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(54) **LIQUID CRYSTAL DISPLAY DEVICE AND  
COLOR FILTER SUBSTRATE**

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(52) **U.S. Cl.** ..... **349/110**

(58) **Field of Classification Search** ..... 349/106-110  
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,128,786 A \* 7/1992 Yanagisawa ..... 349/111

5,754,263 A \* 5/1998 Akiyama et al. .... 349/110  
2001/0040717 A1 \* 11/2001 Minoura et al. .... 359/263  
2005/0225708 A1 \* 10/2005 Oke et al. .... 349/139

**FOREIGN PATENT DOCUMENTS**

TW 463067 B 11/2001

**OTHER PUBLICATIONS**

Office Action issued in corresponding Taiwanese Patent Application  
No. 096150397, mailed Nov. 23, 2011.

\* cited by examiner

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(57) **ABSTRACT**

A liquid crystal display (LCD) device comprises a substrate,  
and red, green, blue (RGB) color filters. The RGB color filters  
are spaced from one another with a predetermined gap ther-  
ebetween on the substrate, and define RGB sub-pixels. The  
LCD device further comprises black matrixes disposed at  
each space between the RGB color filters, and barriers dis-  
posed at each interface among the RGB sub-pixels such that  
the barriers control a path of light that passes through a  
corresponding sub-pixel.

**7 Claims, 6 Drawing Sheets**

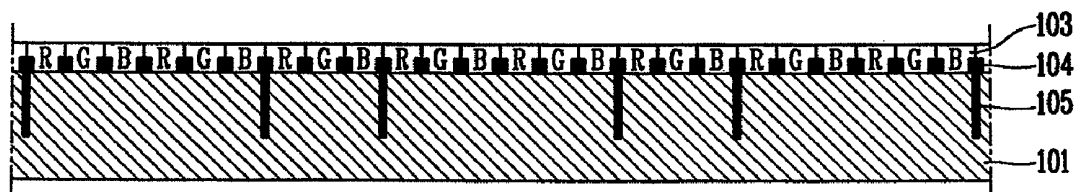


FIG. 1A  
RELATED ART

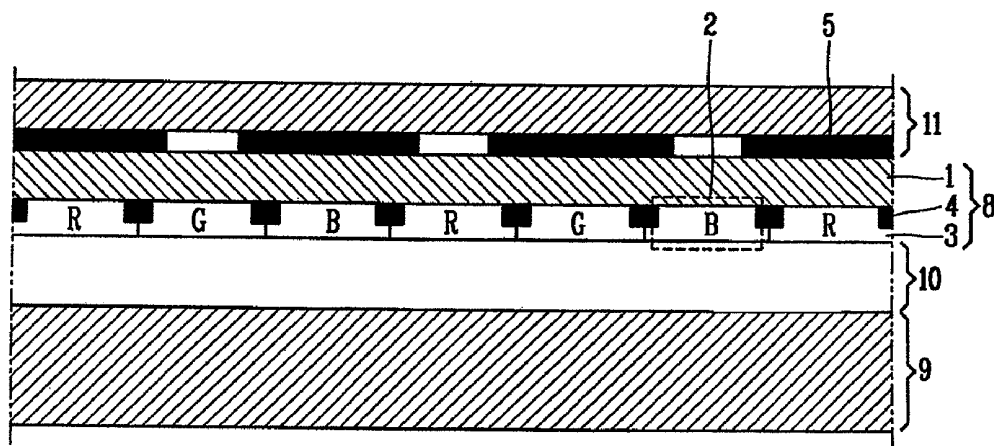


FIG. 1B  
RELATED ART

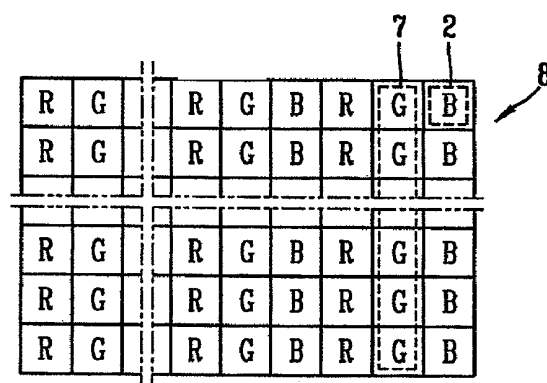


FIG. 2A  
RELATED ART

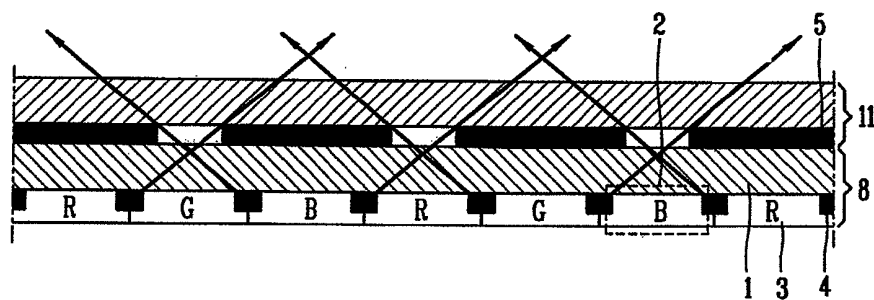
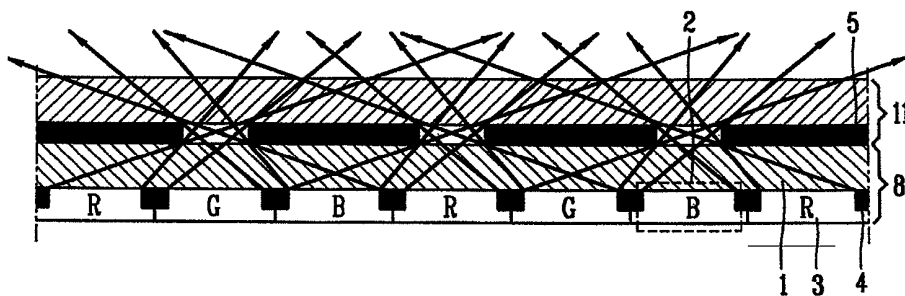


