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Title of invention: TRANSFLECTIVE LIQUID CRYSTAL DISPLAY

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In accordance with the Patent Law, it is found after examination that there is no ground for rejection of the above-identified application, the Patent Office made a decision to grant patent right, issue this patent certificate and register it in the patent register**.** The patent right took effect from the date of announcement of grant of patent right. The duration of patent right for this patent shall be twenty years, counted from the filing date of the application.

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Applicant(s) and Inventor(s) filed on the filing date:

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发明专利证书

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TRANSFLECTIVE LIQUID CRYSTAL DISPLAY

TECHNICAL FIELD

The present invention relates to liquid crystal display (hereinafter "LCD") panels, and more particularly to transflective LCD panels.

BACKGROUND TECHNIQUE

In a transflective LCD panel, ambient light can be reflected by the mirror and its color can be produced in the reflective portion of the sub-pixels contained in the pixels in the pixel array of the panel. In contrast, light generated from within the panel can be transmitted through the filter and its color can be produced in the transmissive portion of the same sub-pixel. Generally, the color produced by the reflective portion of the sub-pixel may be an unsaturated color, and the color produced by the transmissive portion of the sub-pixel may be a fully saturated color. Under low ambient light conditions, the resulting color can be a color with good optical properties. However, under bright ambient light conditions, the unsaturated color from the reflective portion of the sub-pixel dominates, and thus the optical properties of the resulting color are reduced.

In U.S. Patent No. 7,636,076, an additional colorless sub-pixel (referred to as sub-pixel M) is used to increase the optical properties of the color produced under bright ambient light conditions. In U.S. Patent No. 7,760,297, additional sub-pixels are also used to increase the optical properties of the colors produced under bright ambient light conditions. Here, the additional sub-pixel has a color filter that complements the primary color filter. For example, an additional sub-pixel may have a cyan color filter.

SUMMARY OF THE INVENTION

According to an embodiment of the present invention, a pixel of a transflective liquid crystal display panel having a controllable backlight, the pixel includes a sub-pixel array and a color substrate, the color substrate having a corresponding to the sub-pixel array A color array comprising a transmissive color and a reflective color. The color substrate transmits light of at least one wavelength corresponding to the transmitted color in the color array when the controllable backlight emits a first predetermined light level, and emits a second predetermined at the controllable backlight The light level reflects light of at least one wavelength corresponding to the reflected color in the color array from substantially the same area in the color substrate. The transmission color may be a primary color or a secondary color, and the reflection color may be a primary color or an intermediate color.

According to a second embodiment of the present invention, a transflective liquid crystal display includes: a panel divided into a pixel array, each pixel being divided into sub-pixel arrays, the panel having a top substrate; a liquid crystal layer, The liquid crystal layer is located behind the top substrate; a color substrate, the color substrate is located behind the liquid crystal layer; and a controllable backlight system, the controllable backlight system is located behind the color substrate. The color substrate includes a color array corresponding to the sub-pixel array, the color array including a transmissive color and a reflective color, the reflected color being a complementary color of the transmissive color. The transmitted color may be a primary color or an intermediate color, and the reflective color may be a primary color or an intermediate color.

In this second embodiment, the color substrate transmits light of at least one wavelength corresponding to the transmitted color in the color array when the controllable backlight emits a first predetermined light level, and The controllable backlight reflects at least one wavelength of light corresponding to the reflected color in the color array from substantially the same region in the color substrate when the second predetermined light level is emitted.

In both embodiments, the primary colors may form a top row of the sub-pixel array, and the intermediate colors may form a bottom row of the sub-pixel array. The order of the primary colors in the top row of the sub-pixel array may be red, green, and blue, and the order of the intermediate colors in the bottom row of the sub-pixel array may be magenta, cyan, and yellow.

In an alternative embodiment of the two embodiments of the present invention, at least one of the primary colors and at least one of the intermediate colors may form a top row of the sub-pixel array, and the primary colors At least one of the color and at least one of the intermediate colors may form a bottom row of the sub-pixel array. The order of the primary colors and the intermediate colors in the top row of the sub-pixel array may be (1) red, cyan, and blue or (2) magenta, green, and yellow; and the bottom of the sub-pixel array The order of the inter-colors in the line may be (1) magenta, green, and yellow or (2) red, cyan, and blue.

In a further embodiment of the two embodiments of the invention, the display panel may include a light sensor that monitors the ambient light level entering the display panel. In various embodiments of this embodiment, (1) the first predetermined light level may be greater than the measured ambient light level, and the second predetermined light level may be less than the measured ambient light level, or (2) the first predetermined light level may be substantially equal to the second predetermined light level, or (3) the first predetermined light level, the second predetermined light level or the two predetermined light levels may be The measured ambient light level is between 55% and 105%.

In still further embodiments of the two embodiments of the present invention, when the first predetermined light level is greater than the measured ambient light level, the transmitted color may be a primary color, and the reflected color may be a color Or when the second predetermined light level is less than the measured ambient light level, the transmitted color may be an intermediate color, and the reflected color may be a primary color.

DRAWINGS

The foregoing features of the present invention will be more readily understood by reference to the following detailed description,

Figure 1 is a schematic representation of a transflective LCD panel in accordance with an embodiment of the present invention.

Figure 2a is a schematic representation of a transflective LCD in a transmitted light mode, in accordance with an embodiment of the present invention.

Figure 2b is a schematic representation of a transflective LCD in reflected light mode, in accordance with an embodiment of the present invention.

Figure 3 is a schematic representation of a transflective LCD in transmissive and reflected light modes, in accordance with an embodiment of the present invention.

Figure 4 is a schematic representation of a pixel array of a transflective LCD in accordance with an embodiment of the present invention.

Figure 5 is a schematic representation of a first embodiment of a pixel array of a transflective LCD shown in Figure 4.

Figure 6 is a schematic representation of a second embodiment of a pixel array of the transflective LCD shown in Figure 4.

Figure 7a is a perspective view of a pixel array in a transmitted light mode, in accordance with an embodiment of the present invention.

Figure 7b is a perspective view of a pixel array in reflected light mode, in accordance with an embodiment of the present invention.

Detailed Ways

Figure 1 is a schematic representation of a transflective LCD panel in accordance with an embodiment of the present invention. In panel 100, processing unit 102 controls graphics processing unit 104, and processing unit 102, along with ambient light sensor 106, controls backlight 108. In operation, ambient light sensor 106 monitors ambient light levels entering panel 100. As discussed in more detail below, the ambient light sensor 106 signals the processing unit 102 to turn off the backlight 108 when the ambient light level is illuminated to a particular level. In this light mode, the color substrates 110a and 110b act as mirrors and reflect ambient light. As discussed in more detail below, the ambient light sensor 106 signals the processing unit 102 to turn on the backlight 108 when the ambient light level dims to a particular level. In this light mode, the color substrates 110a and 110b act as filters and transmit light emitted from the backlight 108.

In an alternative embodiment, processing unit 102 can signal graphics processing unit 104 and graphics processing unit 104 can control backlight 108. Alternatively, in another alternative embodiment, ambient light sensor 106 can transmit its signal to graphics processing unit 104 (rather than processing unit 102), and graphics processing unit 104 can control backlight 108.

As understood by one of ordinary skill in the art, processing unit 102 can be a central processing unit ("CPU"), a sub-processing unit, or a co-processing unit.

In all light modes, light passes through the liquid crystal layer 112 (which is composed of a plurality of liquid crystals (not shown)) and passes through the diffusion substrate 114. The liquid crystal controls the intensity (ie, brightness) of the reflected or transmitted light.

The transflective LCD panel depicted in Figure 1 further includes a pixel array. As shown in Figure 4, which is a schematic representation of a pixel array in accordance with an embodiment of the invention, the pixel array (denoted 418) contains a number of pixels (denoted as 416), and each pixel contains a number of sub-pixels (represented as 410). Color substrates (eg, 110a and 110b) are arranged according to a sub-pixel array. In other words, each sub-pixel reflects the reflected color of its color substrate and transmits the transmitted color of its color substrate.

Figures 2a and 2b, which are each a schematic representation of a transflective LCD according to an embodiment of the present invention, the transmitted color (denoted as TC) of the color substrate 210a is different from the reflected color of the color substrate 210a (denoted as RC). Similarly, the transmission color of the color substrate 210b is different from the reflection color of the color substrate 210b. For example, the color substrate 210a can transmit red light but reflect blue light. In contrast, the color substrate 210b can transmit cyan light but reflect red light. In industry terms, this type of color substrate can be referred to as a dichroic filter, a dichroic mirror, a dichroic filter/mirror, or an interference filter.

