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Huang et al.

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(54) **COLOR FILTER SUBSTRATE, MULTI-VIEW LIQUID CRYSTAL DISPLAY APPARATUS AND METHOD OF MANUFACTURING THE SAME THEREOF**

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G02F 1/1333 (2006.01)
G02F 1/13 (2006.01)

(52) **U.S. Cl.**
USPC **349/106**; 349/110; 349/187; 430/7

(58) **Field of Classification Search**
USPC 349/106, 110, 187; 430/7
See application file for complete search history.

(56) **References Cited**

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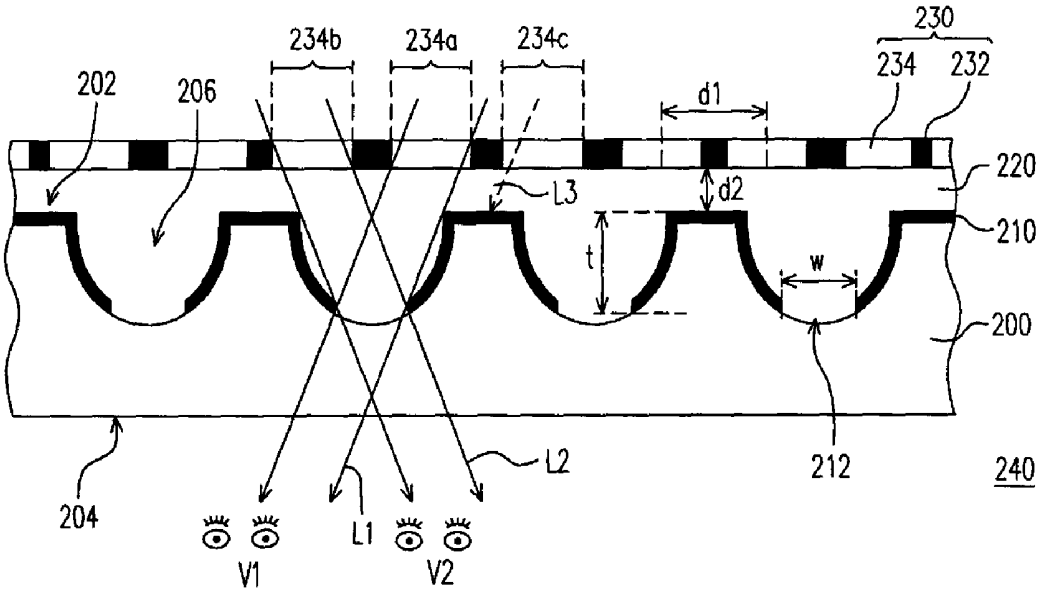
(57) **ABSTRACT**

A color filter substrate for multi-view displaying including a substrate, a light shielding-layer, and a color filter layer is provided. The substrate has a first surface, a second surface, and a plurality of concaves. The first surface is opposite to the second surface. The concaves are located at the first surface. The light-shielding layer disposed on the first surface of the substrate defines a plurality of light-transparent openings. The color filter layer has a plurality of sub-pixel areas including at least one first sub-pixel area and at least one second sub-pixel area. A first light is transmitted to a first viewer by passing through one of the light-transparent openings and one of the at least one first sub-pixel area, and simultaneously, a second light is transmitted to a second viewer by passing through the same one of the light-transparent openings and one of the at least one second sub-pixel area.

15 Claims, 10 Drawing Sheets



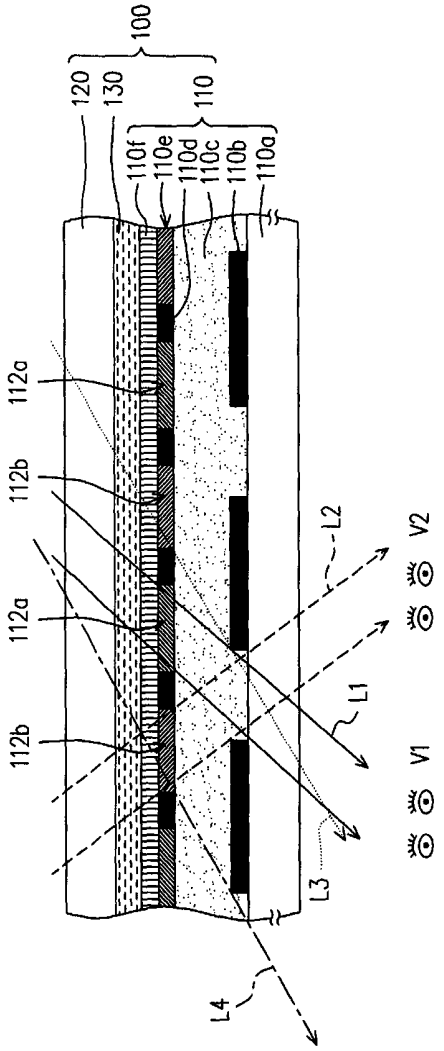


FIG. 1A (PRIOR ART)

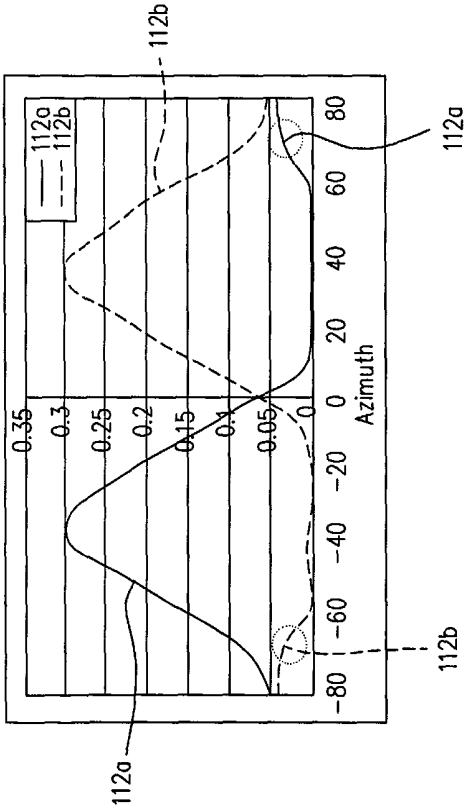


FIG. 1B (PRIOR ART)