FIG. 2B  
RELATED ART



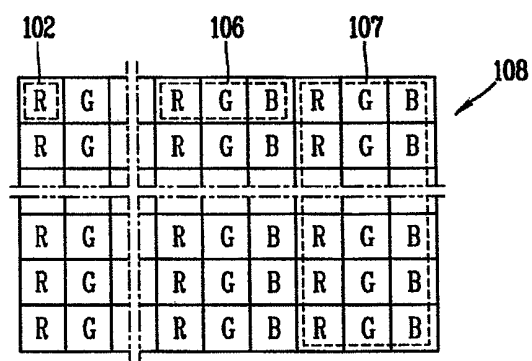


FIG. 4A

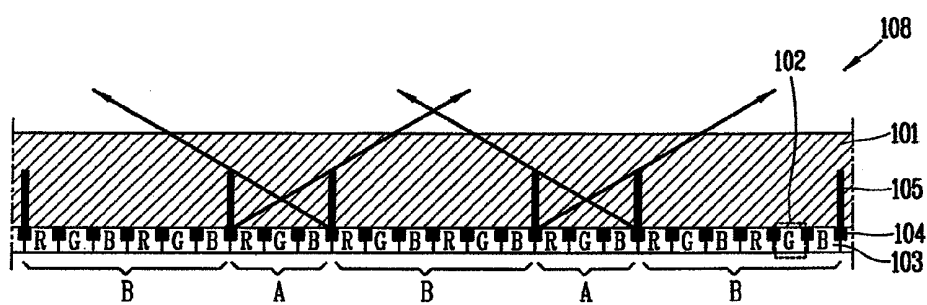


FIG. 4B

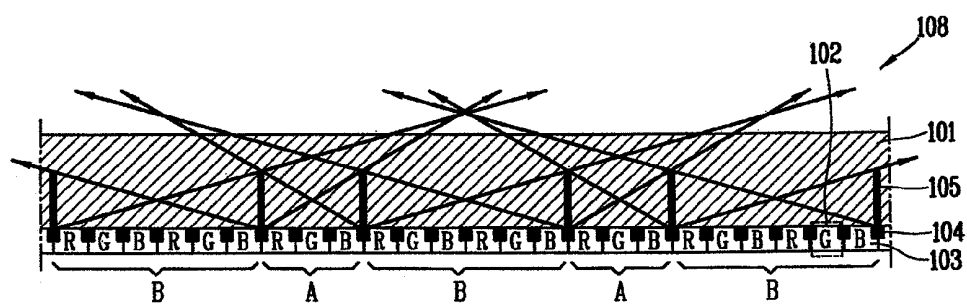


FIG. 5A

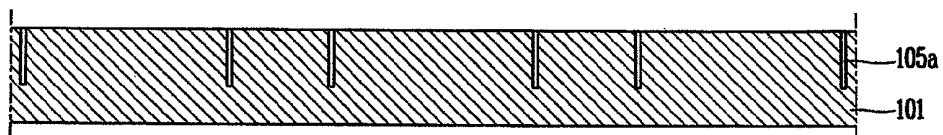


FIG. 5B

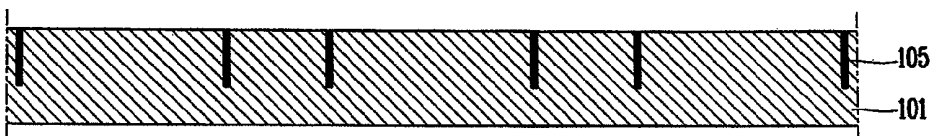


FIG. 5C

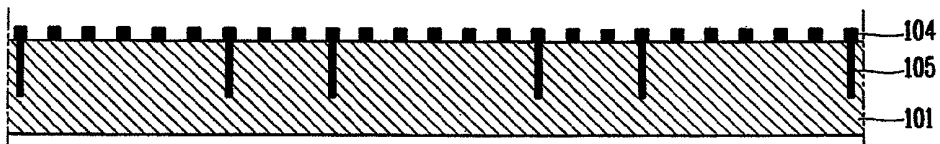


FIG. 5D

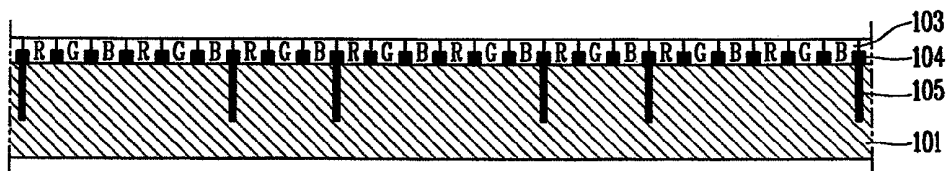


FIG. 6A

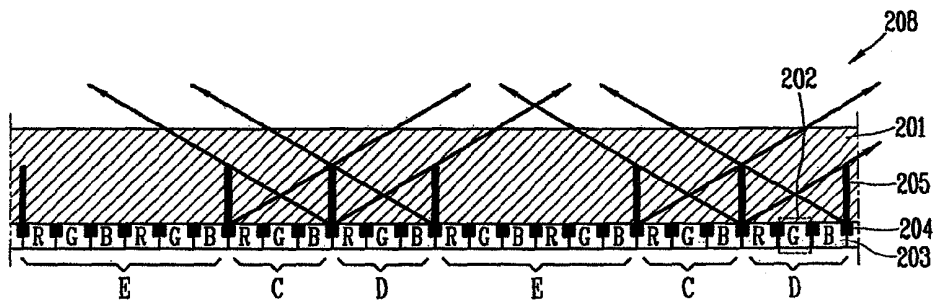


FIG. 6B

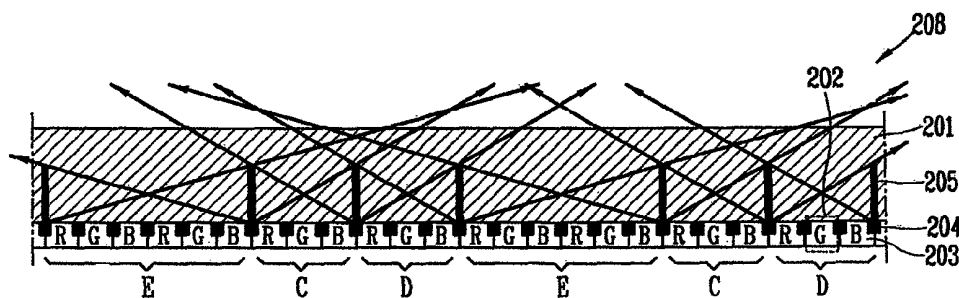


FIG. 7A

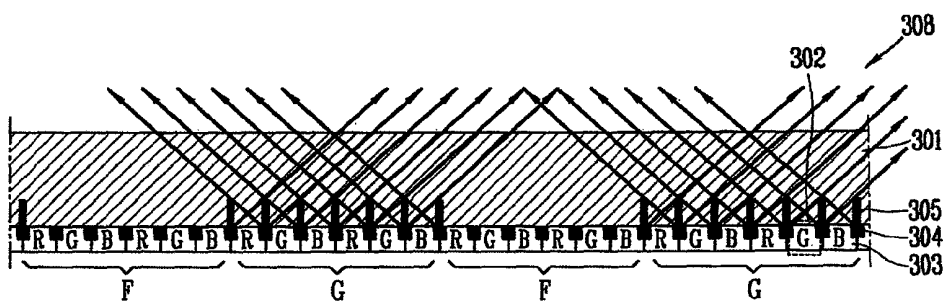
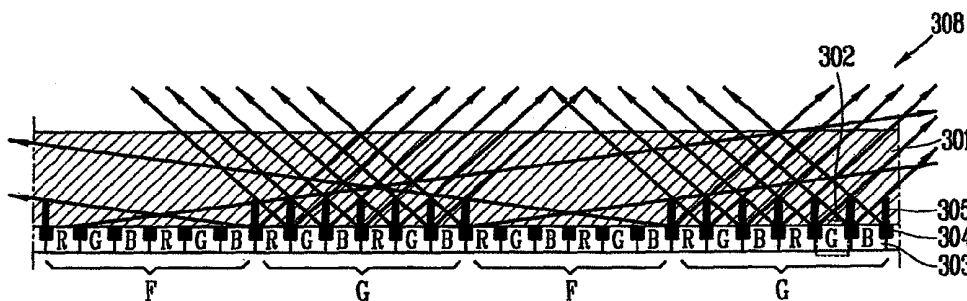


FIG. 7B



# LIQUID CRYSTAL DISPLAY DEVICE AND COLOR FILTER SUBSTRATE

## CLAIM FOR PRIORITY

The present application claims priority to Korean Patent Application No. 10-2007-0070870, filed on Jul. 13, 2007, the entirety of which is herein incorporated by reference.

## FIELD

The present application relates to a liquid crystal display (LCD) device for selectively driving a narrow viewing angle mode and a wide viewing angle mode, and more particularly, to an LCD device capable of enhancing a brightness of a display screen and facilitating a fabrication process by providing barriers in a substrate so that a part or all of one surface of the barriers can come in contact with black matrixes, and a method for fabricating the same.

## BACKGROUND

Generally, an LCD device is being widely used due to its characteristics such as a light weight, a thin thickness, and a low power consumption. Recently, application fields of the LCD device are expanded to a portable computer such as a notebook PC, office automation equipment, and audio/video apparatus.

In the LCD device, a desired image is displayed on a screen by controlling an optical transmittance according to image signals applied to a plurality of switching controllers arranged in a matrix form.

The LCD device comprises an LC panel including a color filter substrate which is an upper substrate, a thin film transistor (TFT) array substrate which is a lower substrate, and an LC layer disposed between the two facing substrates; and an LC panel driving portion for driving the LC panel by supplying scan signals and image signals to the LC panel.

According to arrangement forms of liquid crystals and electrodes for applying an electric field to the liquid crystals, the LCD device is classified into an ECB (Electrically Controlled Birefringence) mode LCD device, a VA (Vertical Alignment) mode LCD device, a TN (Twisted Nematic) mode LCD device, and an IPS (In Plane Switching) mode LCD device.

