(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 439 042 A1

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
06.02.2019 Bulletin 2019/06

(21) Application number: **17775902.4**

(22) Date of filing: **31.03.2017**

(51) Int Cl.:
H01L 27/15 *(2006.01)* ***H01L 33/50*** *(2010.01)*
H01L 33/58 *(2010.01)* ***H05B 33/12*** *(2006.01)*

(86) International application number:
PCT/KR2017/003562

(87) International publication number:
WO 2017/171478 (05.10.2017 Gazette 2017/40)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **01.04.2016 US 201662316927 P**

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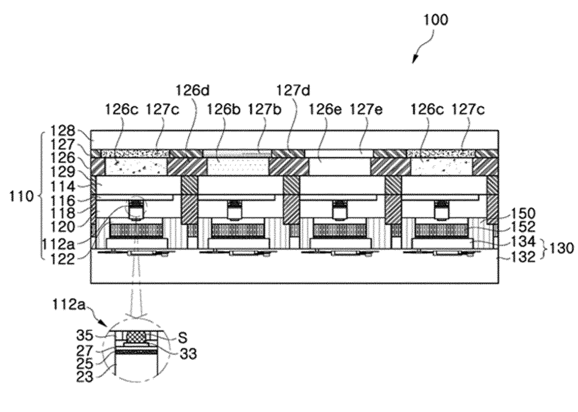
(54) DISPLAY DEVICE AND MANUFACTURING METHOD THEREFOR

(57) A display apparatus and a method of manufacturing the same. The display apparatus includes a first substrate including a plurality of light emitting diodes regularly arranged thereon; a second substrate including a TFT panel part including a plurality of TFTs driving the plurality of light emitting diodes; and a third substrate including a light converter converting light emitted from the first substrate, wherein the first substrate and the second substrate are coupled to each other so as to face each other, the light emitting diodes are electrically connected to the TFTs, respectively, the first substrate and the third substrate are coupled to each other so as to face each other, and light emitted from the plurality of light emitting diodes is converted into at least one of blue light, green light, and red light through the light converter. The display apparatus employs micro-light emitting diodes formed of nitride semiconductors and thus can provide high efficiency and high resolution to be applicable to a wearable apparatus while reducing power consumption.

【FIG. 1】



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Description

[Technical Field]

[0001] Exemplary embodiments of the present disclosure relate to a display apparatus and a method of manufacturing the same, and more particularly, to a display apparatus using micro-light emitting diodes and a method of manufacturing the same.

[Background Art]

[0002] A light emitting diode refers to an inorganic semiconductor device that emits light through recombination of electrons and holes and has recently been used in various fields including displays, automobile lamps, general lighting, and the like. Such a light emitting diode has various advantages such as long lifespan, low power consumption, and rapid response. As a result, a light emitting device using a light emitting diode is used as a light source in various fields.
[0003] Recently, smart TVs or monitors realize colors using a thin film transistor liquid crystal display (TFT LCD) panel and tend to use light emitting diodes (LEDs) as a light source for a backlight unit for color realization. In addition, a display apparatus is often manufactured using organic light emitting diodes (OLEDs).
[0004] In a TFT-LCD, since one LED is used as a light source for many pixels, a backlight light source must be kept in a turned-on state. As a result, the TFT-LCD suffers from constant power consumption regardless of brightness of a displayed screen. On the other hand, although power consumption of an OLED has been continuously reduced due to the development of technology, the OLED still has much higher power consumption than LEDs formed of inorganic semiconductors and thus has low efficiency.
[0005] Moreover, a PM drive type OLED can suffer from deterioration in response speed upon pulse amplitude modulation (PAM) of the OLED having large capacitance, and can suffer from deterioration in lifespan upon high current driving through pulse width modulation (PWM) for realizing a low duty ratio. Moreover, an AM driving type OLED requires connection of TFTs for each pixel, thereby causing increase in manufacturing costs and non-uniform brightness according to characteristics of TFTs.

[Disclosure]

[Technical Problem]

[0006] Exemplary embodiments of the present disclosure provide a display apparatus using micro-light emitting diodes having low power consumption to be applicable to a wearable apparatus, a smartphone or a TV, and a method of manufacturing the same.

[Technical Solution]

[0007] In accordance with one exemplary embodiment of the present disclosure, a display apparatus includes: a first substrate including a plurality of light emitting diodes regularly arranged thereon; a second substrate including a TFT panel part including a plurality of TFTs driving the plurality of light emitting diodes; and a third substrate including a light converter converting light emitted from the first substrate, wherein the first substrate and the second substrate are coupled to each other so as to face each other; the light emitting diodes are electrically connected to the TFTs, respectively; the first substrate and the third substrate are coupled to each other so as to face each other; and light emitted from the plurality of light emitting diodes is converted into at least one of blue light, green light, and red light through the light converter.
[0008] The light converter may include a phosphor layer converting wavelengths of light emitted from the light emitting diode; and a filter unit blocking light of a predetermined wavelength among light having passed through the phosphor layer.
[0009] In accordance with another exemplary embodiment of the present disclosure, a method of manufacturing a display apparatus includes: forming a first substrate having a plurality of light emitting diodes regularly arranged thereon; forming a second substrate including a TFT panel part including a plurality of TFTs driving the plurality of light emitting diodes; forming a third substrate including a light converter converting light emitted from the first substrate; and coupling the first to third substrates to one another, wherein light emitted from the plurality of light emitting diodes is converted into at least one of blue light, green light, and red light through the light converter.

[Advantageous Effects]

[0010] According to exemplary embodiments, the display apparatus employs micro-light emitting diodes formed of nitride semiconductors and thus can provide high efficiency and high resolution to be applicable to a wearable apparatus while reducing power consumption.

[0011] In addition, the display apparatus according to the exemplary embodiments includes a color filter in order to block some fraction of light not subjected to wavelength conversion when light emitted from light emitting diodes is subjected to wavelength conversion while passing through a phosphor layer, thereby improving color purity of light emitted to the outside.

[Description of Drawings]

[0012]

FIG. 1 is a sectional view of a display apparatus according to a first exemplary embodiment of the present disclosure.
FIG. 2 is sectional views illustrating a method of manufacturing the display apparatus according to the first exemplary embodiment of the present disclosure.
FIG. 3 is a sectional view of a display apparatus according to a second exemplary embodiment of the present disclosure.
FIG. 4 is a sectional view of a display apparatus according to a third exemplary embodiment of the present disclosure.
FIG. 5 is a sectional view of a display apparatus according to a fourth exemplary embodiment of the present disclosure.

[Best Mode]

[0013] In accordance with one exemplary embodiment of the present disclosure, a display apparatus includes: a first substrate including a plurality of light emitting diodes regularly arranged thereon; a second substrate including a TFT panel part including a plurality of TFTs driving the plurality of light emitting diodes; and a third substrate including a light converter converting light emitted from the first substrate, wherein the first substrate and the second substrate are coupled to each other so as to face each other; the light emitting diodes are electrically connected to the TFTs, respectively; the first substrate and the third substrate are coupled to each other so as to face each other; and light emitted from the plurality of light emitting diodes is converted into at least one of blue light, green light, and red light through the light converter.

[0014] The first substrate may include a plurality of support substrates; the plurality of light emitting diodes disposed on the plurality of support substrates, respectively; and a blocking portion disposed between the plurality of support substrates and blocking light emitted from the plurality of light emitting diodes.

[0015] The light converter may include a phosphor layer converting wavelengths of light emitted from the light emitting diodes; and a filter unit blocking light of a predetermined wavelength among light having passed through the phosphor layer.

[0016] The light emitting diodes may include blue light emitting diodes emitting blue light; the phosphor layer may include a green phosphor layer emitting green light through wavelength conversion of blue light emitted from the blue light emitting diodes, a red phosphor layer emitting red light through wavelength conversion of blue light emitted from the blue light emitting diodes, and a transparent layer allowing blue light emitted from the blue light emitting diodes to pass therethrough without wavelength conversion; the filter unit may include a green light portion disposed on the green phosphor layer and blocking light of a predetermined wavelength among light having passed through the green phosphor layer, a red light portion disposed on the red phosphor layer and blocking light of a predetermined wavelength among light having passed through the red phosphor layer, and a transparent portion disposed on the transparent layer and allowing light having passed through the transparent layer to pass therethrough without wavelength conversion.

