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Takeya et al.

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(54) **DISPLAY APPARATUS AND MANUFACTURING METHOD THEREOF**

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(51) **Int. Cl.**
H01L 27/14 (2006.01)
H01L 25/16 (2006.01)
(Continued)

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CPC ***H01L 25/167*** (2013.01); ***H01L 21/6835*** (2013.01); ***H01L 24/19*** (2013.01);
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CPC H01L 25/167; H01L 25/0753; H01L 27/1214; H01L 33/0079; H01L 33/06;
(Continued)

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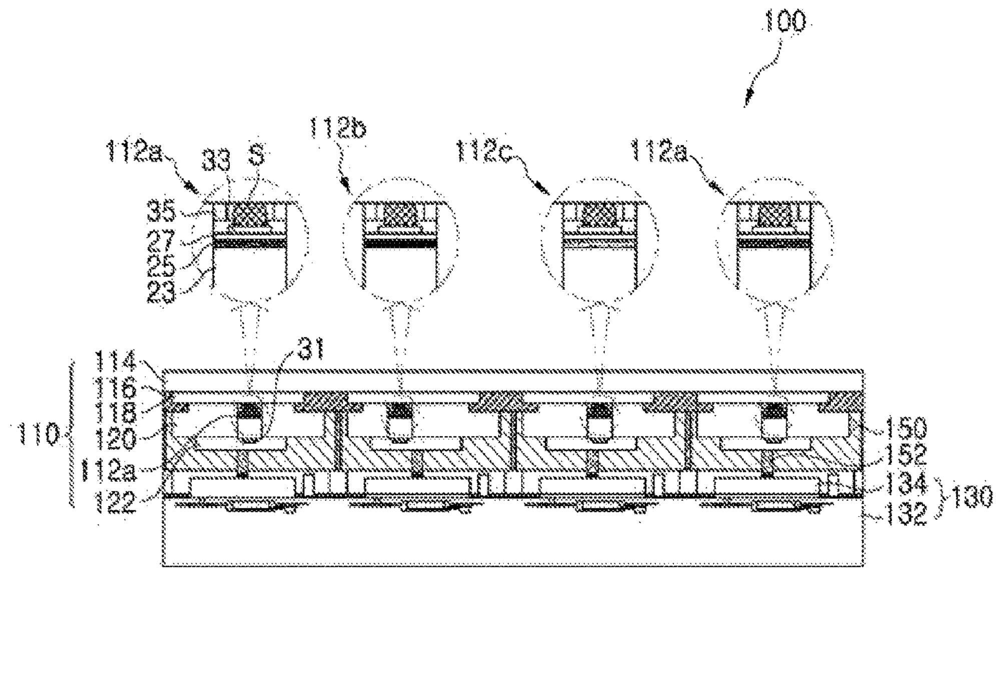
(57) **ABSTRACT**

A display apparatus and a method of manufacturing the same are disclosed. The display apparatus includes: a first substrate including a light emitting diode part including a plurality of light emitting diodes regularly arranged on the first substrate; and a second substrate including a TFT panel unit including a plurality of TFTs driving the light emitting diodes. The first substrate and the second substrate are coupled to each other so as to face each other such that the light emitting diodes are electrically connected to the TFTs, respectively. The display apparatus is implemented using 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.

16 Claims, 16 Drawing Sheets



(51) **Int. Cl.**

H01L 25/075	(2006.01)
H01L 27/12	(2006.01)
H01L 33/00	(2010.01)
H01L 33/06	(2010.01)
H01L 33/32	(2010.01)
H01L 33/38	(2010.01)
H01L 33/50	(2010.01)
H01L 33/58	(2010.01)
H01L 33/62	(2010.01)
H05B 33/12	(2006.01)
H01L 23/00	(2006.01)
H01L 21/683	(2006.01)
G09G 3/32	(2016.01)

(52) **U.S. Cl.**

CPC ***H01L 24/97*** (2013.01); ***H01L 25/0753*** (2013.01); ***H01L 27/1214*** (2013.01); ***H01L 33/0079*** (2013.01); ***H01L 33/06*** (2013.01); ***H01L 33/325*** (2013.01); ***H01L 33/38*** (2013.01); ***H01L 33/502*** (2013.01); ***H01L 33/58*** (2013.01); ***H01L 33/62*** (2013.01); ***H05B 33/12*** (2013.01); *G09G 3/32* (2013.01); *G09G 2300/04* (2013.01); *G09G 2300/0452* (2013.01); *G09G 2300/08* (2013.01); *H01L 2221/68322* (2013.01); *H01L 2221/68327* (2013.01); *H01L 2221/68336* (2013.01); *H01L 2221/68354* (2013.01); *H01L 2221/68368* (2013.01); *H01L 2924/12041* (2013.01); *H01L 2933/0066* (2013.01)

(58) **Field of Classification Search**

CPC H01L 33/325; H01L 33/38; H01L 33/502; H01L 33/58; H01L 33/62; H01L 2933/0066; G09G 3/32; G09G 2300/04

USPC 257/72

See application file for complete search history.

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FIG. 1

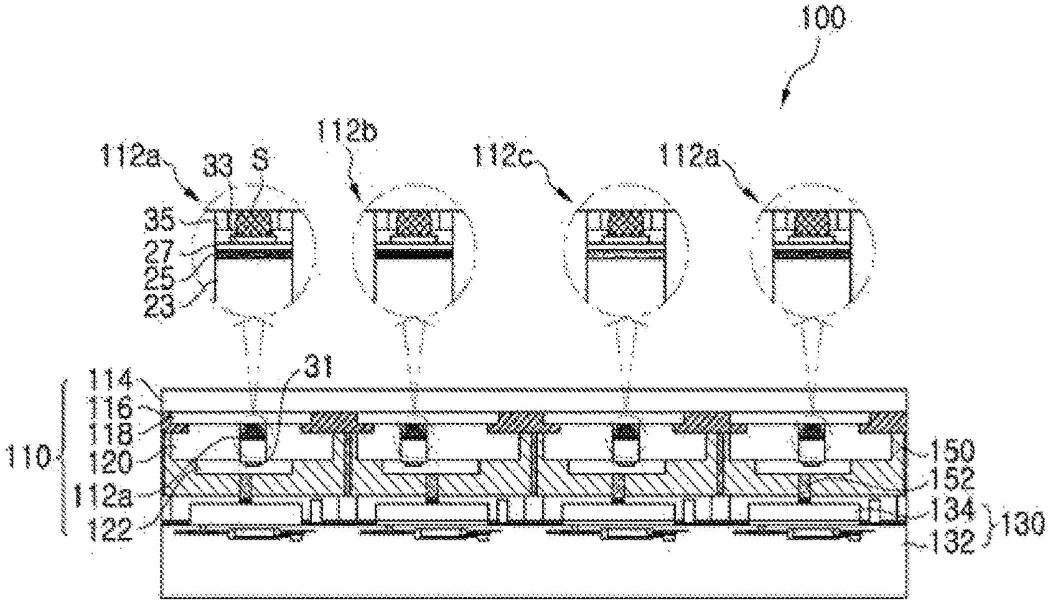
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FIG. 2

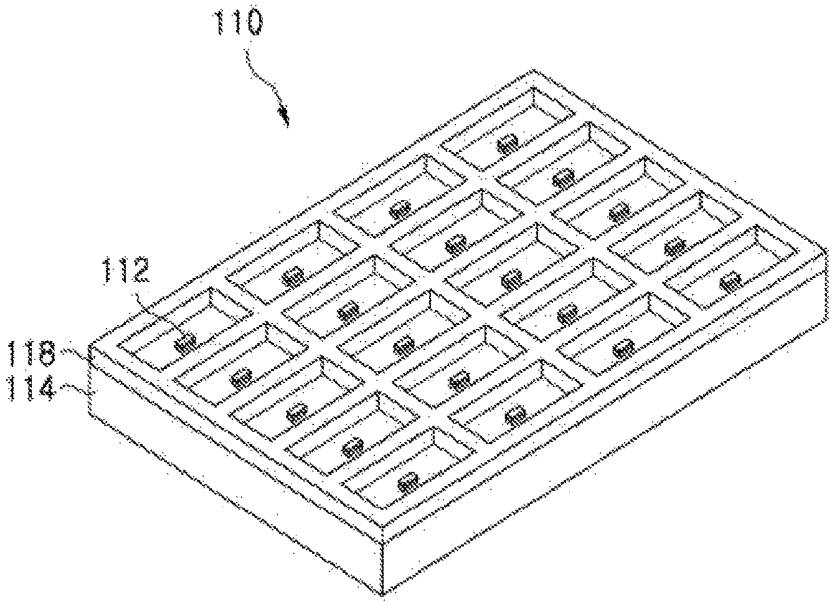
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FIG. 3A