Among the various types, the ECB mode and the TN mode LCD devices have a disadvantage that a viewing angle is narrow. On the contrary, the VA mode and the IPS mode LCD devices have an advantage that a viewing angle is wide. Accordingly, the VA mode and IPS mode LCD devices for a wide viewing angle are being widely practised.

However, the VA mode and the IPS mode LCD devices may cause the following problems. For example, when the VA mode and the IPS mode LCD devices are used for a user's personal purpose, the user's privacy may be damaged by his neighbors. Furthermore, when the VA mode and the IPS mode LCD devices are used for a confidential business, the confidential contents may be leaked out.

So as to solve the problems related to security, an LCD device for selectively implementing a display mode between a narrow viewing angle mode and a wide viewing angle mode has been proposed.

Hereinafter, the LCD device for selectively implementing a display mode between a narrow viewing angle mode and a wide viewing angle mode will be explained in more detail.

As shown in FIG. 1A, the LCD device for selectively implementing a display mode between a narrow viewing

angle mode and a wide viewing angle mode is provided with an LC panel constituted with first, second, and third substrates 8, 11 and 9.

Referring to FIGS. 1A and 1B, the first substrate 8 serves as a color filter substrate. RGB color filters 3 that define RGB sub-pixels 2, and black matrixes 4 are formed on a transparent substrate 1. Here, one group composed of each one line of the RGB sub-pixels 2 defines one sub-pixel line 7. That is, the RGB sub-pixel line 7 corresponds to one vertical line of the RGB sub-pixels 2.

The second substrate 11 serves as a barrier substrate having barriers 5 for controlling a viewing angle. The second substrate 11 is attached to one surface of the first substrate 8 where the black matrixes 4 and the color filter 3 are not formed. The barriers 5 formed at the second substrate 11 are alternately formed above one RGB sub-pixel line 7 among a plurality of the RGB sub-pixel lines 7. More concretely, the barriers 5 are formed above one RGB sub-pixel line 7, but are not formed above an adjacent RGB sub-pixel line 7. Again, the barriers 5 are formed next to the adjacent RGB sub-pixel line 7. The pattern is repeatedly formed. Here, the barriers 5 entirely overlap an entire upper portion of the corresponding sub-pixel line 7, and partially extend to upper portions of adjacent sub-pixel lines 7 in right and left directions.

Although not shown, the third substrate 9 serving as a thin film transistor (TFT) array substrate includes gate and data lines that define RGB sub-pixels 2 by crossing each other on the transparent substrate, TFTs formed at each sub-pixel 2, and pixel electrodes.