[0017] The phosphor layer may further include a blocking layer disposed between the green phosphor layer, the red phosphor layer and the transparent layer, and the filter unit may further include a light blocking portion disposed between the green light portion, the red light portion and the transparent portion.

[0018] The green light portion may allow only green light to pass therethrough and the red light portion may allow only red light to pass therethrough.

[0019] The light emitting diodes may include blue light emitting diodes emitting blue light; the phosphor layer may include a green phosphor layer emitting green light through wavelength conversion of blue light emitted from the blue light emitting diodes, a red phosphor layer emitting red light through wavelength conversion of blue light emitted from the blue light emitting diodes, and a transparent layer allowing blue light emitted from the blue light emitting diodes to pass therethrough without wavelength conversion; and the filter unit may include wavelength filter units disposed on the green phosphor layer and the red phosphor layer, respectively, and blocking light of a predetermined wavelength among light having passed through the green phosphor layer and the red phosphor layer, and a transparent portion disposed on the transparent layer and allowing light having passed through the transparent layer to pass therethrough without wavelength conversion.

[0020] The wavelength filter unit may allow green light and red light to pass therethrough and may block blue light.

[0021] The light emitting diodes may include blue light emitting diodes emitting blue light; the phosphor layer may include a green phosphor layer emitting green light through wavelength conversion of blue light emitted from the blue light emitting diodes, a red phosphor layer emitting red light through wavelength conversion of blue light emitted from the blue light emitting diodes, a transparent layer allowing blue light emitted from the blue light emitting diodes to pass therethrough without wavelength conversion, and a white phosphor layer converting the wavelength of blue light emitted from the blue light emitting diodes; and the filter unit may include may include a green light portion disposed on the green phosphor layer and blocking light of a predetermined wavelength among light having passed through the green phosphor layer, a red light portion disposed on the red phosphor layer and blocking light of a predetermined wavelength among light having passed through the red phosphor layer, and a transparent portion disposed on the transparent layer and the white phosphor layer and allowing light having passed through the transparent layer and the white phosphor layer to pass therethrough without wavelength conversion.

[0022] The light emitting diodes include UV light emitting diodes emitting UV light; the phosphor layer may include a blue phosphor layer emitting blue light through wavelength conversion of UV light emitted from the UV light emitting diodes, a green phosphor layer emitting green light through wavelength conversion of UV light emitted from the UV light emitting diodes, and a red phosphor layer emitting red light through wavelength conversion of UV light emitted from the UV light emitting diodes; and the filter unit may include a blue light portion disposed on the blue phosphor layer and blocking light of a predetermined wavelength among light having passed through the blue phosphor layer, a green light portion disposed on the green phosphor layer and blocking light of a predetermined wavelength among light having passed through the green phosphor layer, and a red light portion disposed on the red phosphor layer and blocking light of a predetermined wavelength among light having passed through the red phosphor layer.

[0023] The blue light portion may allow only blue light to pass therethrough, the green light portion may allow only green light to pass therethrough, and the red light portion may allow only red light to pass therethrough.

[0024] Each of the plurality of light emitting diodes may include an n-type semiconductor layer; a p-type semiconductor layer; an active layer interposed between the n-type semiconductor layer and the p-type semiconductor layer; an n-type electrode coupled to the n-type semiconductor layer; and a p-type electrode coupled to the p-type semiconductor layer.

[0025] The display apparatus may further include an anisotropic conductive film electrically connecting the first substrate to the second substrate.

[0026] In accordance with another exemplary embodiment of the present disclosure, a method of manufacturing a display apparatus includes: forming a first substrate having a plurality of light emitting diodes regularly arranged thereon; forming a second substrate including a TFT panel part including a plurality of TFTs driving the plurality of light emitting diodes; forming a third substrate including a light converter converting light emitted from the first substrate; and coupling the first to third substrates to one another, wherein light emitted from the plurality of light emitting diodes may be converted into one of blue light, green light and red light through the light converter.

[0027] The first substrate and the second substrate may be coupled to each other to face each other such that the light emitting diodes are electrically connected to the TFTs, respectively, and the first substrate may be coupled to the third substrate to face each other.

[0028] Forming the third substrate may include forming a filter unit on a protective substrate, the filter unit blocking light of a predetermined wavelength among light passing therethrough on a protective substrate; and forming a phosphor layer on the filter unit, the phosphor layer converting the wavelength of light passing therethrough.

[0029] The light emitting diodes may include blue light emitting diodes; the phosphor layer may include a green phosphor layer emitting green light through wavelength conversion of blue light emitted from the blue light emitting diodes, a red phosphor layer emitting red light through wavelength conversion of blue light emitted from the blue light emitting diodes, and a transparent layer allowing blue light emitted from the blue light emitting diodes to pass therethrough without wavelength conversion; and the filter unit may include a green light portion disposed on the green phosphor layer and blocking light of a predetermined wavelength among light having passed through the green phosphor layer, a red light portion disposed on the red phosphor layer and blocking light of a predetermined wavelength among light having passed through the red phosphor layer, and a transparent portion disposed on the transparent layer and allowing light having passed through the transparent layer to pass therethrough without wavelength conversion.

[0030] The light emitting diodes may include blue light emitting diodes; the phosphor layer may include a green phosphor layer emitting green light through wavelength conversion of blue light emitted from the blue light emitting diodes, a red phosphor layer emitting red light through wavelength conversion of blue light emitted from the blue light emitting diodes, and a transparent layer allowing blue light emitted from the blue light emitting diodes to pass therethrough without wavelength conversion; and the filter unit may include wavelength filter units disposed on the green phosphor layer and the red phosphor layer, respectively, and blocking light of a predetermined wavelength among light having passed through the green phosphor layer and the red phosphor layer, and a transparent portion disposed on the transparent layer and allowing light having passed through the transparent layer to pass therethrough without wavelength conversion.

[0031] The light emitting diodes may include blue light emitting diodes; the phosphor layer may include a green phosphor layer emitting green light through wavelength conversion of blue light emitted from the blue light emitting diodes, a red phosphor layer emitting red light through wavelength conversion of blue light emitted from the blue light emitting diodes, a transparent layer allowing blue light emitted from the blue light emitting diodes to pass therethrough without wavelength conversion, and a white phosphor layer emitting white light through wavelength conversion of blue light emitted from the blue light emitting diodes; and the filter unit may include a green light portion disposed on the green phosphor layer and blocking light of a predetermined wavelength among light having passed through the green phosphor layer, a red light portion disposed on the red phosphor layer and blocking light of a predetermined wavelength among light having passed through the red phosphor layer, and a transparent portion disposed on the transparent layer and the white phosphor layer and allowing light having passed through the transparent layer and the white phosphor layer to pass therethrough without wavelength conversion.

[0032] The light emitting diodes may include UV light emitting diodes emitting UV light; the phosphor layer may include a blue phosphor layer emitting blue light through wavelength conversion of UV light emitted from the UV light emitting diodes, a green phosphor layer emitting green light through wavelength conversion of UV light emitted from the UV light emitting diodes, and a red phosphor layer emitting red light through wavelength conversion of UV light emitted from the UV light emitting diodes; and the filter unit may include a blue light portion disposed on the blue phosphor layer and blocking light of a predetermined wavelength among light having passed through the blue phosphor layer, a green light portion disposed on the green phosphor layer and blocking light of a predetermined wavelength among light having passed through the green phosphor layer, and a red light portion disposed on the red phosphor layer and blocking light of a predetermined wavelength among light having passed through the red phosphor layer.

[0033] Hereinafter, exemplary embodiments of the present disclosure will be described in detail with reference to the accompanying drawings.

