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(54) TRANSFLECTIVE LIQUID CRYSTAL DISPLAY DEVICE WITH BALANCED CHROMATICITY

(75) Inventors: **Wei-Chih Chang**, Jubei City (TW); **Li-Sen Chuang**, Penghu Hsien (TW); **Dai-Liang Ting**, Hsinchu City (TW)

Correspondence Address:
LIU & LIU
444 S. FLOWER STREET, SUITE 1750
LOS ANGELES, CA 90071 (US)

(73) Assignee: **Toppoly Optoelectronics Corp.**

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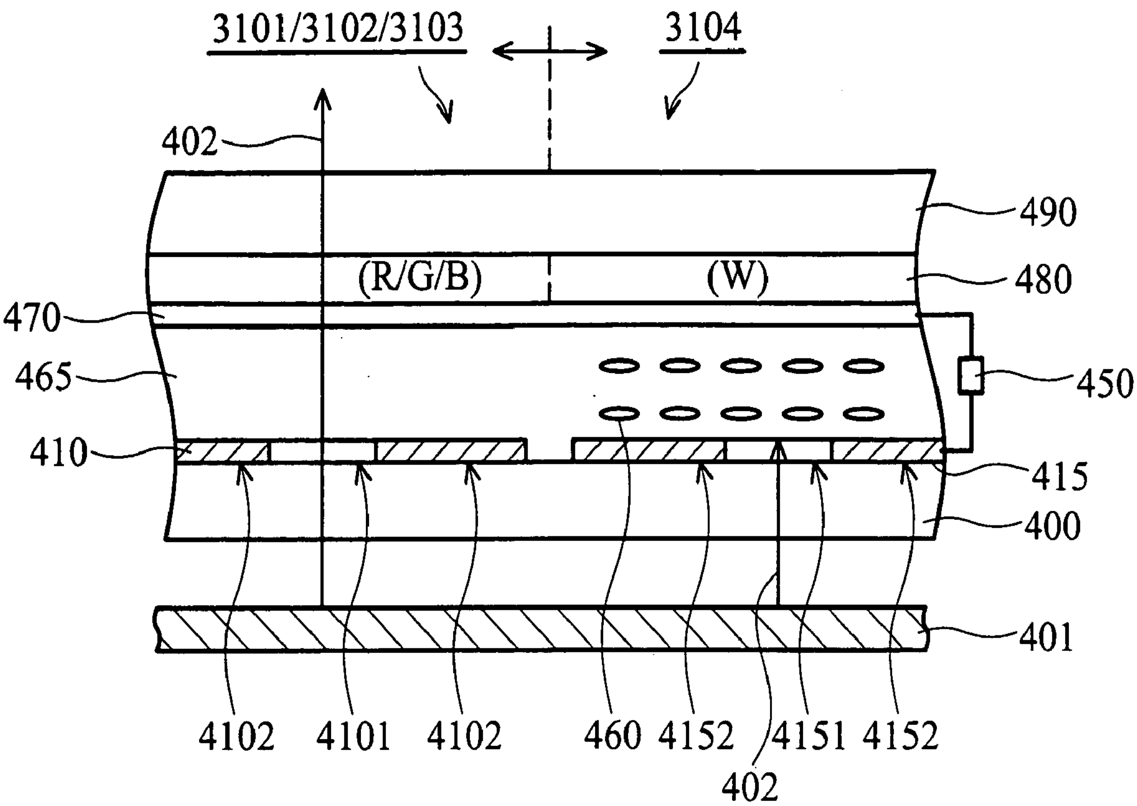
(57) **ABSTRACT**

A four color transflective liquid crystal display device is disclosed. Each main pixel area includes three primary color sub-pixel areas and a white sub-pixel area. Each primary color sub-pixel area includes a first transmissive portion and a first reflective portion. The white sub-pixel area includes a second reflective portion and a second transmissive portion. The second reflection reflects a substantively white light to raise display brightness in the reflective mode. Thus, the chromaticity of the reflective mode approaches that of the transmissive mode.



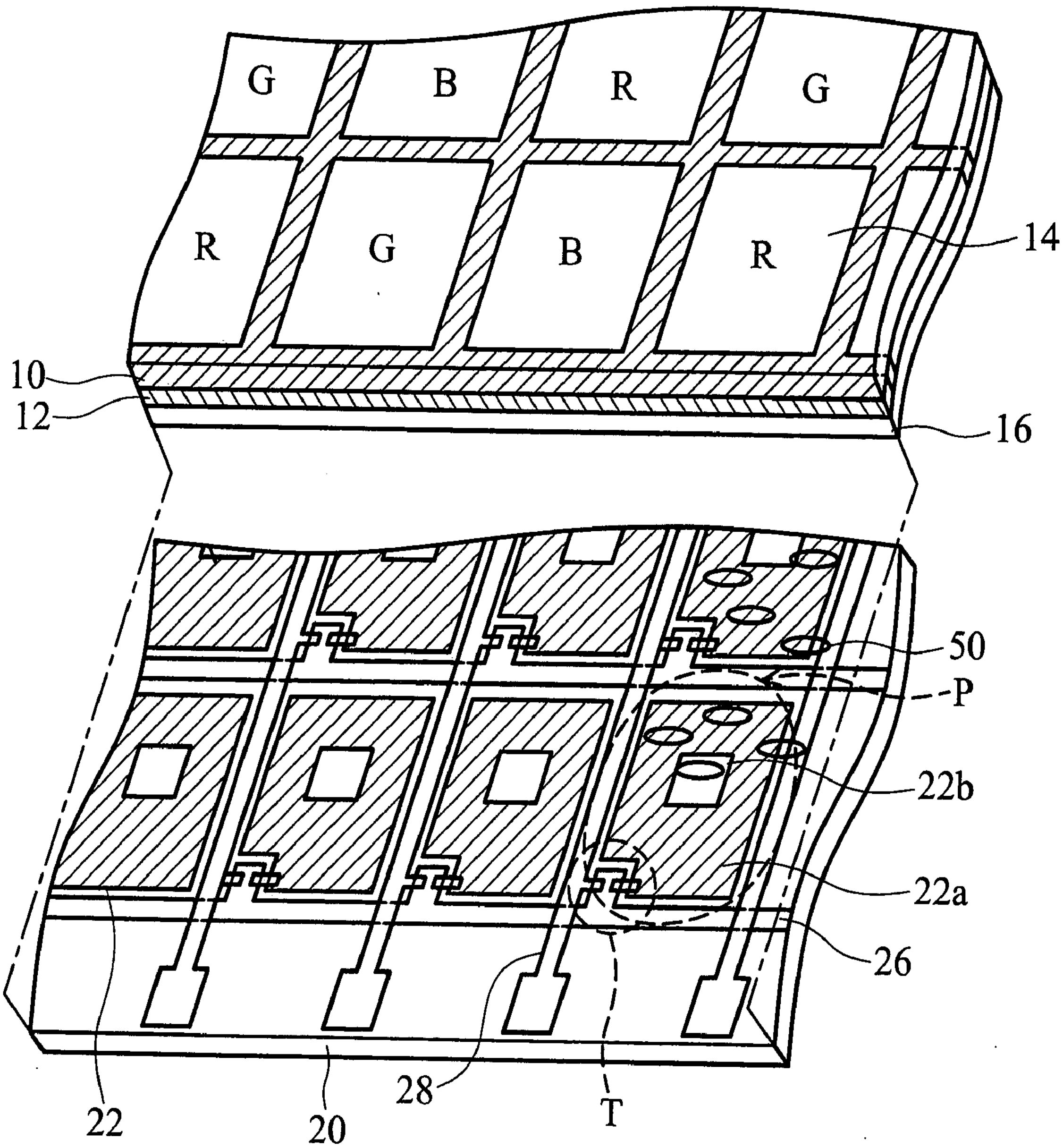


FIG. 1 (RELATED ART)

