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**Jung**

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(54) **REFLECTION TYPE COLOR LIQUID CRYSTAL DISPLAY (LCD) HAVING STEP DIFFERENCE FORMING LAYERS TO CREATE THICKNESS DIFFERENCES BETWEEN REFLECTIVE AREAS AND TRANSMISSIVE AREAS**

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**Related U.S. Application Data**

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(30) **Foreign Application Priority Data**

Dec. 15, 2001 (KR) ..... 2001-79713

(51) **Int. Cl.**
*G02F 1/1335* (2006.01)

(52) **U.S. Cl.** ..... **349/106**; 349/113; 349/114

(58) **Field of Classification Search** ..... 349/106, 349/113, 114

See application file for complete search history.

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(74) *Attorney, Agent, or Firm*—Stein, McEwen & Bui, LLP

(57) **ABSTRACT**

A reflection type color liquid crystal display includes a step difference forming layer installed between a reflection film and a substrate second transmissive holes formed opposite to first transmissive holes, a color filter layer with unit filter layers which are formed in a predetermined pattern and which each have a transmissive area with which the first and second transmissive holes are filled and a reflective area which extends from the transmissive area to the reflection film, a transparent front plate connected to sides of the substrate to form a predetermined interval between the transparent front plate and a transparent substrate, and a liquid crystal display portion formed between the color filter layer and a bottom surface of the transparent front plate. The step difference forming layers create differences in thickness between the reflective areas and the transmissive areas.

**7 Claims, 5 Drawing Sheets**

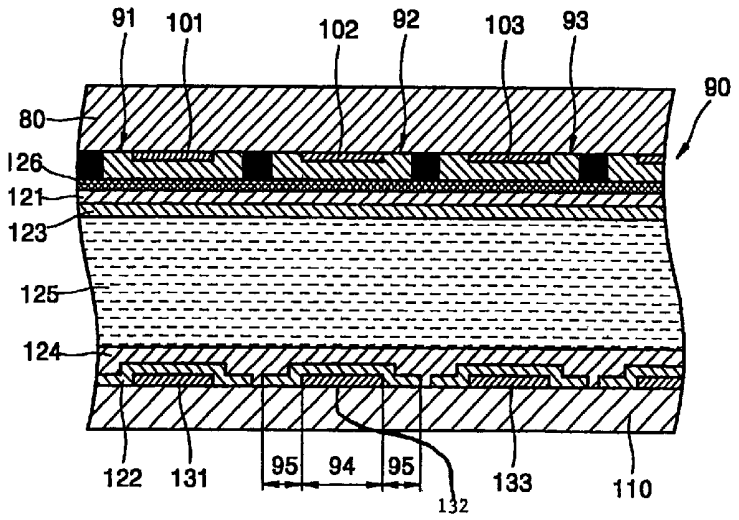

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FIG.1 (PRIOR ART)