[0034] FIG. 1 is a sectional view of a display apparatus according to a first exemplary embodiment of the present disclosure and FIG. 2 is sectional views illustrating a method of manufacturing the display apparatus according to the first exemplary embodiment of the present disclosure.

[0035] Referring to FIG. 1, the display apparatus 100 according to the first exemplary embodiment includes a light emitting diode part 110, a TFT panel part 130, and an anisotropic conductive film 150.

[0036] The light emitting diode part 110 includes light emitting diodes 112a, a support substrate 114, transparent electrodes 116, a first blocking portion 118, an insulation layer 120, first connection electrodes 122, a phosphor layer 126, a color filter 127, and a protective substrate 128.

[0037] The light emitting diode part 110 includes a plurality of light emitting diodes 112a, which are regularly arranged on the support substrate 114. For example, the plurality of light emitting diodes 112a may be arranged at constant intervals in a matrix form. In this exemplary embodiment, the plurality of light emitting diodes 112a may include blue light emitting diodes emitting blue light.

[0038] In the display apparatus 100 according to this exemplary embodiment, the light emitting diode part 110 may be driven by power applied from an exterior power source. That is, an image can be reproduced through on-off combination of the light emitting diodes 112a in the light emitting diode part 110 and the wavelength of light emitted from the light emitting diodes 112a is converted into emit red light, green light and blue light through the phosphor layer 126. Accordingly, the display apparatus 100 can be driven without a separate LCD. In this exemplary embodiment, a region including a single light emitting diode 112a may be used as a subpixel in the display apparatus 100. In the light emitting diode part 110, one subpixel may have a larger size than the light emitting diode 112a disposed in the subpixel.

[0039] Referring to FIG. 1, each of the light emitting diodes 112a includes an n-type semiconductor layer 23, an active layer 25, a p-type semiconductor layer 27, an n-type electrode 31, a p-type electrode 33, and a wall 35.

[0040] The n-type semiconductor layer 23, the active layer 25 and the p-type semiconductor layer 27 may include Group III-V based compound semiconductors. By way of example, the n-type semiconductor layer 23, the active layer 25 and the p-type semiconductor layer 27 may include nitride semiconductors such as (Al, Ga, In)N. In other exemplary embodiments, locations of the n-type semiconductor layer 23 and the p-type semiconductor layer 27 can be interchanged.

[0041] The n-type semiconductor layer 23 may include an n-type dopant (for example, Si) and the p-type semiconductor layer 27 may include a p-type dopant (for example, Mg). The active layer 25 is interposed between the n-type semiconductor layer 23 and the p-type semiconductor layer 27. The active layer 25 may have a multi-quantum well (MQW) structure and the composition of the active layer 25 may be determined so as to emit light having a desired peak wavelength.

[0042] In addition, the light emitting structure including the n-type semiconductor layer 23, the active layer 25 and the p-type semiconductor layer 27 may be formed similar to a vertical type light emitting diode 112a. In this structure, the n-type electrode 31 may be formed on an outer surface of the n-type semiconductor layer 23 and the p-type electrode 33 may be formed on an outer surface of the p-type semiconductor layer 27.

[0043] Further, as shown in FIG. 1, a bonding portion S may be formed between the p-type electrode 33 and the transparent electrode 116 in order to couple the light emitting diode 112a similar to the vertical type light emitting diode to the transparent electrode 116 formed on the support substrate 114. Here, the wall 35 may be formed on the light emitting diode 112a to prevent the bonding portion S from escaping from a space between the p-type electrode 33 and the transparent electrode 116.

[0044] The wall 35 may be formed to cover a portion of the p-type electrode 33 such that the p-type electrode 33 can be exposed on the p-type semiconductor layer 27, and may be composed of a plurality of layers, as shown in the drawings. The wall 35 may include a first layer and a second layer, and may be formed by forming the first layer including SiN on the p-type semiconductor layer 27 so as to cover a portion of the p-type electrode 33, followed by forming the second layer including Si02 on the first layer. The second layer may have a greater thickness and a smaller width than the first layer.

[0045] The support substrate 114 is a substrate on which the plurality of light emitting diodes 112a will be mounted, and may be an insulation substrate, a conductive substrate, or a printed circuit board. By way of example, the support substrate 114 may be at least one of a sapphire substrate, a gallium nitride substrate, a glass substrate, a silicon carbide substrate, a silicon substrate, a metal substrate, and a ceramic substrate. In this exemplary embodiment, the support substrate 114 may be a transparent substrate in order to allow light emitted from the light emitting diodes 112a to pass therethrough. By way of example, the support substrate 114 may be a flexible glass substrate having a certain thickness.

[0046] In this exemplary embodiment, the support substrate 114 is formed of a transparent material and light emitted from the plurality of light emitting diodes 112a can be emitted to the outside through the support substrate 114 and through the phosphor layer 126 and the color filter 127 formed on an upper surface of the support substrate 114. The support substrate 114 is divided into a plurality of support substrates separated from each other so as to be placed only on the light emitting diodes 112a, respectively. In addition, each of a plurality of second blocking portions 129 may be disposed in a space between the support substrates 114.

[0047] The second blocking portion 129 blocks light emitted from one light emitting diode 112a from traveling towards another light emitting diode 112a adjacent thereto. That is, each of the second blocking portions 129 is disposed between the support substrates 114 such that light emitted from one light emitting diode 112a can be discharged to the outside through the support substrate 114 disposed on the light emitting diode 112a and through the phosphor layer 126 and the color filter 127 thereon.

[0048] The transparent electrode 116 may be formed on the support substrate 114 and may be electrically connected to the p-type electrode 33 of the light emitting diode 112. In this exemplary embodiment, a plurality of transparent electrodes 116 may be formed on the support substrate 114 and may be coupled to the plurality of light emitting diodes 112, respectively. Alternatively, the plurality of light emitting diodes 112 may be coupled to one transparent electrode 116, as needed. In addition, the transparent electrodes 116 may be separated from each other on the support substrate 114. By way of example, the transparent electrodes 116 may be formed of indium tin oxide (ITO) and the like.

[0049] The first blocking portion 118 is formed on the support substrate 114 and may be provided in plural. The first blocking portion 118 prevents light emitted from a certain light emitting diode from being directed towards other light emitting diodes 112 adjacent thereto when light emitted from the light emitting diodes 112 is emitted to the outside through the transparent electrodes 116. Accordingly, each of the first blocking portions 118 may be formed between the transparent electrodes 116 separated from each other and may be formed to cover a portion of each of the transparent electrodes 116, as needed. In this exemplary embodiment, the first blocking portion 118 may be formed of aluminum (Al) or chromium (Cr).

[0050] The insulation layer 120 may surround the light emitting diode 112a and cover an exposed surface of a connecting plane between the light emitting diode 112a and the transparent electrode 116 while covering the transparent electrode 116. In the structure wherein the insulation layer 120 surrounds the light emitting diode 112a, the n-type semiconductor layer 23 and the n-type electrode 31 of the light emitting diode 112a can be exposed through the insulation layer 120.

[0051] The first connection electrode 122 covers the insulation layer 120 and may also cover the n-type semiconductor layer 23 and the n-type electrode 31 not covered by the insulation layer 120. Accordingly, the first connection electrode 122 may be electrically connected to the n-type semiconductor layer 23.

[0052] The phosphor layer 126 may be formed on an upper surface of the support substrate 114, and may include a green phosphor layer 126b, a red phosphor layer 126c and a transparent layer 126e. The green phosphor layer 126b, the red phosphor layer 126c and the transparent layer 126e may be alternately arranged to be adjacent to one another or to be separated from one another by a predetermined distance or greater. A blocking layer 126d may be disposed between the green phosphor layer 126b, the red phosphor layer 126c and the transparent layer 126e separated a predetermined distance from one another. The blocking layer 126d may be formed while filling spaces between the green phosphor layer 126b, the red phosphor layer 126c and the transparent layer 126e, and can prevent light emitted through each of the green phosphor layer 126b, the red phosphor layer 126c and the transparent layer 126e from traveling towards another phosphor layer adjacent thereto.

