element **271**, respectively. A thickness of the color resin layer **253** of the reflection section A is equal to that of the transmission section B. The reflection section A defines a plurality of grooves **255** therein, which are areas having no color resin and which are filled with the transparent protection layer **254**. Portions of the reflection section A corresponding to the grooves **255** are non-color portions, and the other portions of the reflection section A are color portions. The combined area of the non-color portions is equal to that of the color portions.

[0029] Operation of the color filter **250** of the transflective mode liquid crystal display **2** is as follows. In the transmission section B, light beams emitted from the backlight transmit through the transparent protection layer **254**, the color resin layer **253** and the transparent substrate **251** in a single pass to display images. In this case, a color is expressed by a color resin contained in the color resin layer **253**, and brightness is adjusted by controlling the voltage applied to the counter electrodes **212** and the pixel electrodes **213**.

[0030] In the reflection section A, light beams incident from the exterior pass through the transparent substrate **251**, the color resin layer **253** and the transparent protection layer **254**, and are then reflected by the reflection section **2171** of the transflective element **271**. The reflected light beams pass back through the transparent protection layer **254**, the color resin layer **253** and the transparent substrate **251** to display images. In this case also, a color is expressed by the color resin contained in the color resin layer **253**, and brightness is adjusted by controlling the voltage applied to the counter electrodes **212** and the pixel electrodes **213**.

[0031] That is, in the transmission section B, light beams pass through the color resin layer **253** once; while in the

reflection section A, light beams pass through the color resin layer **253** twice. Because the grooves **255** have no color resin filled therein, and the combined area of the non-color portions is equal to that of the color portions, a distance for light beams to pass through the color portions of the reflection section A is substantially equal to that for light beams to pass through the transmission section B. Therefore, the brightness and the color of the reflection section A are properly adjusted. As a result, the reflection section A and the transmission section B of the color resin layer **253** have substantially the same levels of brightness and color saturation.

[**0032**] Furthermore, the transflective mode liquid crystal display **2** is an IPS LCD, which yields a wide viewing angle.

[**0033**] In the first embodiment of the transflective mode liquid crystal display **2** of the present invention, a plurality of holes (not shown) can be provided in the reflection section A instead of the grooves **255**. The holes can be cylindrical with polygonal ends, or cylindrical with circular ends. The transparent protection layer **254** is filled into the holes.

[**0034**] **FIG. 3** illustrates an alternative color filter **250'** according to the present invention. The color filter **250'** is similar to the color filter **250**, and includes a transparent substrate **251'**, a black matrix **252'**, a color resin layer **253'** and a transparent protection layer **254'**. The color resin layer **253'** comprises a plurality of RGB segments. Each RGB segment has a reflection section A' and a transmission section B'. A thickness of the color resin layer **253'** in the reflection section A' is half that of the color resin layer **253'** in the transmission section B'. Therefore a distance for light beams to pass through the reflection section A' of the color resin layer **253'** twice is substantially equal to that for light beams to pass through the transmission section B' of the color resin layer **253'** once. In other words, the brightness and the color saturation of the light beams emitting from the reflection section A' is substantially the same as that of the light beams emitting from the transmission section B'.

[**0035**] **FIG. 4** illustrates a further alternative color filter **250"** according to the present invention. The color filter **250"** is similar to the color filters **250** and **250'**. A thickness of a color resin layer **253"** in each reflection section A" is equal to that of the color resin layer **253"** in each transmission section B". A concentration of color resin in the reflection section A" is half of a concentration of color resin in the transmission section B".

[**0036**] Referring to **FIG. 5**, this is a schematic, cross-sectional view of a transflective mode liquid crystal display **3** according to the second embodiment of the present invention. The transflective mode liquid crystal display **3** is similar to the transflective mode liquid crystal display **2** of the first embodiment, and comprises a first substrate **311**, a transflective element **317** and a polarizer **321**. The transflective element **317** is interposed between the first substrate **311** and the polarizer **321**.

[**0037**] It is to be understood, however, that even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size and arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. A transflective mode liquid crystal display comprising:

a first substrate and a second substrate disposed opposite each other and spaced apart a predetermined distance;

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

a plurality of pixel electrodes and a plurality of counter electrodes formed on the first substrate;

a color filter disposed on an inner surface of the second substrate, the color filter having a color resin layer, which comprises a transmission section and a reflection section; and

a transflective element disposed adjacent the first substrate;

wherein a brightness and a color saturation of light beams emitted from the transmission section are substantially the same as a brightness and a color saturation of light beams emitted from the reflection section.

2. The transflective mode liquid crystal display as claimed in claim 1, wherein the pixel electrodes and the counter electrodes are strip-shaped, zigzag shaped, or wave-shaped.

3. The transflective mode liquid crystal display as claimed in claim 2, wherein the transflective element has a transmission section and a reflection section corresponding to the transmission section and the reflection section of the color resin layer, respectively.

4. The transflective mode liquid crystal display as claimed in claim 3, wherein the transflective element is made of a dielectric material.