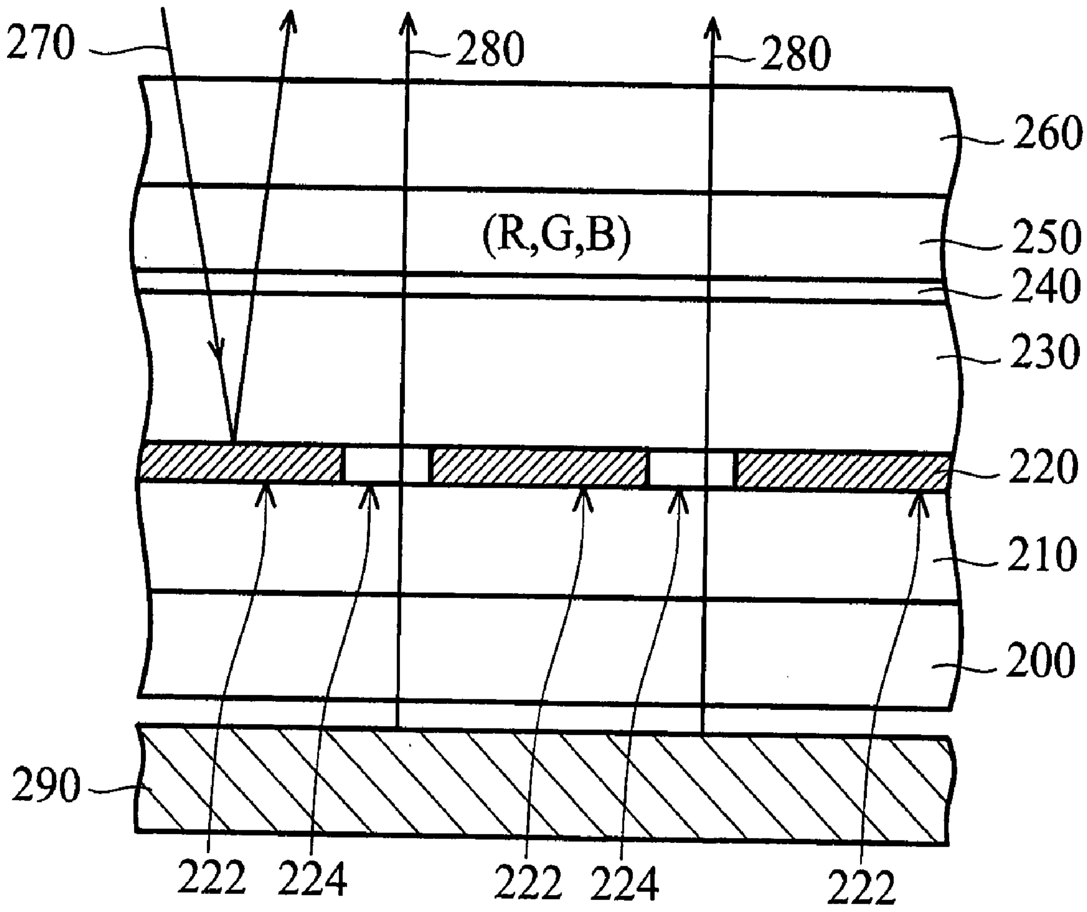


FIG. 2 (RELATED ART)