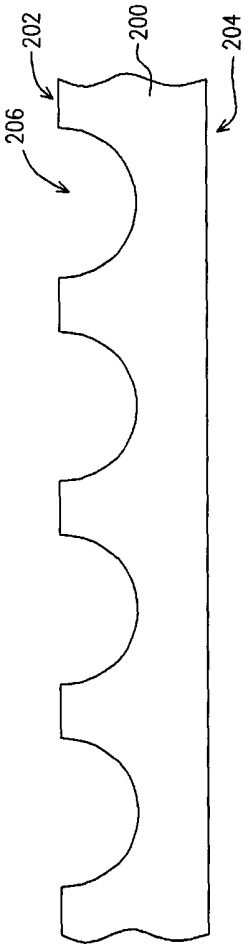


FIG. 2A

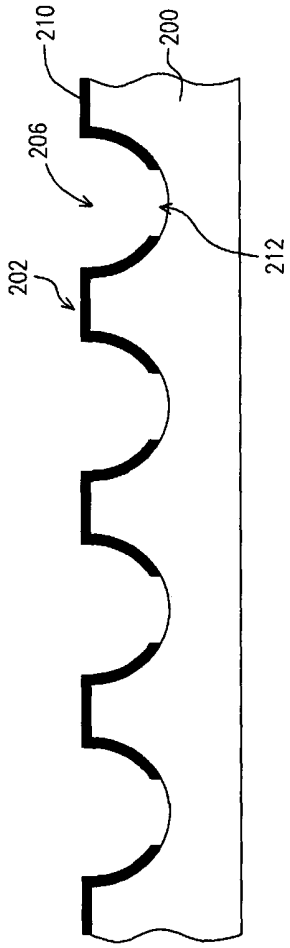


FIG. 2B

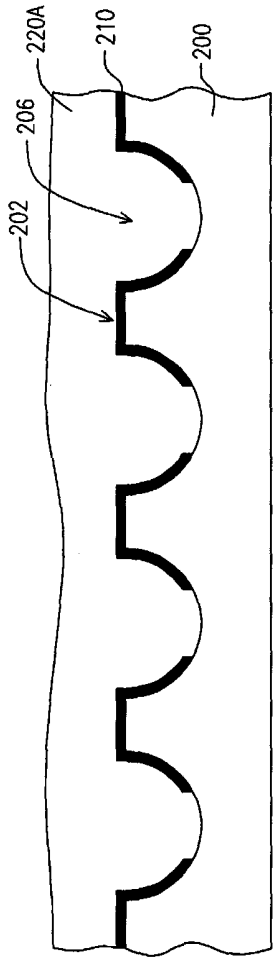


FIG. 2C

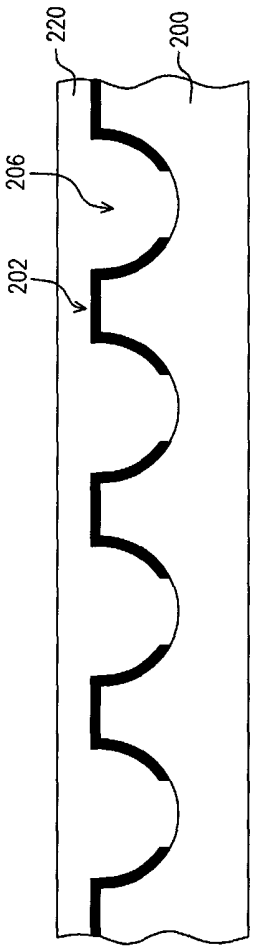


FIG. 2D

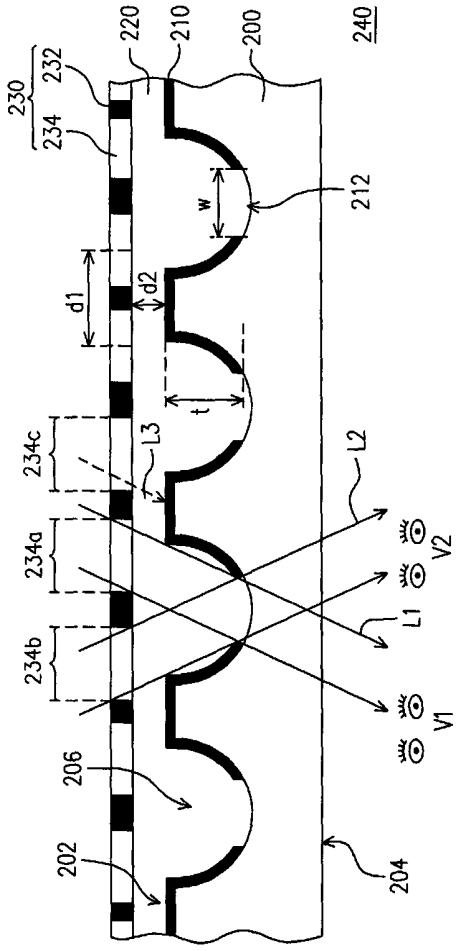

220
210
200
240
230
232
234
212
w
d1
d2
t
234c
L3
L2
234a
V2
L1
234b
V1
206
202
204