[0053] In this exemplary embodiment, the light emitting diodes 112 are blue light emitting diodes. Accordingly, the green phosphor layer 126b converts the wavelength of blue light emitted from the light emitting diodes 112a to emit green light and the red phosphor layer 126c converts the wavelength of blue light emitted from the blue light emitting diodes 112a to emit red light. In addition, the transparent layer 126e allows blue light emitted from the light emitting diodes 112a to pass therethrough without wavelength conversion. Accordingly, green light, red light and blue light can be emitted through the phosphor layer 126.

[0054] The color filter 127 may be disposed on an upper surface of the phosphor layer 126, and may include a green light portion 127b, a red light portion 127c, a light blocking portion 127d, and a transparent portion 127e. The color filter 127 may be formed in a film shape and can block light having passed through the color filter 127 excluding light of a predetermined wavelength having passed therethrough.

[0055] That is, the green light portion 127b allows only green light to pass therethrough by blocking light having other wavelengths than the wavelength of the green light, and the red light portion 127c allows only red light to pass therethrough by blocking light having other wavelengths than the red light. In addition, the light blocking portion 127d is disposed between the green light portion 127b, the red light portion 127c and the transparent portion 127e, and blocks all components of light. In addition, the transparent portion 127e allows light to pass therethrough without wavelength conversion.

[0056] In this exemplary embodiment, the green light portion 127b, the red light portion 127c and the transparent portion 127e of the color filter 127 may be arranged in the same manner as those of the phosphor layer 126. That is, the green light portion 127b of the color filter 127 is disposed on an upper surface of the green phosphor layer 126b and the red light portion 127c thereof is disposed on an upper surface of the red phosphor layer 126c. Further, the transparent portion 127e may be disposed on an upper surface of the transparent layer 126e through which blue light emitted from the light emitting diodes 112a passes without wavelength conversion.

[0057] In this exemplary embodiment, the green light portion 127b, the red light portion 127c and the transparent portion 127e may have greater widths than the green phosphor layer 126b, the red phosphor layer 126c and the transparent layer 126e, respectively. As a result, the entirety of light having passed through the phosphor layer 126 can be discharged to the outside through the color filter 127.

[0058] As such, in this exemplary embodiment, since the red light portion 127c is disposed on the upper surface of the red phosphor layer 126c, light of other wavelengths included in light having passed through the red phosphor layer 126c can be blocked by the red light portion 127c and only red light can be discharged through the red light portion 127c. In addition, since the green light portion 127b is disposed on the upper surface of the green phosphor layer 126b, light of other wavelengths included in light having passed through the green phosphor layer 126b can be blocked by the green light portion 127b and only green light can be discharged through the green light portion 127b.

[0059] That is, blue light emitted from the light emitting diodes 112a is converted into red light while passing through the red phosphor layer 126c, and a fraction of the blue light not subjected to wavelength conversion can be discharged to the outside. Likewise, blue light emitted from the light emitting diodes 112a is converted into green light while passing through the green phosphor layer 126b, such that the green light can be discharged to the outside together with a fraction of the blue light. In this way, since a fraction of blue light passes through the phosphor layer 126 without wavelength conversion and causes deterioration in color purity, the color filter 127 can completely block this fraction of blue light so as to allow a pure color obtained through wavelength conversion to be discharged to the outside.

[0060] Alternatively, in order to reduce the fraction of blue light not subjected to wavelength conversion, the thickness of the phosphor layer 126 can be reduced so as to convert the wavelength of light emitted from the light emitting diodes 112a, instead of using the color filter 127. In this case, however, the intensity of light can be reduced with increasing thickness of the phosphor layer 126. Therefore, the thickness of the phosphor layer 126 and the use of the color filter 127 may be suitably adjusted so as to emit a desired color.

[0061] The protective substrate 128 is disposed on an upper surface of the color filter 127 and can protect the color filter 127 from an external environment by preventing the color filter 127 from being directly exposed to the outside. In this exemplary embodiment, the protective substrate 128 may be formed of a transparent material like the support substrate 114.

[0062] The TFT panel part 130 includes a panel substrate 132 and second connection electrodes 134, and is coupled to the light emitting diode part 110 to supply power to the light emitting diode part 110. The TFT panel part 130 may control power supply to the light emitting diode part 110 to allow only some of the light emitting diodes 112a in the light emitting diode part 110 to emit light.

[0063] The panel substrate 132 has a TFT drive circuit therein. The TFT drive circuit may be a circuit for driving an active matrix (AM) or a circuit for driving a passive matrix (PM).

[0064] The second connection electrodes 134 may be electrically connected to the TFT drive circuit of the panel substrate 132 and to the first connection electrodes 122 of the light emitting diode part 110. In this structure, power supplied through the TFT drive circuit can be supplied to each of the light emitting diodes 112a through the first and second connection electrodes 122, 134. In this exemplary embodiment, the second connection electrodes 134 may be covered by a separate protective layer, which may include, for example, SiNx.

[0065] The anisotropic conductive film 150 serves to electrically connect the light emitting diode part 110 to the TFT panel part 130. The anisotropic conductive film 150 may include an adhesive organic insulation material and may contain conductive particles uniformly dispersed therein to achieve electrical connection. The anisotropic conductive film 150 exhibits conductivity in the thickness direction thereof and insulating properties in the plane direction thereof. In addition, the anisotropic conductive film 150 exhibits adhesive properties. Thus, the anisotropic conductive film 150 may be used to bond the light emitting diode part 110 to the TFT panel part 130 such that the light emitting diode part 110 can be electrically connected to the TFT panel part 130 therethrough. Particularly, the anisotropic conductive film 150 may be advantageously used to connect ITO electrodes which are difficult to solder at high temperature.

[0066] As such, in the structure wherein the light emitting diodes 112a are coupled to the TFT panel part 130 via the anisotropic conductive film 150, the first connection electrodes 122 of the light emitting diode part 110 may be electrically connected to the second connection electrodes 134 of the TFT panel part 130 via an electrode connection portion 152.

[0067] In this exemplary embodiment, the light emitting diode part 110 and the TFT panel part 130 may be separately manufactured, and a light converter 123 of the light emitting diode part 110 may also be separately manufactured. In this exemplary embodiment, the light converter 123 includes the phosphor layer 126, the color filter 127, and the protective substrate 128. That is, as shown in FIG. 2 (a), the color filter 127 is formed on the protective substrate 128 and the phosphor layer 126 is formed on the color filter 127, thereby providing the light converter 123. As shown in FIG. 2 (b), with the light emitting diode part 110 coupled to the TFT panel part 130, the light converter 123 is coupled to the upper surface of the support substrate 114, thereby providing the display apparatus 100.

[0068] FIG. 3 is a sectional view of a display apparatus according to a second exemplary embodiment of the present disclosure.

[0069] Referring to FIG. 3, the display apparatus 100 according to the second exemplary embodiment includes a light emitting diode part 110, a TFT panel part 130, and an anisotropic conductive film 150. In description of this exemplary embodiment, descriptions of the same components as those of the first exemplary embodiment will be omitted.

[0070] According to this exemplary embodiment, the color filter 127 includes a transparent portion 127e, a wavelength filter unit 127f, and a light blocking portion 127d. As in the first exemplary embodiment, the transparent portion 127e is disposed on an upper surface of the transparent layer 126e of the phosphor layer 126, and the wavelength filter unit 127f is disposed on an upper surface of each of the green phosphor layer 126b and the red phosphor layer 126c of the phosphor layer 126. Accordingly, the wavelength filter unit 127f and the transparent layer 126e are provided in plural and are separated from each other. The light blocking portion 127d may be disposed in a space between the wavelength filter unit 127f and the transparent layer 126e.