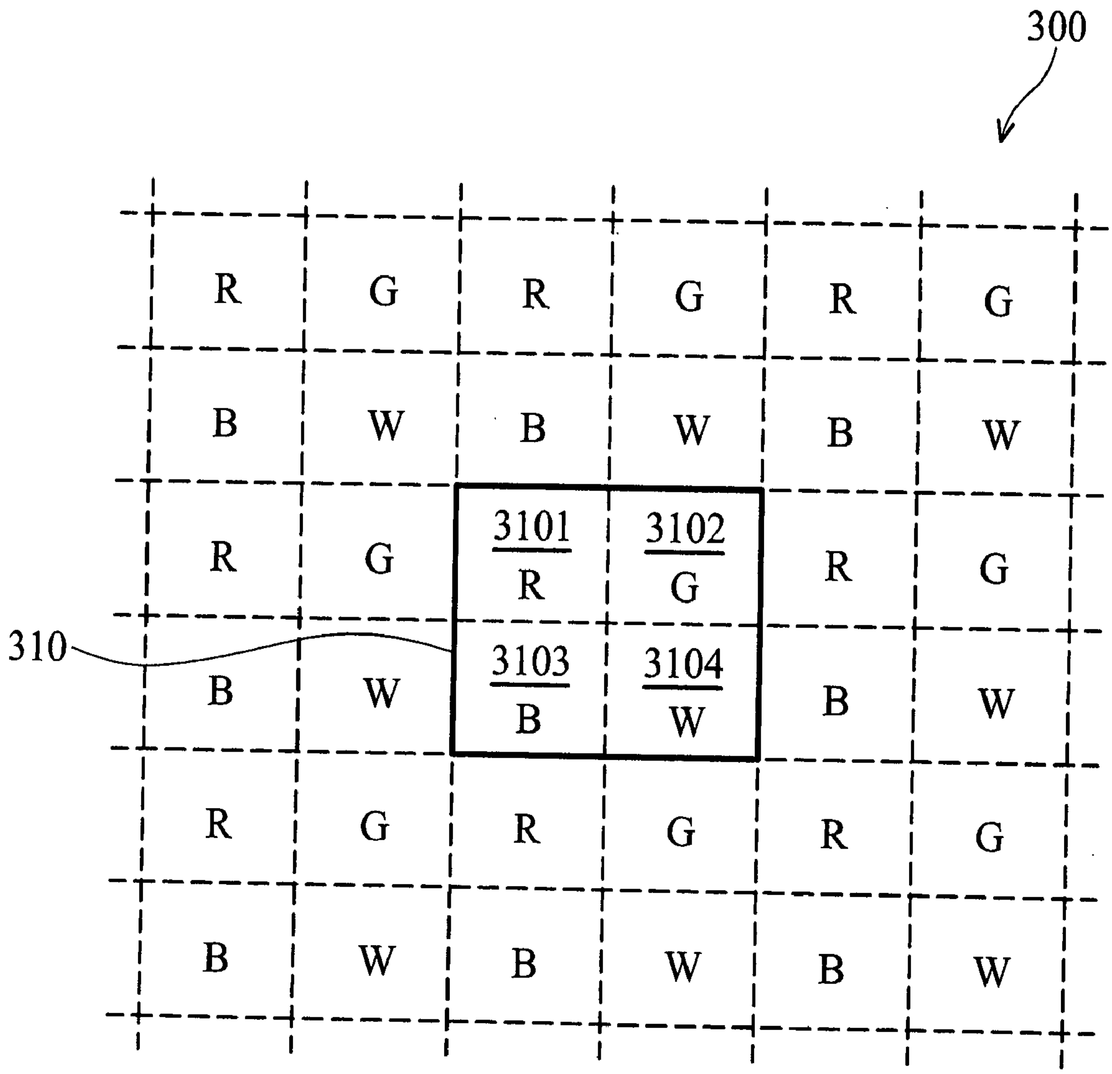

300
R
G
R
G
R
G
B
W
B
W
B
W
R
G
3101
R
3102
G
R
G
310
B
W
3103
B
3104
W
B
W
R
G
R
G
R
G
B
W
B
W
B
W

FIG. 3

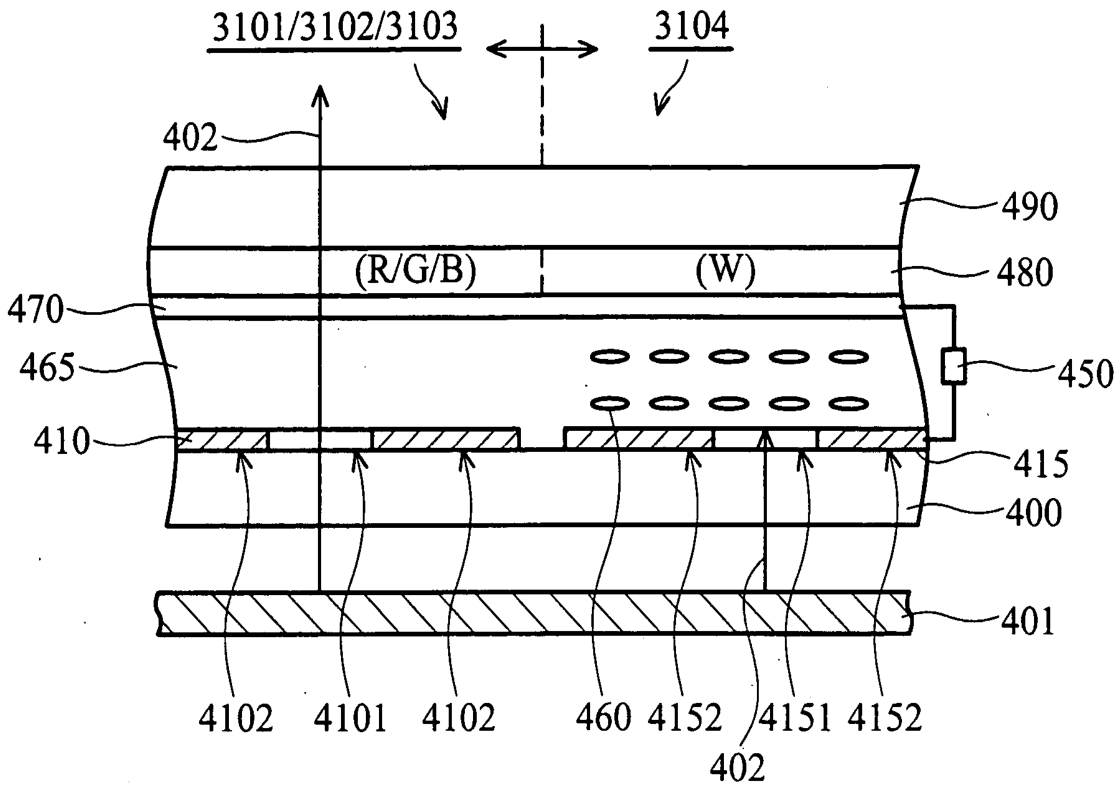

3101/3102/3103
3104
402
490
(R/G/B)
(W)
480
470
465
450
410
415
400
401
4102
4101
4102
460
4152
4151
4152
402

FIG. 4A

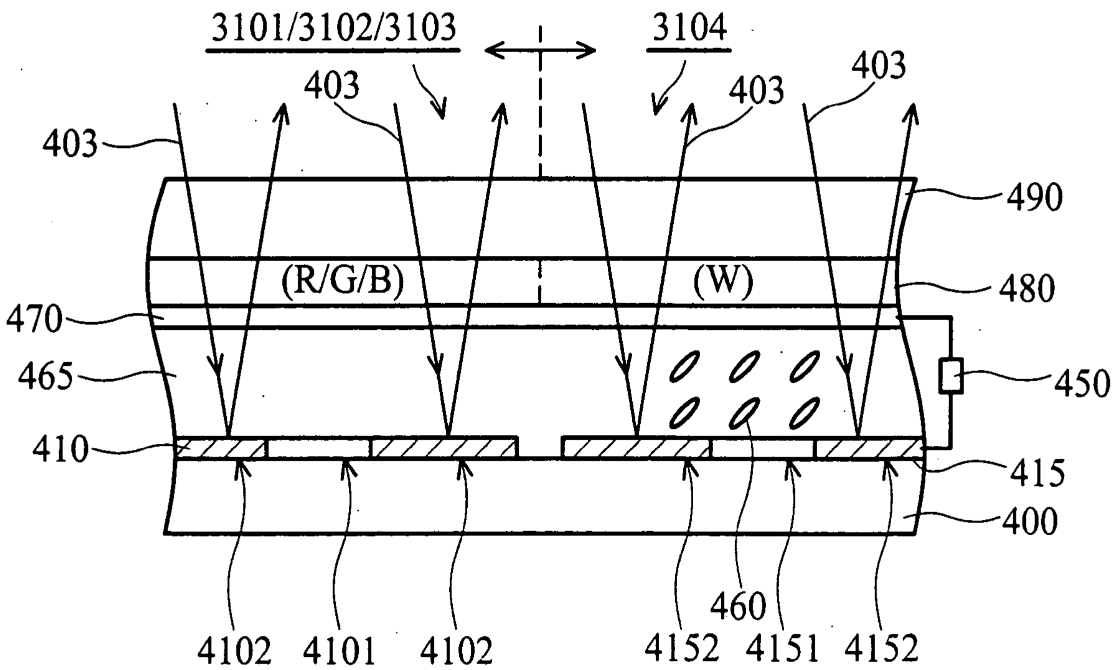

3101/3102/3103
3104
403
403
403
403
490
(R/G/B)
(W)
480
470
465
450
410
415
400
460
4102
4101
4102
4152
4151
4152

FIG. 4B

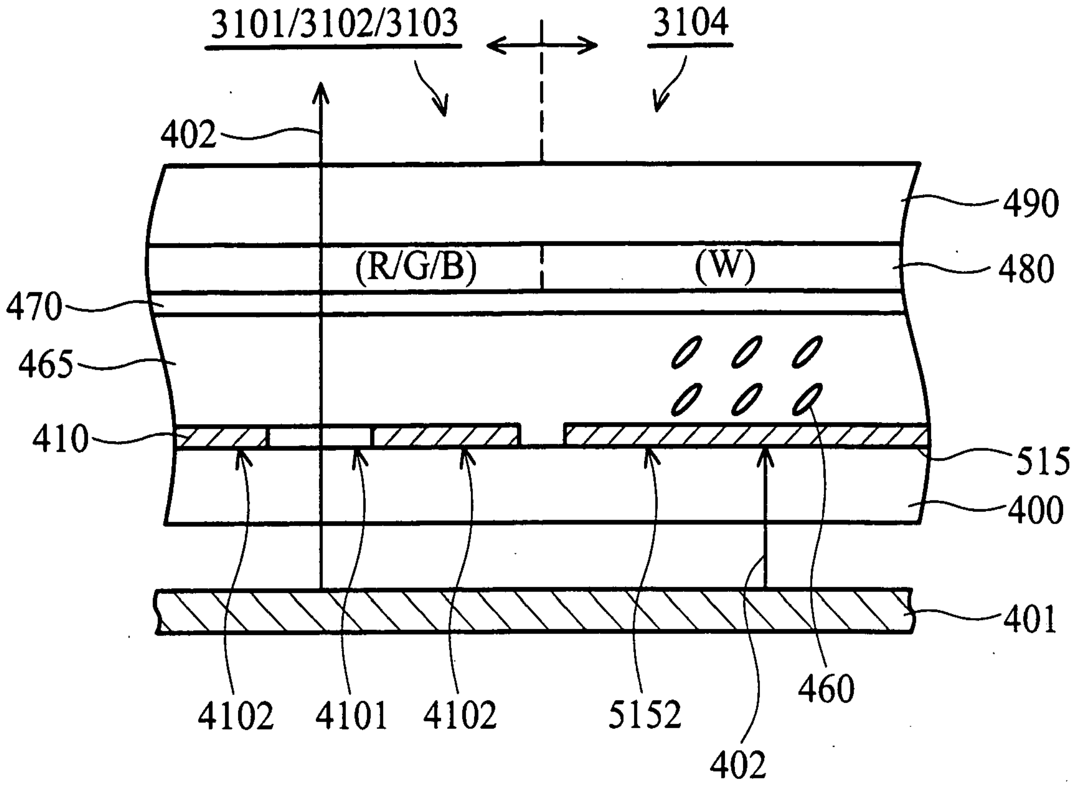

3101/3102/3103
3104
402
490
(R/G/B)
(W)
480
470
465
410
515
400
401
4102
4101
4102
5152
460
402

FIG. 5A

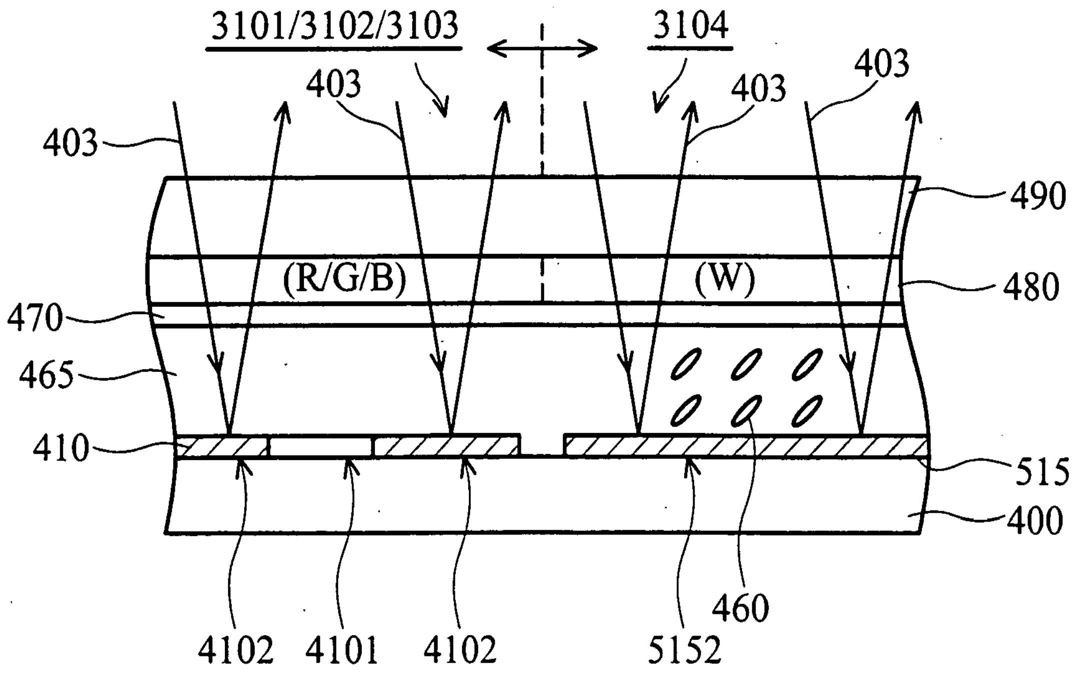

3101/3102/3103
3104
403
403
403
403
490
(R/G/B)
(W)
480
470
465
410
515
400
4102
4101
4102
5152
460

FIG. 5B

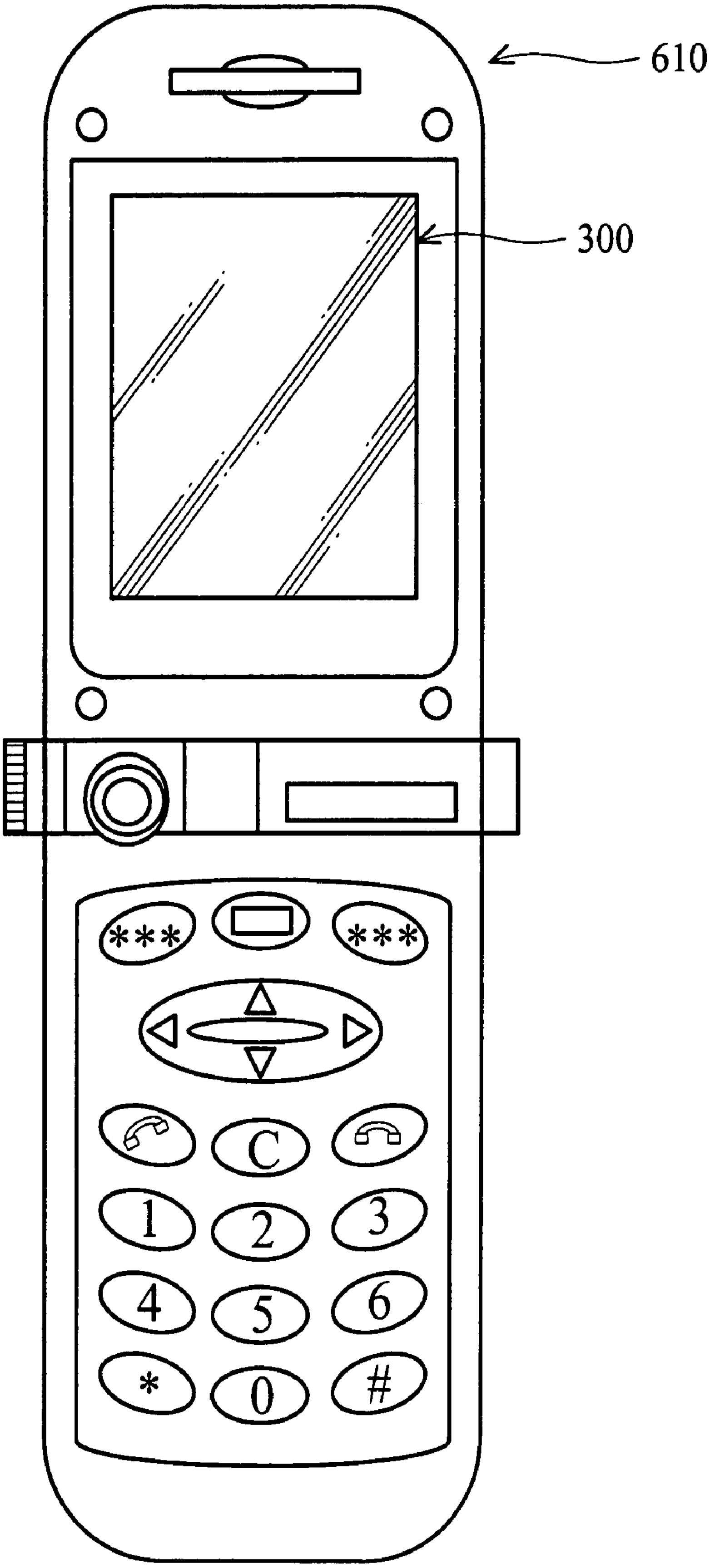


FIG. 6

TRANSFLECTIVE LIQUID CRYSTAL DISPLAY DEVICE WITH BALANCED CHROMATICITY

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a transflective liquid crystal display device, and more particularly, to a transflective liquid crystal display device with balanced chromaticity in both transmissive and reflective modes.

[0003] 2. Description of the Related Art Liquid crystal display (LCD) devices are widely used as displays in electronic devices such as portable computers, PDAs and cell phones. Liquid crystal display devices are classified into two types. One is transmissive type, and the other is reflective type. The former utilizes a backlight as the light source and the latter utilizes ambient light. It is difficult to decrease the power consumption for the transmissive LCD due to the power requirements of the backlight. As for the reflective LCD, it has the advantage of lower power consumption under bright ambient light, but is hindered by environments with less ambient light.