FIG. 2E

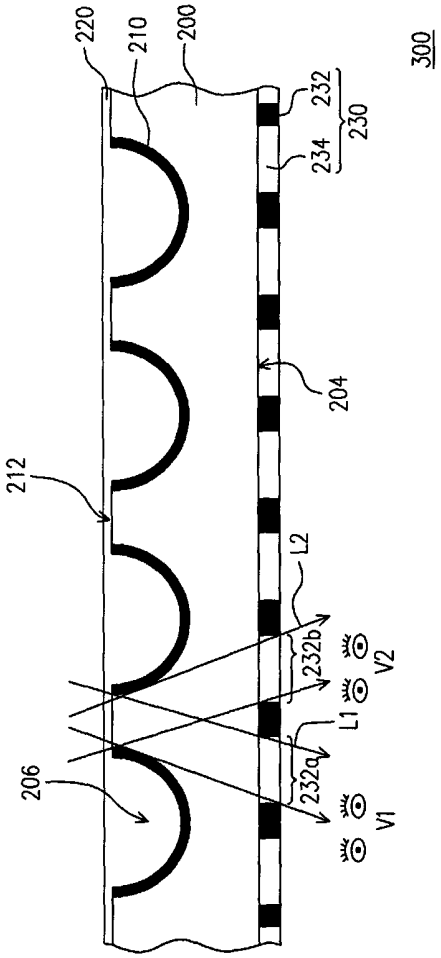


FIG. 3

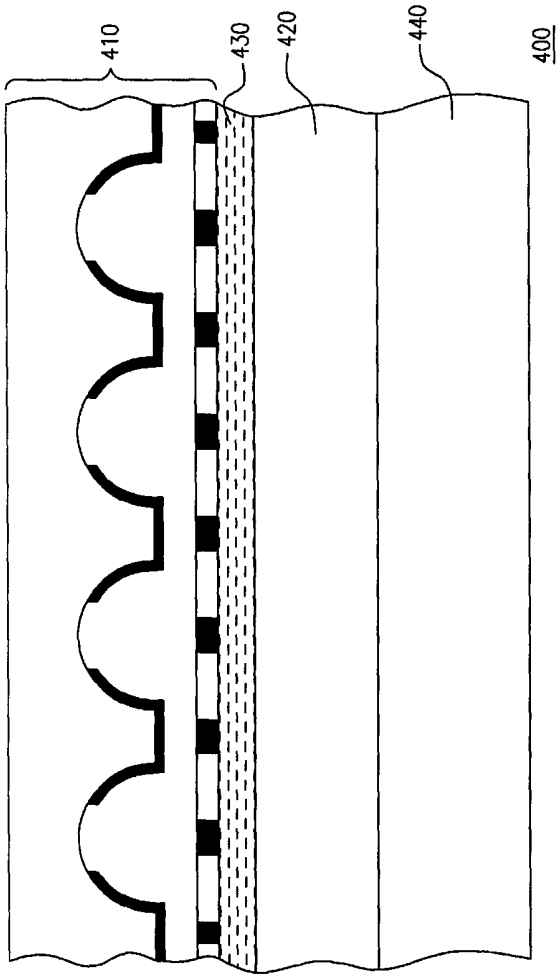


FIG. 4

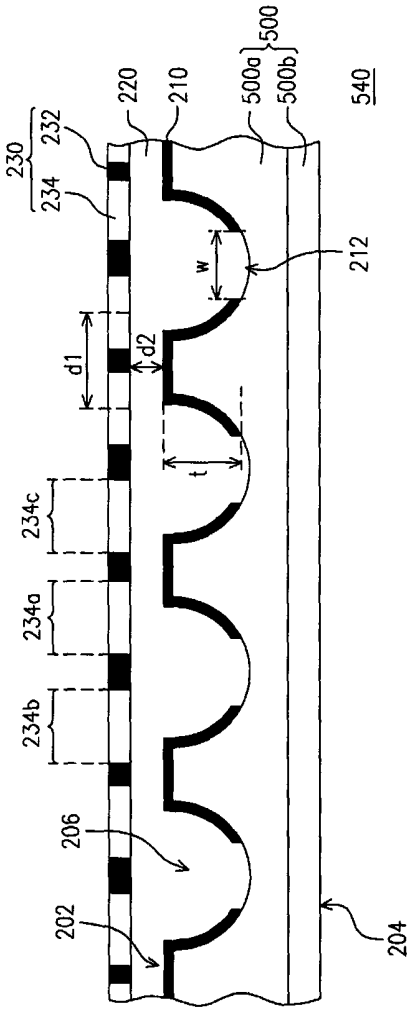

230
232
234
220
210
500
500a
500b
540
212
w
d1
d2
t
234c
234a
234b
206
202
204

FIG. 5

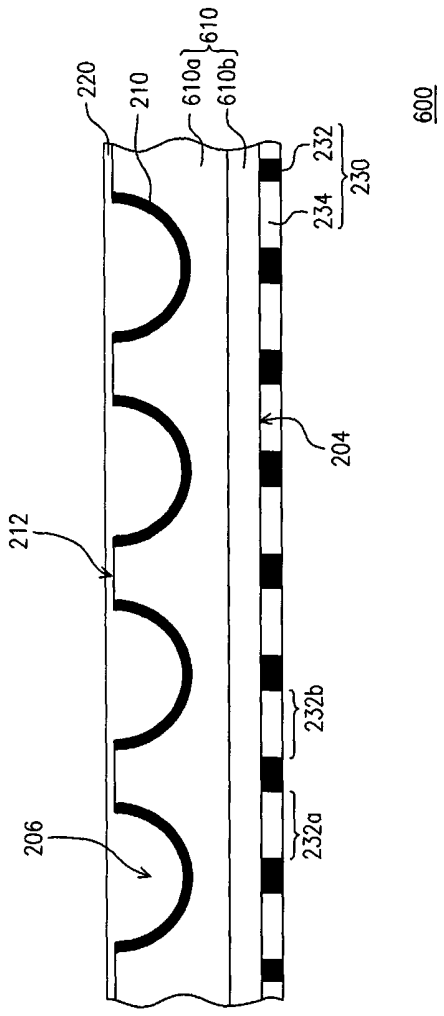


FIG. 6

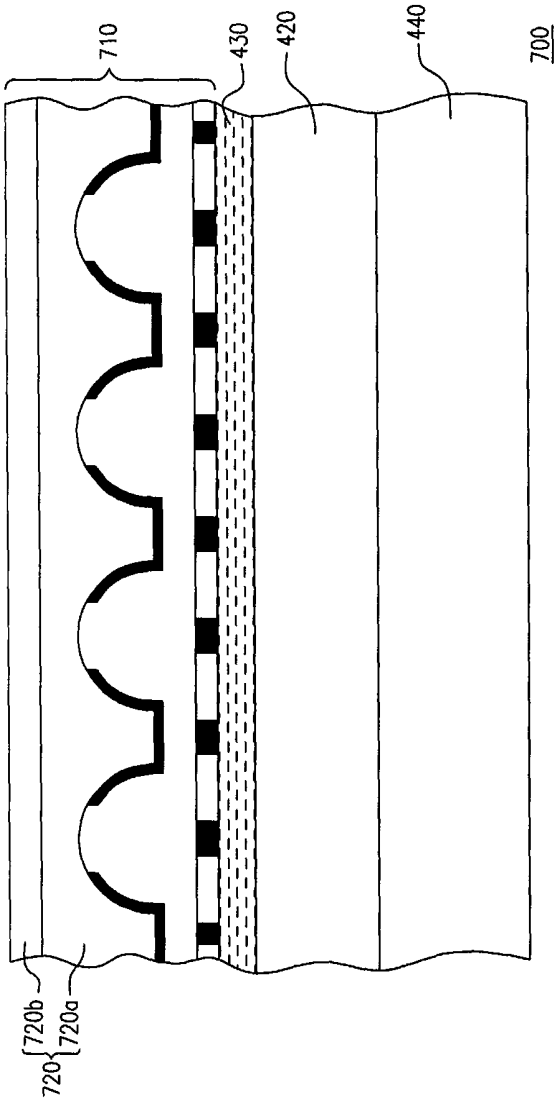


FIG. 7

COLOR FILTER SUBSTRATE, MULTI-VIEW LIQUID CRYSTAL DISPLAY APPARATUS AND METHOD OF MANUFACTURING THE SAME THEREOF

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a liquid crystal display (LCD) apparatus, a color filter substrate, and a method of manufacturing the same thereof and particularly relates to a multi-view LCD apparatus, a color filter substrate, and a method of manufacturing the same thereof.

2. Description of Related Art

Owing to the characteristics of power saving, small volume, etc., an LCD is applied to the displays in automobiles and the global positioning system (GPS) assembled in automobiles for displaying the programs and the maps. Nevertheless, if the driver uses the GPS, the passengers are incapable of watching the programs. To resolve the problem, a dual-view LCD is provided.

FIG. **1**A is a schematic cross-sectional view of a conventional dual-view LCD panel. Referring to FIG. **1**A, the dual-view LCD panel **100** includes a color filter substrate **110**, an active device array substrate **120**, and a liquid crystal layer **130**. The liquid crystal layer **130** is disposed between the color filter substrate **110** and the active device array substrate **120**. By forming an electric field between the color filter substrate **110** and the active device array substrate **120**, the orientation of the liquid crystal molecules in the liquid crystal layer **130** is controlled to determine a light passing through the LCD panel **100** or not.

Particularly, the design of the color filter substrate **110** makes the dual-view liquid crystal panel **100** display different images in different viewing-angle. The color filter substrate **110** includes a glass substrate **110***a*, a light-shielding layer **110***b*, an overcoat layer **110***c*, a black matrix **110***d*, a color filter layer **110***e*, and a common electrode **110***f*, wherein the black matrix **110***d* defines first pixel areas **110***a* and second pixel areas **112***b* which respectively emit a first light L**1** and a second light L**2** with different image information.

By the disposition of the light-shielding layer **110***b*, the first light L**1** and the second light L**2** with different image information are transmitted in different direction so as to display different images in different directions. That is to say, a first viewer V**1** and a second viewer V**2** would see different images. However, the light L**3** and the light L**4** emitted from the second pixel area **112***b* may interfere with the light L**1** emitted from the first pixel area **112***a* so that the display quality is negatively influenced, vice versa.