As shown in FIG. 2A, when the conventional LCD device is to be operated in a narrow viewing angle mode, the RGB sub-pixels 2 having the barriers 5 thereabove are not operated, but the RGB sub-pixels 2 not having the barriers 5 thereabove are operated. On the contrary, as shown in FIG. 2, when the conventional LCD device is to be operated in a wide viewing angle mode, all the RGB sub-pixels 2 are operated.

However, in the conventional LCD device, most of the upper portions of the RGB sub-pixel 2 are shielded by the barriers 5, thereby decreasing an aperture ratio and thus lowering a brightness of a display screen.

Also, in the conventional LCD device for selectively implementing a display mode between a narrow viewing angle mode and a wide viewing angle mode, the second substrate 11 serving as a barrier substrate is provided thus to increase manufacturing costs.

Furthermore, in order to space the color filter 3 formed at the first substrate 8 and the barriers 5 formed at the second substrate 11 from each other, required are a process for etching one surface of the first substrate 8 where the black matrixes 4 and the color filter 3 are not formed, and a process for attaching the first substrate 8 and the second substrate 11 to each other.

## SUMMARY

In one embodiment, a liquid crystal display (LCD) device comprises a substrate, and red, green, blue (RGB) color filters. The RGB color filters are spaced from one another with a predetermined gap therebetween on the substrate, and define RGB sub-pixels. The LCD device further comprises black matrixes disposed at each space between the RGB color filters, and barriers disposed at each interface among the RGB sub-pixels such that the barriers control a path of light that passes through a corresponding sub-pixel.

In another embodiment, a method for fabricating an LCD device comprises preparing a substrate, and forming a plurality of grooves on regions of an upper surface of the substrate

where black matrixes are to be formed, towards inside of the substrate. The method further comprises forming barriers by filling black resins in the grooves, forming black matrixes on the substrate where the barriers are formed, and forming RGB color filters on the substrate where the black matrixes are formed, thereby defining RGB sub-pixels.

In yet another embodiment, a color filter substrate comprises red, green, blue (RGB) color filters that are spaced from one another with a predetermined gap therebetween, and define RGB sub-pixels. The color filter substrate further comprises black matrixes disposed at each space between the RGB color filters, and barriers disposed at each interface among the RGB sub-pixels such that the barriers control a path of light that passes through a corresponding sub-pixel.

### BRIEF DESCRIPTION OF THE DRAWINGS

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

In the drawings:

FIG. 1A is a sectional view of a liquid crystal display (LCD) device in accordance with the conventional art;

FIG. 1B is a plane view of the liquid crystal display (LCD) device in accordance with the conventional art;

FIG. 2A is a sectional view of the LCD device of FIGS. 1A and 1B which is driven in a narrow viewing angle mode;

FIG. 2B is a sectional view of the LCD device of FIGS. 1A and 1B which is driven in a wide viewing angle mode;

FIG. 3A is a sectional view of a liquid crystal display (LCD) device according to a first embodiment;

FIG. 3B is a plane view of the liquid crystal display (LCD) device according to a first embodiment;

FIG. 4A is a sectional view of the LCD device of FIGS. 3A and 3B which is driven in a narrow viewing angle mode;

FIG. 4B is a sectional view of the LCD device of FIGS. 3A and 3B which is driven in a wide viewing angle mode;

FIGS. 5A to 5D are sectional views illustrating a method for fabricating the LCD device of FIGS. 3A and 3B;

FIG. 6A is a sectional view of a liquid crystal display (LCD) device according to a second embodiment which is driven in a narrow viewing angle mode;

FIG. 6B is a plane view of the liquid crystal display (LCD) device according to a second embodiment which is driven in a wide viewing angle mode;

FIG. 7A is a sectional view of a liquid crystal display (LCD) device according to a third embodiment which is driven in a narrow viewing angle mode; and

FIG. 7B is a plane view of the liquid crystal display (LCD) device according to a third embodiment which is driven in a wide viewing angle mode.

### DETAILED DESCRIPTION

Reference will now be made in detail to the preferred embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings.

Hereinafter, a liquid crystal display (LCD) device and a method for fabricating the same according to the preferred embodiments of the present disclosure will be explained in more detail with reference to the attached drawings.

A liquid crystal display (LCD) device according to a first embodiment of the present disclosure will be explained with reference to FIGS. 3A and 3B.

As shown, the liquid crystal display (LCD) device according to a first embodiment of the present disclosure comprises a substrate **101**; RGB color filters **103** spaced from one another with a predetermined gap therebetween on the substrate **101**, and defining RGB sub-pixels **102**; black matrixes **104** formed at each space between the RGB color filters **103**; and barriers **105** formed at each interface among the RGB sub-pixels **102**, for controlling a path of light that passes through a corresponding sub-pixel **102**. The barriers **105** are formed in the substrate with a bar shape so that one surface thereof can come in contact with the black matrixes **104**. A width of the barriers **105** is the same as or similar to a width of the black matrixes **104** in right and left directions. The RGB sub-pixels **102** constitute one unit pixel **106**, and one line of the unit pixels **106** constitutes one unit pixel line **107**. The barriers **105** are formed at each interface between the unit pixel lines **107**. The barriers **105** are formed at each interface between one unit pixel line **107** and two unit pixel lines **107**.

As shown in FIG. 3A, the LCD device according to a first embodiment of the present disclosure comprises a color filter substrate **108**, an upper substrate; a thin film transistor (TFT) array substrate **109**, a lower substrate; and an LC layer **110** disposed between the two substrates.

The color filter substrate **108** includes a transparent substrate **101**, a color filter **103**, black matrixes **104**, barriers **105**, and common electrodes (not shown) each formed on the transparent substrate **101**.

Although not shown, the TFT array substrate **109** includes gate and data lines that define RGB sub-pixels **102** by crossing each other on the transparent substrate, TFTs formed at each sub-pixel **102**, and pixel electrodes.

As shown in FIG. 3A, the color filter substrate **108** defines RGB sub-pixels **102** as RGB color filters **103** are spaced from each other on the transparent substrate **101**.

The color filter **103** passes light of a specific wavelength, thereby implementing a color display.