[0071] The wavelength filter unit 127f allows light of a predetermined wavelength or more among light having passed through the green phosphor layer or the red phosphor layer to pass therethrough. That is, in this exemplary embodiment, the light emitting diodes 112a emit blue light, which is converted into red light or green light while passing through the phosphor layer 126. Accordingly, the wavelength filter unit 127f may allow light of a predetermined wavelength or more among light having passed through the red phosphor layer 126c or the green phosphor layer 126b, while blocking blue light, which has a shorter wavelength than the predetermined wavelength, (for example, the wavelength filter unit 127f may block light having a wavelength of 480 nm or less).

[0072] Furthermore, in this exemplary embodiment, each of the wavelength filter unit 127f and the transparent portion 127e may have a greater width than the green phosphor layer 126b, the red phosphor layer 126c and the transparent layer 126e.

[0073] FIG. 4 is a sectional view of a display apparatus according to a third exemplary embodiment of the present disclosure.

[0074] Referring to FIG. 4, the display apparatus 100 according to the third exemplary embodiment includes a light emitting diode part 110, a TFT panel part 130, and an anisotropic conductive film 150. In description of this exemplary embodiment, descriptions of the same components as those of the first exemplary embodiment will be omitted.

[0075] In this exemplary embodiment, the phosphor layer 126 may include a green phosphor layer 126b, a red phosphor layer 126c, a transparent layer 126e, a white phosphor layer 126f, and a blocking layer 126d. In addition, the color filter 127 may include a green light portion 127b, a red light portion 127c, a transparent portion 127e, and a light blocking portion 127d.

[0076] Accordingly, the green phosphor layer 126b, the red phosphor layer 126c, the transparent layer 126e and the white phosphor layer 126f may be alternately arranged to be adjacent to one another or to be separated from one another by a predetermined distance or greater. The blocking layer 126d may be disposed between the green phosphor layer 126b, the red phosphor layer 126c, the transparent layer 126e and the white phosphor layer 126f separated from one another.

[0077] Furthermore, in the color filter 127, the green light portion 127b may be disposed on an upper surface of the green phosphor layer 126b, the red light portion 127c may be disposed on an upper surface of the red phosphor layer 126c, and the transparent portion 127e may be disposed on an upper surface of each of the transparent layer 126e and the white phosphor layer 126f. In this structure, green light can be emitted through the green light portion 127b and red light can be emitted through the red light portion 127c. In addition, blue light can be emitted through the transparent layer 126e and the transparent portion 127e, and white light can be emitted through the white phosphor layer 126f and the transparent portion 127e.

[0078] That is, in the display apparatus 100 according to this exemplary embodiment, four subpixels emitting blue light, green light, red light and white light, respectively, may be driven as one pixel.

[0079] FIG. 5 is a sectional view of a display apparatus according to a fourth exemplary embodiment of the present disclosure.

[0080] Referring to FIG. 5, the display apparatus 100 according to the fourth exemplary embodiment includes a light emitting diode part 110, a TFT panel part 130, and an anisotropic conductive film 150. In description of this exemplary embodiment, descriptions of the same components as those of the first exemplary embodiment will be omitted.

[0081] In this exemplary embodiment, the light emitting diodes of the light emitting diode part 110 are UV light emitting diodes 112d. Thus, the phosphor layer 126 may include a blue phosphor layer 126a, a green phosphor layer 126b, a red phosphor layer 126c and a blocking layer 126d, and the color filter 127 may include a blue light portion 127a, a green light portion 127b, a red light portion 127c and a light blocking portion 127d.

[0082] In the phosphor layer 126, the blue phosphor layer 126a, the green phosphor layer 126b and the red phosphor layer 126c may be disposed on upper surfaces of the UV light emitting diodes 112d, respectively, and may be alternately arranged to be adjacent to one another or to be separated from one another by a predetermined distance or greater. The blocking layer 126d may be disposed between the blue phosphor layer 126a, the green phosphor layer 126b, and the red phosphor layer 126c.

[0083] In this exemplary embodiment, the blue phosphor layer 126a converts the wavelength of UV light emitted from the UV light emitting diode 112d to emit blue light, the green phosphor layer 126b converts the wavelength of UV light emitted from the UV light emitting diode 112d to emit green light, and the red phosphor layer 126c converts the wavelength of UV light emitted from the UV light emitting diode 112d to emit red light.

[0084] Furthermore, in the color filter 127, the blue light portion 127a may be disposed on an upper surface of the blue phosphor layer 126a, the green light portion 127b may be disposed on an upper surface of the green phosphor layer 126b, and the red light portion 127c may be disposed on an upper surface of the red phosphor layer 126c. That is, the blue light portion 127a, the green light portion 127b and the red light portion 127c may be disposed on the upper surfaces of the blue phosphor layer 126a, the green phosphor layer 126b and the red phosphor layer 126c, respectively, and may be alternately arranged to be adjacent to one another. In addition, the blue light portion 127a, the green light portion 127b and the red light portion 127c may be separated from one another by a predetermined distance or greater, and the light blocking portion 127d may be disposed between the blue light portion 127a, the green light portion 127b and the red light portion 127c separated from one another.

[0085] Light having passed through the blue phosphor layer 126a may include blue light subjected to wavelength conversion and UV light not subjected to wavelength conversion, and the blue light portion 127a allows only the blue light to be discharged to the outside by blocking the UV light among the light having passed through the blue phosphor layer 126a. In addition, light having passed through the green phosphor layer 126b may include green light subjected to wavelength conversion and UV light not subjected to wavelength conversion, and the green light portion 127b allows only the green light to be discharged to the outside by blocking the UV light among the light having passed through the green phosphor layer 126b. Furthermore, light having passed through the red phosphor layer 126c may include red light subjected to wavelength conversion and UV light not subjected to wavelength conversion, and the red light portion 127c allows only the red light to be discharged to the outside by blocking the UV light among the light having passed through the red phosphor layer 126c.

[0086] Although certain exemplary embodiments have been described herein, it should be understood by those skilled in the art that these embodiments are given by way of illustration only, and that various modifications, variations, and alterations can be made without departing from the spirit and scope of the invention. Therefore, the scope of the invention should be limited only by the accompanying claims and equivalents thereof.

<List of Reference Numerals>

100: display apparatus	
110: light emitting diode	
112a: light emitting diode	112d: UV diode
23: n-type semiconductor layer	25: active layer
27: p-type semiconductor layer	31: n-type electrode
33: p-type electrode	35: wall
114: support substrate	116: transparent electrode
118: first blocking portion	120: insulation layer
122: first connection electrode	
123: light converter	126: phosphor layer
126a: blue phosphor layer	126b: green phosphor layer

(continued)

126c: red phosphor layer	126d: blocking layer
126e: transparent layer	126f: white phosphor layer
127: color filter	127a: blue light portion
127b: green light portion	127c: red light portion
127d: light blocking portion	127e: transparent portion
127f: wavelength filter unit	
128: protective substrate	129: second blocking portion
130: TFT panel part	132: panel substrate
134: second connection electrode	
150: anisotropic conductive film	152: electrode connection portion
S: bonding portion	

Claims

1. A display apparatus comprising:

a first substrate comprising a plurality of light emitting diodes regularly arranged thereon;
a second substrate comprising a TFT panel part comprising a plurality of TFTs driving the plurality of light emitting diodes; and
a third substrate comprising a light converter converting light emitted from the first substrate,
wherein the first substrate and the second substrate are coupled to each other so as to face each other; the light emitting diodes are electrically connected to the TFTs, respectively; the first substrate and the third substrate are coupled to each other so as to face each other; and light emitted from the plurality of light emitting diodes is converted into at least one of blue light, green light, and red light through the light converter.

2. The display apparatus according to claim 1, wherein the first substrate comprises:

a plurality of support substrates;
the plurality of light emitting diodes disposed on the plurality of support substrates, respectively; and
a blocking portion disposed between the plurality of support substrates and blocking light emitted from the plurality of light emitting diodes.

3. The display apparatus according to claim 1, wherein the light converter comprises:

a phosphor layer converting wavelengths of light emitted from the light emitting diodes; and
a filter unit blocking light of a predetermined wavelength among light having passed through the phosphor layer.