Specifically, FIG. **1**B is a schematic optical simulation of the conventional dual-view LCD panel. Referring to FIG. **1**B, if the image displayed in the first pixel area **112***a* is watched from a position of the first viewer V**1**, a portion of the light emitted from second pixel area **112***b* is transmitted in the direction of the larger angle (e.g. below −60 degree) to the corresponding position. Similarly, if the image displayed in the second pixel area **112***b* is watched from a position of the second viewer V**2**, a portion of the light emitted from first pixel area **112***a* is transmitted in the direction of the larger angle (e.g. above 60 degree) to the position. It is because that the light L**3** and the light L**4** emitted from the second pixel area **112***b* can be transmitted in the direction of the larger angle to the position of the first viewer V**1** through the adjacent opening of the light-shielding layer **110***b* as shown in FIG. **1**A. Accordingly, the first viewer V**1** receives the image information displayed in the second pixel area **112***b*. The

image light of different pixel areas is interfered with each other if the image is watched in the direction of large angle so as to reduce the display quality. In addition, the overcoat layer **110***c* must have an extreme thickness to accomplish the dual-view display effect, thereby the thickness of the dual-view LCD panel **100** can not be reduced to meet the thin volume requirement of the market. Moreover, because the thermal expansion coefficient of the overcoat layer **110***c* and that of the glass substrate **110***a* are significantly varied, the glass substrate **110***a* may be bent and deformed when the overcoat layer **110***c* is thermal-cured so that the manufacturing process of the black matrix **110***d*, the color filter film **110***e*, and the common electrode **110***f* are negatively influenced.

SUMMARY OF THE INVENTION

The invention is directed to a color filter substrate making an LCD apparatus having the color filter substrate perform a multi-view display function and has good display quality.

The invention is directed to a method of manufacturing a color filter substrate for improving the process yield.

The invention is directed to a multi-view LCD apparatus which facilitates multi-view display function and is capable of solving the image interference problem so as to enhance the display quality of the LCD apparatus.