The RGB sub-pixels **102** constitute one unit pixel **106**, and one line of the unit pixels **106** defines one unit pixel line **107**. That is, the unit pixel line **107** corresponds to one vertical line of the unit pixels **106**.

In the drawings, RGB color filters **103** are formed on the transparent substrate **101**. However, the color filters **103** are not limited to the three colors. Rather, red, green, blue, and white (RGBW) color filters **103** may be implemented. Here, the white color filter is a sub-pixel having no color filter.

In the drawings, RGB sub-pixels **102** of the unit pixel **106** are arranged in a horizontal direction. However, RGB sub-pixels **102** of the unit pixel **106** may be arranged in a horizontal direction, etc.

The black matrixes **104** are formed at each interface among the RGB color filters **103**.

The black matrixes **104** prevent an optical interference among the RGB sub-pixels **102** formed at the RGB color filters **103**, thereby preventing a contrast from lowering. The black matrixes **104** are formed to overlap the gate lines, the data lines, and the TFTs on the TFT array substrate **109**, that is, is formed at each region rather than the pixel electrodes.

As shown in FIG. 3A, the color filter substrate **108** is provided with the barriers **105** formed in the transparent substrate **101** with a bar shape so that one surface thereof can partially or entirely come in contact with the black matrixes **104**.

The barriers **105** are formed at each interface between the unit pixel lines **107** with a long bar shape, which will be explained in more detail.

As shown in FIG. 3A, the barriers **105** of the LCD device according to a first embodiment of the present disclosure are

formed at each interface between one unit pixel line 107 and two unit pixel lines 107. That is, the barriers 105 are formed at each interface between a group (A) of one unit pixel line 107 and a group (B) of two unit pixel lines 107. Each one surface of the barriers 105 entirely or partially comes in contact with the black matrixes 104. Here, the barriers 105 of the LCD device may not come in contact with the black matrixes 104, but may overlap the black matrixes 104.

The barriers 105 may overlap the black matrixes 104 with a width similar to or same as a right-left width of the black matrixes 104. Since the barriers 105 overlap an upper part of the black matrixes 104 without overlapping an upper part of the RGB sub-pixels 102, a user of the LCD device can not recognize the barriers 105.

Each length of the barriers 105 in upper and lower directions, that is, each length from contact points with the black matrixes 104 to upper surfaces of the barriers 105, is properly designed according to a degree of a narrow viewing angle to be implemented. More concretely, when a narrower viewing angle in a narrow viewing angle mode is to be implemented, each length of the barriers 105 in upper and lower directions is designed to be long. On the contrary, when a wider viewing angle in a narrow viewing angle mode is to be implemented, each length of the barriers 105 in upper and lower directions is designed to be short.

In the LCD device according to a first embodiment of the present disclosure, a narrow viewing angle mode and a wide viewing angle mode are selectively implemented, which will be explained in more detail with reference to FIGS. 4A and 4B.

In a narrow viewing angle mode, only the RGB sub-pixels 102 of the group (A) having barriers 105 at both interfaces between adjacent unit pixel lines 107 are driven, but the RGB sub-pixels 102 of the group (B) of the other unit pixel lines 107 are neither driven nor receive black data.

As shown in FIG. 4A, light incident to the RGB sub-pixels 102 of the unit pixel lines 107 having the barriers 105 at each interface between adjacent unit pixel lines 107, with a relatively larger incidence angle, is shielded by the barriers 105. However, light incident thereto with a relatively smaller incidence angle passes through inside of the transparent substrate 101 without being shielded by the barriers 105, and then is emitted outside the transparent substrate 101. Accordingly, an optical path is controlled by the barriers 105, and thus a screen of a narrow viewing angle can be implemented.

When a wide viewing angle mode is to be implemented, all the RGB sub-pixel lines 107 are driven.

As shown in FIG. 4B, most of the light incident to the RGB sub-pixels 102 passes through inside of the transparent substrate 101 without being shielded by the barriers 105, and then is emitted outside the transparent substrate 101. Accordingly, a screen of a wide viewing angle can be implemented.

Although not shown, the light incident to the RGB sub-pixels 102 is light emitted from a backlight assembly provided below the color filter substrate 108 and the TFT array substrate 109.

Hereinafter, a method for fabricating an LCD device according to a first embodiment of the present disclosure will be explained in more detail with reference to FIGS. 5A to 5D and FIGS. 3A and 3B.

First, the transparent substrate 101 is prepared.

As shown in FIG. 5A, a plurality of grooves 105a are formed on an upper surface of the transparent substrate 101 where the black matrixes 104 are to be formed, towards inside of the transparent substrate 101. Here, the grooves 105a are formed to overlap the black matrixes 104 to be formed on the transparent substrate 101, with a width similar to or same as

each width of the black matrixes in right and left directions. A length of the groove 105a in upper and lower directions, that is, a length from a surface of the transparent substrate 101 where the black matrixes 104 are to be formed to a lower end of the groove 105a, is properly designed according to a degree of a narrow viewing angle to be implemented. The grooves 105a are formed at each interface between one unit pixel line 107 and another unit pixel line 107. Here, the unit pixel line 107 corresponds to one vertical line of the unit pixels 106, and one unit pixel 106 is composed of three RGB sub-pixels 102.

As shown in FIG. 5B, a black resin is filled in the grooves 105a formed on the transparent substrate 101, thereby forming the barriers 105.

As shown in FIG. 5C, the black matrixes 104 are formed on the transparent substrate 101 where the barriers 105 are formed. Here, the black matrixes 104 are formed to overlap the barriers 105 with a width similar to or same as a right-left width of the barriers 105.

As shown in FIG. 5D, RGB color filters 103 are formed on the transparent substrate 101 where the black matrixes 104 are formed, thereby defining RGB sub-pixels 102. Here, the RGB sub-pixels 102 constitute one unit pixel 106, and one line of the unit pixels 106 constitutes one unit pixel line 107.

A liquid crystal display (LCD) device according to a second embodiment of the present disclosure will be explained with reference to FIGS. 6A and 6B.

Explanation for same components of the LCD device according to the second embodiment as those of the LCD device according to the first embodiment will be omitted. And, components of the LCD device according to the second embodiment not shown in FIGS. 6A and 6B will be explained with reference to the LCD device according to the first embodiment.