4. The display apparatus according to claim 3, wherein the light emitting diodes comprise blue light emitting diodes;
the phosphor layer comprises a green phosphor layer emitting green light through wavelength conversion of blue light emitted from the blue light emitting diodes, a red phosphor layer emitting red light through wavelength conversion of blue light emitted from the blue light emitting diodes, and a transparent layer allowing blue light emitted from the blue light emitting diodes to pass therethrough without wavelength conversion; and
the filter unit comprises a green light portion disposed on the green phosphor layer and blocking light of a predetermined wavelength among light having passed through the green phosphor layer, a red light portion disposed on the red phosphor layer and blocking light of a predetermined wavelength among light having passed through the red phosphor layer, and a transparent portion disposed on the transparent layer and allowing light having passed through the transparent layer to pass therethrough without wavelength conversion.

5. The display apparatus according to claim 4, wherein the phosphor layer further comprises a blocking layer disposed between the green phosphor layer, the red phosphor layer, and the transparent layer; and
the filter unit further comprises a light blocking portion disposed between the green light portion, the red light portion, and the transparent portion.

6. The display apparatus according to claim 4, wherein the green light portion allows only green light to pass therethrough and the red light portion allows only red light to pass therethrough.

7. The display apparatus according to claim 3, wherein the light emitting diodes comprise blue light emitting diodes;
the phosphor layer comprises a green phosphor layer emitting green light through wavelength conversion of blue light emitted from the blue light emitting diodes, a red phosphor layer emitting red light through wavelength conversion of blue light emitted from the blue light emitting diodes, and a transparent layer allowing blue light emitted from the blue light emitting diodes to pass therethrough without wavelength conversion; and
the filter unit comprises wavelength filter units disposed on the green phosphor layer and the red phosphor layer, respectively, and blocking light of a predetermined wavelength among light having passed through the green phosphor layer and the red phosphor layer, and a transparent portion disposed on the transparent layer and allowing light having passed through the transparent layer to pass therethrough without wavelength conversion.

8. The display apparatus according to claim 7, wherein the wavelength filter unit allows green light and red light to pass therethrough and blocks blue light.

9. The display apparatus according to claim 3, wherein the light emitting diodes comprise blue light emitting diodes;
the phosphor layer comprises a green phosphor layer emitting green light through wavelength conversion of blue light emitted from the blue light emitting diodes, a red phosphor layer emitting red light through wavelength conversion of blue light emitted from the blue light emitting diodes, a transparent layer allowing blue light emitted from the blue light emitting diodes to pass therethrough without wavelength conversion, and a white phosphor layer emitting white light through wavelength conversion of blue light emitted from the blue light emitting diodes; and
the filter unit comprises a green light portion disposed on the green phosphor layer and blocking light of a predetermined wavelength among light having passed through the green phosphor layer, a red light portion disposed on the red phosphor layer and blocking light of a predetermined wavelength among light having passed through the red phosphor layer, and a transparent portion disposed on the transparent layer and the white phosphor layer and allowing light having passed through the transparent layer and the white phosphor layer to pass therethrough without wavelength conversion.

10. The display apparatus according to claim 3, wherein the light emitting diodes comprise UV light emitting diodes emitting UV light;
the phosphor layer comprises a blue phosphor layer emitting blue light through wavelength conversion of UV light emitted from the UV light emitting diodes, a green phosphor layer emitting green light through wavelength conversion of UV light emitted from the UV light emitting diodes, and a red phosphor layer emitting red light through wavelength conversion of UV light emitted from the UV light emitting diodes; and
the filter unit comprises a blue light portion disposed on the blue phosphor layer and blocking light of a predetermined wavelength among light having passed through the blue phosphor layer, a green light portion disposed on the green phosphor layer and blocking light of a predetermined wavelength among light having passed through the green phosphor layer, and a red light portion disposed on the red phosphor layer and blocking light of a predetermined wavelength among light having passed through the red phosphor layer.

11. The display apparatus according to claim 10, wherein the blue light portion allows only blue light to pass therethrough, the green light portion allows only green light to pass therethrough, and the red light portion allows only red light to pass therethrough.

12. The display apparatus according to claim 1, wherein each of the plurality of light emitting diodes comprises:

an n-type semiconductor layer;
a p-type semiconductor layer;
an active layer interposed between the n-type semiconductor layer and the p-type semiconductor layer;
an n-type electrode coupled to the n-type semiconductor layer; and
a p-type electrode coupled to the p-type semiconductor layer.

13. The display apparatus according to claim 1, further comprising:
an anisotropic conductive film electrically connecting the first substrate to the second substrate.

14. A method of manufacturing a display apparatus, comprising:

forming a first substrate having a plurality of light emitting diodes regularly arranged thereon;

forming a second substrate comprising a TFT panel part comprising a plurality of TFTs driving the plurality of light emitting diodes;
forming a third substrate comprising a light converter converting light emitted from the first substrate; and coupling the first to third substrates to one another,
wherein light emitted from the plurality of light emitting diodes is converted into one of blue light, green light and red light through the light converter.

15. The method of manufacturing a display apparatus according to claim 14, wherein the first substrate and the second substrate are coupled to each other to face each other such that the light emitting diodes are electrically connected to the TFTs, respectively, and the first substrate is coupled to the third substrate to face each other.

16. The method of manufacturing a display apparatus according to claim 14, wherein forming the third substrate comprises:

forming a filter unit on a protective substrate, the filter unit blocking light of a predetermined wavelength among light passing therethrough on a protective substrate; and
forming a phosphor layer on the filter unit, the phosphor layer converting the wavelength of light passing therethrough.

17. The method of manufacturing a display apparatus according to claim 16, wherein the light emitting diodes comprise blue light emitting diodes;
the phosphor layer comprises a green phosphor layer emitting green light through wavelength conversion of blue light emitted from the blue light emitting diodes, a red phosphor layer emitting red light through wavelength conversion of blue light emitted from the blue light emitting diodes, and a transparent layer allowing blue light emitted from the blue light emitting diodes to pass therethrough without wavelength conversion; and
the filter unit comprises a green light portion disposed on the green phosphor layer and blocking light of a predetermined wavelength among light having passed through the green phosphor layer, a red light portion disposed on the red phosphor layer and blocking light of a predetermined wavelength among light having passed through the red phosphor layer, and a transparent portion disposed on the transparent layer and allowing light having passed through the transparent layer to pass therethrough without wavelength conversion.