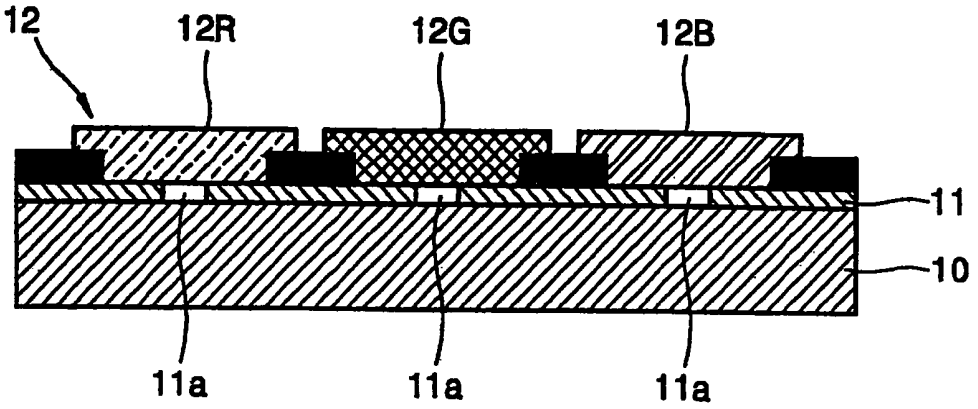



FIG.2

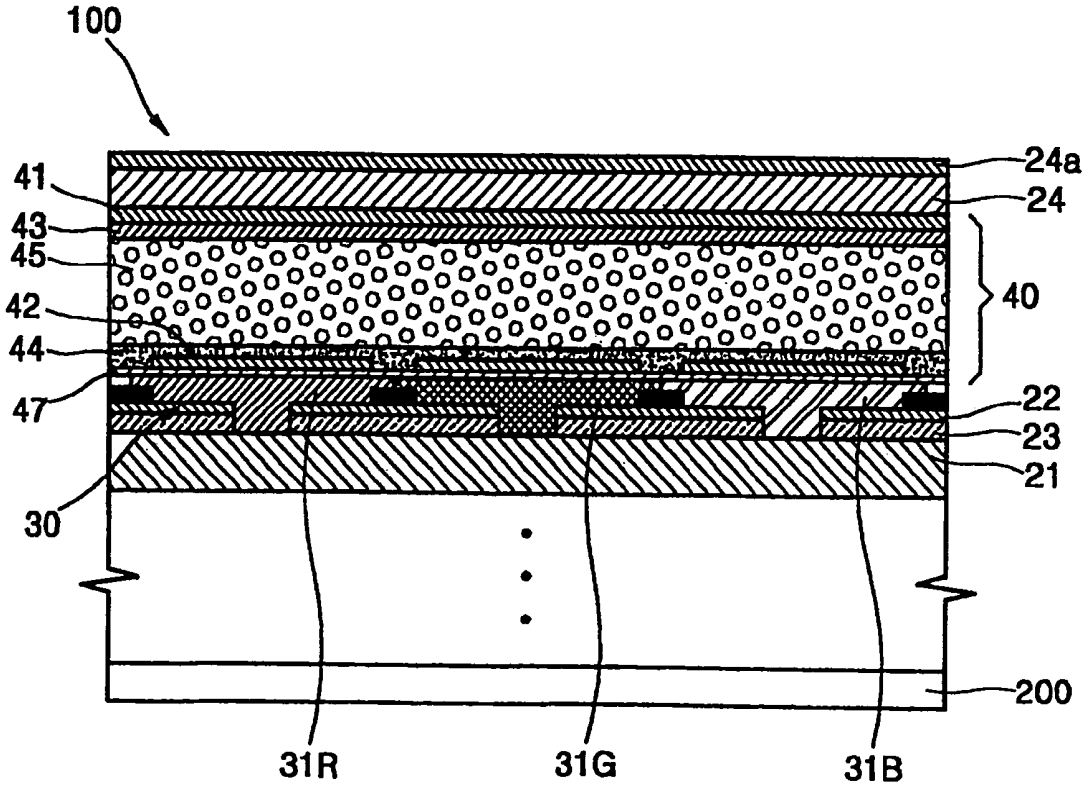


FIG.3

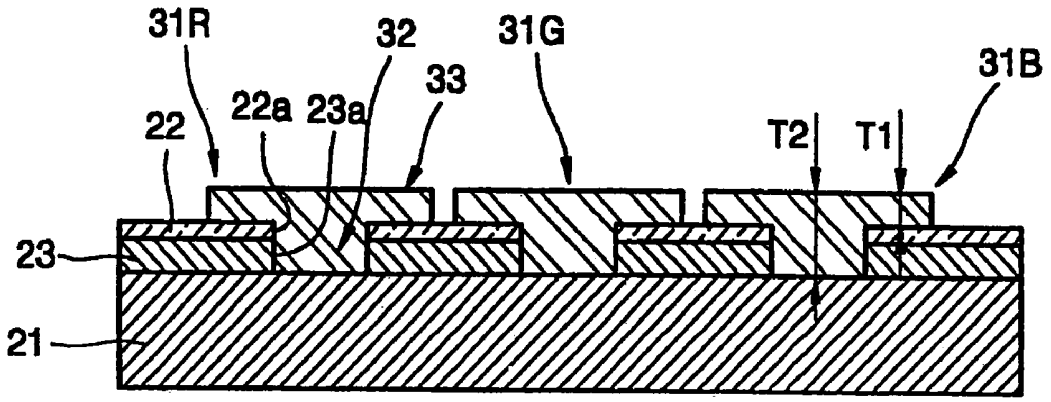

31R
32
31G
33
31B
22
22a
23a
T2
T1
23
21

FIG.4

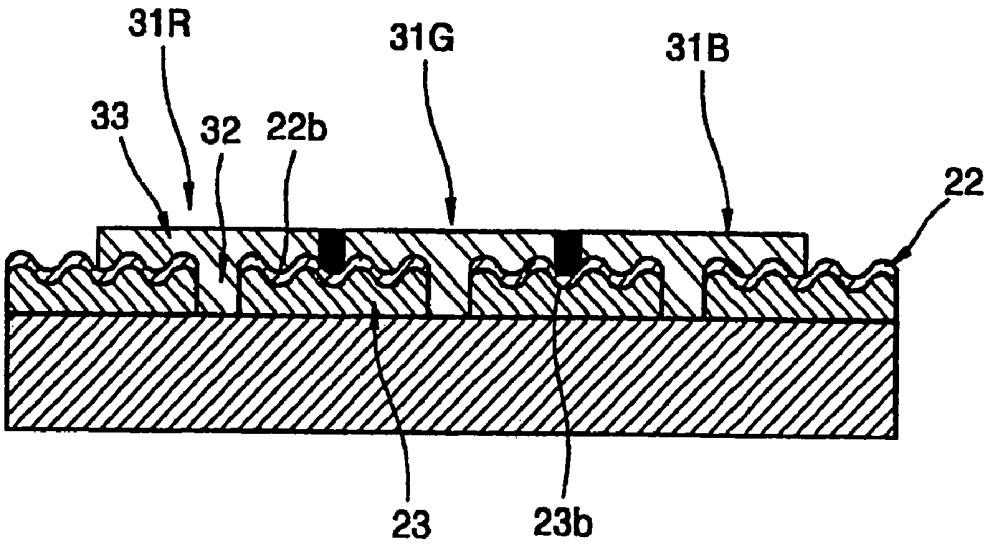

31R
31G
31B
33
32
22b
22
23
23b

FIG.5

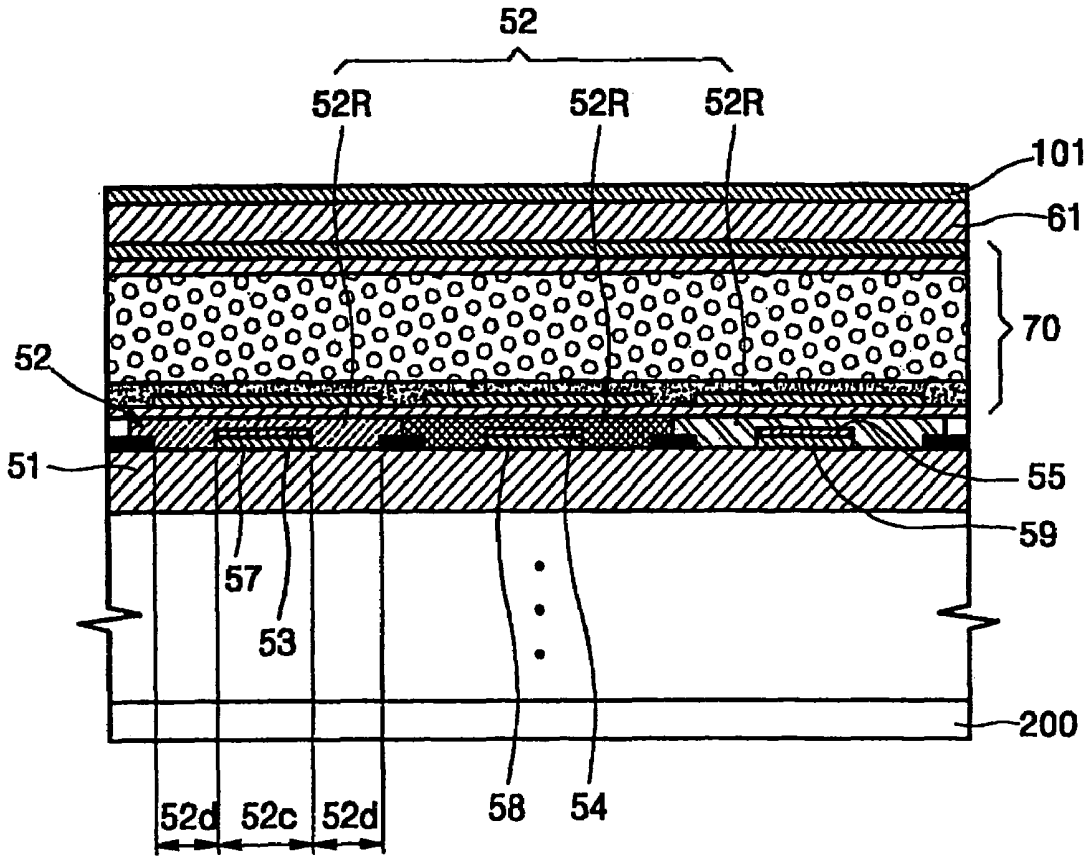