The invention provides a color filter substrate for multi-view displaying, and the color filter substrate is used for simultaneously transmitting a first light and a second light to a first viewer and a second viewer, respectively. The color filter substrate includes a substrate, a light-shielding layer, and a color filter layer. The substrate has a first surface, a second surface, and a plurality of concaves, wherein the first surface is opposite to the second surface, and the concaves are located at the first surface. The light-shielding layer disposed on the first surface of the substrate defines a plurality of light-transparent openings. The color filter layer has a plurality of sub-pixel areas including at least one first sub-pixel area and at least one second sub-pixel area, wherein the first light is transmitted to the first viewer by passing through one of the light-transparent openings and one of the at least one first sub-pixel area, and simultaneously, the second light is transmitted to the second viewer by passing through the same one of the light-transparent openings and one of the at least one second sub-pixel area.

The invention also provides a multi-view LCD apparatus including a color filter substrate, an opposite substrate, and a liquid crystal layer. The liquid crystal layer is disposed between the color filter substrate and the opposite substrate. The color filter substrate includes a substrate, a light-shielding layer, and a color filter layer. The substrate has a first surface, a second surface, and a plurality of concaves, wherein the first surface is opposite to the second surface, and the concaves are located at the first surface. The light-shielding layer disposed on the first surface of the substrate defines a plurality of light-transparent openings. The color filter layer has a plurality of sub-pixel areas including at least one first sub-pixel area and at least one second sub-pixel area, wherein the first light is transmitted to the first viewer by passing through one of the light-transparent openings and one of the at least one first sub-pixel area, and simultaneously, the second light is transmitted to the second viewer by passing through the same one of the light-transparent openings and one of the at least one second sub-pixel area.

In a color filter substrate and the multi-view LCD apparatus according to an embodiment of the invention, the light-trans-

parent openings are located at bottoms of the concaves, and the color filter layer is disposed on the first surface of the substrate.

In a color filter substrate and the multi-view LCD apparatus according to an embodiment of the invention, the light-transparent openings are located between the concaves, and the color filter layer is disposed on the second surface of the substrate.

In a color filter substrate and the multi-view LCD apparatus according to an embodiment of the invention, the color filter layer includes a black matrix and a plurality of color filter films, wherein the black matrix defines the sub-pixel areas, and the color filter films are located within the sub-pixel areas.

In a color filter substrate and the multi-view LCD apparatus according to an embodiment of the invention, a distance between centers of two adjacent sub-pixel areas is P, and a width of each of the light-transparent openings is substantially equal to or smaller than P.

In a color filter substrate and the multi-view LCD apparatus according to an embodiment of the invention, a distance between centers of two adjacent sub-pixel areas is P, and a depth of the concaves covered by the light-shielding layer is substantially equal to or smaller than P.

The invention further provides a method of manufacturing a color filter substrate for simultaneously transmitting a first light and a second light respectively to a first viewer and a second viewer, and the method of manufacturing a color filter substrate includes the following steps. A substrate having a first surface and a second surface opposite to the first surface is provided. A plurality of concaves are formed on the first surface of the substrate. A light-shielding layer is formed on the first surface of the substrate, and the light shielding layer defines a plurality of light-transparent openings. A color filter layer is formed on the substrate. The color filter layer has a plurality of sub-pixel areas including at least one first sub-pixel area and at least one second sub-pixel area, wherein the first light is transmitted to the first viewer by passing through one of the light-transparent openings and one of the at least one first sub-pixel area, and simultaneously, the second light is transmitted to the second viewer by passing through the same one of the light-transparent openings and one of the at least one second sub-pixel area.

In a method of manufacturing a color filter substrate according to an embodiment of the invention, the method of forming the color filter layer includes forming the light-transparent openings at bottoms of the concaves, and disposing the color filter layer on the first surface of the substrate.

In a method of manufacturing a color filter substrate according to an embodiment of the invention, the method of forming the color filter layer includes forming the light-transparent openings between the concaves, and disposing the color filter layer on the second surface of the substrate.

The invention is provided by forming a plurality of concaves on a substrate of a color filter substrate and forming a light-shielding layer on the surface having the concaves. Therefore, the color filter substrate of the invention facilitates a multi-view LCD apparatus to have desirable display quality. In addition, the method of manufacturing the color filter substrate according to the invention does not require the formation of an extreme thick planar layer on the substrate so that the bending and the deformation of the substrate is mitigated so as to improve the process yield, and the thickness of the color filter substrate is significantly reduced. Therefore, the thickness of the LCD apparatus according to the invention is significantly reduced, too.

To make the above and other features and advantages of the present invention more comprehensible, several embodiments accompanied with figures are detailed as follows.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings are included to provide a further understanding of the invention, and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

FIG. **1**A is a schematic cross-sectional view of a conventional dual-view LCD panel.

FIG. **1**B is a schematic optical simulation of the conventional dual-view LCD panel.

FIG. **2**A to FIG. **2**E illustrate steps of manufacturing a color filter substrate according to an embodiment of the invention.

FIG. **3** is a color filter substrate according to another embodiment of the invention.

FIG. **4** illustrates a schematic cross-sectional view of an LCD apparatus according to an embodiment of the invention.

FIG. **5** illustrates a schematic cross-sectional view of a color filter substrate according another embodiment of the invention.

FIG. **6** illustrates a schematic cross-sectional view of a color filter substrate according to further another embodiment of the invention.

FIG. **7** illustrates a schematic cross-sectional view of an LCD apparatus according to another embodiment of the invention.

DESCRIPTION OF EMBODIMENTS

FIG. **2**A to FIG. **2**E illustrate steps of manufacturing a color filter substrate according to an embodiment of the invention. First, referring to FIG. **2**A, a substrate **200** is provided. The substrate **200** has a first surface **202** and a second surface **204** opposite to each other. A plurality of concaves **206** are formed on the first surface **202** of the substrate **200**. In the present embodiment, the substrate **200** may be, for example, a glass substrate, a plastic substrate, or other suitable substrates for manufacturing a color filter substrate. The method of forming the concaves **206** includes, for example, performing an etching process. Specifically, the etching process includes an anisotropic etching process or an isotropic etching process.