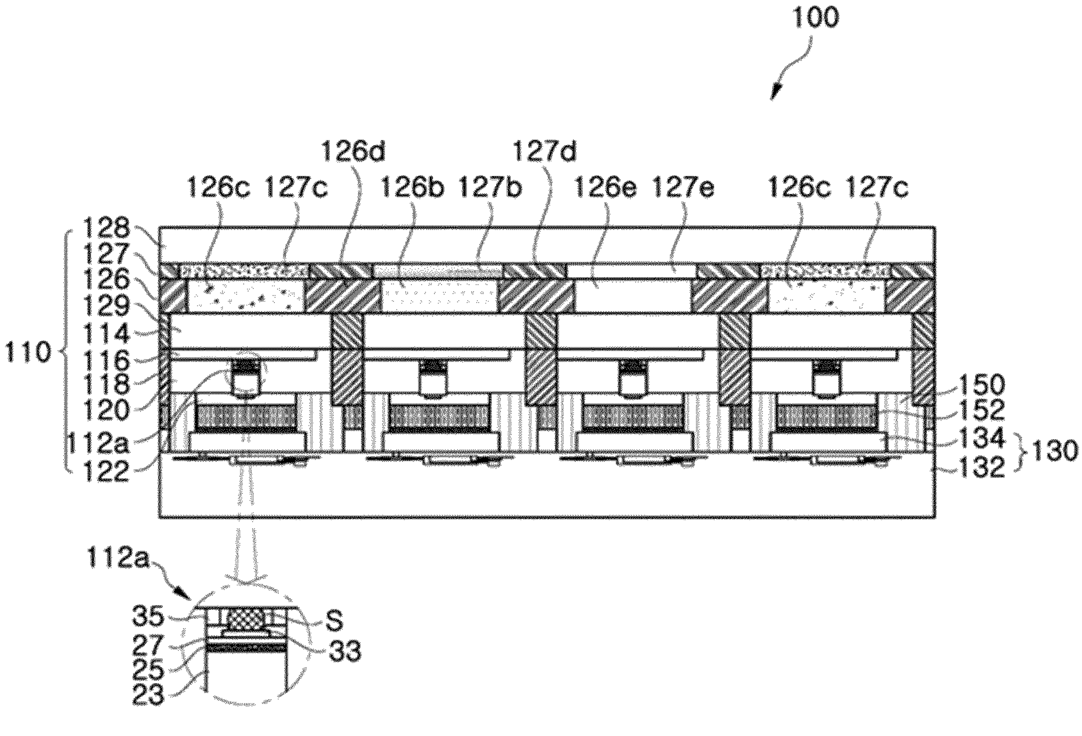
18. The method of manufacturing a display apparatus according to claim 16, wherein the light emitting diodes comprise blue light emitting diodes;
the phosphor layer comprises a green phosphor layer emitting green light through wavelength conversion of blue light emitted from the blue light emitting diodes, a red phosphor layer emitting red light through wavelength conversion of blue light emitted from the blue light emitting diodes, and a transparent layer allowing blue light emitted from the blue light emitting diodes to pass therethrough without wavelength conversion; and
the filter unit comprise wavelength filter units disposed on the green phosphor layer and the red phosphor layer, respectively, and blocking light of a predetermined wavelength among light having passed through the green phosphor layer and the red phosphor layer, and a transparent portion disposed on the transparent layer and allowing light having passed through the transparent layer to pass therethrough without wavelength conversion.

19. The method of manufacturing a display apparatus according to claim 16, wherein the light emitting diodes comprise blue light emitting diodes;
the phosphor layer comprises a green phosphor layer emitting green light through wavelength conversion of blue light emitted from the blue light emitting diodes, a red phosphor layer emitting red light through wavelength conversion of blue light emitted from the blue light emitting diodes, a transparent layer allowing blue light emitted from the blue light emitting diodes to pass therethrough without wavelength conversion, and a white phosphor layer emitting white light through wavelength conversion of blue light emitted from the blue light emitting diodes; and
the filter unit comprises a green light portion disposed on the green phosphor layer and blocking light of a predetermined wavelength among light having passed through the green phosphor layer, a red light portion disposed on the red phosphor layer and blocking light of a predetermined wavelength among light having passed through the red phosphor layer, and a transparent portion disposed on the transparent layer and the white phosphor layer and allowing light having passed through the transparent layer and the white phosphor layer to pass therethrough without wavelength conversion.

20. The method of manufacturing a display apparatus according to claim 16, wherein the light emitting diodes comprise UV light emitting diodes emitting UV light;

the phosphor layer comprises a blue phosphor layer emitting blue light through wavelength conversion of UV light emitted from the UV light emitting diodes, a green phosphor layer emitting green light through wavelength conversion of UV light emitted from the UV light emitting diodes, and a red phosphor layer emitting red light through wavelength conversion of UV light emitted from the UV light emitting diodes; and
the filter unit comprises a blue light portion disposed on the blue phosphor layer and blocking light of a predetermined wavelength among light having passed through the blue phosphor layer, a green light portion disposed on the green phosphor layer and blocking light of a predetermined wavelength among light having passed through the green phosphor layer, and a red light portion disposed on the red phosphor layer and blocking light of a predetermined wavelength among light having passed through the red phosphor layer.

【FIG. 1】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127d
126c 127c
126b 127b
126e 127e
126c 127c
128
127
126
129
114
110
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118
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112a
122
150
152
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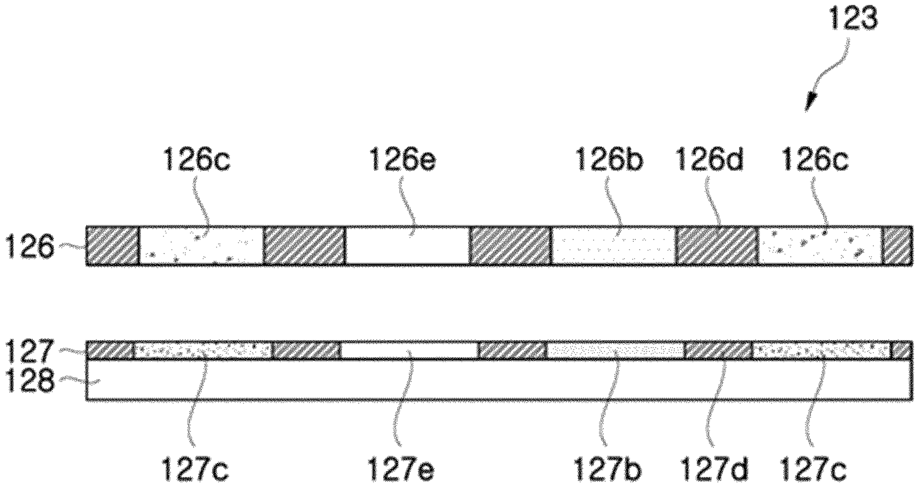
132
130
112a
35
27
25
23
S
33

【FIG. 2】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126e
126b
126d
126c
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127c
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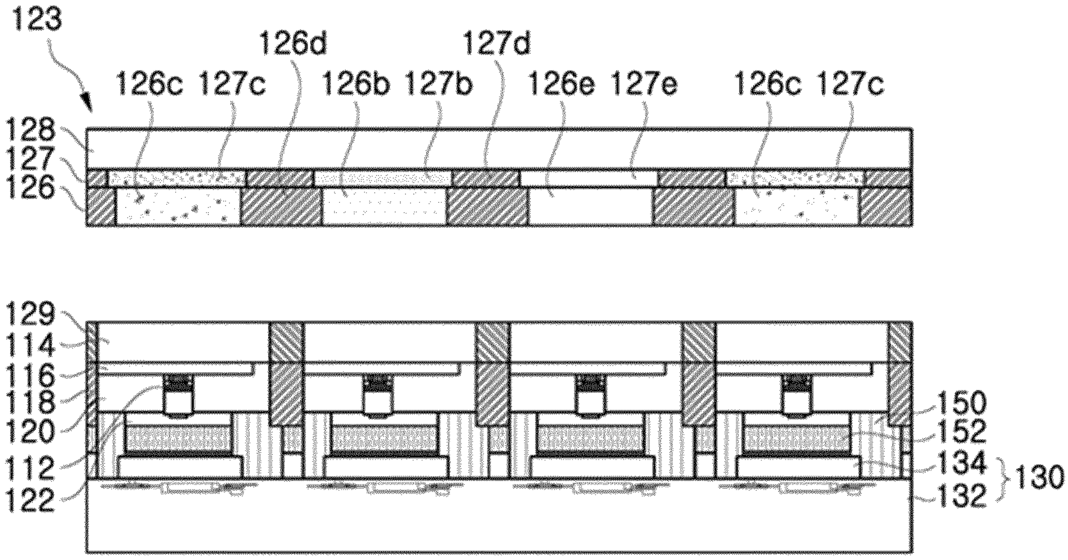
127b
127d
127c

(a)