FIG.6

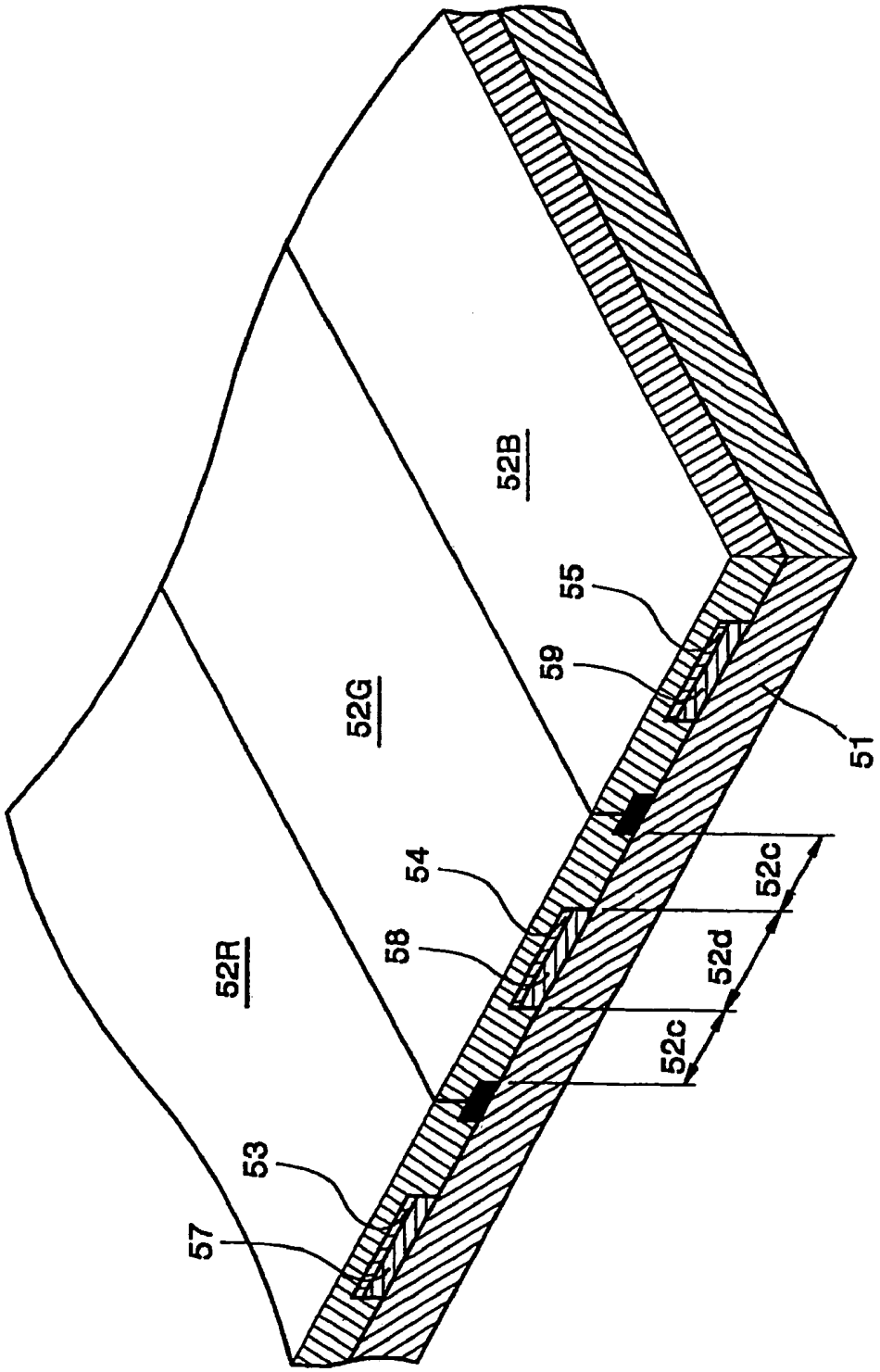
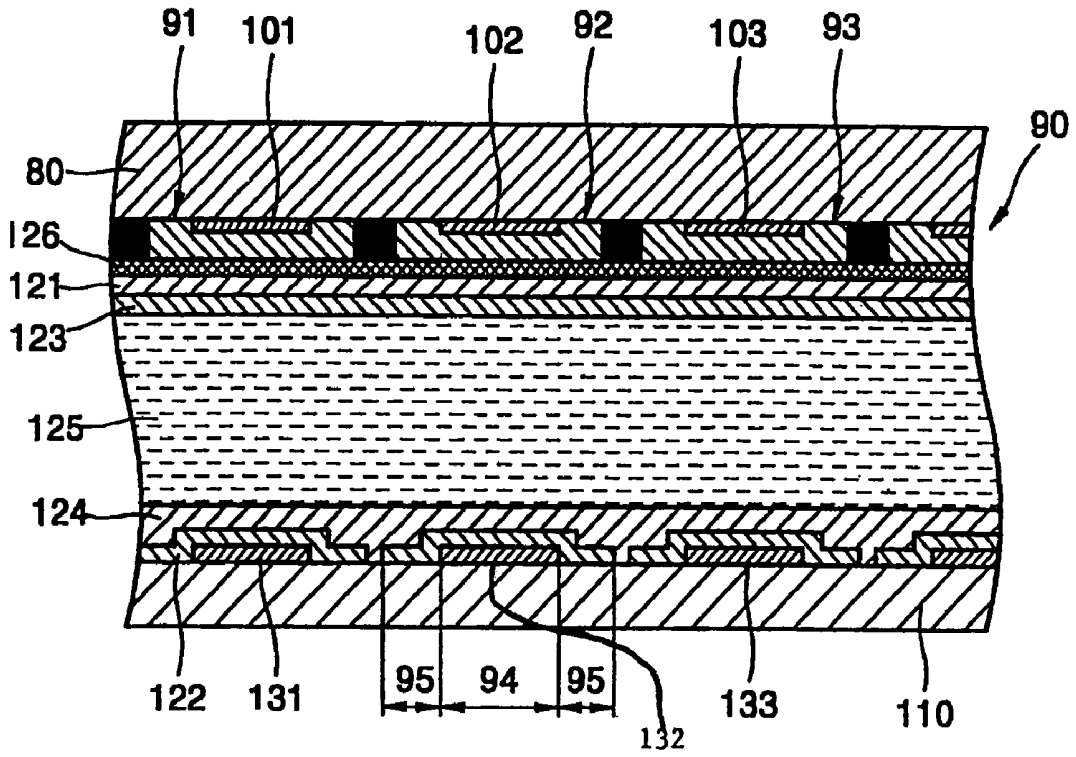


FIG.7


91
101
102
92
103
93
90
80
126
121
123
125
124
122
131
95
94
95
132
133
110

# REFLECTION TYPE COLOR LIQUID CRYSTAL DISPLAY (LCD) HAVING STEP DIFFERENCE FORMING LAYERS TO CREATE THICKNESS DIFFERENCES BETWEEN REFLECTIVE AREAS AND TRANSMISSIVE AREAS

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a divisional of application Ser. No. 10/318,102 filed on Dec. 13, 2002, now U.S. Pat. No. 6,972,814. The contents of application Ser. No. 10/318,102 are hereby incorporated herein by reference in their entirety.