The color substrate can be composed of a thin transparent spacer (such as glass (eg, borofloat glass) or a thermoplastic elastomer (such as polycarbonate) that has been coated on at least one side. As understood by one of ordinary skill in the art, the gasket is coated with a thin layer of one or more metal oxides (e.g., chromium, silicon, titanium, magnesium, aluminum, zirconium, etc.). Typically, the gasket is coated in a vacuum chamber at elevated temperatures. The optical properties of the coating depending on color selection and use can range from non-reflective to partially reflective to fully reflective. In an alternative embodiment, the color substrate may also be dyed or painted glass, dyed or painted gelatin, dyed or painted synthetic polymer, or created or transformed to meet desired optical properties. Any material composition in which the transmission color of the material can be selected or the reflection color of the material can be selected.

For the transflective LCD panel described herein, the optical properties can include a color substrate in which the transmitted color is a complementary color of the reflected color. For example, a color substrate that transmits red may reflect cyan, a color substrate that transmits magenta may reflect green, a substrate that transmits blue may reflect yellow, and the like.

As shown in Figure 3, is a schematic representation of a transflective LCD according to an embodiment of the present invention, when the ambient light level approaches the level of light emitted from the backlight 308, the panel 300 is in a transmitted light mode and reflected light. The mode operates in both. This reflected light pattern is derived from the optical characteristics of the color substrates 310a and 310b. Unlike the most conventional transflective LCD panel having sub-pixels having a transmissive area and a reflective area, the color substrates 310a and 310b do not have a transmissive area and a reflective area. Rather, under certain lighting conditions, color substrates 310a and 310b can act simultaneously (or substantially simultaneously) and act as filters (transmitted light mode) or mirrors (reflections) from the same (or substantially the same) location on the substrate. Light mode).

In the transflective LCD panel described herein, this transflective mode is of the utmost importance when the ambient light level is the same or substantially the same as the level of light emitted from the backlight. As understood by one of ordinary skill in the art, the interaction occurring between the transmitted and reflected light at this point changes the saturation and/ or wavelength of the displayed color as appropriate. For example, when the transmitted light is a complementary color of the reflected light, the displayed color will become less saturated (ie, near grayscale), or when the reflected light exceeds the transmitted light, the displayed color will be reversed.

As discussed above with respect to Figure 1, ambient light sensor 106 monitors ambient light levels and controls backlight 108 via processing unit 102 and/or graphics processing unit 104. Control types can range from two-state control to variable state control. In two-state control, backlight 108 has two states - on and off. In contrast, in variable state control, backlight 108 can have two states - open or partially open - or can have three states - open, partially open, or closed.

In two-state control, when backlight 108 is turned on (ie, emitting light), the processed signal from ambient light sensor 106 turns off backlight 108, and when backlight 108 is turned off, the processed signal from ambient light sensor 106 The backlight 108 is turned on. Depending on the device in which the panel 100 is mounted and the use and/or application of the device, the ambient light sensor 106 can transmit its signal when the ambient light level is the same (or within a certain percentage) of the level of light emitted from the backlight 108. For example, if the backlight 108 has an illuminance level of 100, the ambient light sensor 106 can have an illuminance level of ambient light of 100, an illuminance level of 80 (ie, 80% of the illuminance level of the backlight 108), or an illuminance level of 120 (i.e., 120% of the illumination level of backlight 108) transmits its signal.

When the panel 100 is displaying reflected light (ie, the backlight 108 is off), the ambient light sensor can transmit its signal to be at the ambient light level and the "rated" level of light emitted from the backlight 108 (ie, when the backlight 108 is turned on) The backlight 108 is turned on when the light level is the same (or within a certain percentage). For example, if backlight 108 has an illumination level of 100 (when turned on), ambient light sensor 106 may have an illumination level of ambient light of 100, when the illumination level is 80 (ie, 80% of the illumination level of backlight 108), Or, when the illuminance level is 120 (i.e., 120% of the illumination level of the backlight 108), its signal is transmitted.

In variable state control, the level of light emitted from backlight 108 varies according to LCD panel settings, which may be set by the manufacturer and/or by the user. These LCD panel settings can include, for example, automatic brightness settings and brightness level settings. In turn, ambient light sensor 106 controls backlight 108 using this "calculated" level of light emitted from backlight 108. In a similar manner to the two-state control, the ambient light sensor 106 can transmit its signal when the ambient light level is the same (or within a certain percentage) of the light emitted from the backlight 108.

In an alternative embodiment, the light reflectance level of panel 100 can be used to control backlight 108 in the calculations. For example, in two-state control or variable state control, the light reflectance level can modify the ambient light level at which ambient light sensor 106 sends its signal to control backlight 108.

In two-state control or variable state control, the process of controlling backlight 108 may be performed by processing unit 102 or graphics processing unit 104. In an alternative embodiment of the invention, the process may be performed by ambient light sensor 106. As noted above, processing unit 102 can be a central processing unit ("CPU"), a sub-processing unit, or a co-processing unit.

As discussed above with respect to Figures 1-4, the transflective LCD panel described herein includes a pixel array. As shown in Figure 5, which is a schematic representation of an embodiment of a pixel array (represented by 518) comprising a plurality of pixels (represented by 516), each of the plurality of pixels being contained in three columns and An array of six sub-pixels aligned in two rows (represented by 510). The corresponding color substrates of the sub-pixels are the primary colors (red, green, blue) and the intermediate colors (cyan, magenta, yellow). In this embodiment for pixel 516, the primary color sub-pixels form the top row of the sub-pixel array, and the intermediate color sub-pixels form the bottom row of the sub-pixel array. In an alternative embodiment for pixel 516, the dichromatic sub-pixels form the top row of the sub-pixel array, and the primary color sub-pixels form the bottom row of the sub-pixel array.

In Figure 6, is a schematic representation of an alternative embodiment of a pixel array (represented by 618) containing a plurality of pixels (represented by 616a and 616b), each of the plurality of pixels being contained in three columns and An array of six sub-pixels aligned in two rows (represented by 610). In pixel 616a, the top row of the sub-pixel array is formed by two primary color sub-pixels adjacent to one color-colored sub-pixel, and the bottom row of the sub-pixel array is formed by two intermediate color sub-pixels adjacent to one primary color sub-pixel. In contrast, in pixel 616b, the top row of the sub-pixel array is formed by two inter-color sub-pixels adjacent to one primary color sub-pixel, and the bottom row of the sub-pixel array is composed of two primary chromons adjacent to one inter-color sub-pixel Pixel formation. In this embodiment for pixel array 618, pixel 616a forms an odd column of pixel array 618, and pixel 616b forms an even column of pixel array 618. In an alternative embodiment for pixel array 618, pixel 616a forms an odd column of pixel array 618, and pixel 616b forms an even column of pixel array 618.

Figure 7a shows a perspective view of the pixel array depicted in Figure 6 in a transmitted light mode. In this embodiment, backlight 708 is turned on (ie, it is emitting light) and the transmitted color is generated from primary color sub-pixels 710a, 710c, and 710e (which transmit red, blue, and green, respectively). In a further embodiment, the dichroic sub-pixels 710b, 710d, and 710f (which transmit magenta, cyan, and yellow, respectively) can also be used, and thus produce a brighter, more saturated color.

Figure 7b shows a perspective view of the pixel array depicted in Figure 6 in a reflected light mode. In this embodiment, backlight 708 is turned off (ie, it does not emit light), and the reflected color is generated from intermediate color sub-pixels 710b, 710d, and 710f, which reflect green, red, and blue, respectively. In a further embodiment, primary color sub-pixels 710a, 710c, and 710e (which reflect cyan, magenta, and yellow, respectively) may also be used, and thus produce a brighter, more saturated color.

The pixel arrays described herein may need to be controlled via a six color signal instead of a standard three color signal. As understood by one of ordinary skill in the art, the standard tricolor signal output by the graphics processing unit can be easily converted to a six-color signal, or the graphics processing unit can be easily converted for outputting a six-color signal.

Although various exemplary embodiments of the invention have been disclosed, it will be apparent to those skilled in the art . The appended claims are intended to cover these and other obvious modifications.