123
126d
127d
126c 127c
126b 127b
126e 127e
126c 127c
128
127
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114
116
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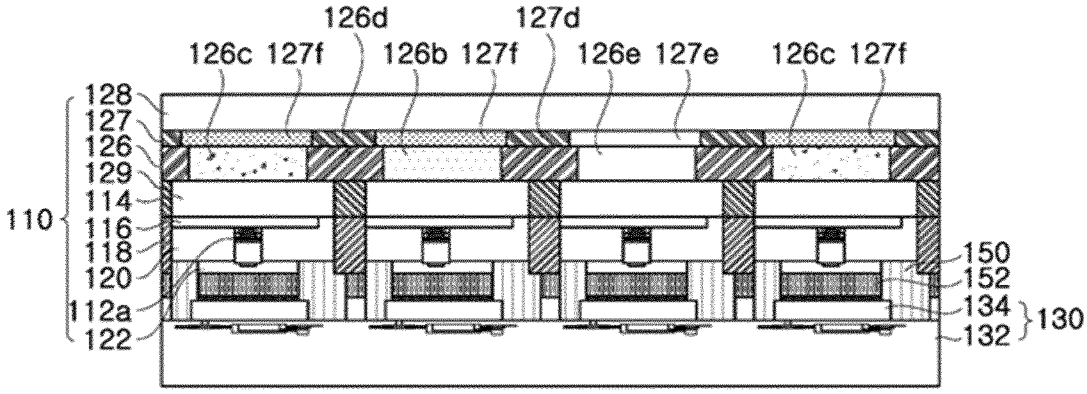
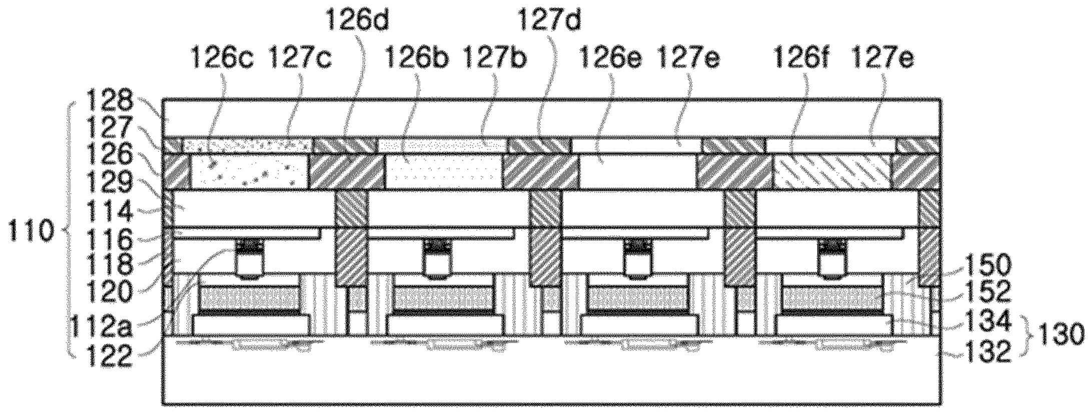
120
112
122
150
152
134
132
130

(b)

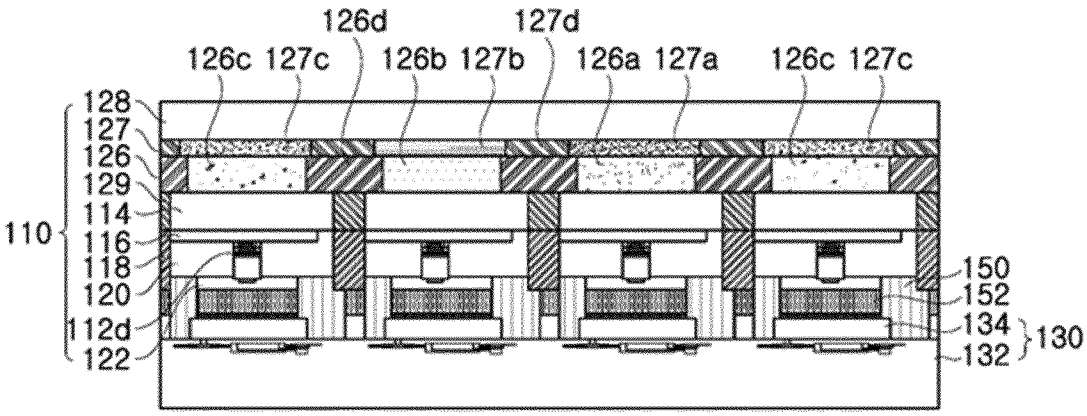
【FIG. 3】



【FIG. 4】



【FIG. 5】



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2017/003562

A. CLASSIFICATION OF SUBJECT MATTER

H01L 27/15(2006.01)i, H01L 33/50(2010.01)i, H01L 33/58(2010.01)i, H05B 33/12(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01L 27/15; H01L 27/32; H05B 33/12; G09F 9/33; G02B 5/20; H01L 33/36; H05B 33/02; H01L 33/04; H01L 51/56; H01L 33/50; H01L 33/58

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models: IPC as above
Japanese Utility models and applications for Utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS (KIPO internal) & Keywords: display, light emitting diode, TFT panel part, optical change part, counter, blue light, green light, red light, phosphor layer, filter part

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR 10-2015-0077764 A (LG DISPLAY CO., LTD.) 08 July 2015 See paragraphs [0025]-[0050], [0063]-[0076] and figures 2, 7.	1-20
A	KR 10-1524726 B1 (SILICON DISPLAY TECHNOLOGY) 10 June 2015 See paragraphs [0026]-[0048] and figures 1-2.	1-20
A	KR 10-2013-0137985 A (LG ELECTRONICS INC.) 18 December 2013 See paragraphs [0038]-[0070] and figure 1.	1-20
A	US 2015-0249120 A1 (BOE TECHNOLOGY GROUP CO., LTD.) 03 September 2015 See paragraphs [0037]-[0041] and figure 1.	1-20
A	JP 2013-037138 A (PANASONIC CORP.) 21 February 2013 See paragraphs [0023]-[0041] and figures 1-2.	1-20

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 JULY 2017 (20.07.2017)	**20 JULY 2017 (20.07.2017)**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office Government Complex-Daejeon, 189 Seonsa-ro, Daejeon 302-701, Republic of Korea Facsimile No. +82-42-481-8578	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2017/003562

Patent document cited in search report	Publication date	Patent family member	Publication date
KR 10-2015-0077764 A	08/07/2015	NONE	
KR 10-1524726 B1	10/06/2015	WO 2015-194870 A1	23/12/2015
KR 10-2013-0137985 A	18/12/2013	KR 10-1476207 B1	24/12/2014
US 2015-0249120 A1	03/09/2015	CN 103456764 A	18/12/2013
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		US 9543368 B2	10/01/2017
		WO 2015-032240 A1	12/03/2015
JP 2013-037138 A	21/02/2013	NONE	

Form PCT/ISA/210 (patent family annex) (January 2015)

专利名称(译)	显示装置及其制造方法		
公开(公告)号	EP3439042A1	公开(公告)日	2019-02-06
申请号	EP2017775902	申请日	2017-03-31
[标]申请(专利权)人(译)	首尔半导体股份有限公司		
申请(专利权)人(译)	首尔半导体CO.，LTD.		
当前申请(专利权)人(译)	首尔半导体CO.，LTD.		
[标]发明人	TAKEYA MOTONOBU LEE JONG IK KIM YOUNG HYUN		
发明人	TAKEYA, MOTONOBU LEE, JONG IK KIM, YOUNG HYUN		
IPC分类号	H01L27/15 H01L33/50 H01L33/58 H05B33/12		
CPC分类号	H01L25/0753 H01L25/167 H01L33/50 H01L2933/0041		
优先权	62/316927 2016-04-01 US		
其他公开文献	EP3439042A4		
外部链接	Espacenet		

摘要(译)

显示装置及其制造方法。该显示装置包括第一基板，该第一基板包括规则地布置在其上的多个发光二极管;第二基板，包括TFT面板部分，所述TFT面板部分包括驱动所述多个发光二极管的多个TFT;第三基板包括转换从第一基板发射的光的光转换器，其中第一基板和第二基板彼此连接以便彼此面对，发光二极管分别电连接到TFT。第一基板和第三基板彼此耦合以彼此面对，并且从多个发光二极管发射的光通过光转换器被转换为蓝光，绿光和红光中的至少一种。该显示装置采用由氮化物半导体形成的微发光二极管，因此可以提供高效率和高分辨率，以适用于可穿戴设备，同时降低功耗。