[0004] In order to overcome the drawbacks of these two types of LCDs, a transflective LCD is disclosed. Transflective LCDs are capable of displaying images in both transmissive and reflective modes. Under bright ambient light, the backlight can be turned off, so the power consumption of the transflective LCD is lower than that of the transmissive LCD. Additionally, when less ambient light is available, the backlight can be turned on, so the image quality of the transflective LCD is better than that of the reflective LCD.

[0005] **FIG. 1** is an exploded perspective view illustrating a typical transflective LCD device. The transflective LCD device includes an upper substrate **10** and a lower substrate **20** with a liquid crystal layer **50** interposed therebetween. The upper substrate **10** is a color filter substrate and the lower substrate **20** is an array substrate. In the upper substrate **10**, on a surface opposing the lower substrate **20**, a black matrix **12** and a color filter layer **14** including a plurality of red (R), green (G) and blue (B) color filters are formed. That is, the black matrix **12** surrounds each color filter, in the shape of an array matrix. Further on the upper substrate **10**, a common electrode **16** is formed to cover the color filter layer **14** and the black matrix **12**.

[0006] In the lower substrate **20**, on a surface opposing the upper substrate **10**, a TFT "T" serving as a switching device is formed in shape of an array matrix corresponding to the color filter layer **14**. In addition, a plurality of crossing gate and data lines **26** and **28** are positioned such that each TFT is located near each cross point of the gate and data lines **26** and **28**. Further on the lower substrate **20**, a plurality of pixel regions (P) are defined by the gate and data lines **26** and **28**. Each pixel region P has a pixel electrode **22** comprising a transparent portion **22**a and an opaque portion **22**b. The transparent portion **22**a comprises a transparent conductive material, such as ITO (indium tin oxide) or IZO (indium zinc oxide), and the opaque portion **22**b comprises a metal having high reflectivity, such as Al (aluminum).