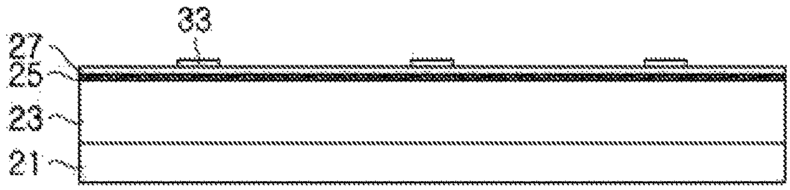


FIG. 3B

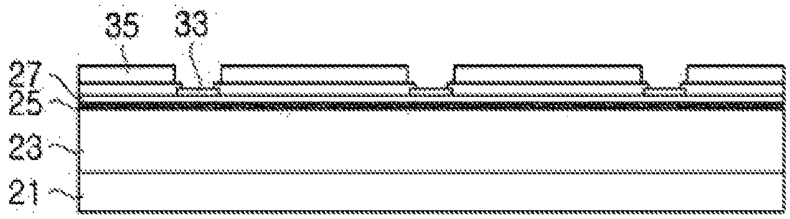


FIG. 3C

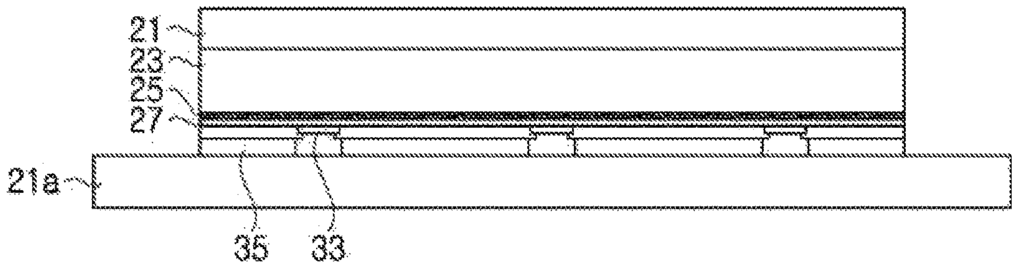


FIG. 3D

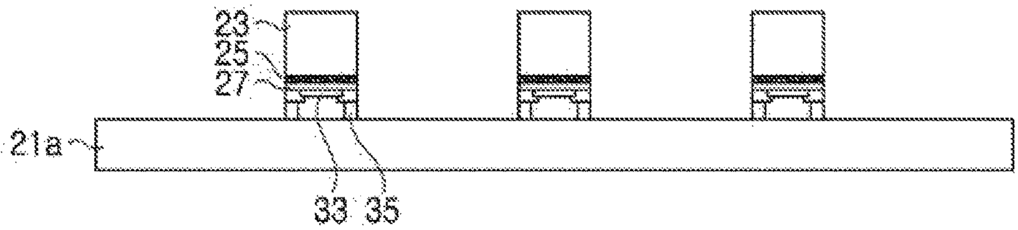


FIG. 3E

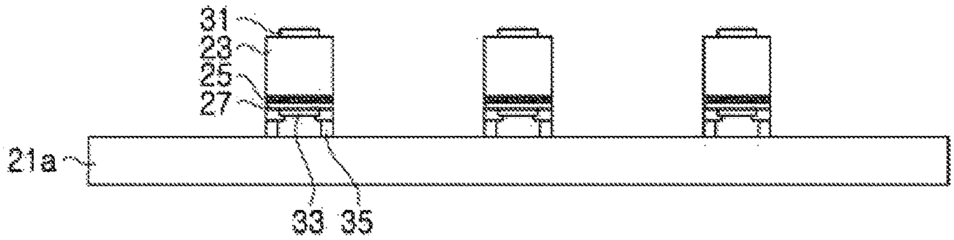


FIG. 3F

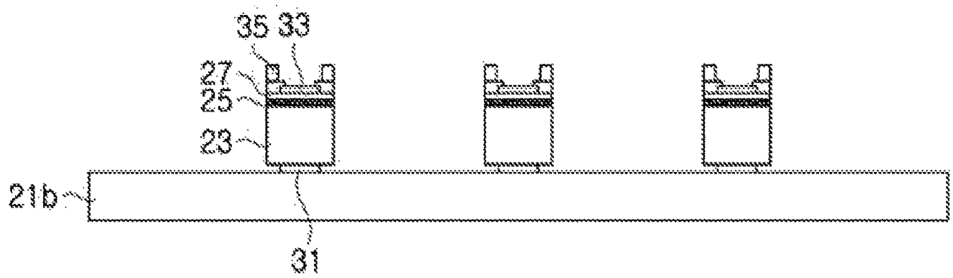


FIG. 3G

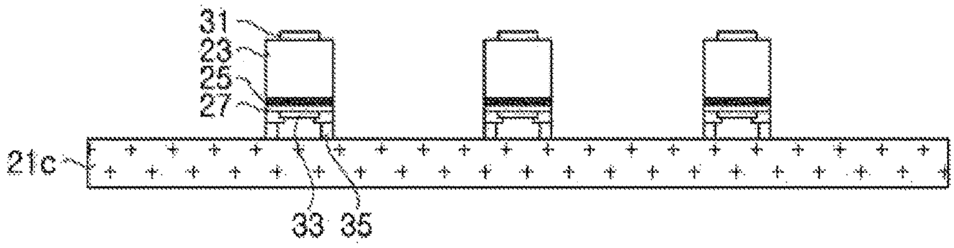


FIG. 3H

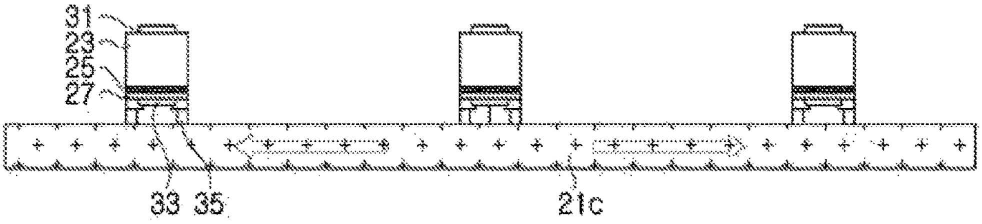
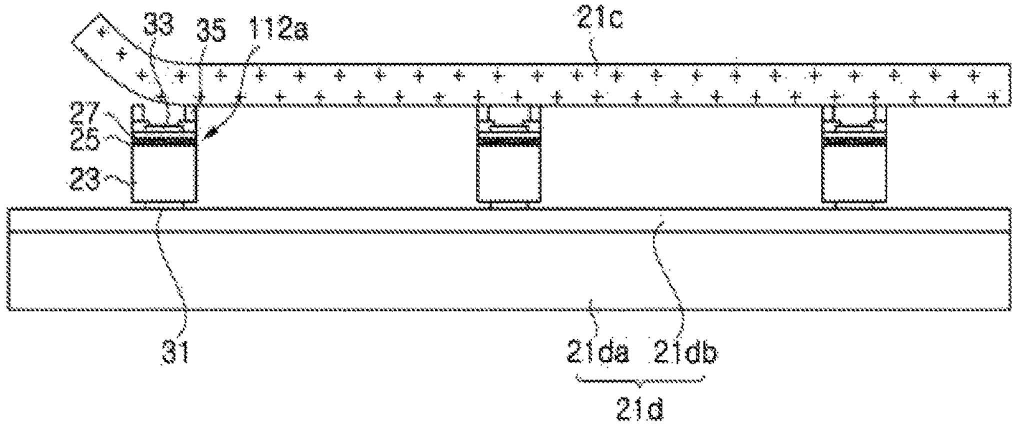


FIG. 3I



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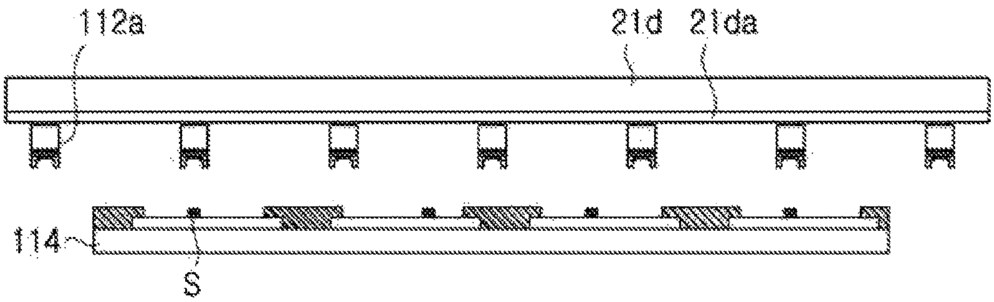


FIG. 3K

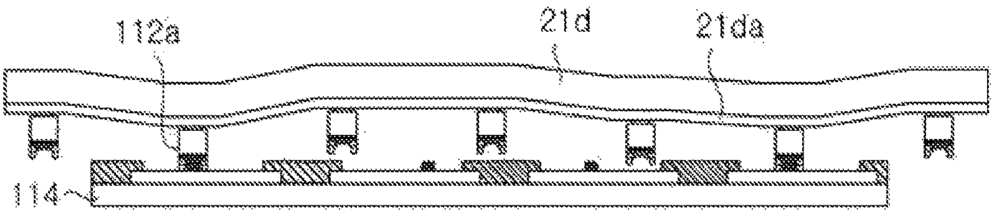
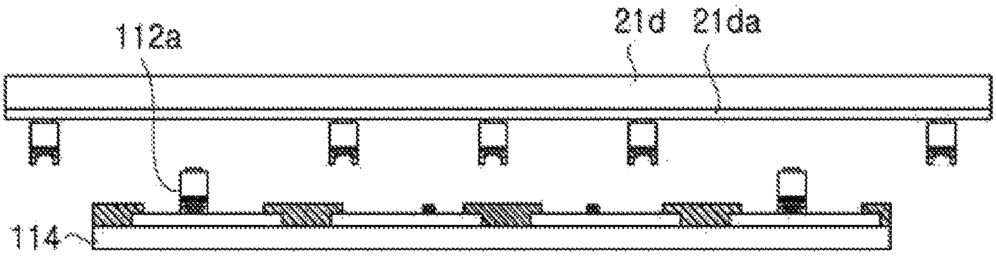


FIG. 3L



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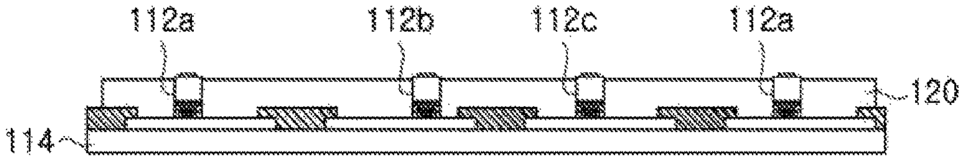