CLAIMS

1. A pixel of a transflective liquid crystal display panel, the display panel having a controllable backlight, the pixel comprising:

a sub-pixel array;

a color substrate having an array of colors corresponding to the sub-pixel array, the color array comprising a transmissive color and a reflective color, the reflected color being a complementary color of the transmissive color, the color substrate being The controllable backlight transmits at least one wavelength of light corresponding to the transmitted color in the color array when the first predetermined light level is emitted, and from the controllable backlight when the second predetermined light level is emitted A substantially identical region in the color substrate reflects light of at least one wavelength corresponding to the reflected color in the color array;

wherein the transmission color is a primary color or an intermediate color, and the reflected color is a primary color or an intermediate color.

2. The pixel of claim 1 wherein the primary colors form a top row of the sub-pixel array and the inter-color forms a bottom row of the sub-pixel array.

3. The pixel of claim 1, wherein at least one of the primary colors and at least one of the intermediate colors form a top row of the sub-pixel array, and at least one of the primary colors At least one of the inter-colors forms a bottom row of the sub-pixel array.

4. The pixel of claim 2, wherein the order of the primary colors in the top row of the sub-pixel array is red, green, and blue, and the inter-color in the bottom row of the sub-pixel array The order is cyan, magenta, and yellow.

5. The pixel of claim 3, wherein the order of the primary color and the intermediate color in a top row of the sub-pixel array is red, magenta, and blue or cyan, green, and yellow; and the sub- The order of the primary colors and the intermediate colors in the bottom row of the pixel array is cyan, green, and yellow or red, magenta, and blue.

6. The pixel of claim 1 wherein the display panel further comprises a light sensor that measures ambient light levels entering the display panel.

7. The pixel of claim 6 wherein the first predetermined light level is greater than the measured ambient light level and the second predetermined light level is less than the measured ambient light level.

8. The pixel of claim 1 wherein said first predetermined light level is substantially equal to said second predetermined light level.

9. The pixel of claim 6 wherein the first predetermined light level, the second predetermined light level, or the two predetermined light levels are between 55% and 105% of the measured ambient light level.

10. A liquid crystal display panel comprising a plurality of pixels, wherein at least one of the pixels is the pixel of claim 1.

11. A transflective liquid crystal display comprising:

a panel, the panel being divided into a pixel array, each pixel being divided into sub-pixel arrays, the panel having a top substrate;

a liquid crystal layer, the liquid crystal layer being located behind the top substrate;

a color substrate, the color substrate being located behind the liquid crystal layer, the color substrate comprising an array of colors corresponding to the sub-pixel array, the color array comprising a transmissive color and a reflective color, the reflective color being a complementary color of a transmitted color, wherein the transmitted color is a primary color or an intermediate color, and the reflected color is a primary color or an intermediate color;

a controllable backlight system, the controllable backlight system being located behind the color substrate;

wherein the color substrate transmits light of at least one wavelength corresponding to the transmitted color in the color array when the controllable backlight emits a first predetermined light level, and emits a second predetermined at the controllable backlight The light level reflects light of at least one wavelength corresponding to the reflected color in the color array from substantially the same area in the color substrate.

12. The transflective liquid crystal display of claim 11, wherein the primary colors form a top row of the sub-pixel array, and the intermediate color forms a bottom row of the sub-pixel array.

13. The transflective liquid crystal display of claim 11, wherein at least one of the primary colors and at least one of the intermediate colors form a top row of the sub-pixel array, and in

the primary color at least one of the at least one of the intermediate colors forms a bottom row of the sub-pixel array.

14. The transflective liquid crystal display according to claim 12, wherein the order of the primary colors in the top row of the sub-pixel array is red, green, and blue, and in the bottom row of the sub-pixel array The order of the intermediate colors is cyan, magenta, and yellow.

15. The transflective liquid crystal display according to claim 13, wherein the order of the primary color and the intermediate color in a top row of the sub-pixel array is red, magenta, and blue or cyan, green, and yellow And the order of the primary colors and the intermediate colors in the bottom row of the sub-pixel array is cyan, green, and yellow or red, magenta, and blue.

16. A pixel of a transflective liquid crystal display panel, the display panel having a controllable backlight, the pixel comprising:

a sub-pixel array;

a color substrate having an array of colors corresponding to the sub-pixel array, the color array comprising a transmissive color and a reflective color, the reflected color being a complementary color of the transmissive color, the color substrate being The controllable backlight transmits at least one wavelength of light corresponding to the transmitted color in the color array when the first predetermined light level is emitted, and from the controllable backlight when the second predetermined light level is emitted A substantially identical region in the color substrate reflects light of at least one wavelength corresponding to the reflected color in the color array.

17. The pixel of claim 16 wherein the display panel further comprises a light sensor that measures ambient light levels entering the display panel.

18. The pixel of claim 17, wherein when the first predetermined light level is greater than the measured ambient light level, the transmitted color is a primary color and the reflected color is an intermediate color.

19. The pixel of claim 17, wherein when the second predetermined light level is less than the measured ambient light level, the transmitted color is a meta color and the reflected color is a primary color.

20. A liquid crystal display panel comprising a plurality of pixels, wherein at least one of the pixels is a pixel according to claim 16.

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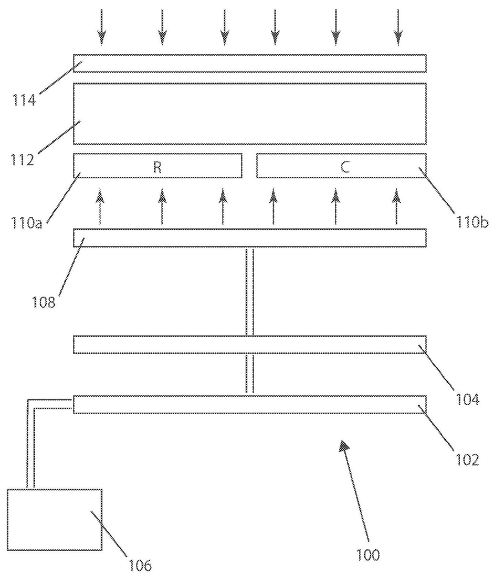
(54)发明名称

半透反射式液晶显示器

(57)摘要

一种具有可控背光的半透反射式液晶显示面板的像素，所述像素包括子像素阵列和颜色基板，所述颜色基板具有与所述子像素阵列相对应的颜色阵列，所述颜色阵列包括透射颜色和反射颜色。所述颜色基板在所述可控背光发射第一预定光水平时透射与所述颜色阵列中的所述透射颜色相对应的至少一种波长的光，并且在所述可控背光发射第二预定光水平时从所述颜色基板中的基本上相同区域反射与所述颜色阵列中的所述反射颜色相对应的至少一种波长的光。所述透射颜色可以是原色或间色，并且所述反射颜色可以是原色或间色。所述原色可以形成所述子像素阵列的顶行，并且所述间色可以形成所述子像素阵列的底行，或者所述原色中的至少一种和所述间色中的至少一种可以形成所述子像素阵列的顶行，并且所述原色中的至少一种和所述间色中的至少一种可以形成所述子像素阵列的底行。



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1.一种半透反射式液晶显示面板的像素，所述显示面板具有可控背光，所述像素包括：

子像素阵列；

颜色基板，所述颜色基板具有与所述子像素阵列相对应的颜色阵列，所述颜色阵列包括透射颜色和反射颜色，所述反射颜色是所述透射颜色的互补色，所述颜色基板在所述可控背光发射第一预定光水平时透射与所述颜色阵列中的所述透射颜色相对应的至少一种波长的光，并且在所述可控背光发射第二预定光水平时从所述颜色基板中的基本上相同区域反射与所述颜色阵列中的所述反射颜色相对应的至少一种波长的光；并且

其中，所述透射颜色是原色或间色，并且所述反射颜色是原色或间色。

2.根据权利要求1所述的像素，其中，所述原色形成所述子像素阵列的顶行，并且所述间色形成所述子像素阵列的底行。

3.根据权利要求1所述的像素，其中，所述原色中的至少一种和所述间色中的至少一种形成所述子像素阵列的顶行，并且所述原色中的至少一种和所述间色中的至少一种形成所述子像素阵列的底行。