[0007] **FIG. 2** is a sectional view of a conventional transflective LCD device, which helps to illustrate the operation of such device. As shown in **FIG. 2**, the conventional transflective LCD device includes a lower substrate **200**, an upper substrate **260** and a liquid crystal layer **230** interposed therebetween. The upper substrate **260** has a common electrode **240** and a color filter **250** formed thereon. The color filter **250** includes red (R), green (G) and blue (B) regions. The lower substrate **200** has an insulating layer **210** and a pixel electrode **220** formed thereon, wherein the pixel electrode **220** has an opaque portion **222** and a transparent portion **224**. The opaque portion **222** of the pixel electrode **220** can be an aluminum layer, and the transparent portion **224** of the pixel electrode **220** can be an ITO (indium tin oxide) layer. The opaque portion **222** reflects ambient light **270**, while the transparent portion **224** transmits light **280** from a backlight device **290** disposed at the exterior side of the lower substrate **200**. The liquid crystal layer **230** is interposed between the lower and upper substrates **200** and **260**. Therefore, the transflective LCD device is capable of display in both reflective and transmissive modes.

[0008] Referring to **FIG. 2**, the backlight **280** penetrates the transmissive portion **224** and passes through the color filter **250** once, and the ambient light **270** is reflected by the reflective portion **222** and passes through the color filter **250** twice. This leads to different chromaticity in the reflective and transmissive regions, decreasing display quality.

[0009] U.S. Pat. No. 5,233,385 discloses a method for increasing the brightness of a scene in a color projection. This method uses a white light to raise the brightness in both temporal and spatial filtering systems.