FIG. 3N

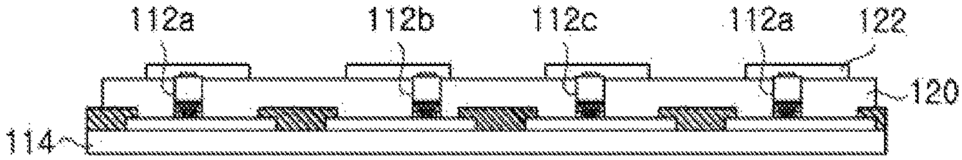


FIG. 3O

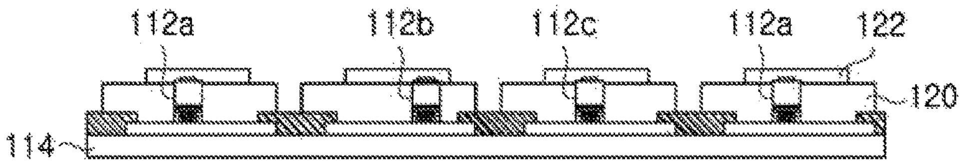


FIG. 3P

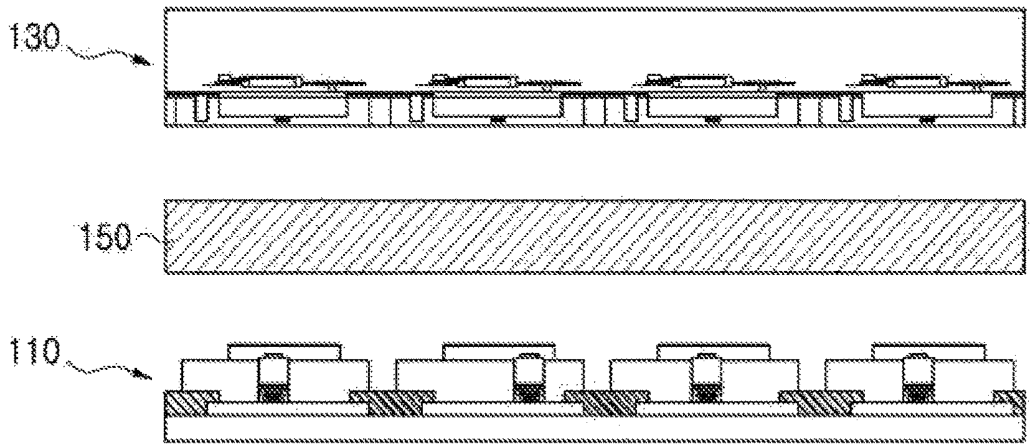


FIG. 4A

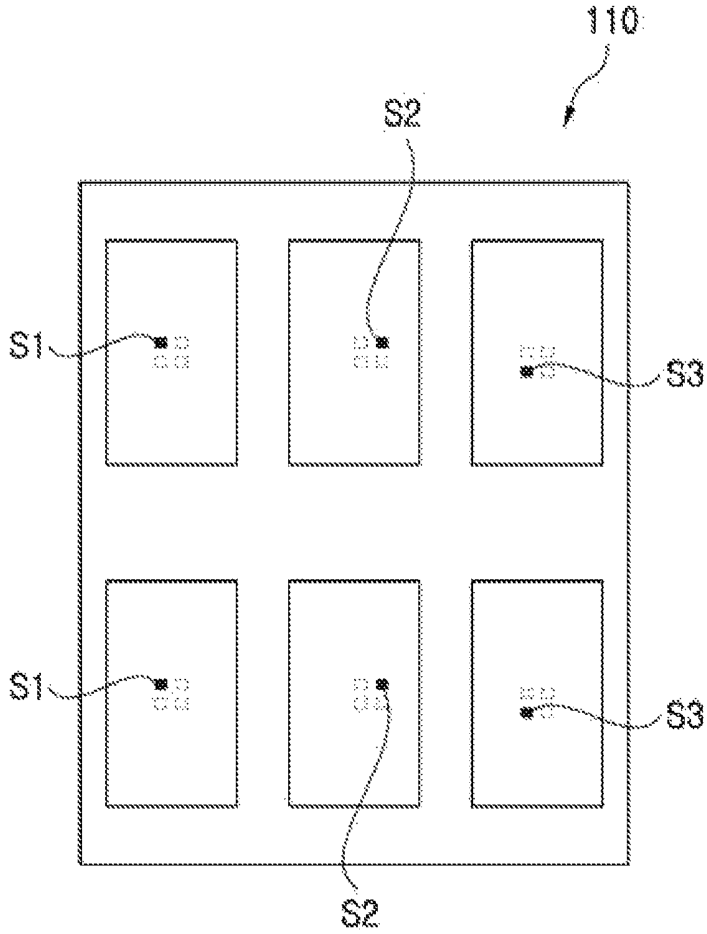


FIG. 4B

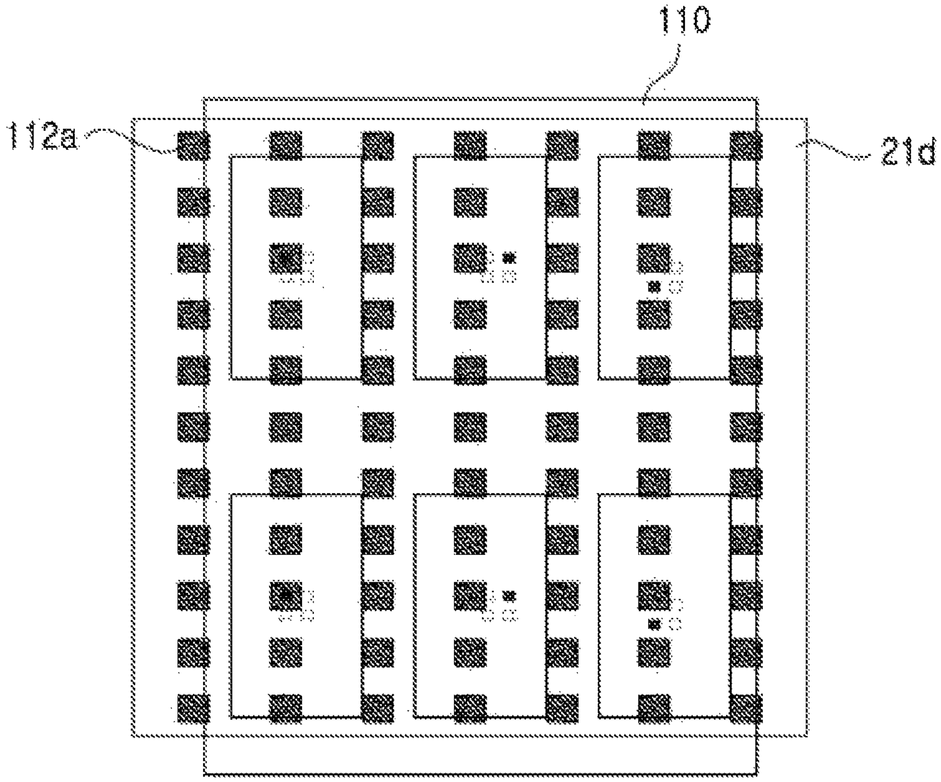


FIG. 4C

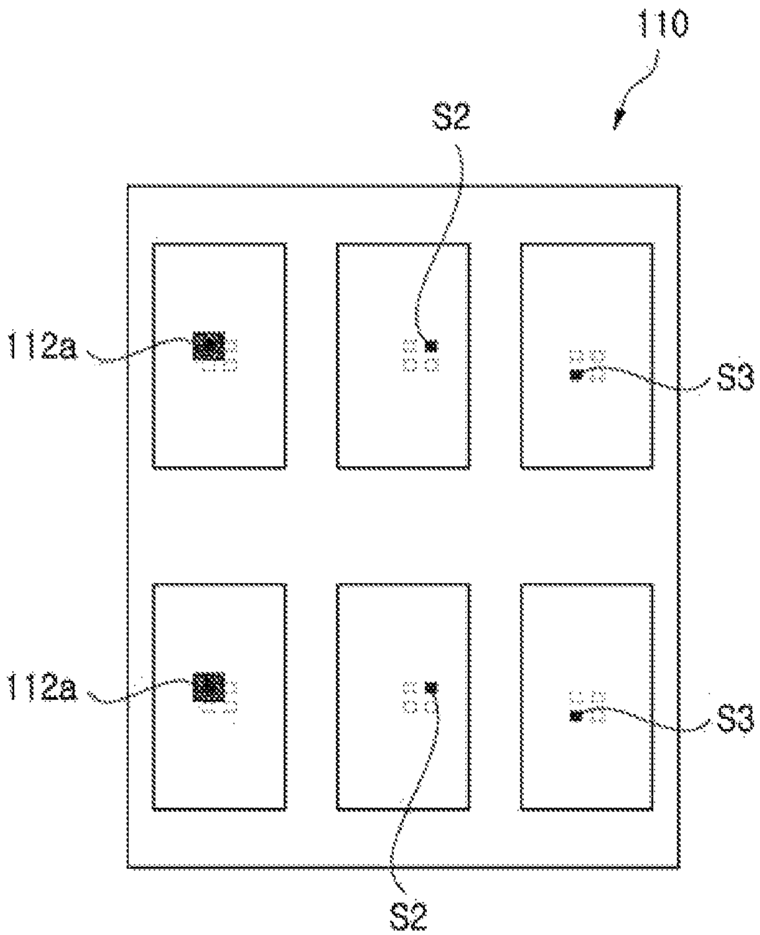


FIG. 4D

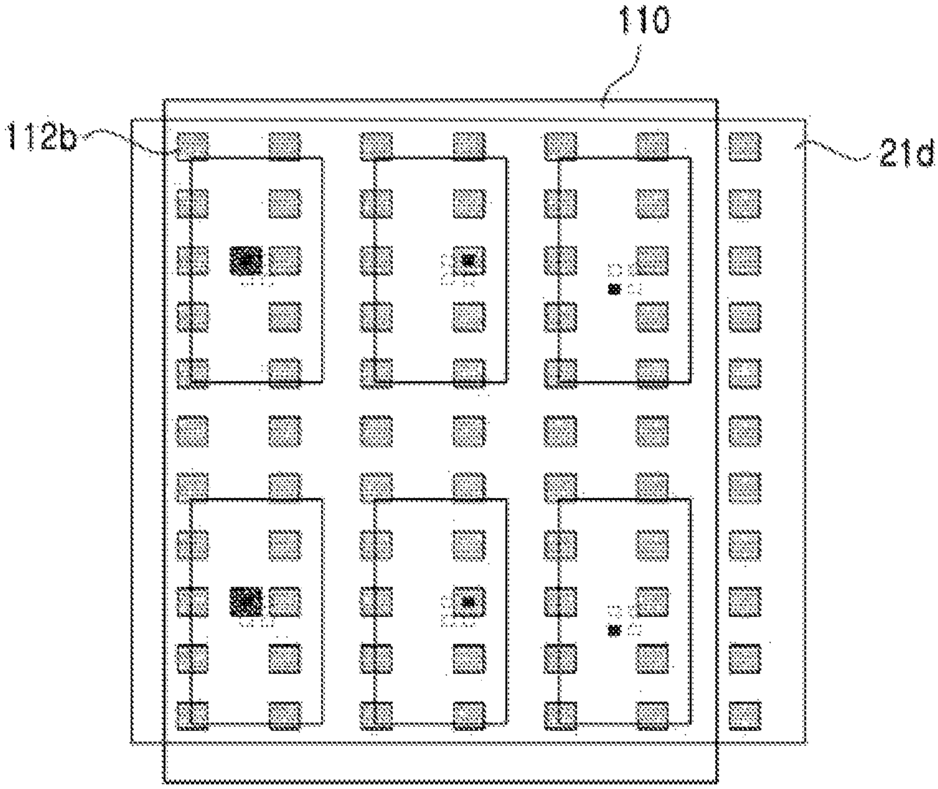


FIG. 4E

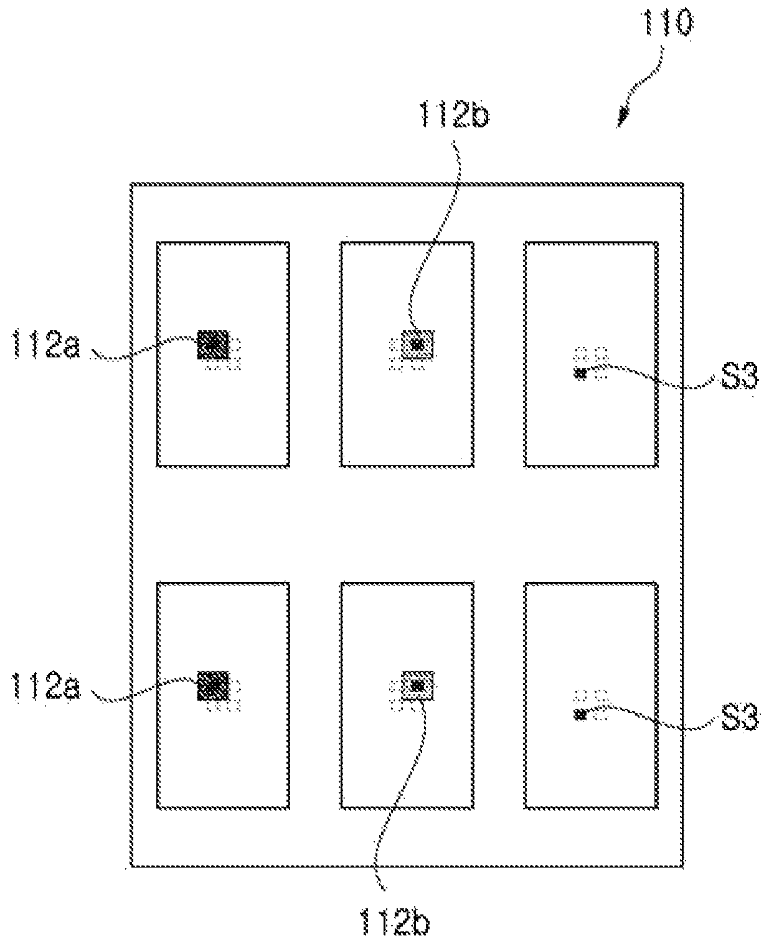


FIG. 4F

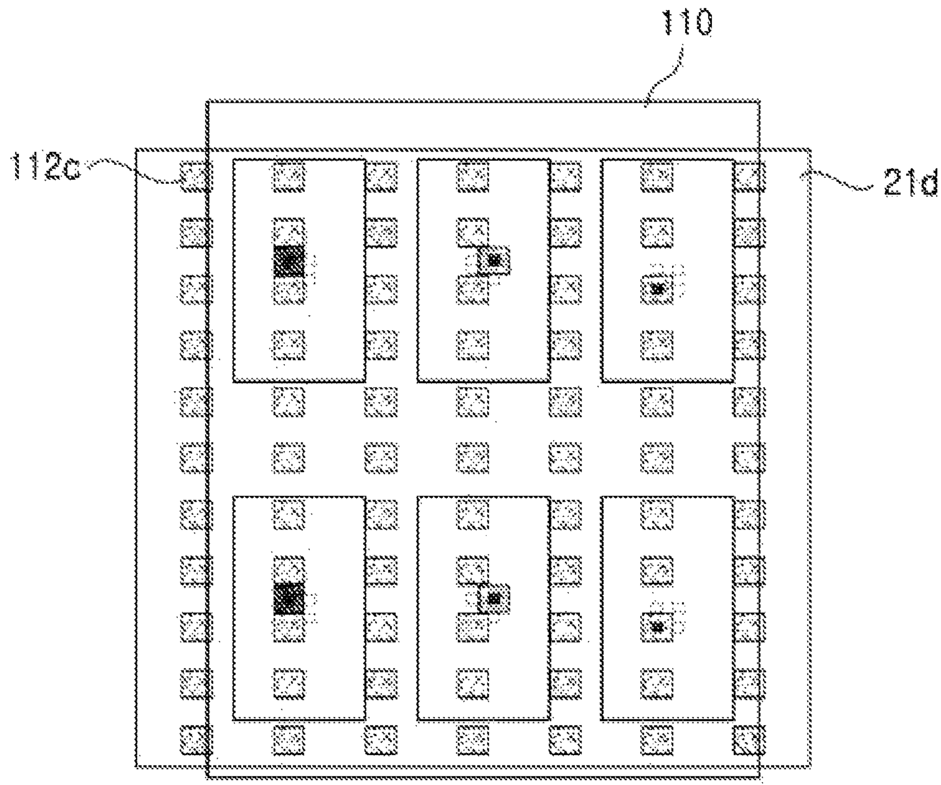


FIG. 4G

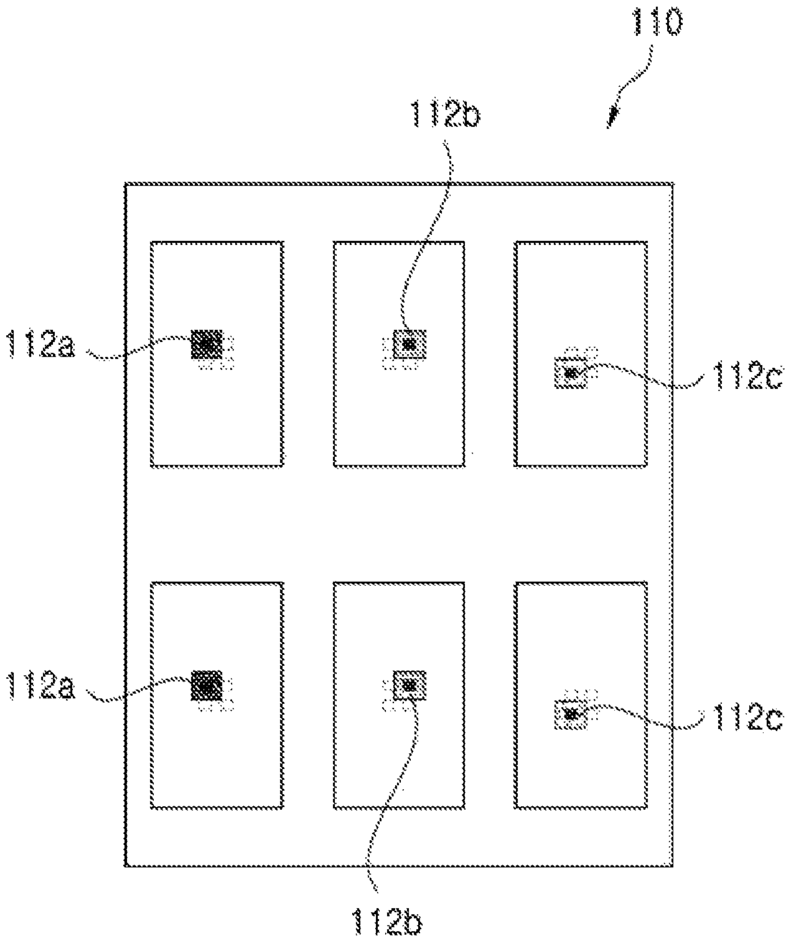


FIG. 5

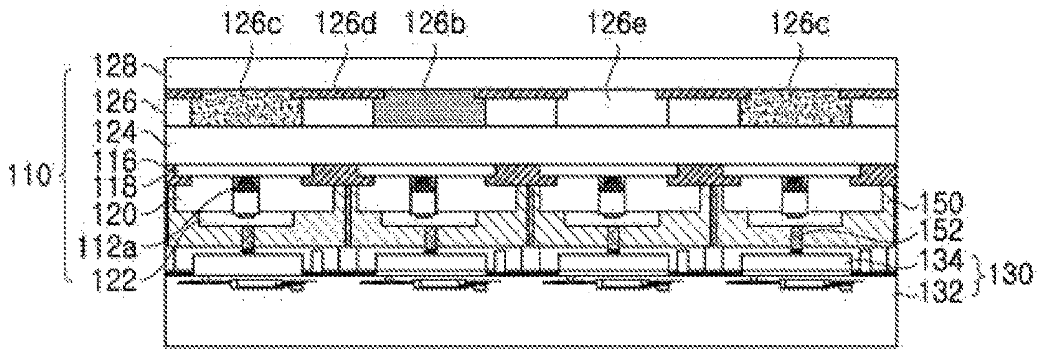


FIG. 6

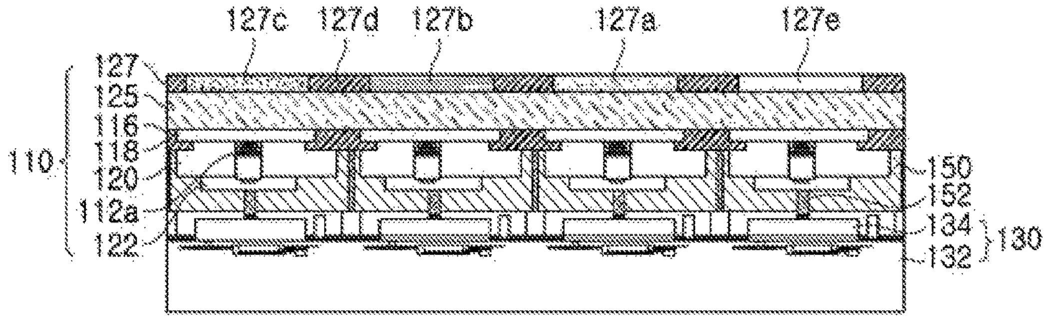


FIG. 7

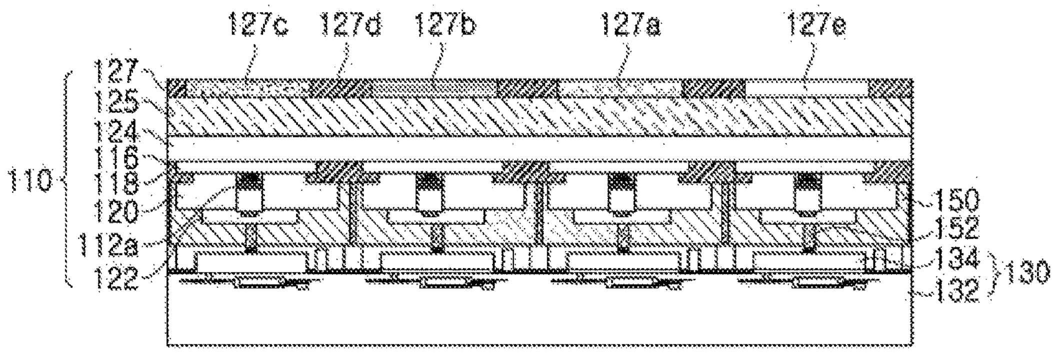


FIG. 8A

FIG. 8B

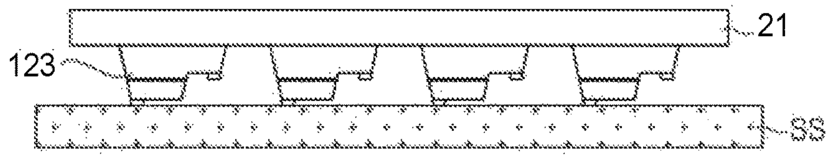


FIG. 8C

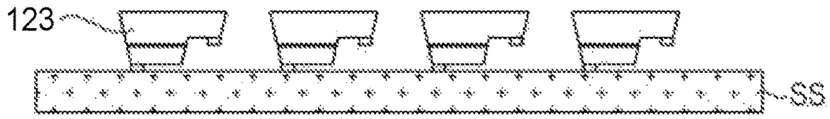


FIG. 8D

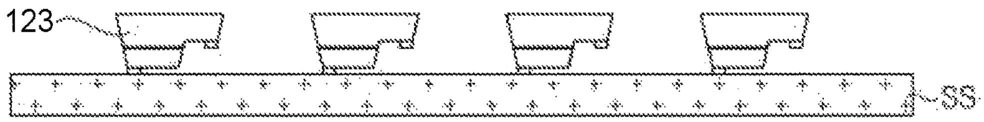


FIG. 8E

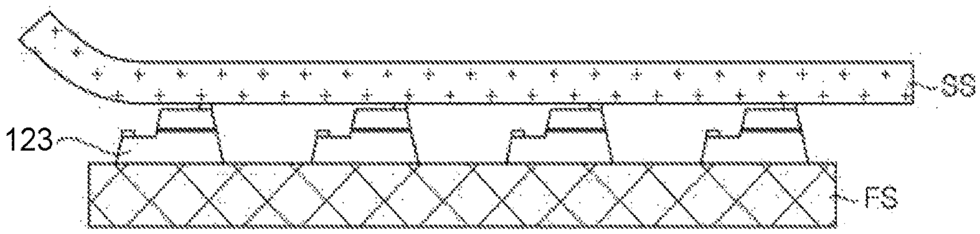
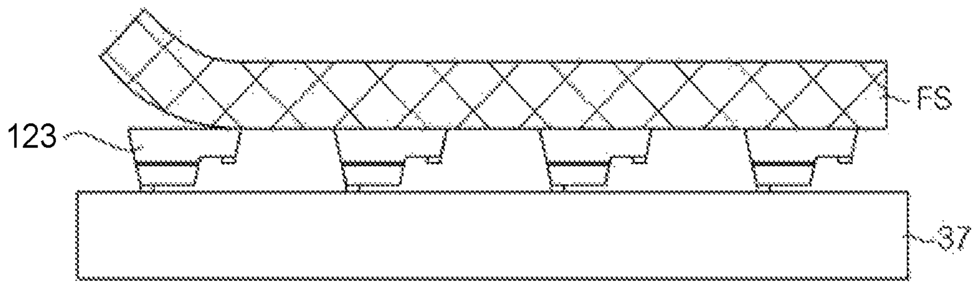


FIG. 8F



DISPLAY APPARATUS AND MANUFACTURING METHOD THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to and the benefit of U.S. provisional patent application Nos. 62/196,282, filed on Jul. 23, 2015, and 62/267,770, filed on Dec. 15, 2015, each of which is incorporated by reference for all purposes as if fully set forth herein.

BACKGROUND

Field

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.

Discussion of the Background

A light emitting diode refers to an inorganic semiconductor device configured to emit light through recombination of electrons and holes, and has been used in various fields including displays, automobile lamps, general lighting, and the like. Since the light emitting diode has various advantages such as long lifespan, low power consumption, and rapid response, it is expected that a light emitting device using the light emitting diode will replace existing light sources.

Recently, smart TVs or monitors have realized 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). However, for a TFT-LCD, since one LED is used as a light source for many pixels, a light source of a backlight unit is always turned on. Accordingly, the TFT-LCD suffers from constant power consumption regardless of brightness on a displayed screen. In order to compensate for this problem, some display apparatuses are configured to divide a screen into several regions so as to allow control of brightness in these regions. However, since several to dozens of thousands of pixels are used as a unit for division of the screen, it is difficult to achieve accurate regulation of brightness while reducing power consumption. On the other hand, although an OLED has continuously reduced power consumption through development of technology, the OLED still has much higher power consumption than LEDs formed of inorganic semiconductors, and thus has low efficiency.