This application claims the benefit of Korean Patent Application No. 2001-79713 filed on Dec. 15, 2001 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to liquid crystal displays, and more particularly, to reflection type color liquid crystal displays (LCDs) having an improved reflection film and an improved color filter layer.

2. Description of the Related Art

Generally, reflection type LCDs use a twisted pneumatic liquid crystal or a super-twisted pneumatic liquid crystal to display a monotone picture. However, with demand for color pictures, research into reflection type color LCDs including a color filter layer is being actively conducted.

Such reflection type LCDs having a color filter layer include an LCD adopting a guest host technique, in which a black dye is mixed in a liquid crystal, and a polymer scattering technique, in which a liquid crystal is scattered on a high molecular polymer. These techniques provide a good luminance because they do not use a polarization plate, but provide a low contrast.

To solve this problem, Korean Patent Publication No. 2001-022609 discloses a reflection type LCD which reflects external light using a reflective polarization plate, or transmits light radiating from a backlight. Such a display device improves a contrast by using a reflection type polarization plate, but degrades a luminance of the display device.

To solve this problem, there is provided a conventional reflection type LCD having an LCD portion, a color filter layer, and a reflection film. The LCD portion forms a picture using a liquid crystal. The color filter layer includes a patterned red filter layer, a patterned green filter layer, and a patterned blue filter layer so as to color the picture formed by the LCD portion. The reflection film is formed below the color filter layer.

FIG. **1** shows such a reflection type LCD in which a reflection film **11** and a color filter layer **12** are deposited on a substrate **10**. As shown in FIG. **1**, the reflection film **11** is formed on the substrate **10** and a color filter layer **12** having patterned red, green, and blue filter layers **12**R, **12**G, and **12**B is formed on the reflection film **11**. Apertures **11***a* which transmit light radiating from a backlight (not shown) are formed in parts of the reflection film **11** that face the red, green, and blue filter layers **12**R, **12**G, and **12**B.

However, in this structure, the thickness of the color filter layer **12** formed on the reflection film **11** is uniform over a transmissive area corresponding to the apertures **11***a* of the reflection film **11**, and a reflective area of the reflection film **11**. Thus, the color filter layer **12** provides a poor color reproducibility of color pictures.



## SUMMARY OF THE-INVENTION

Accordingly, it is an aspect of the present invention to provide a reflection type color liquid crystal display (LCD) capable of improving a color reproducibility of a transmissive area without significantly affecting a reflectability of a reflection film.

Another aspect of the present invention is to provide a reflection type color LCD capable of increasing a brightness by enhancing the reflectability of the reflection film.

Additional aspects and advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

To achieve the above and/or other aspects of the present invention, there is provided a reflection type color LCD comprising a transparent substrate, a reflection film, a step difference forming layer, a color filter layer, and a transparent front plate. The reflection film is formed on the transparent substrate, and includes first transmissive holes which transmit light in a predetermined pattern. The step difference forming layer is installed between the reflection film and the transparent substrate, and includes second transmissive holes which are formed opposite to the first transmissive holes. The color filter layer includes unit filter layers formed in a predetermined pattern. Each of the unit filter layers has a transmissive area with which the corresponding first and second transmissive holes are filled, and a reflective area which extends from the transmissive area to the reflection film. The transparent front plate is connected to sides of the substrate so as to form a predetermined interval in between the transparent front plate and the substrate. The transparent front plate includes a liquid crystal display portion which is formed between the color filter layer and a bottom surface of itself.

Each of the unit filter layers may have an upper surface which is even, and the transmissive areas are thicker than the respective reflective areas. At least one of the step difference forming layer, the reflective areas of the color filter layer, and the reflection film may have a wavy surface so as to increase a reflectability of the light.

To achieve the above and/or other aspects of the present invention, there is provided a reflection type color LCD, wherein a color filter layer is formed on a transparent substrate and includes red, green, and blue unit filter layers which are formed in strips. Reflection films are formed between the transparent substrate and the color filter layer so as to be narrower than the red, green, and blue unit filter layers, and define reflective areas and transmissive areas of the color filter layer. The reflection films are buried in the corresponding red, green, and blue unit filter layers. The step difference forming layers are installed between the respective reflection films and the transparent substrate, and form the difference in thickness between the reflective areas and the transmissive areas of the color filter layer. A transparent front plate is connected to sides of the transparent substrate so as to form a predetermined distance in between the transparent front plate and the transparent substrate. The transparent front plate includes a liquid crystal display portion which is formed between the color filter layer and a bottom surface of the transparent front plate.

To achieve the above and/or other objects of the present invention, there is provided a reflection type color LCD according to yet another embodiment of the present invention. In this embodiment, a color filter layer having red, green, and blue unit filter layers formed parallel to each other is formed on a front plate. Transparent step difference forming layers are installed between the corresponding red, green, and blue unit filter layers and the front plate so as to be narrower than the red, green, and blue unit filter layers.