[0010] U.S. Pat. No. 5,929,843 discloses a method and apparatus for processing image data comprising the steps of extracting white component data from input R, G, B data, suppressing the white component data in accordance with a non-linear characteristic, generating R, G, B, W display data and driving a liquid crystal display panel having R, G, B, W filters in accordance with R, G, B, W data in order to display a full color image.

[0011] U.S. Publication No. 2004/0046725 discloses a four color liquid crystal display including R,-G., B and W pixels, for improving optical efficiency.

[0012] None of the above cited references are directed to transflective LCD displays.

SUMMARY OF THE INVENTION

[0013] The present invention is directed to a novel transflective LCD structure configured to reduce the difference in chromaticity between the transmissive mode and the reflective mode by providing a substantively white light in the reflective mode. In one aspect of the present invention, a novel structure is disclosed wherein the pixel area comprises a white sub-pixel area providing a white light in the reflective mode, compared to the transmissive mode. In another aspect of the present invention, a method for normalizing chromaticity between transmissive and reflective modes of a transflective LCD device is disclosed. The structure and method of the present invention comprises the provision of a white sub-pixel area that supports a white light to raise brightness in the reflective mode, compared to the transmissive mode.

[0014] In one embodiment, a transflective LCD device having a plurality of main pixel areas is provided, wherein each main pixel area comprises three primary sub-pixels and a white sub-pixel. Each sub-pixel comprises a transmissive portion and a reflective portion and corresponds to a color filter. The color filter comprises three primary color regions and a white region, wherein the primary sub-pixels correspond to the primary color regions and the white sub-pixel corresponds to the white region. The white region may have no color layer or have a transparent resist layer. When the transflective LCD device is operated in a transmissive mode, the white sub-pixel is driven to not emit light. Conversely, when the transflective LCD device is operated in a reflective mode, the white sub-pixel area is driven to emit light. That is, the white sub-pixel only provides the white light in the reflective mode, thereby normalizing chromaticity between transmissive and reflective modes.

[0015] In another embodiment, a transflective LCD device comprising a plurality of main pixel areas is provided, wherein each main pixel area comprises three primary sub-pixels and a white sub-pixel and a color filter corresponding to the sub-pixels. Each primary sub-pixel comprises a transmissive portion and a reflective portion and the white sub-pixel is a reflective pixel. The color filter comprises three primary color regions and a white region, wherein the primary sub-pixels correspond to the primary color regions and the white sub-pixel corresponds to the white region. The white region may have no color layer or have a transparent resist layer. When the transflective LCD device is operated in a transmissive mode, there is no light transmitted through the white sub-pixel. Conversely, when the transflective LCD device is operated in a reflective mode, the white sub-pixel reflects ambient light to display white light, thereby normalizing chromaticity between transmissive and reflective modes.

[0016] The present invention improves the chromaticity of the conventional transflective LCD devices by introducing a white sub-pixel to provide white light in the reflective mode. The white sub-pixel comprises a reflective portion reflecting the white light when in the reflective mode. Thus, the chromaticity of the reflective mode approaches that of transmissive mode, improving display quality.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The invention can be more fully understood by reading the subsequent detailed description in conjunction with the examples and references made to the accompanying drawings, wherein:

[0018] **FIG. 1** is an exploded perspective view illustrating a typical transflective LCD device;

[0019] **FIG. 2** is a sectional view illustrating the operation of a conventional transflective LCD. device;

[0020] **FIG. 3** illustrates a part of a transflective LCD device according to the present invention, showing a main pixel area consisting of three primary color sub-pixel areas and a white sub-pixel area;

[0021] **FIG. 4A** is a sectional view of a transflective LCD device according to a first embodiment of the present invention, illustrating the operation thereof in a transmissive mode;

[0022] **FIG. 4B** is a sectional view of a transflective LCD device according to a first embodiment of the present invention, illustrating the operation thereof in a reflective mode;

[0023] **FIG. 5A** is a sectional view of a transflective LCD device according to a second embodiment of the present invention, illustrating the operation thereof in a transmissive mode;

[0024] **FIG. 5B** is a sectional view of a transflective LCD device according to a second embodiment of the present invention, illustrating the operation thereof in a reflective mode; and

[0025] **FIG. 6** is a schematic diagram of an electronic device incorporating a transflective LCD device of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0026] Reference will now be made in detail to preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or like parts.

[0027] **FIG. 3** illustrates a portion of a transflective LCD device **300** according to one embodiment of the present invention. The transflective LCD device **300** comprises a plurality of main pixel areas **310**, wherein each main pixel area **310** consists of at least one color sub-pixel area (three primary color sub-pixel areas **3101**, **3102** and **3103** are represented hereinafter) and a white sub-pixel area **3104**. In **FIG. 3**, numeral"**3101**" represents a red (R) sub-pixel area, numeral "**3102**" represents a green (G) sub-pixel area and numeral "**3103**" represents a blue (B) sub-pixel area. The arrangement of the sub-pixel areas **3101**, **3102**, **3103** and **3104** is a chessboard type shown in **FIG. 3**, but is not intended to limit the present invention. That is, the arrangement of the sub-pixel areas **3101**, **3102**, **3103** and **3104** can be a stripe type, a mosaic type, a delta type or others.

FIRST EMBODIMENT

[0028] **FIG. 4A** is a sectional view schematically showing one main pixel area **310** of the transflective LCD device **300** according to the first embodiment of the present invention and illustrating the operation thereof in a transmissive mode. **FIG. 4B** illustrates the operation of the transflective LCD device **300** according to the first embodiment in a reflective mode. The main pixel area **310** comprises red, green and blue sub-pixel areas **3101**, **3102** and **3103** and a white sub-pixel area **3104**. For simplicity, the three primary color sub-pixel areas **3101**, **3102**, and **3103** and a white sub-pixel area **3104** are respectively shown in **FIGS. 4A and 4B**.

[0029] A first substrate **400**, serving as a lower substrate, can be a glass substrate including an array of pixel driving elements (not shown), such as an array of thin film transistors (TFTs). A backlight device **401** is disposed at the outer side (i.e. the backside) of the first substrate **400**. Three primary sub-pixel electrodes **410** and an additional sub-pixel electrode **415** are formed on the first substrate **400**, wherein each primary sub-pixel electrode **410** is located in each primary color sub-pixel area **3101**/**3102**/**3103** and the additional sub-pixel electrode **415** is located in the white sub-pixel area **3104**. Note that a representative primary sub-pixel electrode **410** is shown in **FIGS. 4A and 4B**. Each primary sub-pixel electrode **410** comprises a first transmissive portion **4101** and a first reflective portion **4102**. The additional sub-pixel electrode **415** comprises a second transmissive portion **4151** and a second reflective portion **4152**. The first and second transmissive portions **4101** and **4151** can be transparent conductive material such as ITO (indium tin oxide) or IZO (indium zinc oxide). The first and second reflective portions **4102** and **4152** can be opaque and reflective material such as aluminum, aluminum alloy or silver.