In addition, 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.

The above information disclosed in this Background section is only for enhancement of understanding of the background of the inventive concept, and, therefore, it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

SUMMARY

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

Exemplary embodiments provide a display apparatus providing low power consumption and enabling accurate regulation of brightness and a method of manufacturing the same.

Additional aspects will be set forth in the detailed description which follows, and, in part, will be apparent from the disclosure, or may be learned by practice of the inventive concept.

An exemplary embodiment discloses a display apparatus including: a first substrate including a light emitting diode part including a plurality of light emitting diodes regularly arranged on the first substrate; and a second substrate including a TFT panel unit including a plurality of TFTs driving the light emitting diodes, wherein the first substrate and the second substrate are coupled to each other so as to face each other such that the light emitting diodes are electrically connected to the TFTs, respectively.

The display apparatus may also include: a support substrate; a plurality of blue light emitting diodes arranged on an upper surface of the support substrate; a plurality of green light emitting diodes arranged on the upper surface of the support substrate to be placed adjacent the plurality of blue light emitting diodes; and a plurality of red light emitting diodes arranged on the upper surface of the support substrate to be placed adjacent either the plurality of blue light emitting diodes or the plurality of green light emitting diodes.

Each of the plurality of blue light emitting diodes, the plurality of green light emitting diodes and the plurality of red 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; a p-type electrode coupled to the p-type semiconductor layer; and a wall surrounding the p-type electrode.