As shown, the liquid crystal display (LCD) device according to the second embodiment of the present disclosure comprises a substrate 201; RGB color filters 203 spaced from one another with a predetermined gap therebetween on the substrate 201, and defining RGB sub-pixels 202; black matrixes 204 formed at each space between the RGB color filters 203; and barriers 205 formed at each interface among the RGB sub-pixels 202, for controlling a path of light that passes through a corresponding sub-pixel 202. The barriers 205 are formed in the substrate 201 with a bar shape so that one surface thereof can come in contact with the black matrixes 204. A width of the barriers 205 is the same as or similar to a width of the black matrixes 204. The RGB sub-pixels 202 constitute one unit pixel (refer to 106 of FIG. 3B), and one line of the unit pixels constitutes one unit pixel line (refer to 107 of FIG. 3B). The barriers 205 are formed at each interface among one unit pixel line, one unit pixel line, and two unit pixel lines.

Referring to FIG. 3A of the first embodiment of the present disclosure, the LCD device according to the second embodiment of the present disclosure comprises a color filter substrate 208 which is an upper substrate, and a thin film transistor (TFT) array substrate (refer to 109 of FIG. 3A) which is a lower substrate.

The color filter substrate 208 includes the transparent substrate 201, the color filter 203, the black matrixes 204, the barriers 205, and common electrodes (not shown) each formed on the transparent substrate 201. Although not shown, the TFT array substrate includes gate and data lines that define RGB sub-pixels 202 by crossing each other on the transparent substrate 201, TFTs formed at each sub-pixel 202, and pixel electrodes.

As shown in FIGS. 6A and 6B, RGB color filters 203 of the color filter substrate 208 are spaced from one another with a

predetermined gap therebetween on the transparent substrate **201**, thereby defining RGB sub-pixels **202**.

The RGB sub-pixels **202** constitute one unit pixel (refer to **106** of FIG. **3B**), and one line of the unit pixels defines one unit pixel line (refer to **107** of FIG. **3B**). That is, the unit pixel line corresponds to one vertical line of the unit pixels.

The black matrixes **204** are formed at each space between the RGB color filters **203**.

As shown in FIGS. **6A** and **6B**, the barriers **205** are formed in the transparent substrate **201** with a bar shape so that one surface thereof can partially or entirely come in contact with the black matrixes **204**.

The barriers **205** are formed at each interface between the unit pixel lines with a long bar shape, which will be explained in more detail.

As shown in FIGS. **6A** and **6B**, the barriers **205** of the LCD device according to a second embodiment of the present disclosure are formed at each interface among one unit pixel line, one unit pixel line, and two unit pixel lines. That is, the barriers **205** are formed at each interface among a group (C) of one unit pixel line, a group (D) of one unit pixel line, and a group (E) of two unit pixel lines. Each one surface of the barriers **205** entirely or partially comes in contact with the black matrixes **204**. Here, the barriers **205** of the LCD device may not come in contact with the black matrixes **204**, but may overlap the black matrixes **204**.

The barriers **205** may overlap the black matrixes **204** with a width similar to or same as a right and left width of the black matrixes **204**. Since the barriers **205** overlaps an upper part of the black matrixes **204** without overlapping an upper part of the RGB sub-pixels **202**, a user of the LCD device can not recognize the barriers **205**.

Each length of the barriers **205** in upper and lower directions, that is, each length from contact points with the black matrixes **204** to upper surfaces of the barriers **205**, is properly designed according to a degree of a narrow viewing angle to be implemented. More concretely, when a narrower viewing angle in a narrow viewing angle mode is to be implemented, each length of the barriers **205** in upper and lower directions is designed to be long. On the contrary, when a wider viewing angle in a narrow viewing angle mode is to be implemented, each length of the barriers **205** in upper and lower directions is designed to be short.

In the LCD device according to a second embodiment of the present disclosure, a narrow viewing angle mode and a wide viewing angle mode are selectively implemented, which will be explained in more detail with reference to FIGS. **6A** and **6B**.

In a narrow viewing angle mode, only the RGB sub-pixels **202** of the unit pixel line having barriers **105** at both interfaces between adjacent unit pixel lines are driven, but the RGB sub-pixels **202** of the other unit pixel lines are neither driven nor receive black data.

That is, in a narrow viewing angle mode, only the RGB sub-pixels **202** of a first group (C) having one unit pixel line, and a second group (D) having another unit pixel line are driven, but a third group (E) having two unit pixel lines are neither driven nor receive black data. Here, the C, D, and E are respectively provided with the barriers **205** at each interface between adjacent unit pixel lines.

As shown in FIGS. **6A** and **6B**, light incident to the RGB sub-pixels **202** of the unit pixel lines having the barriers **205** at each interface between adjacent unit pixel lines, with a relatively larger incidence angle, is shielded by the barriers **205**. However, light incident thereto with a relatively smaller incidence angle passes through inside of the transparent substrate **201** without being shielded by the barriers **205**, and then

is emitted outside the transparent substrate **201**. Accordingly, an optical path is controlled by the barriers **205**, and thus a screen of a narrow viewing angle can be implemented.

In the narrow viewing angle mode, only a half of the RGB sub-pixels of the color filter substrate **208** are driven, thereby having a higher aperture ratio than that of the first embodiment.

When a wide viewing angle mode is to be implemented, all the RGB sub-pixel lines are driven.

As shown in FIGS. **6A** and **6B**, most of the light incident to the RGB sub-pixels **202** passes through inside of the transparent substrate **201** without being shielded by the barriers **205**, and then is emitted outside the transparent substrate **201**. Accordingly, a screen of a wide viewing angle can be implemented.

Although not shown, the light incident to the RGB sub-pixels **202** is light emitted from a backlight assembly provided below the color filter substrate **208** and the TFT array substrate.

A method for fabricating an LCD device according to a second embodiment of the present disclosure is the same as the method according to the first embodiment except for the position of the barriers **205**. Therefore, explanation for the method for fabricating an LCD device according to a second embodiment of the present disclosure will be omitted.

That is, the method for fabricating an LCD device according to the second embodiment of the present disclosure is the same as the method according to the first embodiment, except that the barriers **205** are formed at each interface between one unit pixel line and one unit pixel line, or between one unit pixel line and two unit pixel lines.