4.根据权利要求2所述的像素，其中，所述子像素阵列的顶行中的所述原色的顺序是红色、绿色和蓝色，并且所述子像素阵列的底行中的所述间色的顺序是青色、品红色和黄色。

5.根据权利要求3所述的像素，其中，所述子像素阵列的顶行中的所述原色和所述间色的顺序是红色、品红色和蓝色或者青色、绿色和黄色；并且所述子像素阵列的底行中的所述原色和所述间色的顺序是青色、绿色和黄色或者红色、品红色和蓝色。

6.根据权利要求1所述的像素，其中，所述显示面板进一步包括光传感器，所述光传感器测量进入所述显示面板的环境光水平。

7.根据权利要求6所述的像素，其中，所述第一预定光水平大于所测量的环境光水平，并且所述第二预定光水平小于所测量的环境光水平。

8.根据权利要求1所述的像素，其中，所述第一预定光水平基本上等于所述第二预定光水平。

9.根据权利要求6所述的像素，其中，所述第一预定光水平、所述第二预定光水平或这两个预定光水平在所测量的环境光水平的55％到105％之间。

10.一种液晶显示面板，所述液晶显示面板包括多个像素，其中，所述像素中的至少一个像素是如权利要求1所述的像素。

11.一种半透反射式液晶显示器，包括：

面板，所述面板被分成像素阵列，每个像素被分成子像素阵列，所述面板具有顶部基板；

液晶层，所述液晶层位于所述顶部基板的后面；

颜色基板，所述颜色基板位于所述液晶层的后面，所述颜色基板包括与所述子像素阵列相对应的颜色阵列，所述颜色阵列包括透射颜色和反射颜色，所述反射颜色是所述透射颜色的互补色，其中，所述透射颜色是原色或间色，并且所述反射颜色是原色或间色；

可控背光系统，所述可控背光系统位于所述颜色基板的后面；并且

所述颜色基板在所述可控背光发射第一预定光水平时透射与所述颜色阵列中的所述透射颜色相对应的至少一种波长的光，并且在所述可控背光发射第二预定光水平时从所述颜色基板中的基本上相同区域反射与所述颜色阵列中的所述反射颜色相对应的至少一种

波长的光。

12.根据权利要求11所述的半透反射式液晶显示器，其中，所述原色形成所述子像素阵列的顶行，并且所述间色形成所述子像素阵列的底行。

13.根据权利要求11所述的半透反射式液晶显示器，其中，所述原色中的至少一种和所述间色中的至少一种形成所述子像素阵列的顶行，并且所述原色中的至少一种和所述间色中的至少一种形成所述子像素阵列的底行。

14.根据权利要求12所述的半透反射式液晶显示器，其中，所述子像素阵列的顶行中的所述原色的顺序是红色、绿色和蓝色，并且所述子像素阵列的底行中的所述间色的顺序是青色、品红色和黄色。

15.根据权利要求13所述的半透反射式液晶显示器，其中，所述子像素阵列的顶行中的所述原色和所述间色的顺序是红色、品红色和蓝色或者青色、绿色和黄色；并且所述子像素阵列的底行中的所述原色和所述间色的顺序是青色、绿色和黄色或者红色、品红色和蓝色。

16.一种半透反射式液晶显示面板的像素，所述显示面板具有可控背光，所述像素包括：

子像素阵列；

颜色基板，所述颜色基板具有与所述子像素阵列相对应的颜色阵列，所述颜色阵列包括透射颜色和反射颜色，所述反射颜色是所述透射颜色的互补色，所述颜色基板在所述可控背光发射第一预定光水平时透射与所述颜色阵列中的所述透射颜色相对应的至少一种波长的光，并且在所述可控背光发射第二预定光水平时从所述颜色基板中的基本上相同区域反射与所述颜色阵列中的所述反射颜色相对应的至少一种波长的光。

17.根据权利要求16所述的像素，其中，所述显示面板进一步包括光传感器，所述光传感器测量进入所述显示面板的环境光水平。

18.根据权利要求17所述的像素，其中，当所述第一预定光水平大于所测量的环境光水平时，所述透射颜色是原色，并且所述反射颜色是间色。

19.根据权利要求17所述的像素，其中，当所述第二预定光水平小于所测量的环境光水平时，所述透射颜色是间色，并且所述反射颜色是原色。

20.一种液晶显示面板，所述液晶显示面板包括多个像素，其中，所述像素中的至少一个像素是如权利要求16所述的像素。

半透反射式液晶显示器

技术领域

[0001] 本发明涉及液晶显示(在下文中“LCD”)面板,并且更具体地涉及半透反射式LCD面板。

背景技术

[0002] 在半透反射式LCD面板中,环境光可以被反光镜反射,并且其颜色可以在包含在面板的像素阵列中的像素中的子像素的反射部分中产生。相比而言,从面板内产生的光可以透射穿过滤光器,并且其颜色可以在同一子像素的透射部分中产生。通常,由子像素的反射部分产生的颜色可以是不饱和颜色,而由子像素的透射部分产生的颜色可以是完全饱和颜色。在低环境光条件下,所产生的颜色可以是具有良好光学特性的颜色。然而,在明亮的环境光条件下,来自子像素的反射部分的不饱和颜色占主导,并且因此减少了所产生的颜色的光学特性。

[0003] 在美国专利号7,636,076中,附加无色子像素(被称为子像素M)用于增加明亮的环境光条件下所产生的颜色的光学特性。在美国专利号7,760,297中,附加子像素也用于增加明亮的环境光条件下所产生的颜色的光学特性。在此,附加子像素具有补充原色滤色器的滤色器。例如,附加子像素可能具有青色滤色器。

发明内容

[0004] 根据本发明的一个实施例,一种具有可控背光的半透反射式液晶显示面板的像素,所述像素包括子像素阵列和颜色基板,所述颜色基板具有与所述子像素阵列相对应的颜色阵列,所述颜色阵列包括透射颜色和反射颜色。所述颜色基板在所述可控背光发射第一预定光水平时透射与所述颜色阵列中的所述透射颜色相对应的至少一种波长的光,并且在所述可控背光发射第二预定光水平时从所述颜色基板中的基本上相同区域反射与所述颜色阵列中的所述反射颜色相对应的至少一种波长的光。所述透射颜色可以是原色(primary color)或间色(secondary color),并且所述反射颜色可以是原色或间色。

[0005] 根据本发明的第二实施例,一种半透反射式液晶显示器,包括:面板,所述面板被分成像素阵列,每个像素被分成子像素阵列,所述面板具有顶部基板;液晶层,所述液晶层位于所述顶部基板的后面;颜色基板,所述颜色基板位于所述液晶层的后面;以及可控背光系统,所述可控背光系统位于所述颜色基板的后面。所述颜色基板包括与所述子像素阵列相对应的颜色阵列,所述颜色阵列包括透射颜色和反射颜色,所述反射颜色是所述透射颜色的互补色。所述透射颜色可以是原色或间色,并且所述反射颜色可以是原色或间色。

[0006] 在此第二实施例中,所述颜色基板在所述可控背光发射第一预定光水平时透射与所述颜色阵列中的所述透射颜色相对应的至少一种波长的光,并且在所述可控背光发射第二预定光水平时从所述颜色基板中的基本上相同区域反射与所述颜色阵列中的所述反射颜色相对应的至少一种波长的光。

[0007] 在两个实施例中,所述原色可以形成所述子像素阵列的顶行,并且所述间色可以

形成所述子像素阵列的底行。所述子像素阵列的顶行中的所述原色的顺序可以是红色、绿色和蓝色，并且所述子像素阵列的底行中的所述间色的顺序可以是品红色、青色和黄色。

[0008] 在本发明的两个实施例的替代性实施例中，所述原色中的至少一种颜色和所述间色中的至少一种颜色可以形成所述子像素阵列的顶行，并且所述原色中的至少一种颜色和所述间色中的至少一种颜色可以形成所述子像素阵列的底行。所述子像素阵列的顶行中的所述原色和所述间色的顺序可以是(1)红色、青色和蓝色或者(2)品红色、绿色和黄色；并且所述子像素阵列的底行中的所述间色的顺序可以是(1)品红色、绿色和黄色或者(2)红色、青色和蓝色。

[0009] 在本发明的两个实施例的进一步实施例中，所述显示面板可以包括光传感器，所述光传感器监测进入所述显示面板的所述环境光水平。在此实施例的各个实施例中，(1)所述第一预定光水平可以大于所述测量的环境光水平，并且所述第二预定光水平可以小于所述测量的环境光水平，或者(2)所述第一预定光水平可以基本上等于所述第二预定光水平，或者(3)所述第一预定光水平、所述第二预定光水平或这两个预定光水平可以在所述测量的环境光水平的55％到105％之间。