In the current step, the conditions of the manufacturing process can be adjusted so as to control the shape, the size, and the depth of the concaves **206**. For example, the concaves **206** are formed by an anisotropic etching process so as to have arc-like sidewalls as shown in FIG. **2**A. In other embodiment, if the concaves **206** are formed by an isotropic etching process, the concaves **206** may have substantially vertical sidewalls. On the other hand, the shapes of the concaves **206** can be a bowl-like shape or a band-like shape if the substrate **200** is viewed from the upper side of the first surface **202**. It is noted that the distribution of the concaves **206** can be delta distribution, i.e. two neighboring columns (or rows) of the concaves **206** are interlaced.

Next, referring to FIG. **2**B, a light-shielding layer **210** is formed on the first surface **202** of the substrate **200**, and the light shielding layer **210** defines a plurality of light-transparent openings **212**. The method of forming light-shielding layer **210** includes forming a non-transparent material on the first surface **202** of the substrate **200** by performing a coating process. Thereafter, a photolithographic process is performed to define the patterns of the light-transparent openings **212**, and an etching process is performed on the non-transparent

material coated on the first surface **202** to form the plurality of the light-transparent openings **212** so that the light-shielding layer **210** is fabricated. The size and the disposition location of the light-transparent openings **212** are changed through the adjustment of the photolithographic process. In FIG. **2**B, each light-transparent opening **212** is substantially located at the right center of the bottom of one concave **206**. In other embodiments, each light-transparent opening **212** can be located at the location beside the right center of the bottom of one concave **206**, the location between two concaves **206**, or other locations. If each light-transparent opening **212** is located at the location beside the right center of the bottom of one concave **206**, the viewers located at different sides of the multi-view LCD apparatus having the color filter substrate can view at different viewing-angle for the best displayed images so that the color filter substrate can be applied in an automobile display apparatus.

Then, referring to FIGS. **2**C and **2**D, a planar layer **220** can be formed on the first surface **202** of the substrate **200** for rendering the first surface **202** of the substrate **200** flat in the present embodiment. The method of forming the planar layer **220** includes forming a planar material layer **220**A and performing a planarization process, wherein the planar material layer **220**A completely fills the concaves **206** and covers the light shielding layer **210**. In the process shown in FIG. **2**C, the condition of coating the planar material layer **220**A on the first surface **202** is difficultly controlled so that the surface of the planar material layer **220**A is not exactly flat. Therefore, the planarization process such as a polishing process or a reflow process is required to forming the planar layer **220**.

In other embodiments, the method of forming the planar layer **220** can include forming a first planar material layer on the substrate **200** and subsequently forming a second planar material layer on the first planar material layer, wherein the first planar material layer completely fills the concaves **206** and covers the light-shielding layer **210**. The second planar material layer formed on the first planar material layer with poor surface planarity can have better surface uniformity. Substantially, a material of the planar layer **220** can be transparent material, and the refraction index of the planar layer **220** can be similar or equivalent to that of the substrate **200**.

Next, referring to FIG. **2**E, a color filter layer **230** is formed on the substrate **200** to complete the color filter substrate **240**. In the present embodiment, the light-transparent openings **212** are located at the bottoms of concaves **206**, and the color filter layer **230** is formed on the first surface **202** of the substrate **200**. The method of forming the color filter layer **230** includes forming a black matrix **232** on the first surface **202** of the substrate **200** and subsequently forming a plurality of color filter films **234** in at least one first sub-pixel area **234***a* and at least one second sub-pixel area **234***b* defined by the black matrix **232**. It is noted that the formation sequence of the black matrix **232** and the color filter films **234** is not restricted by the aforesaid description, and the formation sequence of the black matrix **232** and the color filter films **234** can be varied and are not listed herein. In an embodiment, the color filter films **234** include red filter films, green filter films or blue filter films.

The color filter substrate **240** includes the substrate **200**, the light-shielding layer **210**, and the color filter layer **230**. The substrate **200** has the first surface **202**, the second surface **204**, and the concaves **206**, wherein the first surface **202** is opposite to the second surface **204**, and the concaves **206** are located at the first surface **202**. The light-shielding layer **210** disposed on the first surface **202** of the substrate **200** defines a plurality of light-transparent openings **212**. The light-transparent openings **212** are located at the bottoms of the concaves **206** and the color filter layer **230** is disposed on the first surface **202** of the substrate **200**. Furthermore, the planar layer **220** can be further disposed between the substrate **200** and the color filter layer **230**.

By the light-shielding effect of the light-shielding layer **210**, the first light L**1** and the second light L**2** carry different image information after passing through the first sub-pixel area **234***a* and the second sub-pixel area **234***b*, respectively. In addition, the first light L**1** and the second light L**2** pass through the light-transparent openings **212** in different directions to display two different displayed images. That is to say, a first viewer V**1** and a second viewer V**2** located at different sides of the color filter substrate **240** would see different images. Furthermore, the light-shielding layer **210** of the present embodiment is conducive to prevent the first viewer V**1** or the viewer watching the image in a larger angle from seeing the light L**3** emitted from other sub-pixel area such as the sub-pixel area **234***c*. Therefore, the color filter substrate **240** applied in a multi-view display apparatus is helpful to enhance the display quality thereof. Particularly, the light-transparent openings **212** of the light-shielding layer **210** are formed at the bottoms of the concaves **206** to keep a distance from the color filter layer **230** in the color filter substrate **240** of the present embodiment, so that the planar layer **202** does not necessarily have extreme thickness to accomplish the multi-view function. Accordingly, the bending and the deformation of the substrate **200** causing by the variation between the thermal expansion coefficients of the substrate **200** and the planar layer **220** is prevented so that the subsequent process is not affected and the process yield of the color filter substrate **240** is improved.

For example, when a distance d**1** between the centers of two adjacent sub-pixel areas such as sub-pixel areas **234***a* and **234***b*, or sub-pixel areas **234***b* and **234***c* is P, a width w of each light-transparent opening **212** is substantially smaller than or equal to P, e.g. the width w can be from 2 P/5 to 2 P/3. Moreover, the depth t of the concave **206** covered by the light-shielding layer **210** can be smaller than or equal to P. Owing that the concaves **206** covered by the light-shielding layer **210** is located inside the substrate **200**, the increase of the depth t of the concave **206** covered by the light-shielding layer **210** would not increase the thickness of the color filter substrate **240**. That is to say, the thickness of the color filter substrate **240** is not increased in order to achieve the multi-view function, which facilitates the thickness miniaturization of the display apparatus.