[0030] A second substrate **490**, such as glass, opposite the first substrate **400** is provided. The second substrate **490** serves as an upper substrate. A color filter **480** is formed on the inner side of the second substrate **490**. The color filter **480** comprises three primary color regions R, G and B and a white region W. The white region W may have no color layer or have a transparent resist layer. Note that a representative primary color region R/G/B is shown in **FIGS. 4A and 4B**. Each primary sub-pixel electrode **410** corresponds to each primary color region R/G/B. The additional sub-pixel electrode **415** corresponds to the white region W.

[0031] A common electrode **470** is then formed on an inner side of the second substrate **490**. The common electrode **470** may be an ITO or IZO layer. In **FIGS. 4A and 4B**, liquid crystal molecules **460** fill a space between the first substrate **400** and the second substrate **490** to form a liquid crystal layer **465**. The liquid crystal orientation of the liquid crystal layer **465** is controlled by an electric field generating electrodes such as sub-pixel electrodes **410** and **415** and the common electrode **470**. In this embodiment, the additional sub-pixel electrode **415** and the common electrode **470** are electrically connected to a controller **450** further. The controller **450** is used to adjust the electric field intensity between the additional sub-pixel electrode **415** and the common electrode **470**, thereby controlling the liquid crystal orientation above the additional sub-pixel electrode **415**.

[0032] An operational example of this embodiment is illustrated hereinafter.

[0033] **FIG. 4A** illustrates the operation of the transflective LCD device **300** according to the first embodiment of the present invention in a transmissive mode. In **FIG. 4A**, a backlight **402** from the backlight device **401** passes through the primary color regions R, G and B once. According to this embodiment, the liquid crystal orientation above the additional sub-pixel electrode **415** is controlled to emit different brightness light levels by the controller **450**. In one aspect of this embodiment, the controller **450** controls the white sub-pixel area **3104** not to emit light (i.e. the white sub-pixel area **3104** is dark), thus the color gamut is preserved in the transmissive mode. And in another aspect of this embodiment, the white sub-pixel area **3104** is allowed to emit light, so the color gamut will change with the difference brightness light.

[0034] **FIG. 4B** illustrates the operation of the transflective LCD device **300** according to the first embodiment of the present invention in a reflective mode. A reflective light **403** from an exterior light source (not shown) passes through the primary color regions R, G and B twice, causing display color in the reflective mode to be darker than that in the transmissive mode. At this time, according to the present invention, the liquid crystal orientation above the additional sub-pixel electrode **415** is controlled by the controller **450** to cause the reflective light **403** to penetrate the liquid crystal layer **465** above the second reflective portion **4152** (i.e. the additional sub-pixel electrode **415**). That is, the controller **450** controls the white sub-pixel area **3104** to emit white light to raise display brightness and dilute the color purity in the reflective mode, thereby reducing color gamut of the reflective mode to approach that of the transmissive mode. Also, the white sub-pixel area **3104** can be driven to not to emit white light, thus the color gamut of the reflective mode is greater than that of the transmissive mode. It is noted that the controller **450** can adjust power output to modulate the brightness of the white light emitted from the white sub-pixel area **3104** to a desired level. Thus, the overall chromaticity for the two modes may be controlled to a desired point, which may be substantially the same chromaticity or different chromaticity.

SECOND EMBODIMENT

[0035] **FIG. 5A** is a sectional view schematically showing one main pixel area **310** of the transflective LCD device **300** according to the second embodiment of the present invention and illustrating the operation thereof in a transmissive mode. **FIG. 5B** illustrates the operation of the transflective LCD device **300** according to the second embodiment in a reflective mode. Elements in **FIGS. 5A and 5B** repeated from **FIGS. 4A and 4B** use the same reference numbers.

[0036] The main pixel area **310** comprises red, green and blue sub-pixel areas **3101**, **3102** and **3103** and a white sub-pixel area **3104**. For simplicity, the three primary color sub-pixel areas **3101**, **3102**, and **3103** and a white sub-pixel area **3104** are respectively shown in **FIGS. 5A and 5B**.

[0037] A first substrate **400**, serving as a lower substrate, can be a glass substrate including an array of pixel driving elements (not shown), such as an array of thin film transistors (TFTs). A backlight device **401** is disposed at the outer side (i.e. the backside) of the first substrate **400**. Three primary sub-pixel electrodes **410** and an additional sub-pixel electrode **515** are formed on the first substrate **400**, wherein each primary sub-pixel electrode **410** is located in each primary color sub-pixel area **3101**/**3102**/**3103** and the additional sub-pixel electrode **515** is located in the white sub-pixel area **3104**. Note that a representative primary sub-pixel electrode **410** is shown in **FIGS. 5A and 5B**. Each primary sub-pixel electrode **410** comprises a first transmissive portion **4101** and a first reflective portion **4102**. The additional sub-pixel electrode **515** merely comprises a reflective portion **5152**. The first transmissive portion **4101** can be transparent conductive material such as ITO (indium tin oxide) or IZO (indium zinc oxide). The reflective portion **5152** can be opaque and reflective material such as aluminum, aluminum alloy or silver. That is, the additional sub-pixel electrode **515** is a reflective layer.

[0038] A second substrate **490**, such as a glass substrate, disposed opposite the first substrate **400** is provided. The second substrate **490** serves as an upper substrate. A color filter **480** is formed on the inner side of the second substrate **490**. The color filter **480** comprises three primary color regions R, G and B and a white region W. The white region W may have no color layer or have a transparent resist layer. Note that a representative primary color region R/G/B is shown in **FIGS. 5A and 5B**. Each primary sub-pixel electrode **410** corresponds to each primary color region R/G/B. The additional sub-pixel electrode **515** corresponds to the white region W.

[0039] A common electrode **470** is then formed on an inner side of the second substrate **490**. The common electrode **470** may be an ITO or IZO layer. In **FIGS. 5A and 5B**, liquid crystal molecules **460** fill a space between the first substrate **400** and the second substrate **490** to form a liquid crystal layer **465**. The liquid crystal orientation of the liquid crystal layer **465** is controlled by an electric field generating electrodes such as sub-pixel electrodes **410** and **515** and the common electrode **470**.

[0040] An operational example of this embodiment is illustrated hereinafter.

[0041] **FIG. 5A** illustrates the operation of the transflective LCD device **300** according to the second embodiment of the present invention in a transmissive mode. A backlight **402** from the backlight device **401** passes through the primary color regions R, G and B once. Note that the additional sub-pixel electrode **515** blocks backlight **402** from the backlight device **401** because the additional sub-pixel electrode **515** is opaque. That is, the white sub-pixel area **3104** does not emit light (i.e. the white sub-pixel area **3104** is dark) in the transmissive mode.