The transparent step difference forming layers define reflective areas and transmissive areas of the color filter layers and are buried in the corresponding red, green, and blue unit filter layers. A substrate is connected to sides of the front plate so as to form a predetermined interval in between them. This embodiment includes a liquid crystal display portion having first and second electrodes, orientation films, and a liquid crystal layer. The first and second electrodes are formed in a predetermined pattern on the color filter layer and the substrate, respectively, so as to face each other. The orientation films are formed on corresponding opposed surfaces of the first and second electrodes so as to bury the first and second electrodes. The liquid crystal layer is formed between the orientation films. Reflection films are formed between the corresponding second electrodes and areas of the substrate that face the step difference forming layers.

The unit filter layers may have different sizes according to a color reproducibility of the color filter layer.

## BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and advantages of the present invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

FIG. **1** is a cross-sectional view of a conventional reflection type-LCD in which a reflection film and a color filter layer are formed on a substrate;

FIG. **2** is a cross-sectional view of a reflection type color liquid crystal display (LCD) according to an embodiment of the present invention;

FIG. **3** is a cross-sectional view of a structure in which a reflection film and a color filter layer are formed on a substrate, according to an aspect of the present invention;

FIG. **4** is a cross-sectional view of a structure in which a reflection film and a color filter layer are formed on a substrate, according to another aspect of the present invention;

FIG. **5** is a cross-sectional view of a reflection type color LCD according to another embodiment of the present invention;

FIG. **6** is a perspective view of the structure in which a reflection film and a color filter layer are formed on a substrate, the structure shown in FIG. **5**; and

FIG. **7** is a cross-sectional view of a reflection type color LCD according to yet another embodiment of the present invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below in order to explain the present invention by referring to the figures.

FIG. **2** shows a reflection type liquid crystal display (LCD) **100** according to an embodiment of the present invention. As shown in FIG. **2**, a reflection film **22** which demarcates a transmissive area and a reflective area is formed on a transparent substrate **21**. A color filter layer **30** having unit filter layers **31**R, **31**G, and **31**B, in the same pattern as the configuration of pixels to form color pictures, is formed on the reflection film **22**. A step difference forming layer **23** is formed between the substrate **21** and the reflection film **22** to form a step difference between the transmissive area and reflective area of the unit filter layers **31**R, **31**G, and **31**B. The substrate **21** is connected to sides of a front plate **24** so as to form a predetermined interval in between them. A LCD portion **40** is formed on a lower surface of the front plate **24** and an upper surface of the color filter layer **30**.

FIGS. **3** and **4** show detailed structures of the LCD **100** of FIG. **1**, according to aspects of the present invention, in which the color filter layer **30**, the reflection film **22**, and the step difference forming layer **23** are stacked on the substrate **21**.

As shown in FIG. **3**, the step difference forming layer **23** formed on the substrate **21** has second transmissive holes **23***a* in the same pattern as an arrangement pattern of red, green, and blue colors to form a picture. The second transmissive holes **23***a* can have different sizes depending on a color reproducibility of the color filter layer **30** and a color temperature. The reflective film **22** formed on the step difference forming layer **23** has first transmissive holes **22***a* formed directly over the second transmissive holes **23***a*.

As shown in FIG. **4**, the reflection film **22** can have a wavy surface **22***b* to increase a reflectability of external light. The wavy surface **22***b* can be formed by forming the reflection film **22** along a wavy surface **23***b* of the step difference forming layer **23**.

Each of the unit filter layers **31**R, **31**G, and **31**B of the color filter layer **30** includes a transmissive area **32** which is formed in the coaxially-formed first and second transmissive holes **22***a* and **23***a*, and a reflective area **33** which extends from the transmissive area **32** to cover an area of the reflection film **22**. Each of the unit filter layers **31**R, **31**G, and **31**B having the transmissive and reflective areas **32** and **33** has an even upper surface. The transmissive area **32** is formed to a thickness T**2**, which is greater than a thickness T**1** of the reflective area **33**, by filling the first and second transmissive holes **22***a* and **23***a* with a unit filter layer material. For example, the step difference forming layer **23** which creates a difference in thickness between the transmissive area **32** and the reflective area **33** that form each of the unit filter layers **31**R, **31**G, and **31**B, is formed to a thickness of about 0.1 to 0.2 μm.

Referring back to FIG. **2**, the LCD portion **40** formed between the color filter layer **30** and the bottom surface of the front plate **24** includes first and second electrodes **41** and **42**, orientation films **43** and **44**, and a liquid crystal layer **45**. The first and second electrodes **41** and **42** are transparent and formed in predetermined patterns on the bottom surface of the front plate **24** and on the upper surface of the color filter layer **30**, respectively. The orientation films **43** and **44** have rubbed surfaces and are formed on the front plate **24** and the color filter layer **30**, respectively, such that the first and second electrodes **41** and **42** are buried in the orientation films **43** and **44**, as shown in FIG. **2**. The liquid crystal layer **45** is installed between the orientation films **43** and **44**. A transparent dielectric layer **47** can be further installed on the color filter layer **30**.