Specifically, the width w of each light-transparent openings **212** and the partial depth t of the concaves **206** covered by the light-shielding layer **210** can be larger or smaller based on different design requirements. If the color filter layer **230** is disposed on the first surface **202** as shown in the present embodiment, the distance d**2** between the color filter layer **230** and the substrate **200** can be from 5 μm to 10 μm. In particular, the opening of each concave **206** in the color filter substrate **240** illustrated in the cross-sectional view of FIG. **2**E is corresponding to two sub-pixel areas **234***a* and **234***b* so that the color filter substrate **240** can be used in the dual-view display apparatus. Nevertheless, in other embodiments, the opening of each concave **206** can be located corresponding to more than two sub-pixel areas **234***a*, **234***b*, **234***c* . . . so that the color filter substrate **240** can be used in multi-view display apparatus.

FIG. **3** is a color filter substrate according to another embodiment of the invention. Referring to FIG. **3**, the color filter substrate **300** is similar to the aforesaid color filter substrate **240**, so that most of the components of the color filter **300** are substantially the same as those of the color filter

substrate **240**. Specifically, the difference between the color filter substrate **240** and the color filter substrate **300** is the disposition location of the color filter layer **230**. In the color filter substrate **300**, the light-transparent openings **212** are located between the concaves **206**, and the color filter layer **230** is disposed on the second surface **204** of the substrate **200**. In other words, the concaves **206** and the color filter layer **230** are located at two different surfaces of the substrate **200**. The color filter substrate **300** can be applied in the dual-view display apparatus, and the color filter substrate **300** having the light-shielding layer **210** is helpful to improve the display quality of the multi-view display apparatus and the process yield thereof, and is further apt to reduce the thickness of the multi-view display apparatus.

According to the color filter substrates **240** and **300** illustrated in FIGS. **2**E and **3**, the first light L**1** and the second light L**2** are simultaneously transmitted to the first viewer V**1** and the second viewer V**2**. The first light L**1** is transmitted to the first viewer V**1** by passing through one of the light-transparent openings **212** and one of the first sub-pixel areas **234***a*. Meanwhile, the second light L**2** is transmitted to the second viewer V**2** by passing through the same one of the light-transparent openings **212** and one of the second sub-pixel areas **234***b*. Accordingly, the color filter substrates **240** and **300** can have multi-view display effect.

FIG. **4** illustrates a schematic cross-sectional view of an LCD apparatus according to another embodiment of the invention. Referring to FIG. **4**, an LCD apparatus **400** includes a color filter substrate **410**, an opposite substrate **420**, and a liquid crystal layer **430**. The liquid crystal layer **430** is disposed between the color filter substrate **410** and the opposite substrate **420**. The color filter substrate **410** can be selected from one of the color filter substrates **240** and **300** depicted in the foregoing descriptions, and can also be other color filter substrates designed in a manner consistent with the scope of the invention. The opposite substrate **420** can be an active device array substrate. In other embodiments, the color filter substrate **420** may further include an active device array structure. If the LCD apparatus **400** is a transmissive LCD or a transflective LCD, a backlight module **440** can be further included in the LCD apparatus **400**, and the color filter substrate **410**, the opposite substrate **420**, and the liquid crystal layer **430** are disposed above the backlight module **440**. The color filter substrate **410** can be any of the color filter substrates described in the aforesaid embodiments, so that the LCD apparatus **400** is a multi-view display apparatus having desirable display quality and high process yield.

A multi-layer substrate can be used during manufacturing the color filter substrate to improve the yield of the color filter substrate. For example, FIG. **5** illustrates a schematic cross-sectional view of a color filter substrate according to further another embodiment of the invention. Referring to FIG. **5**, the color filter substrate **540** has similar structure to the color filter substrate **240** illustrated in FIG. **2**E. Nevertheless, the substrate **500** can be consisted of the first substrate **500***a* and the second substrate **500***b*. The first substrate **500***a* can be a glass substrate or a plastic substrate and can be fabricated through the foregoing process. The second substrate **500***b* can be the other glass substrate or the other plastic substrate for supporting the first substrate **500***a*. Other embodiments can be shown as those illustrated in FIGS. **6** and **7**. FIG. **6** illustrates a schematic cross-sectional view of a color filter substrate according to further another embodiment of the invention. FIG. **7** illustrates a schematic cross-sectional view of an LCD apparatus according to another embodiment of the invention. Referring to FIG. **16**, the color filter substrate **600** is similar to the color filter substrate **300** illustrated in FIG. **3**, but the substrate **610** of the color filter substrate **600** is consisted of a first substrate **610***a* and a second substrate **610***b*. In addition, the method of manufacturing the first substrate **610***a* can be referred to the method of manufacturing the substrate **200** mentioned above, and the second substrate **610***b* is used to support the first substrate **610***a*.

Referring to FIG. **7**, an LCD apparatus **700** is approximately identical to the LCD apparatus **400**. Nevertheless, the substrate **720** of the color filter substrate **710** in the LCD apparatus **700** includes a first substrate **720***a* and a second substrate **720***b*. The method of manufacturing the first substrate **720***a* can be referred to the method of manufacturing the substrate **200** mentioned above. In addition, the second substrate **720***b* is also used for carrying and supporting the first substrate **720***a*.

In view of the above, the color filter substrate of the invention accomplish the multi-view display effect by forming the shielding layer having the plurality of light-transparent openings on the substrate having the concaves. Accordingly, the light-shielding layer efficiently separates the light to-be transmitted to different fields of view and prevents the light to-be transmitted to different fields of view from interfering with each other so that the light-shielding layer is apt to improve the display quality of the multi-view LCD apparatus of the invention. When the light-shielding layer is formed on the substrate having the concaves, the light-transparent openings of the light-shielding layer keep a distance from the color filter layer by the substrate. Therefore, the planar layer does not require having extreme thickness to facilitate the multi-view display effect, which is conducive to reduce the thickness of the color filter substrate and enhance the process yield of the color filter substrate. Consequently, the color filter substrate and the LCD apparatus of the invention have desirable display quality and high process yield, and further comply with the thinner volume requirement of the market.