5. The transflective mode liquid crystal display as claimed in claim 4, wherein the reflection section of the transflective element is made of a plurality of layers of high reflectivity materials stacked one on the other, and the transmission section of the transflective element is made of a plurality of layers of high transmission materials stacked one on the other.

6. The transflective mode liquid crystal display as claimed in claim 2, wherein the reflection section of the color resin layer has a plurality of grooves, and an area of the grooves is substantially equal to an area of the color resin in the reflection section of the color resin layer.

7. The transflective mode liquid crystal display as claimed in claim 5, wherein the reflection section of the color resin layer has a plurality of grooves, and an area of the grooves is substantially equal to an area of the color resin in the reflection section of the color resin layer.

8. The transflective mode liquid crystal display as claimed in claim 2, wherein the reflection section of the color resin layer has a plurality of holes.

9. The transflective mode liquid crystal display as claimed in claim 5, wherein said reflection section of the color resin layer has a plurality of holes.

10. The transflective mode liquid crystal display as claimed in claim 9, wherein the holes are cylindrical with polygonal ends or cylindrical with circular ends.

11. The transflective mode liquid crystal display as claimed in claim 2, wherein a thickness of the color resin

layer at the reflection section thereof is substantially half a thickness of the color resin layer at the transmission section thereof.

12. The transflective mode liquid crystal display as claimed in claim 5, wherein a thickness of the color resin layer at the reflection section thereof is substantially half a thickness of the color resin layer at the transmission section thereof.

13. The transflective mode liquid crystal display as claimed in claim 2, wherein a thickness of the color resin layer at the reflection section thereof is substantially equal to a thickness of the color resin layer at the transmission section thereof, and a concentration of color resin in the reflection section of the color resin layer is substantially half a concentration of color resin in the transmission section of the color resin layer.

14. The transflective mode liquid crystal display as claimed in claim 5, wherein a thickness of the color resin layer at the reflection section thereof is substantially equal to a thickness of the color resin layer at the transmission section thereof, and a concentration of color resin in the reflection section of the color resin layer is substantially half a concentration of color resin in the transmission section of the color resin layer.

15. The transflective mode liquid crystal display as claimed in claim 1, wherein an electric filed is provided to have horizontal components parallel to the first substrate.

16. A transflective mode liquid crystal display comprising:

a first substrate and a second substrate disposed opposite each other and spaced apart a predetermined distance;

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

a plurality of pixel electrodes and a plurality of counter electrodes formed on the first substrate;

a color filter disposed on an inner surface of the second substrate, the color filter having a color resin layer, which comprises a transmission area and a reflection area;

a transflective element disposed adjacent the first substrate with a transmission section and a reflection section essentially aligned with the corresponding transmission area and the reflection area, respectively; and

means for keeping a brightness and a color saturation of light beams emitted from the transmission area substantially the same as a brightness and a color saturation of light beams emitted from the reflection area.

17. A transflective mode liquid crystal display comprising:

a first substrate and a second substrate disposed opposite each other and spaced apart a predetermined distance;

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

a plurality of pixel electrodes and a plurality of counter electrodes formed on the first substrate;

a color filter disposed on an inner surface of the second substrate, the color filter having a color resin layer, which comprises a transmission area and a reflection area; and

a transflective element disposed adjacent the first substrate with a transmission section and a reflection section essentially aligned with the corresponding transmission area and the reflection area, respectively; wherein

either the transmission area and the reflection area of the color filter or the transmission section and the reflection section of the transflective element is arranged different from each other either dimensionally or characteristically to keep a brightness and a color saturation of light beams emitted from the transmission area substantially the same as a brightness and a color saturation of light beams emitted from the reflection area.

* * * * *

专利名称(译)	透反模式液晶显示器		
公开(公告)号	US20050157231A1	公开(公告)日	2005-07-21
申请号	US11/026638	申请日	2004-12-30
[标]申请(专利权)人(译)	群创光电股份有限公司		
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当前申请(专利权)人(译)	群创光电		
[标]发明人	YANG CHIU LIEN CHEN CHUEH JU		
发明人	YANG, CHIU-LIEN CHEN, CHUEH-JU		
IPC分类号	G02F1/1335 G02F1/1343		
CPC分类号	G02F1/133514 G02F1/134363 G02F1/133555		
优先权	093101195 2004-01-16 TW		
外部链接	Espacenet USPTO		

摘要(译)

透反模式液晶显示器（2）包括第一基板（211）和第二基板（210），插入在第一基板和第二基板之间的液晶层（230），多个像素电极（213）和形成在第一基板上的多个反电极（212），设置在第二基板的内表面上的滤色器（250），以及设置在第一基板上的透反射元件（271）。滤色器具有彩色树脂层，其包括透射部分和反射部分。从透射部分发射的光束的亮度和色彩饱和度与从反射部分发射的光束的亮度和色彩饱和度基本相同。因此，透射反射模式液晶显示器具有改善的颜色和亮度特性。