A liquid crystal display (LCD) device according to a third embodiment of the present disclosure will be explained with reference to FIGS. **7A** and **7B**.

Explanation for same components of the LCD device according to the third embodiment as those of the LCD devices according to the first and second embodiments will be omitted. And, components of the LCD device according to the third embodiment not shown in FIGS. **7A** and **7B** will be explained with reference to the LCD device according to the first embodiment.

As shown in FIGS. **7A** and **7B**, the liquid crystal display (LCD) device according to the third embodiment of the present disclosure comprises: a substrate **301**; RGB color filters **303** spaced from one another with a predetermined gap therebetween on the substrate **301**, and defining RGB sub-pixels **302**; black matrixes **304** formed at each space between the RGB color filters **303**; and barriers **305** formed at each interface among the RGB sub-pixels **302**, for controlling a path of light that passes through a corresponding sub-pixel **302**. The barriers **305** are formed in the substrate **301** with a bar shape so that one surface thereof can come in contact with the black matrixes **304**. Each width of the barriers **305** in right and left directions is the same as or similar to each width of the black matrixes **304** in right and left directions. The RGB sub-pixels **302** constitute one unit pixel (refer to **106** of FIG. **3B**), and one line of the unit pixels constitutes one unit pixel line (refer to **107** of FIG. **3B**). The barriers **305** are further formed at each interface among the RGB sub-pixels **302** in an alternate manner between two unit pixel lines and two unit pixel lines.

Referring to FIG. **3A** of the first embodiment of the present disclosure, the LCD device according to the third embodiment of the present disclosure comprises a color filter substrate **308** which is an upper substrate, and a thin film transistor (TFT) array substrate (refer to **109** of FIG. **3A**) which is a lower substrate.

The color filter substrate **308** includes the transparent substrate **301**, the color filter **303**, the black matrixes **304**, the barriers **305**, and common electrodes (not shown) each formed on the transparent substrate **301**.

Although not shown, the TFT array substrate includes gate and data lines that define RGB sub-pixels **302** by crossing each other on the transparent substrate **301**, TFTs formed at each sub-pixel **302**, and pixel electrodes.

As shown in FIGS. 7A and 7B, RGB color filters **303** of the color filter substrate **308** are spaced from one another with a predetermined gap therebetween on the transparent substrate **301**, thereby defining RGB sub-pixels **302**.

The RGB sub-pixels **302** constitute one unit pixel, and one line of the unit pixels defines one unit pixel line. That is, the unit pixel line corresponds to one vertical line of the unit pixels.

The black matrixes **304** are formed at each space between the RGB color filters **303**.

As shown in FIGS. 7A and 7B, the barriers **305** are formed in the transparent substrate **301** with a bar shape so as to come in contact with the black matrixes **304**.

The barriers **305** are formed at each interface between the unit pixel lines with a long bar shape, which will be explained in more detail.

As shown in FIGS. 7A and 7B, the barriers **305** of the LCD device according to a third embodiment of the present disclosure are formed at each interface between two unit pixel lines and two unit pixel lines. The barriers **305** are further formed at each interface among the RGB sub-pixels **302** in an alternate manner between the two unit pixel lines and the two unit pixel lines.

That is, the barriers **305** are formed at each interface between a group having two unit pixel lines and a group having another two unit pixel lines, and are further formed at each interface among the RGB sub-pixels **302** in an alternate manner between the two groups. Each one surface of the barriers **305** entirely or partially comes in contact with the black matrixes **304**. Here, the barriers **305** of the LCD device may not come in contact with the black matrixes **304**, but may overlap the black matrixes **304**.

The barriers **305** may overlap the black matrixes **304** with a width similar to or same as a right-left width of the black matrixes **304**. Since the barriers **305** overlap an upper part of the black matrixes **304** without overlapping an upper part of the RGB sub-pixels **302**, a user of the LCD device can not recognize the barriers **305**.

Each length of the barriers **305** in upper and lower directions, that is, each length from contact points with the black matrixes **304** to upper surfaces of the barriers **305**, is properly designed according to a degree of a narrow viewing angle to be implemented. More concretely, when a narrower viewing angle in a narrow viewing angle mode is to be implemented, each length of the barriers **305** in upper and lower directions is designed to be long. On the contrary, when a wider viewing angle in a narrow viewing angle mode is to be implemented, each length of the barriers **305** in upper and lower directions is designed to be short.

In the LCD device according to a third embodiment of the present disclosure, a narrow viewing angle mode and a wide viewing angle mode are selectively implemented, which will be explained in more detail with reference to FIGS. 7A and 7B.

In a narrow viewing angle mode, only the RGB sub-pixels **302** of the unit pixel lines having the barriers **305** at each interface among the RGB color filters **303** are driven, but the RGB sub-pixels **302** of other unit pixel lines are not driven.

That is, in a narrow viewing angle mode, only the RGB sub-pixels **302** of a group (G) are driven, the group (G) having two unit pixel lines in which the barriers **305** are formed at each interface among the RGB color filters **303**. However, the RGB sub-pixels **302** of a group (F) having another two unit pixel lines are not driven.

As shown in FIGS. 7A and 7B, light incident to the RGB sub-pixels **302** of the unit pixel lines having the barriers **305** at each interface among the RGB color filters **303**, with a relatively larger incidence angle is shielded by the barriers **305**. However, light incident thereto with a relatively smaller incidence angle passes through inside of the transparent substrate **301** without being shielded by the barriers **305**, and then is emitted outside the transparent substrate **301**. Accordingly, an optical path is controlled by the barriers **305**, and thus a screen of a narrow viewing angle can be implemented.

In the narrow viewing angle mode, only a half of the RGB sub-pixel lines of the color filter substrate **308** are driven, thereby having a higher aperture ratio than that of the first embodiment and the second embodiment.

When a wide viewing angle mode is to be implemented, all the RGB sub-pixel lines are driven.

As shown in FIGS. 7A and 7B, most of the light incident to the RGB sub-pixels **302** passes through inside of the transparent substrate **301**, and then is emitted outside the transparent substrate **301**. Accordingly, a screen of a wide viewing angle can be implemented.

Although not shown, the light incident to the RGB sub-pixels **302** is light emitted from a backlight assembly provided below the color filter substrate **308** and the TFT array substrate.