[0042] **FIG. 5B** illustrates the operation of the transflective LCD device **300** according to the second embodiment of the present invention in a reflective mode. A reflective light **403** from an exterior light source (not shown) passes through the primary color regions R, G and B twice, causing display color in the reflective mode to be darker than that in the transmissive mode. At this time, according to the invention, the white sub-pixel area **3104** emits a white light to raise display brightness by reflection of the additional sub-pixel electrode **515**, thereby causing the chromaticity of the reflective mode to approach that of the transmissive mode.

[0043] Although the color filter **480** is located on the inner side of the second substrate **490** in the first and second embodiments, the color filter **480** can overlie the first substrate **400** by known COA (color filter on array) technology. For example, the color filter **480** can be formed on the sub-pixel electrodes **410** and **415**/**515**. The conventional COA processes and structures are described in, for example, U.S. Pat. No. 6,162,654. In order to avoid obscuring aspects of the present invention, detailed COA processes and structures are not described again here. Depending on designs, the sub-pixel electrodes **410**, **415**, **515** can be supported by the second substrate **490** and the common electrode **470** can be supported by the first substrate **400**.

[0044] The present invention provides a novel transflective LCD device and a method for normalizing chromaticity between transmissive and reflective modes of a transflective LCD device. The present invention employs the white sub-pixel area providing a white light in the reflective mode. The white sub-pixel area comprises a reflective portion reflecting the white light during the reflective mode. Thus, the chromaticity of the reflective mode approaches that of the transmissive mode, improving display quality.

[0045] **FIG. 6** is a schematic diagram of an electronic device **610** incorporating a transflective LCD **300** of the present invention. The electronic device **610** can be a mobile phone, a hand-held computer and others. A representative mobile phone is shown in **FIG. 6**. Even so, the teachings may be further applied to any form of display device comprising the transflective LCD **300**. The electronic device **610** comprises the transflective LCD **300** of the present invention, control electronics (such as ICs and others, not shown) operatively coupled to the transparent LCD **300** and other components (such as a keypad). The control electronics are used to control the transparent LCD **300** to display an image in accordance with display data.

[0046] Finally, while the invention has been described by way of example and in terms of the above, it is to be understood that the invention is not limited to the disclosed embodiments. On the contrary, it is intended to cover various modifications and similar arrangements as would be apparent to those skilled in the art. Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

What is claimed is:

1. A transflective liquid crystal display device comprising a plurality of main pixel areas, each main pixel area comprising:

at least one primary color sub-pixel area, wherein the at least one primary color sub-pixel area comprises a first transmissive portion and a first reflective portion; and

a white sub-pixel area, wherein the white sub-pixel area comprises a second reflective portion.

2. The transflective LCD device according to claim 1, wherein the white sub-pixel area further comprises a second transmissive portion.

3. The transflective LCD device according to claim 1, wherein each main pixel areas comprise three color sub-pixel areas which correspond to primary colors.

4. The transflective LCD device according to claim 3, wherein the primary colors include red, green and blue.

5. The transflective LCD device according to claim 1, wherein the at least one color sub-pixel area is defined by an electrode comprising a transmissive portion and a reflective portion, and at least one color region of a color filter corresponding to the at least one color sub-pixel area.

6. The transflective LCD device according to claim 5, wherein the white sub-pixel area is defined by a white region of the color filter.

7. The transflective LCD device according to claim 6, wherein the white region of the color filter is transparent to white light.

8. The transflective LCD device according to claim 7, wherein the white sub-pixel area is further defined by an electrode comprising a reflective portion.

9. The transflective LCD device according to claim 8, wherein the white sub-pixel area is further defined by the electrode comprising a transmissive portion.

10. The transflective LCD device according to claim 1, further comprising a first substrate and a second substrate disposed opposite each other with a liquid crystal layer interposed therebetween, wherein the at least one color sub-pixel area is defined by a color region of a color filter supported by one of the first and second substrates, a first electrode comprising a transmissive portion and a first reflective portion supported by at least one of the first and second substrates, and the white sub-pixel area is defined by a second electrode comprising a second reflective portion supported by at least one of the first and second substrates and a white region of the color filter supported by at least one of the first and second substrates.

11. The transflective LCD device according to claim 10, wherein the white region of the color filter comprises a transparent material.

12. A transflective liquid crystal display device comprising a plurality of main pixel areas, each main pixel area comprising:

three primary sub-pixel electrodes and an additional sub-pixel electrode disposed on a substrate, wherein each primary sub-pixel electrode comprises a first transmissive portion and a first reflective portion and the additional sub-pixel electrode comprises a second reflective portion; and

a color filter comprising three primary color regions and a white region, wherein the primary sub-pixel electrodes correspond to the primary color regions and the additional sub-pixel electrode corresponds to the white region.

13. The transflective LCD device according to claim 12, wherein the substrate is a glass substrate comprising an array of thin film transistors.

14. The transflective LCD device according to claim 12, wherein the additional sub-pixel electrode further comprises a second transmissive portion.

15. The transflective LCD device according to claim 14, further comprising a controller electrically connected to the additional sub-pixel electrode, wherein the controller controls a brightness level of a white light emitted from the white sub-pixel area.

16. The transflective LCD device according to claim 15, wherein the first and second transmissive portions are transparent conductive layers and the first and second reflective portions are reflective layers.

17. The transflective LCD device according to claim 12, wherein the three primary color regions comprise red, green and blue color regions.

18. A transflective liquid crystal display device comprising a plurality of main pixel areas, each main pixel area comprising:

a first substrate and a second substrate disposed opposite each other with a liquid crystal layer interposed therebetween;

three primary sub-pixel electrodes and an additional sub-pixel electrode formed on the first substrate, wherein each primary sub-pixel electrode comprises a first transmissive portion and a first reflective portion and the additional sub-pixel electrode comprises a second reflective portion;

a color filter formed on an inner side of the second substrate, wherein the color filter comprises three primary color regions and a white region, the primary sub-pixel electrodes correspond to the primary color regions and the additional sub-pixel electrode corresponds to the white region; and

a common electrode formed over the color filter.

19. The transflective LCD device according to claim 18, wherein the additional sub-pixel electrode further comprises a second transmissive portion.

20. An electronic device, comprising:

a transflective liquid crystal display device as in claim 1; and

control electronics operatively coupled to the transflective liquid crystal display device, controlling the transflective liquid crystal display device to display an image in accordance with display data.

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专利名称(译)	具有平衡色度的半透半反液晶显示装置		
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当前申请(专利权)人(译)	群创光电		
[标]发明人	CHANG WEI CHIH CHUANG LI SEN TING DAI LIANG		
发明人	CHANG, WEI-CHIH CHUANG, LI-SEN TING, DAI-LIANG		
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摘要(译)

公开了一种四色透反液晶显示装置。每个主像素区域包括三个基色子像素区域和白色子像素区域。每个原色子像素区域包括第一透射部分和第一反射部分。白色子像素区域包括第二反射部分和第二透射部分。第二次反射反射实质上白光以提高反射模式下的显示亮度。因此，反射模式的色度接近透射模式的色度。