The display apparatus may further include a first bonding portion bonding the plurality of blue light emitting diodes to the support substrate; a second bonding portion bonding the plurality of green light emitting diodes to the support substrate; and a third bonding portion bonding the plurality of red light emitting diodes to the support substrate, and the first to third bonding portions may have different melting points.

The display apparatus may further include an anisotropic conductive film electrically connecting the light emitting diode part to the TFT panel unit.

The plurality of light emitting diodes may include blue light emitting diodes emitting blue light, and the display apparatus may further include a wavelength conversion part including at least one of a blue light portion emitting the blue light, a green light portion emitting green light through conversion of the blue light into the green light, and a red light portion emitting red light through conversion of the blue light into the red light.

The plurality of light emitting diodes may include blue light emitting diodes emitting blue light and red light emitting diodes emitting red light, and the display apparatus may further include a wavelength conversion part including at least one of a blue light portion emitting the blue light, a

green light portion emitting green light through conversion of the blue light into the green light, and a red light portion emitting the red light.

The wavelength conversion part may be formed on a third substrate and the first substrate may be coupled to the third substrate to allow wavelength conversion of light emitted from the plurality of light emitting diodes. The green light portion and the red light portion may include phosphors. Specifically, the green light portion may include nitride phosphors and the red light portion may include nitride or fluoride phosphors (KSF).

At least one of the first to third substrates may be a transparent substrate or an opaque flexible substrate.

The plurality of light emitting diodes may include blue light emitting diodes emitting blue light, and the display apparatus may further include a white phosphor portion converting blue light emitted from the blue light emitting diodes into white light; and a color filter including a blue light portion allowing blue light of the white light emitted through the white phosphor portion to pass therethrough, a green light portion allowing green light of the white light emitted through the white phosphor portion to pass therethrough, and a red light portion allowing red light of the white light emitted through the white phosphor portion to pass therethrough.