[0010] 在本发明的两个实施例的又进一步实施例中，当所述第一预定光水平大于所述测量的环境光水平时，所述透射颜色可以是原色，并且所述反射颜色可以是间色，或者当所述第二预定光水平小于所述测量的环境光水平时，所述透射颜色可以是间色，并且所述反射颜色可以是原色。

附图说明

[0011] 参照以下详细说明结合附图将更加容易理解本发明的前述特征，在附图中：

[0012] 图1是根据本发明的实施例的半透反射式LCD面板的示意性表示。

[0013] 图2a是根据本发明实施例的在透射光模式下的半透反射式LCD的示意性表示。

[0014] 图2b是根据本发明的实施例的在反射光模式下的半透反射式LCD的示意性表示。

[0015] 图3是根据本发明的实施例的在透射和反射光模式下的半透反射式LCD的示意性表示。

[0016] 图4是根据本发明实施例的半透反射式LCD的像素阵列的示意性表示。

[0017] 图5是图4中所示出的半透反射式LCD的像素阵列的第一实施例的示意性表示。

[0018] 图6是图4中所示出的半透反射式LCD的像素阵列的第二实施例的示意性表示。

[0019] 图7a是根据本发明实施例的在透射光模式下的像素阵列的透视图。

[0020] 图7b是根据本发明实施例的在反射光模式下的像素阵列的透视图。

具体实施方式

[0021] 图1是根据本发明实施例的半透反射式LCD面板的示意性表示。在面板100中，处理单元102控制图形处理单元104，并且处理单元102连同环境光传感器106一起控制背光108。在操作中，环境光传感器106监测进入面板100的环境光水平。如以下更加详细讨论的，当环境光水平变亮到特定水平时，环境光传感器106发信号通知处理单元102关闭背光108。在这种光模式下，颜色基板110a和110b充当反光镜，并且反射环境光。如以下更加详细讨论的，当环境光水平变暗到特定水平时，环境光传感器106发信号通知处理单元102打开背光108。

在这种光模式下，颜色基板110a和110b充当滤光器，并且透射从背光108处发射的光。

[0022] 在替代性实施例中，处理单元102可以发信号通知图形处理单元104，并且图形处理单元104可以控制背光108。或者，在另一个替代性实施例中，环境光传感器106可以向图形处理单元104(而不是处理单元102)发送其信号，并且图形处理单元104可以控制背光108。

[0023] 如本领域普通技术人员理解的，处理单元102可以是中央处理单元(“CPU”)、子处理单元或协处理单元。

[0024] 在所有光模式下，光穿过液晶层112(所述液晶层由许多液晶(未示出)组成)，并且通过扩散基板114。液晶控制反射光或透射光的强度(即，亮度)。

[0025] 图1中描述的半透反射式LCD面板进一步包括像素阵列。如图4中所示出的，是根据本发明实施例的像素阵列的示意性表示，像素阵列(表示为418)包含许多像素(表示为416)，并且每个像素包含许多子像素(表示为410)。颜色基板(例如，110a和110b)根据子像素阵列被排列。换言之，每个子像素反射其颜色基板的反射颜色，并且透射其颜色基板的透射颜色。

[0026] 如图2a和2b中所示出的，是根据本发明实施例的半透反射式LCD的示意性表示，颜色基板210a的透射颜色(表示为TC)不同于颜色基板210a的反射颜色(表示为RC)。类似地，颜色基板210b的透射颜色不同于颜色基板210b的反射颜色。例如，颜色基板210a可以透射红光，但反射青光。相比而言，颜色基板210b可以透射青光，但反射红光。在行业说法中，这种类型的颜色基板可以被称为分色滤光器、分色镜、分色滤光器/反射镜或干扰滤光器。

[0027] 颜色基板可以由已经在至少一侧上涂覆的薄透明垫片(如玻璃(例如，borofloat玻璃)或热塑弹性体(如聚碳酸酯))组成。如本领域普通技术人员理解的，垫片涂覆有一个或多个金属氧化物(如铬、硅、钛、镁、铝、锆等)薄层。通常，在高温下在真空室中对垫片涂敷涂层。涂层的取决于颜色选择和使用的光学特性可以从无反射性到部分反射性再到完全反射性。在替代性实施例中，颜色基板还可以由被染色或涂漆的玻璃、被染色或涂漆的明胶、被染色或涂漆的合成聚合物、或者被创建或转变以满足所需光学特性的任何材料组成，其中，可以选择材料的透射颜色或者可以选择材料的反射颜色。

[0028] 对于本文中所描述的半透反射式LCD面板，光学特性可以包括颜色基板，在所述颜色基板中，透射颜色是反射颜色的互补色。例如，透射红色的颜色基板可以反射青色，透射品红色的颜色基板可以反射绿色，透射蓝色的颜色基板可以反射黄色等等。

[0029] 如图3中所示出的，是根据本发明实施例的半透反射式LCD的示意性表示，当环境光水平接近从背光308发射的光的水平时，面板300在透射光模式和反射光模式两者中操作。此反射光模式源于颜色基板310a和310b的光学特性。不像具有拥有透射区域和反射区域的子像素的最常规半透反射式LCD面板，颜色基板310a和310b不具有透射区域和反射区域。而是，在某些光照条件下，颜色基板310a和310b可以同时(或基本上同时)并从基板上相同(或基本上相同)的地点充当滤光器(透射光模式)或反光镜(反射光模式)。

[0030] 在本文中所描述的半透反射式LCD面板中，当环境光水平与从背光处发射的光的水平相同或基本上相同时，此半透反射式光模式是最重要的。如本领域普通技术人员理解的，在此点处在透射光与反射光之间发生的交互适时改变所显示颜色的饱和度和/或波长。例如，当透射光是反射光的互补色时，所显示的颜色将变得较不饱和(即，接近灰度)，或者

当反射光超过透射光时，所显示的颜色将反转。

[0031] 如以上关于图1所讨论的，环境光传感器106监测环境光水平，并且经由处理单元102和/或图形处理单元104来控制背光108。控制类型可以从双态控制到可变状态控制。在双态控制中，背光108具有两种状态——打开和关闭。相比而言，在可变状态控制中，背光108可以具有两种状态——打开或部分打开——或者可以具有三种状态——打开、部分打开或关闭。

[0032] 在双态控制中，当背光108打开时(即，发射光)，来自环境光传感器106的经处理的信号将背光108关闭，并且当背光108关闭时，来自环境光传感器106的经处理的信号将背光108打开。根据面板100安装在其中的设备以及设备的使用和/或应用，环境光传感器106可以在环境光水平与从背光108处发射的光的水平相同(或在某百分比内)时发送其信号。例如，如果背光108具有照度等级100，则环境光传感器106可以在环境光的照度等级为100时、在照度等级为80(即，背光108的照度等级的80％)时、或者在照度等级为120(即，背光108的照度等级的120％)时发送其信号。

[0033] 当面板100正显示反射光(即，背光108关闭)时，环境光传感器可以发送其信号以便在环境光水平与从背光108处发射的光的“额定”水平(即，当背光108打开时的光水平)相同(或在某百分比内)时打开背光108。例如，如果背光108具有照度等级100(当打开时)，则环境光传感器106可以在环境光的照度等级为100时、在照度等级为80(即，背光108的照度等级的80％)时、或者在照度等级为120(即，背光108的照度等级的120％)时发送其信号。

[0034] 在可变状态控制中，从背光108处发射的光的水平根据LCD面板设置变化，所述LCD面板设置可以由制造商和/或由用户设置。这些LCD面板设置可以包括例如自动亮度设置和亮度水平设置。进而，环境光传感器106使用从背光108处发射的光的此“经计算的”水平来控制背光108。在与双态控制类似的方式中，环境光传感器106可以在环境光水平与从背光108处发射的光的“经计算的”水平相同(或在某百分比内)时发送其信号。

[0035] 在替代性实施例中，面板100的光反射比水平可以在计算中被用来控制背光108。例如，在双态控制或可变状态控制中，光反射比水平可以修改环境光水平，在所述环境光水平处，环境光传感器106发送其信号以便控制背光108。