Additionally, a polarization plate **24***a* can be installed on at least one surface of the outer surface of the substrate **21** and that of the front plate **24**. Also, a backlight **200** can be installed below the substrate **21**.

In the reflection type color LCD **100** having the above-described structure, where a predetermined voltage is applied to the first and second electrodes **41** and **42**, the liquid crystal in the liquid crystal layer **45** is oriented in a predetermined pattern so as to selectively transmit light, thereby forming a picture. In this operation, where a back light is not needed, light is transmitted by the liquid crystal layer **45**, again transmitted by the reflective areas **33** of the unit filter layers **31**R, **31**G, and **31**B, and then reflected by the reflection film **32**, thereby forming a color picture. On the other hand, where light from the backlight **200** is required, the light generated from the backlight **200** is

transmitted by the transmissive areas **32** of the unit filter layers **31**R, **31**G, and **31**B and the liquid crystal layer **45** to create a color picture. As described above, the transmissive areas **32** are thicker than the reflective areas **33**. Accordingly, a color reproducibility of the color picture is improved.

FIGS. **5** and **6** show a reflection type color LCD according to another embodiment of the present invention. As shown in FIG. **5**, a color filter layer **52** having red, green, and blue unit filter layers **52**R, **52**G, and **52**B, in strips, is formed on a transparent substrate **51**. Reflection films **53**, **54**, and **55** are formed between the transparent substrate **51** and the unit filter layers **52**R, **52**G, and **52**B so as to be thinner than the unit filter layers **52**R, **52**G, and **52**B, respectively, and accordingly define a reflective area **52***c* and a transmissive area **52***d*. The reflection films **53**, **54**, and **55** are buried in the unit filter layers **52**R, **52**G, and **52**B, respectively. Step difference forming layers **57**, **58**, and **59** are installed between the reflection films **53**, **54**, and **55** and the substrate **51**, and create a difference in thickness between the reflective area **52***c* and transmissive area **52***d* of each of the unit filter layers **52**R, **52**G, and **52**B. According to an aspect of the present invention, the step difference forming layers **57**, **58** and **59**, and the reflection films **53**, **54** and **55** have irregular surfaces so as to improve a reflectability of external light.

The perimeter of the substrate **51** is coupled to that of the front plate **61** so as to form a predetermined interval in between them. An LCD portion **70** is formed between a bottom surface of the front plate **61** and an upper surface of the color filter layer **52**. The LCD portion **70** is the same as the LCD portion of FIG. **2**, and therefore, will not be described below.

In the reflection type LCD having the above-described structure, the reflective area **52***c* and transmissive area **52***d* of each of the unit filter layers **52**R **52**G and **52**B are different in thickness due to the formation of the reflection films **53**, **54**, and **55** and the step difference forming layers **57**, **58**, and **59**. This improves a color reproducibility of a color picture.

FIG. **7** shows a reflection type color LCD according to yet another embodiment of the present invention. As shown in FIG. **7**, a color filter layer **90** having red, green, and blue unit filter layers **91**, **92**, and **93** parallel to one another is formed on one side of a front plate **80**. Transparent step difference forming layers **101**, **102**, and **103** are formed between the front plate **80** and the unit filter layers **91**, **92**, and **93** so as to be narrower than the unit filter layers **91**, **92**, and **93**, respectively, and accordingly define a reflective area **94** and a transmissive area **95**. The transparent step difference forming layers **101**, **102**, and **103** are buried in the unit filter layers **91**, **92**, and **93**, respectively. For example, the step difference forming layers **101**, **102**, and **103** are formed of an organic material.

A substrate **110** is connected to sides of the front plate **80** so as to form a predetermined distance in between them. First and second electrodes **121** and **122** are formed in predetermined patterns on the color filter layer **90** and the substrate **110**, respectively. Orientation films **123** and **124** are formed on the first and second electrodes **121** and **122**, respectively, so as to bury them. A transparent planarization film **126** can be further formed between the color filter layer **90** and the first electrode **121**.

Reflection films **131**, **132**, and **133** are formed between the substrate **110** and the second electrodes **122** so as to face the corresponding step difference forming layers **101**, **102**, and **103**. A liquid crystal layer **125** is formed between the orientation films **123** and **124**.

In the embodiment described above, widths of the step difference forming layers **101**, **102**, and **103** are the same as those of the reflection films **131**, **132**, and **133**. The transmissive areas **95** of the unit filter layers **91**, **92**, and **93** are thicker than the reflective areas **94** thereof. The unit filter layers **91**, **92**, and **93** can have different sizes depending on a color reproducibility of the color filter layer **90**.

In a color LCD having a structure as described above, unit filter layers corresponding to red, green, and blue pixels have different-sized transmissive and reflective areas. Accordingly, transmissivity is different for each pixel in a transmission mode. Therefore, the luminance and color reproducibility of an image can be improved.

A result of an experiment on the luminance and color reproducibility, depending on the difference in thickness between the transmissive and reflective areas of a unit filter layer, is shown in Table 1.