Each of the light emitting diodes may include an n-type semiconductor layer, a p-type semiconductor layer, and an active layer interposed between the n-type semiconductor layer and the p-type semiconductor layer, and a wall may be formed on the p-type semiconductor layer.

An exemplary embodiment further discloses a method of manufacturing a display apparatus including: forming a light emitting diode part such that a plurality of light emitting diodes is regularly arranged therein; and coupling the light emitting diode part to a TFT panel unit, wherein forming the light emitting diode part may include forming the plurality of light emitting diodes on a substrate to be regularly arranged thereon; transferring the plurality of light emitting diodes to a stretchable substrate; two-dimensionally enlarging the stretchable substrate such that a separation distance between the light emitting diodes is enlarged; and coupling at least one of the light emitting diodes to a support substrate, with the separation distance between the light emitting diodes enlarged by the stretchable substrate.

The separation distance between the light emitting diodes enlarged by the stretchable substrate may be twice a width of the light emitting diodes.

Coupling the light emitting diode part to the TFT panel unit may be performed using an anisotropic conductive film.

According to exemplary embodiments, the display apparatus may employ 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.

Further, the display apparatus according to the exemplary embodiments may employ a stretchable substrate, thereby providing more convenience in manufacture of the display apparatus than manufacture of the display apparatus using micro-light emitting diodes.

The foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

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

FIG. **1** is a sectional view of a display apparatus according to a first exemplary embodiment of the present disclosure.

FIG. **2** is a perspective view of a light emitting part of the display apparatus according to the first exemplary embodiment of the present disclosure.

FIGS. **3**A, **3**B, **3**C, **3**D, **3**E, **3**F, **3**G, **3**H, **3**I, **3**J, **3**K, **3**L, **3**M, **3**N, **3**O, and **3**P and FIGS. **4**A, **4**B, **4**C, **4**D, **4**E, **4**F, and **4**G are sectional views and plan views illustrating a process of forming the light emitting diode part of the display apparatus according to the first exemplary embodiment of the present disclosure.

FIG. **5** is a sectional view of a display apparatus according to a second exemplary embodiment of the present disclosure.

FIG. **6** is a sectional view of a display apparatus according to a third exemplary embodiment of the present disclosure.

FIG. **7** is a sectional view of a display apparatus according to a fourth exemplary embodiment of the present disclosure.

FIGS. **8**A, **8**B, **8**C, **8**D, **8**E, and **8**F show sectional views of a display apparatus according to a fifth exemplary embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

In the following description, for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of various exemplary embodiments. It is apparent, however, that various exemplary embodiments may be practiced without these specific details or with one or more equivalent arrangements. In other instances, well-known structures and devices are shown in block diagram form in order to avoid unnecessarily obscuring various exemplary embodiments.

In the accompanying figures, the size and relative sizes of layers, films, panels, regions, etc., may be exaggerated for clarity and descriptive purposes. Also, like reference numerals denote like elements.

When an element or layer is referred to as being "on," "connected to," or "coupled to" another element or layer, it may be directly on, connected to, or coupled to the other element or layer or intervening elements or layers may be present. When, however, an element or layer is referred to as being "directly on," "directly connected to," or "directly coupled to" another element or layer, there are no intervening elements or layers present. For the purposes of this disclosure, "at least one of X, Y, and Z" and "at least one selected from the group consisting of X, Y, and Z" may be construed as X only, Y only, Z only, or any combination of two or more of X, Y, and Z, such as, for instance, XYZ, XYY, YZ, and ZZ. Like numbers refer to like elements throughout. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

Although the terms first, second, etc. may be used herein to describe various elements, components, regions, layers, and/or sections, these elements, components, regions, layers, and/or sections should not be limited by these terms. These terms are used to distinguish one element, component, region, layer, and/or section from another element, component, region, layer, and/or section. Thus, a first element, component, region, layer, and/or section discussed below could be termed a second element, component, region, layer, and/or section without departing from the teachings of the present disclosure.

Spatially relative terms, such as “beneath,” “below,” “lower,” “above,” “upper,” and the like, may be used herein for descriptive purposes, and, thereby, to describe one element or feature’s relationship to another element(s) or feature(s) as illustrated in the drawings. Spatially relative terms are intended to encompass different orientations of an apparatus in use, operation, and/or manufacture in addition to the orientation depicted in the drawings. For example, if the apparatus in the drawings is turned over, elements described as “below” or “beneath” other elements or features would then be oriented “above” the other elements or features. Thus, the exemplary term “below” can encompass both an orientation of above and below. Furthermore, the apparatus may be otherwise oriented (e.g., rotated 90 degrees or at other orientations), and, as such, the spatially relative descriptors used herein interpreted accordingly.

The terminology used herein is for the purpose of describing particular embodiments and is not intended to be limiting. As used herein, the singular forms, “a,” “an,” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. Moreover, the terms “comprises,” “comprising,” “includes,” and/or “including,” when used in this specification, specify the presence of stated features, integers, steps, operations, elements, components, and/or groups thereof, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

Various exemplary embodiments are described herein with reference to sectional illustrations that are schematic illustrations of idealized exemplary embodiments and/or intermediate structures. As such, variations from the shapes of the illustrations as a result, for example, of manufacturing techniques and/or tolerances, are to be expected. Thus, exemplary embodiments disclosed herein should not be construed as limited to the particular illustrated shapes of regions, but are to include deviations in shapes that result from, for instance, manufacturing. Regions illustrated in the drawings are schematic in nature and their shapes are not intended to illustrate the actual shape of a region of a device and are not intended to be limiting.

Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure is a part. Terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense, unless expressly so defined herein.

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

FIG. **1** is a sectional view of a display apparatus according to a first exemplary embodiment of the present disclosure, and FIG. **2** is a perspective view of a light emitting part of the display apparatus according to the first exemplary embodiment of the present disclosure.

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

Referring to FIG. **1** and FIG. **2**, the light emitting diode part **110** includes light emitting diodes **112**, a support substrate **114**, transparent electrodes **116**, a blocking part **118**, an insulation layer **120**, and first connection electrodes **122**.

The light emitting diode part **110** includes a plurality of light emitting diodes **112**, and the plurality of light emitting diodes **112** is regularly arranged on the support substrate **114**. For example, the plurality of light emitting diodes **112** may be arranged in a matrix form thereon, as shown in FIG. **2**. In this exemplary embodiment, the plurality of light emitting diodes **112** includes a plurality of blue light emitting diodes **112*a*** emitting blue light, a plurality of green light emitting diodes **112*b*** emitting green light, and a plurality of red light emitting diodes **112*c*** emitting red light. The plural blue light emitting diodes **112*a***, the plural green light emitting diodes **112*b*** and the plural red light emitting diodes **112*c*** are alternately arranged such that the blue light emitting diode **112*a***, the green light emitting diode **112*b*** and the red light emitting diode **112*c*** are adjacent to one another.

In this exemplary embodiment, as shown in FIG. **2**, the light emitting diode part **110** allows the display apparatus **100** to 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 **112** in the light emitting diode part **110** without using a separate LCD. Accordingly, a region including a single light emitting diode **112** may be used as a sub-pixel in the display apparatus **100**. As shown in FIG. **2**, in the light emitting diode part **110**, one sub-pixel may have a larger size than the light emitting diode **112** disposed inside the sub-pixel.

Referring to FIG. **1** again, each of the light emitting diodes **112** may include 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**. 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.

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 a composition of the active layer **25** may be determined so as to emit light having a desired peak wavelength.

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 **112**. 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**.

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

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 SiO_2 on the first layer. The second layer may have a greater thickness and a smaller width than the first layer.

The support substrate **114** is a substrate on which the plurality of light emitting diodes **112** will be mounted, and may be an insulation substrate, a conductive substrate, or a circuit board. By way of example, the support substrate **114** may be a sapphire substrate, a gallium nitride substrate, a glass substrate, a silicon carbide substrate, a silicon substrate, a metal substrate, or a ceramic substrate. The support substrate **114** is formed on an upper surface thereof with the plurality of conductive patterns to be electrically connected to the plurality of light emitting diodes **112** and may include a circuit pattern therein, as needed. The support substrate **114** may be a flexible substrate.

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 one light emitting diode **112** may be coupled to one transparent electrode **116**, or the plurality of light emitting diodes **112** may be coupled to one transparent electrode **116**, as needed. In addition, the plural 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.

The blocking part **118** is formed on the support substrate **114** and is provided in plural. The blocking part **118** allows light emitted from the light emitting diodes **112** to be emitted to the outside only through the transparent electrodes **116** and prevents light emitted from a certain light emitting diode from mixing with light emitted from adjacent light emitting diodes **112**. Accordingly, the blocking part **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 blocking part **118** is formed of chromium (Cr).

The insulation layer **120** surrounds each of the light emitting diodes **112** and covers an exposed surface of a connecting plane between the light emitting diodes **112**. With this structure, the insulation layer **120** may be formed to partially cover the blocking part **118**. In the structure wherein the insulation layer **120** surrounds each of the light emitting diodes **112**, the n-type semiconductor layer **23** and the n-type electrode **31** of each of the light emitting diodes **112** can be exposed through the insulation layer **120**.

The first connection electrodes **122** cover 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 electrodes **122** may be electrically connected to the n-type semiconductor layer **23**.

The TFT panel unit **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 unit **130** controls power supplied to the light emitting diode part **110** to allow only some of the light emitting diodes **112** in the light emitting diode part **110** to emit light.

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).

The second connection electrode **134** may be electrically connected to the TFT drive circuit of the panel substrate **132** and to the first connection electrode **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 **112** through the first and second connection electrodes **122**, **134**. In this exemplary embodiment, the second connection electrode **134** may be covered by a separate protective layer, which may include SiN_x.

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

As such, in the structure wherein the light emitting diode part **110** is coupled to the TFT panel via the anisotropic conductive film **150**, the first connection electrode **122** of the light emitting diode part **110** is electrically connected to the second connection electrode **134** of the TFT panel unit **130**, thereby forming an electrode connection portion **152**.

FIGS. **3**A-**3**P and FIGS. **4**A-**4**G are sectional views and plan views illustrating a process of forming the light emitting diode part **110** of the display apparatus **100** according to the first exemplary embodiment of the present disclosure.