A method for fabricating an LCD device according to a third embodiment of the present disclosure is the same as the methods according to the first and second embodiments except for each position and longitudinal length of the barriers **305**. Therefore, explanation for the method for fabricating an LCD device according to the third embodiment of the present disclosure will be omitted.

That is, the method for fabricating an LCD device according to the third embodiment of the present disclosure is different from the methods according to the first and second embodiments, in that the barriers **305** are formed at each interface between two unit pixel lines and two unit pixel lines, and the barriers **305** are further formed at each interface among the RGB sub-pixels in an alternate manner between the two unit pixel lines and the two unit pixel lines.

In the method for fabricating an LCD device according to the third embodiment of the present disclosure, the barriers **305** are formed at each interface among the RGB sub-pixels **302**. Accordingly, even if each length of the barriers **305** in upper and lower directions is shorter than each length of the first and second embodiments, the same effect as those of the first and second embodiments can be obtained. As a result, the grooves formed on the transparent substrate **301** (refer to **105a** of FIG. 5A) can have a minimized depth when the barriers **305** are formed.

In the LCD device, the barriers are formed in the substrate so as to come in contact with the black matrixes, thereby selectively implementing a narrow viewing angle mode and a wide viewing angle mode.

Furthermore, in the LCD device, each width of the barriers in right and left directions is the same as or similar to each width of the black matrixes in right and left directions. Accordingly, an aperture ratio is increased than that of the conventional LCD device for selectively implementing a narrow viewing angle mode and a wide viewing angle mode, thereby enhancing a brightness of a display screen.

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Moreover, in the LCD device, the barriers are simply formed by forming the grooves on the transparent substrate of the color filter substrate and then by filling black resins in the grooves. Accordingly, the fabrication process of the LCD device is facilitated.

The foregoing embodiments and advantages are merely exemplary and are not to be construed as limiting the present disclosure. The present teachings can be readily applied to other types of apparatuses. This description is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art. The features, structures, methods, and other characteristics of the exemplary embodiments described herein may be combined in various ways to obtain additional and/or alternative exemplary embodiments.

As the present features may be embodied in several forms without departing from the characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be construed broadly within its scope as defined in the appended claims, and therefore all changes and modifications that fall within the metes and bounds of the claims, or equivalents of such metes and bounds are therefore intended to be embraced by the appended claims.

What is claimed is:

1. A liquid crystal display (LCD) device, comprising:

a substrate having a plurality of unit pixels, wherein each unit pixel includes a red sub-pixel, a green sub-pixel and a blue sub-pixel;

a plurality of black matrix elements, each black matrix element being disposed at each interface between the red, green and blue sub-pixels;

red, green, and blue color filters that are respectively disposed at the red, green and blue sub-pixels

a plurality of barriers disposed in the substrate such that each barrier comes into contact with a corresponding black matrix element, the plurality of barriers including

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at least two barriers that are disposed on matrix elements at interfaces that are one unit pixels apart without any intervening barriers in-between, and the plurality of barriers including at least two barriers that are disposed on matrix elements at interfaces that are two unit pixels apart without having any intervening barriers in-between;

wherein each barrier comes into contact with a corresponding black matrix element such that both the barrier and corresponding black matrix element overlap over at least two color filters.

2. The LCD device of claim 1, wherein in a narrow viewing angle mode, only unit pixels that are between two barriers spaced one unit pixel apart are driven, and wherein in a wide viewing angle mode all unit pixels are driven.

3. The LCD device of claim 1, wherein the RGB sub-pixels comprise one unit pixel, one line of the unit pixels comprises one unit pixel line, and the barriers are disposed at each interface between the unit pixel lines.

4. The LCD device of claim 3, wherein the barriers are disposed at each interface among one unit pixel line, one unit pixel line, and two unit pixel lines.

5. The LCD device of claim 4, wherein in a narrow viewing angle mode, only the unit pixel lines that have the barriers at both sides thereof are driven, whereas all the unit pixel lines are driven in a wide viewing angle mode.

6. The LCD device of claim 3, wherein the barriers are disposed at each interface between two unit pixel lines and two unit pixel lines, and are further disposed at each interface among the RGB sub-pixels in an alternate manner between the two unit pixel lines and the two unit pixel lines.

7. The LCD device of claim 6, wherein in a narrow viewing angle mode, only the unit pixel lines that have the barriers at each interface among the RGB color filters are driven, whereas all the unit pixel lines are driven in a wide viewing angle mode.

\* \* \* \* \*

|                |                                                 |         |            |
|----------------|-------------------------------------------------|---------|------------|
| 专利名称(译)        | 液晶显示装置和滤色器基板                                    |         |            |
| 公开(公告)号        | <a href="#">US8325301</a>                       | 公开(公告)日 | 2012-12-04 |
| 申请号            | US11/967670                                     | 申请日     | 2007-12-31 |
| [标]申请(专利权)人(译) | WOO JONG HOON<br>LEE YOUNG BOK                  |         |            |
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| 当前申请(专利权)人(译)  | LG DISPLAY CO. , LTD.                           |         |            |
| [标]发明人         | WOO JONG HOON<br>LEE YOUNG BOK                  |         |            |
| 发明人            | WOO, JONG-HOON<br>LEE, YOUNG-BOK                |         |            |
| IPC分类号         | G02F1/1333                                      |         |            |
| CPC分类号         | G02F1/133512 G02F2201/40                        |         |            |
| 代理机构(译)        | BRINKS霍费尔GILSON & LIONE                         |         |            |
| 审查员(译)         | ROBINSON , MARK                                 |         |            |
| 优先权            | 1020070070870 2007-07-13 KR                     |         |            |
| 其他公开文献         | US20090015763A1                                 |         |            |
| 外部链接           | <a href="#">Espacenet</a> <a href="#">USPTO</a> |         |            |

#### 摘要(译)

液晶显示 ( LCD ) 装置包括基板和红色 , 绿色 , 蓝色 ( RGB ) 滤色器。 RGB滤色器在基板之间以预定间隙彼此隔开 , 并限定RGB子像素。 LCD装置还包括设置在RGB滤色器之间的每个空间处的黑矩阵 , 以及设置在RGB子像素中的每个界面处的屏障 , 使得屏障控制穿过相应子像素的光的路径。