TABLE 1

| | Transmissive area | | | Reflective area | | |
|---|---|---|---|---|---|---|
| | Thickness of unit filter layer (μm) | Color reproducibility (%) | Luminance (%) | Thickness of unit filter layer (μm) | Color reproducibility (%) | Luminance (%) |
| Conventional reflection type LCD | 0.75 | 4.9 | 64.4 | 0.75 | 4.9 | 64.6 |
| Reflection type LCD according to the present invention | 1.47 | 14.6 | 50.2 | 0.75 | 4.9 | 64.6 |

As shown from the result of Table 1, a reflection type LCD of the present invention has a significantly improved color reproducibility compared to that of a conventional reflection type LCD. In the reflection type LCD of the present invention, where reflection films have an irregular surface and the difference in thickness between a reflection area and a transmissive area of a unit filter layer is large, the color reproducibility is increased three times or greater than the conventional reflection type LCD.

A reflection type LCD according to the present invention as described above includes unit filter layers, each having a reflective area and a transmissive area having different thicknesses to improve a color reproducibility. Furthermore, a color purity and luminance of a picture can be improved.

Although a few embodiments of the present invention have been shown and described, it will be appreciated by those skilled in the art that changes may be made in these

embodiments without departing from the principles and spirit of the invention, the scope of which is defined in the appended claims and their equivalents.

What is claimed is:

1. A reflection type color liquid crystal display comprising:

a front plate;

a color filter layer having red, green, and blue unit filter layers formed parallel to each other on the front plate;

transparent step difference forming layers which are installed between the corresponding red, green, and blue unit filter layers and the front plate so as to be narrower than the red, green, and blue unit filter layers, define reflective areas and transmissive areas of the color filter layer, and are buried in and spaced apart from sides of the corresponding red, green, and blue unit filter layers;

a substrate which is connected to sides of the front plate so as to form a predetermined interval in between the substrate and the front plate;

a liquid crystal display portion including:

first and second electrodes which are formed in a predetermined pattern on the color filter layer and the substrate, respectively, so as to face each other,

orientation films which are formed on corresponding opposed surfaces of the first and second electrodes so as to bury the first and second electrodes, and

a liquid crystal layer formed between the orientation films; and

reflection films formed between the corresponding second electrodes and areas of the substrate that face the step difference forming layers.

2. The reflection type color liquid crystal display of claim 1, wherein the step difference forming layers have the same widths as those of the respective reflection films.

3. The reflection type color liquid crystal display of claim 1, wherein the transmissive areas of the color filter layer are thicker than the reflective areas.

4. The reflection type color liquid crystal display of claim 1, wherein the red, green, and blue unit filter layers have different sizes according to a color reproducibility of the color filter layer.

5. The reflection type color liquid crystal display of claim 1, further comprising a transparent planarization film provided between the color filter layer and the first electrode.

6. A reflection type color liquid crystal display comprising:

a substrate;

a reflection film having a predetermined pattern provided on the substrate;

a color filter layer having unit filter portions, wherein each of the unit filter portions includes a transmissive area and a reflective area which have different thicknesses;

a front plate connected to the substrate so as to form a predetermined interval therebetween;

a liquid crystal display portion formed between the front plate and the substrate; and

step difference forming layers which are arranged between the corresponding unit filter portions and the front plate, narrower than, buried within and spaced apart from sides of the corresponding unit filter portions, and provide a thickness difference between the transmissive areas and the reflective areas.

7. The reflection type color liquid crystal display of claim 6, wherein the unit filter portions have different sizes according to a color reproducibility of the color filter layer.

* * * * *

| | | | |
|---|---|---|---|
| 专利名称(译) | 反射型彩色液晶显示器（LCD）具有阶梯差形成层，以在反射区域和透射区域之间产生厚度差异 | | |
| 公开(公告)号 | US7372526 | 公开(公告)日 | 2008-05-13 |
| 申请号 | US11/081720 | 申请日 | 2005-03-17 |
| 申请(专利权)人(译) | 三星SDI CO.，LTD. | | |
| 当前申请(专利权)人(译) | 三星DISPLAY CO.，LTD. | | |
| [标]发明人 | JUNG TAEHYEOG | | |
| 发明人 | JUNG, TAEHYEOG | | |
| IPC分类号 | G02F1/1335 G02B5/20 | | |
| CPC分类号 | G02F1/133514 G02F1/133555 | | |
| 优先权 | 1020010079713 2001-12-15 KR | | |
| 其他公开文献 | US20050179839A1 | | |
| 外部链接 | Espacenet USPTO | | |


摘要(译)

反射型彩色液晶显示器包括：台阶差形成层，安装在反射膜和基板之间，与第一透射孔相对形成的第二透射孔;滤色器层，具有以预定图案形成的单元滤光层，每个都有填充第一和第二透射孔的透射区域和从透射区域延伸到反射膜的反射区域，透明前板连接到基板的侧面以在透明前板和透明前板之间形成预定间隔透明基板和形成在滤色器层和透明前板的底表面之间的液晶显示部分。台阶差形成层在反射区域和透射区域之间产生厚度差异。