The process of forming the light emitting diode part **110** according to this exemplary embodiment will be described with reference to FIGS. **3**A-**3**P and FIGS. **4**A-**4**G. First, as shown in FIG. **3**A, an n-type semiconductor layer **23**, an active layer **25** and a p-type semiconductor layer **27** are sequentially grown on a growth substrate. Then, a p-type electrode **33** is formed on the p-type semiconductor layer **27**. In this exemplary embodiment, a plurality of p-type electrodes **33** may be formed to be separated from each other by a predetermined distance such that one p-type electrode **33** is provided to one light emitting diode **112**.

Referring to FIG. **3**B, after forming the p-type electrodes **33**, a wall **35** is formed on the p-type semiconductor layer **27**. The wall **35** may be composed of first and second layers. The first layer includes SiN and is formed to cover the entirety of the p-type semiconductor layer **27** while covering a portion of each of the p-type electrodes **33**. The second layer includes SiO_2 and is formed on the first layer. The second layer may have a greater thickness than the first layer and may be formed on a region of the first layer in which the p-type electrode **33** is not formed.

Referring to FIG. **3**C, after the wall **35** is formed on the p-type semiconductor layer **27**, the grown semiconductor layers are coupled to a first substrate. In this process, the second layer of the wall **35** is coupled to the first substrate.

The first substrate may be the same as the support substrate **114** and may be a sapphire substrate in this exemplary embodiment.

Referring to FIG. **3**D, with the semiconductor layers coupled to the first substrate, the growth substrate may be removed from the semiconductor layers by LLO and the semiconductor layers may be divided into individual light emitting diodes **112** by etching. Here, division of the semiconductor layers into individual light emitting diodes **112** may be performed by dry etching.

Referring to FIG. **3**E, after the semiconductor layers are divided into the individual light emitting diodes **112**, n-type electrodes **31** may be formed on the n-type semiconductor layer **23**. Alternatively, the n-type electrodes **31** may be formed before division of the semiconductor layers into the individual light emitting diodes **112**. Then, as shown in FIG. **3**F, the light emitting diodes **112** are coupled to a second substrate such that the n-type electrodes **31** can be coupled to the second substrate, followed by removing the first substrate. The second substrate may be the same kind of substrate as the first substrate.

Then, as shown in FIG. **3**G, the light emitting diodes **112** are coupled to a third substrate such that the wall **35** can be coupled to the third substrate, followed by removing the second substrate. In this exemplary embodiment, the third substrate may be a stretchable substrate that is stretchable in the plane direction thereof. Thus, as shown in FIG. **3**H, the stretchable third substrate is stretched to enlarge distances between the light emitting diodes **112**.

With the distances between the light emitting diodes **112** enlarged, the light emitting diodes **112** are coupled to a fourth substrate such that the n-type electrodes **31** can be coupled to the fourth substrate, as shown in FIG. **3**I. As a result, the distances between the light emitting diodes **112** can be maintained by the stretchable third substrate. In this exemplary embodiment, the fourth substrate may include a flexible base and a bonding layer formed on the base.

Then, referring to FIG. **3**J, the plurality of light emitting diodes **112** arranged on the fourth substrate is bonded to the support substrate **114**, which may be formed with a bonding portion S at a location corresponding to each of the light emitting diodes **112**. With the transparent electrodes **116** and the blocking part **118** formed on the support substrate **114**, the bonding portion S is formed at a mounting location of each of the light emitting diodes **112** on the support substrate **114**. Accordingly, even when the entire plural light emitting diodes coupled to the fourth substrate are transferred to an upper surface of the support substrate **114**, the light emitting diodes **112** can be transferred only to locations of the support substrate **114** at which the bonding portions S are formed.

Referring to FIG. **3**K, external force may be applied only to the light emitting diodes **112** disposed corresponding to the locations of the bonding portions S on the support substrate **114** among the light emitting diodes **112** coupled to the fourth substrate, such that only the light emitting diodes **112** disposed corresponding to the bonding portions S can be bonded to the support substrate **114**. As a result, as shown in FIG. **3**L, the light emitting diodes **112** can be coupled to the support substrate at the locations of the bonding portions S thereon.

Although not shown in the drawings, in the case where only some light emitting diodes **112** are selectively coupled to the support substrate **114** by applying external force only to target light emitting diodes among the plurality of light emitting diodes **112** arranged on the fourth substrate as shown in FIG. **3**K, the stretchable third substrate may be omitted. That is, only some light emitting diodes **112** may be coupled to the support substrate **114** by selectively applying external force only to target light emitting diodes to be coupled to the support substrate **114** using a flexible fourth substrate instead of the second substrate shown in FIG. **3**F.

In this exemplary embodiment, with regard to mounting the light emitting diodes **112** on the support substrate **114** as shown in FIG. **3**L, the following description will be given of mounting blue light emitting diodes **112***a*, green light emitting diodes **112***b* and red light emitting diodes **112***c* on the support substrate **114** with reference to FIGS. **4**A-**4**G. Here, the processes of manufacturing each of the blue light emitting diodes **112***a*, the green light emitting diodes **112***b* and the red light emitting diodes **112***c* are the same those shown in FIG. **3**A to FIG. **3**I.

Like FIG. **3**J, FIG. **4**A shows the bonding portions S formed on the support substrate **114**, in which the bonding portions S are formed at all locations on the support substrate **114** at which the blue light emitting diodes **112***a*, the green light emitting diodes **112***b* and the red light emitting diodes **112***c* are coupled, respectively. The bonding portions S may be classified into first to third bonding portions **S1**, **S2**, **S3**. The first bonding portion **S1** is formed to bond the blue light emitting diodes **112***a* to the support substrate and the second bonding portion **S2** is formed to bond the green light emitting diodes **112***b* thereto. The third bonding portion **S3** is formed to bond the red light emitting diodes **112***c* thereto.

The first to third bonding portions **S1**, **S2**, **S3** may have different bonding temperatures. Specifically, the first bonding portion **S1** has the highest bonding temperature and the third bonding portion **S3** has the lowest bonding temperature. For example, the first bonding portion **S1** is formed of AgSn and has a bonding temperature of about 230° C. and the second bonding portion **S2** is formed of ZnSn and has a bonding temperature of about 198° C. The third bonding portion **S3** is formed of In and has a bonding temperature of about 157° C. The bonding temperatures of the first to third bonding portions **S1**, **S2**, **S3** are differently set due to different bonding sequences of the light emitting diodes **112** to the respective bonding portions S.

Since the blue light emitting diodes **112***a* are first bonded to the support substrate **114**, the first bonding portion **S1** has the highest bonding temperature. Thus, since the first bonding portion **S1** has a higher bonding temperature than the second bonding portion **S2** or the third bonding portion **S3**, the first bonding portion **S1** can maintain a bonded state of the blue light emitting diodes **112***a* during bonding of the green light emitting diodes **112***b* or the red light emitting diodes **112***c*.

After the first to third bonding portions **S1**, **S2**, **S3** are formed on the support substrate **114** as shown in FIG. **4**A, the fourth substrate on which the blue light emitting diodes **112***a* are formed is placed at a corresponding location on the support substrate **114**, and the blue light emitting diodes **112***a* are coupled to the support substrate **114**, as shown in FIG. **4**B. Here, the distances between the blue light emitting diodes **112***a* formed on the fourth substrate are widened by the stretchable substrate, which is provided as the third substrate, as compared with the distances between the blue light emitting diodes **112***a* formed on the growth substrate. Accordingly, each of the blue light emitting diodes **112***a* is not disposed at a location corresponding to the second bonding portion **S2** or the third bonding portion **S3**. Then, with the blue light emitting diodes **112***a* contacting the first bonding portion **S1**, the first bonding portion **S1** is heated to about 230° C. and cooled to bond the blue light emitting diodes **112***a* to the support substrate **114** via the first bonding portion S**1**.

FIG. **4**C shows the blue light emitting diodes **112***a* bonded to the support substrate **114**. Thereafter, the fourth substrate on which the green light emitting diodes **112***b* are formed is placed at a corresponding location on the support substrate **114**, and the green light emitting diodes **112***b* are bonded to the support substrate **114**, as shown in FIG. **4**D. Here, the distances between the green light emitting diodes **112***b* formed on the fourth substrate are greater than the distances between the green light emitting diodes **112***b* formed on the growth substrate, as described above. Accordingly, there is no interference between the blue light emitting diode **112***a* and the green light emitting diode **112***b* placed at locations corresponding to the second bonding portion S**2** formed on the support substrate **114**. Then, with the green light emitting diodes **112***b* contacting the second bonding portion S**2**, the second bonding portion S**2** is heated to about 198° C. and cooled to bond the green light emitting diodes **112***b* to the support substrate **114** via the second bonding portion S**2**. In this way, the green light emitting diodes **112***b* can be bonded to the support substrate **114**.

FIG. **4**E shows the blue light emitting diodes **112***a* and the green light emitting diodes **112***b* bonded to the support substrate **114**. Thereafter, the fourth substrate on which the red light emitting diodes **112***c* are formed is placed at a corresponding location on the support substrate **114**, and the red light emitting diodes **112***c* are bonded to the support substrate **114**, as shown in FIG. **4**F. Here, the distances between the red light emitting diodes **112***c* formed on the fourth substrate are greater than the distances between the red light emitting diodes **112***c* formed on the growth substrate, as described above, thereby preventing interference with the blue light emitting diodes **112***a* or the green light emitting diodes **112***b* disposed on the support substrate **114**. Then, with the red light emitting diodes **112***c* contacting the third bonding portion S**3**, the third bonding portion S**3** are heated to about 157° C. and cooled to bond the red light emitting diodes **112***c* o the support substrate **114** via the third bonding portion S**3**. In this way, the green light emitting diodes **112***b* can be bonded to the support substrate **114**. FIG. **4**G shows the blue light emitting diode **112***a*, the green light emitting diode **112***b* and the red light emitting diode **112***c* bonded to the support substrate **114**.