Although the present invention has been disclosed by the above embodiments, they are not intended to limit the present invention. Any person having ordinary knowledge in the art may make some modifications and alterations without departing from the spirit and scope of the present invention. Therefore, the scope for which protection is sought by the present invention falls in the appended claims.

What is claimed is:

1. A color filter substrate for multi-view displaying by simultaneously transmitting a first light and a second light to a first viewer and a second viewer, respectively through the color filter substrate, wherein the color filter substrate comprises:

a substrate having a first surface, a second surface, and a plurality of concaves, wherein the first surface is opposite to the second surface, and the concaves are located at the first surface;

a light-shielding layer disposed on the first surface of the substrate, wherein the light-shielding layer having a plurality of light-transparent openings; and

a color filter layer having a plurality of sub-pixel areas comprising at least one first sub-pixel area and at least one second sub-pixel area, wherein the first light is transmitted to the first viewer by passing through one of the light-transparent openings and one of the at least one first sub-pixel area, and simultaneously, the second light is transmitted to the second viewer by passing through the same one of the light-transparent openings and one of the at least one second sub-pixel area.

2. The color filter substrate according to claim 1, wherein the light-transparent openings are located at bottoms of the concaves, and the color filter layer is disposed on the first surface of the substrate.

3. The color filter substrate according to claim 1, wherein the light-transparent openings are located between the concaves, and the color filter layer is disposed on the second surface of the substrate.

4. The color filter substrate according to claim 1, wherein the color filter layer comprises a black matrix and a plurality of color filter films, the black matrix defines the sub-pixel areas, and the color filter films are located within the sub-pixel areas.

5. The color filter substrate according to claim 1, wherein a distance between centers of two adjacent sub-pixel areas is P, and a width of each of the light-transparent openings is smaller than or equal to P.

6. The color filter substrate according to claim 1, wherein a distance between centers of two adjacent sub-pixel areas is P, and a depth of the concaves covered by the light-shielding layer is smaller than or equal to P.

7. A multi-view liquid crystal display (LCD) apparatus, comprising:

a color filter substrate, a first light and a second light simultaneously transmitted to a first viewer and a second viewer respectively through the color filter substrate, wherein the color filter substrate comprises:

a substrate having a first surface, a second surface and a plurality of concaves, wherein the first surface is opposite to the second surface, and the concaves are located at the first surface;

a light-shielding layer disposed on the first surface of the substrate, and the light shielding layer having a plurality of light-transparent openings; and

a color filter layer having a plurality of sub-pixel areas comprising at least one first sub-pixel area and at least one second sub-pixel area, wherein the first light is transmitted to the first viewer by passing through one of the light-transparent openings and one of the at least one first sub-pixel area, and the second light is simultaneously transmitted to the second viewer by passing through the same one of the light-transparent openings and one of the at least one second sub-pixel area;

an opposite substrate; and

a liquid crystal layer disposed between the color filter substrate and the opposite substrate.

8. The multi-view LCD apparatus according to claim 7, wherein the light-transparent openings are located at bottoms of the concaves, and the color filter layer is disposed on the first surface of the substrate.

9. The multi-view LCD apparatus according to claim 7, wherein the light-transparent openings are located between the concaves, and the color filter layer is disposed on the second surface of the substrate.

10. The multi-view LCD apparatus according to claim 7, wherein the color filter layer comprises a black matrix and a plurality of color filter films, the black matrix defines the sub-pixel areas, and the color filter films are located within the sub-pixel areas.

11. The multi-view LCD apparatus according to claim 7, wherein a distance between centers of two adjacent sub-pixel areas is P, and a width of each of the light-transparent openings is smaller than or equal to P.

12. The multi-view LCD apparatus according to claim 7, wherein a distance between centers of two adjacent sub-pixel areas is P, and a depth of each of the concaves covered by the light-shielding layer is smaller than or equal to P.

13. A method of manufacturing a color filter substrate, a first light and a second light simultaneously transmitting to a first viewer and a second viewer respectively through the color filter substrate, and the method of manufacturing a color filter substrate comprising:

providing a substrate having a first surface and a second surface opposite to the first surface;

forming a plurality of concaves on the first surface of the substrate;

forming a light-shielding layer on the first surface of the substrate, and the light shielding layer having a plurality of light-transparent openings; and

forming a color filter layer on the substrate, the color filter layer having a plurality of sub-pixel areas comprising at least one first sub-pixel area and at least one second sub-pixel area, so that the first light is substantially transmitted to the first viewer by passing through one of the light-transparent openings and one of the at least one first sub-pixel area, and simultaneously, the second light is substantially transmitted to the second viewer by passing through the same one of the light-transparent openings and one of the at least one second sub-pixel area.

14. The method of manufacturing a color filter substrate according to claim 13, wherein the method of forming the color filter layer comprises forming the light-transparent openings at bottoms of the concaves, and disposing the color filter layer on the first surface of the substrate.

15. The method of manufacturing a color filter substrate according to claim 13, wherein the method of forming the color filter layer comprises forming the light-transparent openings between the concaves, and disposing the color filter layer on the second surface of the substrate.

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摘要(译)

提供一种用于多视图显示的滤色器基板，包括基板，遮光层和滤色器层。基板具有第一表面，第二表面和多个凹部。第一表面与第二表面相对。凹陷位于第一表面。设置在基板的第一表面上的遮光层限定多个透光开口。滤色器层具有多个子像素区域，包括至少一个第一子像素区域和至少一个第二子像素区域。第一光通过穿过一个透光开口和一个至少一个第一子像素区域传输到第一观察者，同时，第二光通过穿过同一个光传输到第二观察者。光透明开口和至少一个第二子像素区域中的一个。