[0036] 在双态控制或可变状态控制中，控制背光108的过程可以由处理单元102或图形处理单元104执行。在本发明的替代性实施例中，所述过程可以由环境光传感器106执行。如以上所指出的，处理单元102可以是中央处理单元(“CPU”)、子处理单元或协处理单元。

[0037] 如以上关于图1至图4所讨论的，本文中所描述的半透反射式LCD面板包括像素阵列。如图5中所示出的，是像素阵列的实施例的示意性表示，像素阵列(由518表示)包含许多像素(由516表示)，所述许多像素中的每个像素包含在三列和两行中对齐的六个子像素组成的阵列(由510表示)。子像素的相应颜色基板是原色(红色、绿色、蓝色)和间色(青色、品红色、黄色)。在针对像素516的这个实施例中，原色子像素形成子像素阵列的顶行，并且间色子像素形成子像素阵列的底行。在针对像素516的替代性实施例中，间色子像素形成子像素阵列的顶行，并且原色子像素形成子像素阵列的底行。

[0038] 在图6中，是像素阵列的替代性实施例的示意性表示，像素阵列(由618表示)包含许多像素(由616a和616b表示)，所述许多像素中的每个像素包含在三列和两行中对齐的六个子像素组成的阵列(由610表示)。在像素616a中，子像素阵列的顶行由毗邻一个间色子像

素的两个原色子像素形成，并且子像素阵列的底行由毗邻一个原色子像素的两个间色子像素形成。相比而言，在像素616b中，子像素阵列的顶行由毗邻一个原色子像素的两个间色子像素形成，并且子像素阵列的底行由毗邻一个间色子像素的两个原色子像素形成。在针对像素阵列618的这个实施例中，像素616a形成像素阵列618的奇数列，并且像素616b形成像素阵列618的偶数列。在针对像素阵列618的替代性实施例中，像素616a形成像素阵列618的奇数列，并且像素616b形成像素阵列618的偶数列。

[0039] 图7a示出了图6中所描述的像素阵列在透射光模式下的透视图。在此实施例中，背光708打开(即，其正发射光)，并且透射的颜色从原色子像素710a、710c和710e(其分别透射红色、蓝色和绿色)中生成。在进一步实施例中，也可以使用间色子像素710b、710d和710f(其分别透射品红色、青色和黄色)，并且因此产生更明亮更饱和的颜色。

[0040] 图7b示出了图6中所描述的像素阵列在反射光模式下的透视图。在此实施例中，背光708关闭(即，其不发射光)，并且反射的颜色从间色子像素710b、710d和710f(其分别反射绿色、红色和蓝色)中生成。在进一步实施例中，也可以使用原色子像素710a、710c和710e(其分别反射青色、品红色和黄色)，并且因此产生更明亮更饱和的颜色。

[0041] 本文中所描述的像素阵列可能需要经由六色信号(而不是标准的三色信号)控制。如本领域普通技术人员理解的，由图形处理单元输出的标准三色信号可以很容易转换成六色信号，或者图形处理单元可以很容易被转换用于输出六色信号。

[0042] 尽管已经公开了本发明的各个示例性实施例，但是对本领域的技术人员应当明显的是，在不脱离本发明真实范围的情况下，可以进行将实现本发明的一些优点的各种改变和修改。所附权利要求书旨在覆盖这些或其他明显的修改。

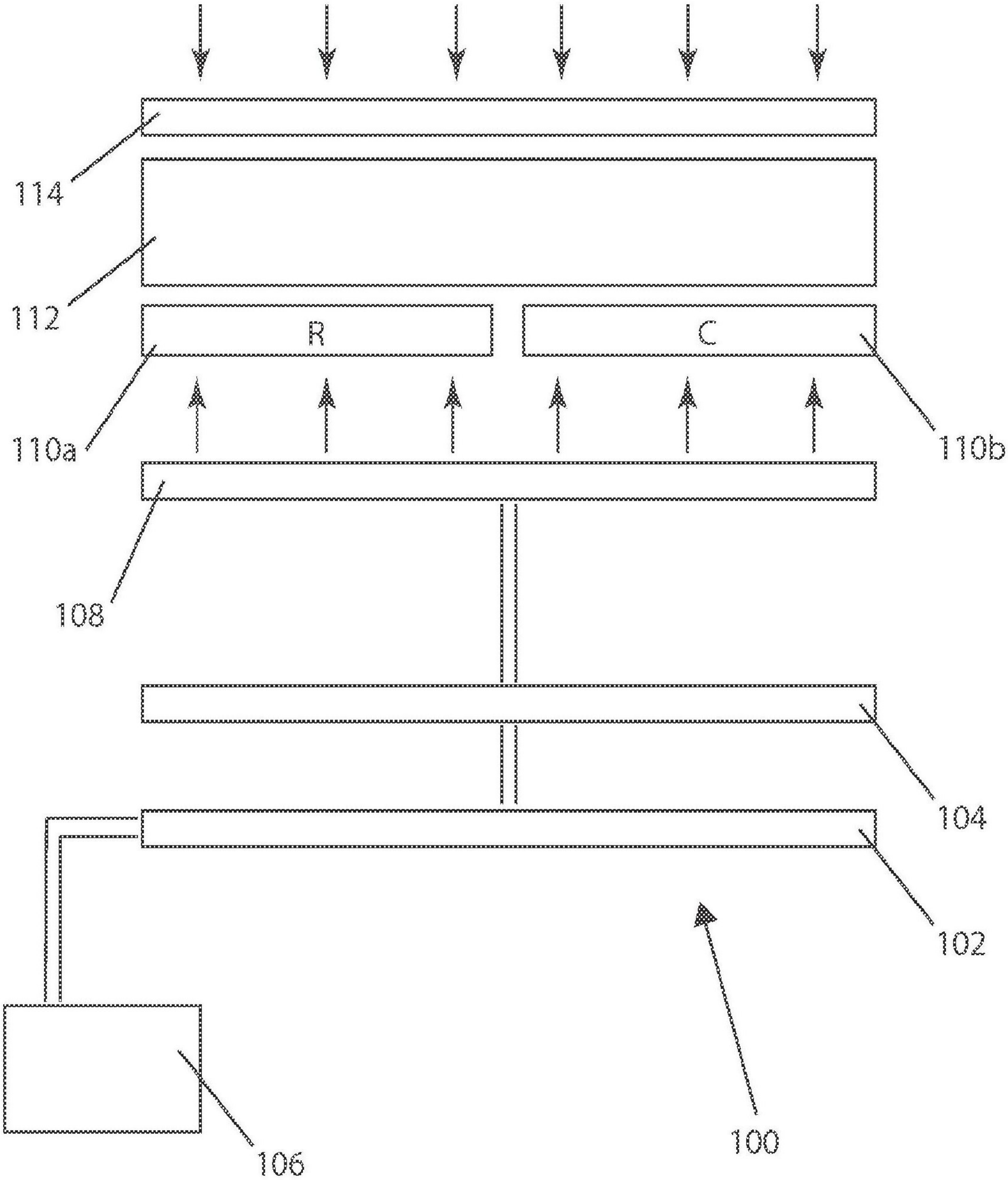

图1

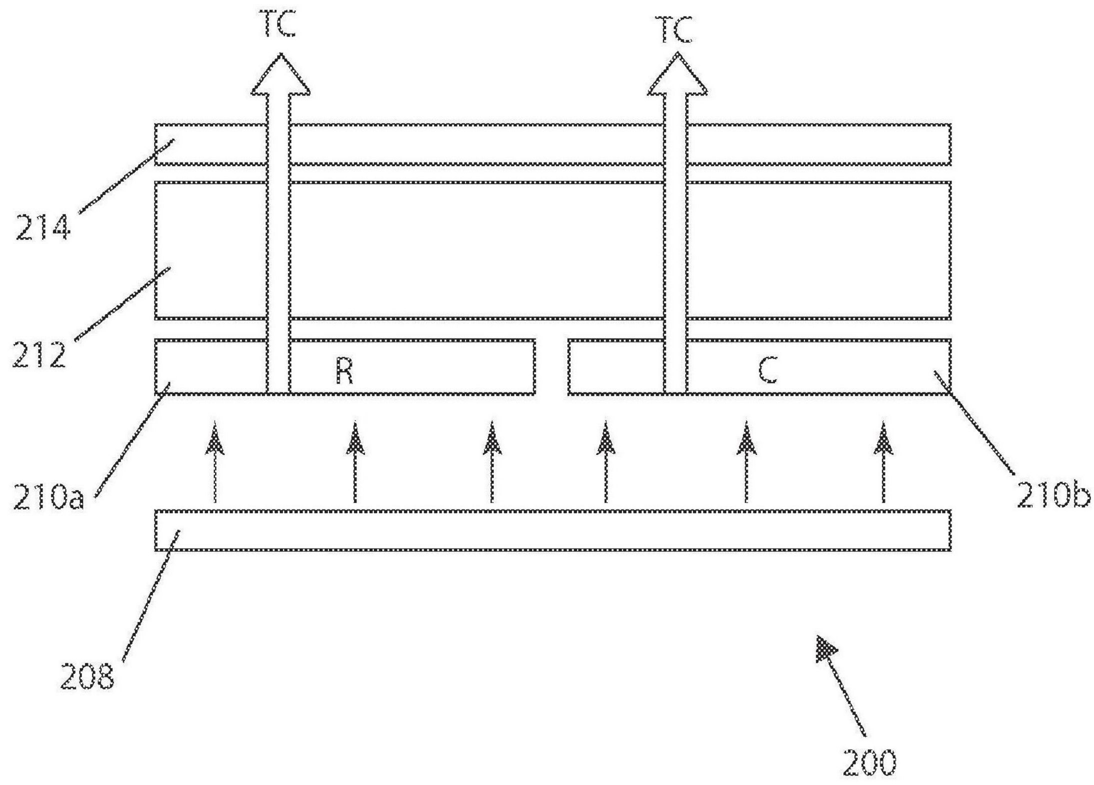
TC
TC
214
212
R
C
210a
210b
208
200

图2a

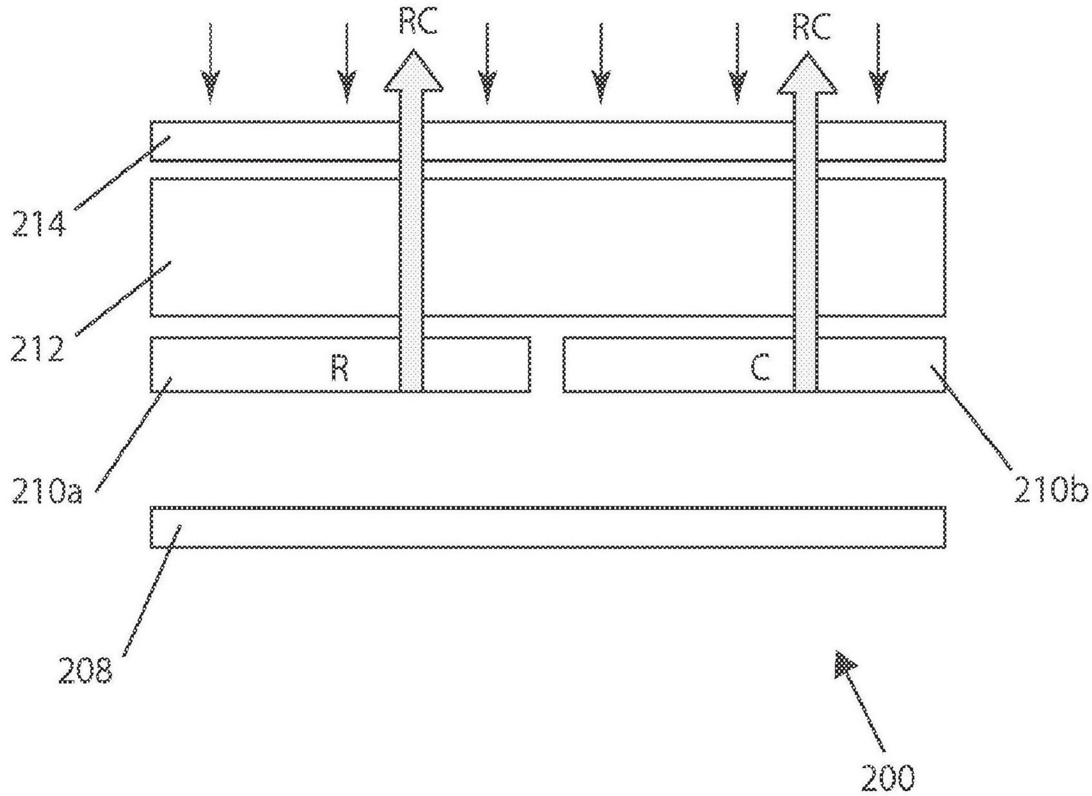
RC
RC
214
212
R
C
210a
210b
208
200

图2b

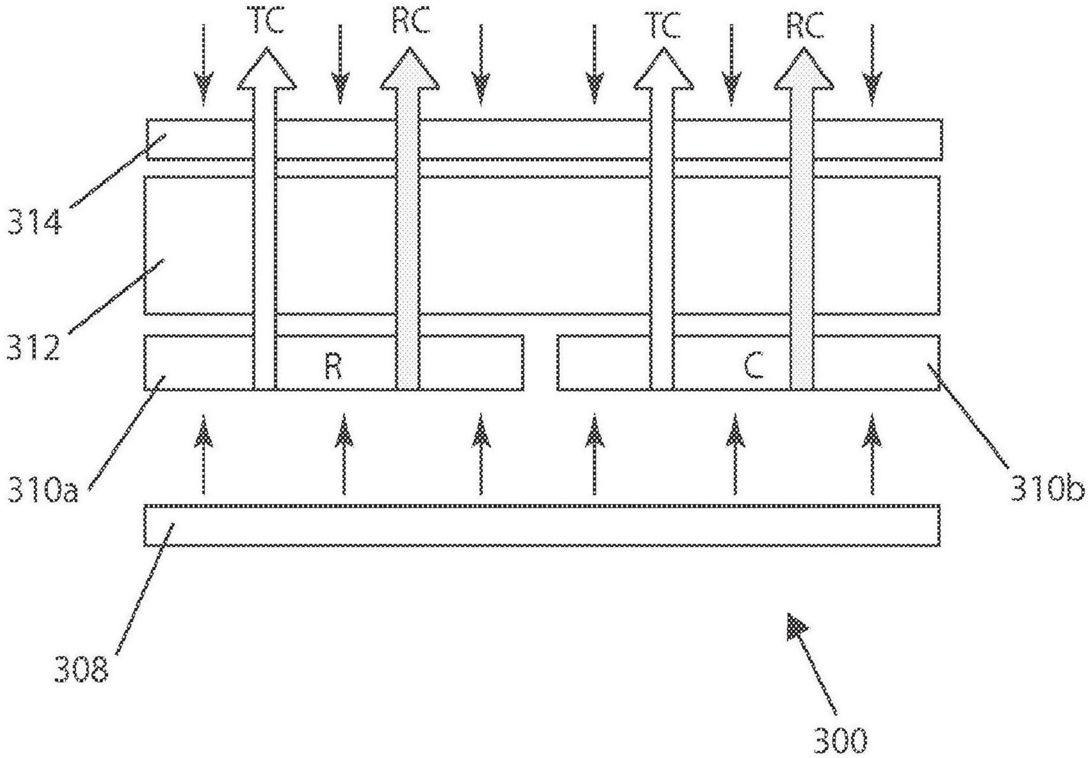

图3

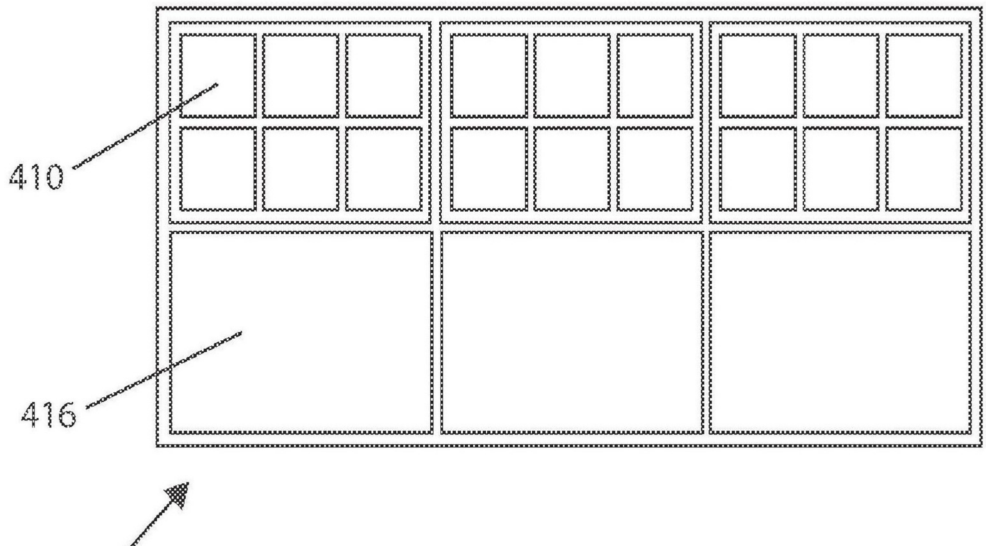

图4

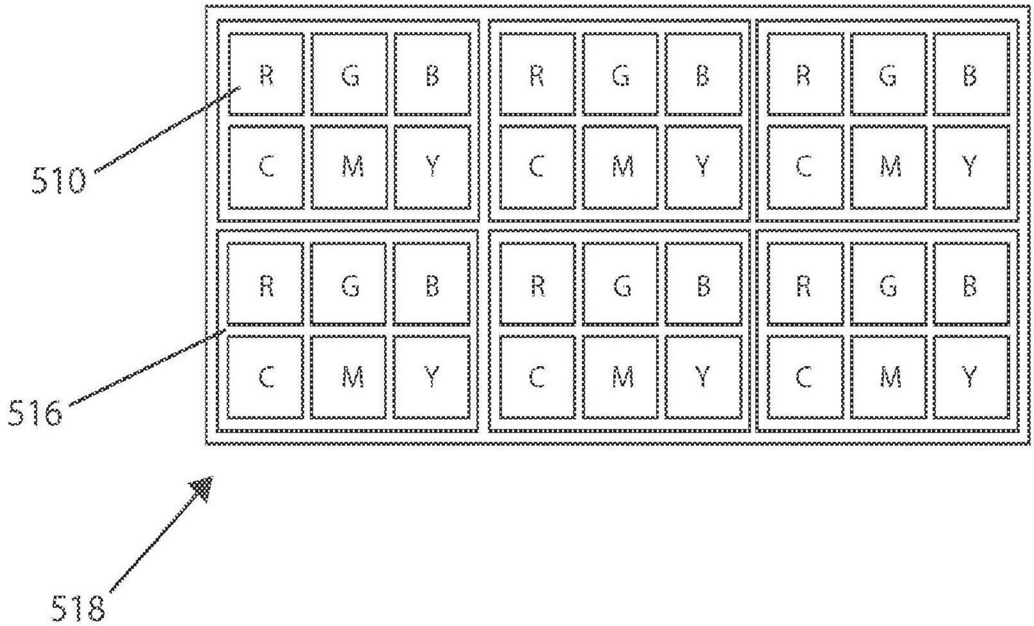

图5

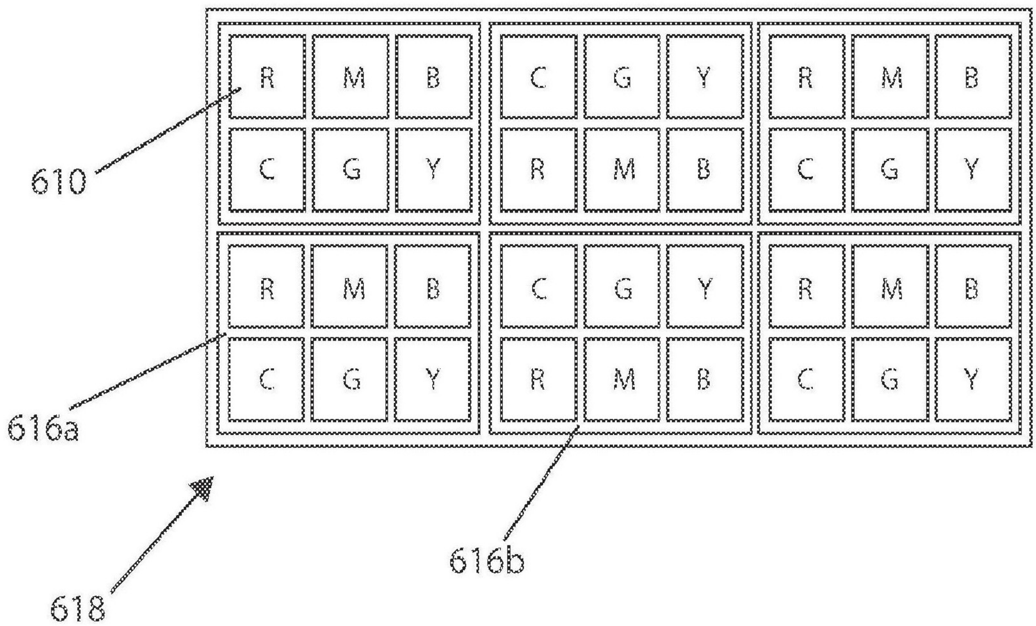

图6

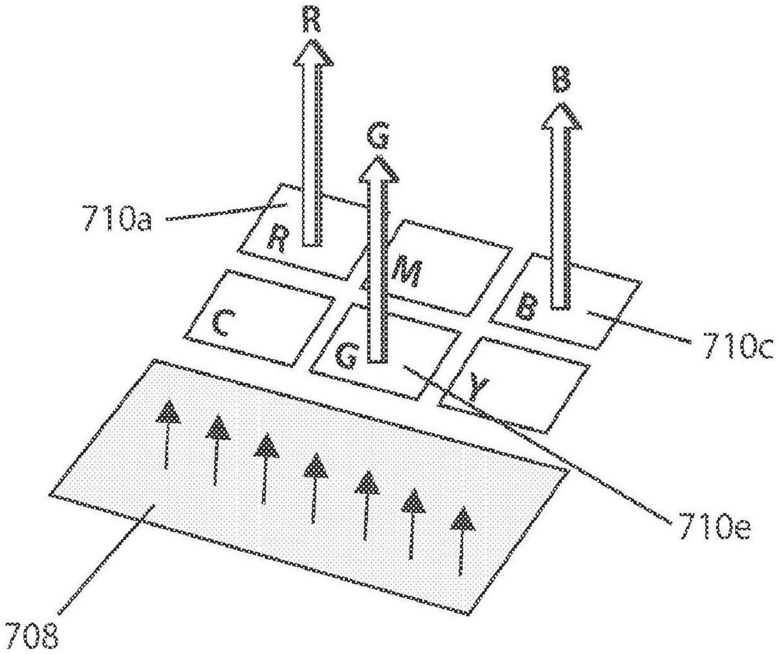

图7a

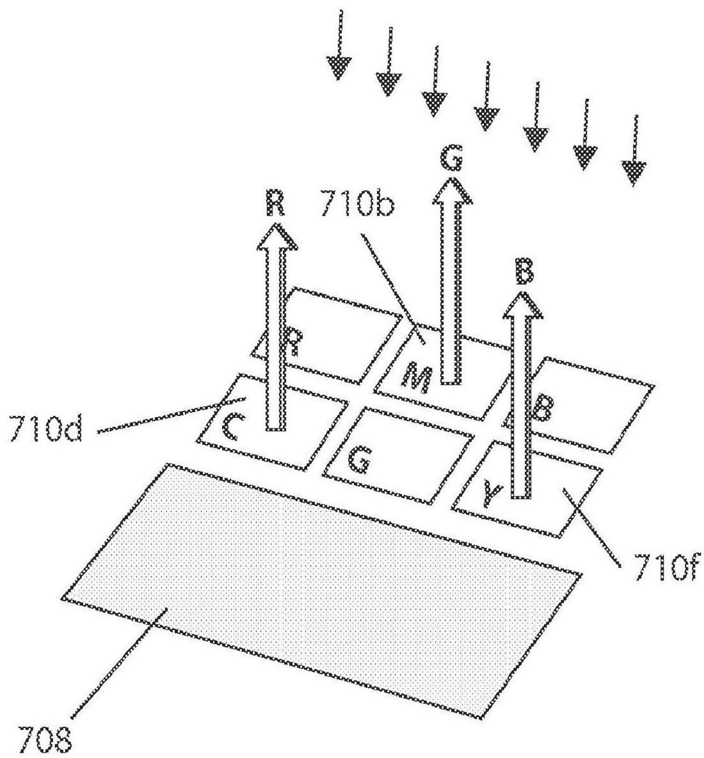

图7b