In this exemplary embodiment, separation distances between the blue light emitting diode **112***a*, the green light emitting diode **112***b* and the red light emitting diode **112***c* formed on the different fourth substrates may be at least twice the width of each of the light emitting diodes **112**. In this way, with the distances between the light emitting diodes maintained at at least twice the width of each of the light emitting diodes on the support substrate **114**, the light emitting diodes **112** are bonded to the support substrate **114**, thereby preventing interference between the other light emitting diodes **112**.

FIG. **3**M is a sectional view corresponding to the plan view shown in FIG. **4**G. That is, referring to FIG. **3**M, each of the blue light emitting diodes **112***a*, the green light emitting diodes **112***b* and the red light emitting diodes **112***c* is bonded to the support substrate **114**. In this state, an insulation layer **120** may be formed to cover the entirety of each of the light emitting diodes **112** excluding a portion thereof, as shown in FIG. **3**N. The insulation layer **120** is formed to cover both the transparent electrodes **116** and the blocking part **118** while surrounding each of the light emitting diodes **112**. With this structure, the insulation layer **120** can prevent the transparent electrode **116** electrically connected to each of the light emitting diodes **112** from being exposed to the outside. An upper surface of the n-type semiconductor layer **23** and the n-type electrode **31** of each of the light emitting diodes **112** can be exposed through an upper surface of the insulation layer **120**.

With the n-type semiconductor layer **23** and the n-type electrode **31** exposed through the upper surface of the insulation layer **120**, first connection electrodes **122** may be formed on the upper surface of the insulation layer **120** to cover the n-type semiconductor layer **23** and the n-type electrodes **31**, as shown in FIG. **30**. As a result, the light emitting diode part **110** according to this exemplary embodiment can be formed.

Thereafter, the light emitting diode part **110** is bonded to the TFT panel unit **130** via an anisotropic connection film, as shown in FIG. **3**P, thereby providing the display apparatus **100** according to the first exemplary embodiment, as shown in FIG. **1**.

FIG. **5** is a sectional view of a display apparatus according to a second exemplary embodiment of the present disclosure.

Referring to FIG. **5**, a display apparatus **100** according to the second exemplary embodiment of the present disclosure includes a light emitting diode part **110**, a TFT panel unit **130**, and an anisotropic conductive film **150**. Description of the same components as those of the first exemplary embodiment will be omitted.

The light emitting diode part **110** includes light emitting diodes **112**, transparent electrodes **116**, a blocking part **118**, an insulation layer **120**, first connection electrodes **122**, a transparent substrate **124**, a phosphor layer **126**, and a protective substrate **128**.

The light emitting diode part **110** includes a plurality of light emitting diodes **112**, and blue light emitting diodes **112***a* emitting blue light may be used as the light emitting diodes **112**. The blue light emitting diodes **112***a* are electrically connected to the transparent electrodes **116** and the blocking part **118** may be form ed between the transparent electrodes **116**. In addition, the transparent substrate **124** may be formed on the transparent electrode **116**. The transparent substrate **124** may serve as the support substrate **114** of the display apparatus **100** according to the first exemplary embodiment. Alternatively, as in the first exemplary embodiment, after forming the light emitting diode part **110** using the support substrate **114**, the support substrate **114** may be removed therefrom and the transparent substrate **124** may be formed again.

The phosphor layer **126** may be formed on an upper surface of the transparent substrate **124**. The phosphor layer **126** may be formed on the blue light emitting diodes **112***a* such that one of a green phosphor layer **126***b*, a red phosphor layer **126***c* and a transparent layer **126***e* is formed thereon. In addition, a blocking layer **126***d* may be formed between the green phosphor layer **126***b*, the red phosphor layer **126***c* and the transparent layer **126***e*. The green phosphor layer **126***b* converts wavelengths of light emitted from the blue light emitting diode **112***a* such that green light can be emitted from the green phosphor layer **126***b*, and the red phosphor layer **126***c* converts wavelengths of light emitted from the blue light emitting diode **112***a* such that red light can be emitted from the red phosphor layer **126***c*. The transparent layer **126***e* is placed near the green phosphor layer **126***b* and the red phosphor layer **126***c* to allow blue light emitted from the blue light emitting diode **112***a* to pass therethrough. Accordingly, red light, green light and blue light can be emitted through the phosphor layer **126**.

The protective substrate **128** may be formed on an upper surface of the phosphor layer **126**. The protective substrate **128** can prevent the phosphor layer **126** from being exposed to the outside and may be formed of a transparent material as in the transparent substrate **124**.

FIG. **6** is a sectional view of a display apparatus according to a third exemplary embodiment of the present disclosure.

Referring to FIG. **6**, a display apparatus **100** according to the third exemplary embodiment includes a light emitting diode part **110**, a TFT panel unit **130**, and an anisotropic conductive film **150**. Description of the same components as those of the first exemplary embodiment will be omitted.

The light emitting diode part **110** includes light emitting diodes **112**, transparent electrodes **116**, a blocking part **118**, a white phosphor film **125**, and a color film.

The light emitting diode part **110** includes a plurality of light emitting diodes **112**, and blue light emitting diodes **112***a* are used as in the second exemplary embodiment. The blue light emitting diodes **112***a* are electrically connected to the transparent electrodes **116** and the blocking part **118** may be formed between the transparent electrodes **116**. The white phosphor film **125** may be formed on an upper surface of the transparent electrode **116**.

The white phosphor film **125** converts blue light emitted from the blue light emitting diode **112***a* into white light. To this end, the white phosphor film **125** may include a green phosphor and a red phosphor.

The color filter **127** may be formed on an upper surface of the white phosphor film **125**. The color filter **127** may be formed in a film shape and filters white light emitted from the white phosphor film **125** excluding one of blue light, green light and red light of the white light. The color filter **127** may include a blue light portion **127***a* that filters white light to allow blue light to pass therethrough, a green light portion **127***b* that filters white light to allow green light to pass therethrough, and a red light portion **127***c* that filters white light to allow red light to pass therethrough. The color filter **127** may further include a transparent portion **127***e* to allow white light to pass therethrough without wavelength conversion.

The blue light portion **127***a*, the green light portion **127***b*, the red light portion **127***c* and the transparent portion **127***e* may be disposed adjacent one another. Alternatively, a light blocking portion **127***d* may be formed between the blue light portion **127***a*, the green light portion **127***b*, the red light portion **127***c* and the transparent portion **127***e*.

FIG. **7** is a sectional view of a display apparatus according to a fourth exemplary embodiment of the present disclosure.

Referring to FIG. **7**, a display apparatus **100** according to the fourth exemplary embodiment includes a light emitting diode part **110**, a TFT panel unit **130**, and an anisotropic conductive film **150**. Description of the same components as those of the first and third exemplary embodiments will be omitted.

The light emitting diode part **110** includes light emitting diodes **112**, transparent electrodes **116**, a blocking part **118**, a transparent substrate **124**, a white phosphor film **125**, and a color film.

The light emitting diode part **110** includes a plurality of light emitting diodes **112**, and blue light emitting diodes **112***a* are used as in the second exemplary embodiment. The blue light emitting diodes **112***a* are electrically connected to the transparent electrodes **116** and the blocking part **118** may be formed between the transparent electrodes **116**. The transparent substrate **124** may be formed on an upper surface of the transparent electrode **116**.

The transparent substrate **124** may serve as the support substrate **114** of the display apparatus **100** according to the first exemplary embodiment. Alternatively, as in the first exemplary embodiment, after forming the light emitting diode part **110** using the support substrate **114**, the support substrate **114** may be removed therefrom and the transparent substrate **124** may be formed again.

The white phosphor film **125** may be formed on an upper surface of the transparent electrode **116** and the color filter **127** may be formed on an upper surface of the white phosphor film **125**. The white phosphor film **125** and the color filter **127** are the same as those of the display apparatus according to the third exemplary embodiment and detailed descriptions thereof will be omitted.

FIGS. **8A-8F** show sectional views of a display apparatus according to a fifth exemplary embodiment of the present disclosure. FIGS. **8A-8F** are sectional views illustrating a process of manufacturing the display apparatus according to the fifth exemplary embodiment, in which a plurality of light emitting structures grown on a growth substrate is coupled to a support substrate after adjustment of separation distances between the light emitting structures using a stretchable sheet SS.

The display apparatus according to the fifth exemplary embodiment includes light emitting structures **123**, n-type bumps, p-type bumps, a support substrate **37**, and a wavelength conversion part. Description of the same components as those of the above exemplary embodiments will be omitted. The following description will focus on a process of coupling light emitting structures **123** grown on the growth substrate **21** to the support substrate **37** with reference to FIGS. **8A-8F**.

The light emitting structure **123** may include a partially exposed region of the n-type semiconductor layer, which is formed by partially removing the p-type semiconductor layer and the active layer. An n-type electrode pad may be placed on the exposed region of the n-type semiconductor layer and a p-type electrode pad may be placed on the p-type semiconductor layer.

Although the light emitting structure **123** uses a flip-chip type light emitting diode in this exemplary embodiment, it should be understood that a vertical type light emitting diode or a lateral type light emitting diode may also be used.

The growth substrate **21** may be selected from among any substrates allowing growth of nitride semiconductor layers thereon and may be an insulation or conductive substrate. By way of example, the growth substrate **21** may be a sapphire substrate, a silicon substrate, a silicon carbide substrate, an aluminum nitride substrate, or a gallium nitride substrate. In this exemplary embodiment, the growth substrate **21** may be a sapphire substrate and may include a C-plane as a growth plane on which nitride semiconductor layers are grown.

As shown in FIG. **8**A, the plurality of light emitting structures **123** is grown on the growth substrate **21**. In this exemplary embodiment, the plural light emitting structures **123** are arranged in a predetermined pattern on the growth substrate **21** and are separated from each other during growth.

With the growth substrate **21** turned upside down, the light emitting structures **123** grown on the growth substrate **21** are coupled to an upper surface of the stretchable sheet, as shown in FIG. **8**B. In addition, after the plurality of light emitting structures **123** is coupled to the stretchable sheet (SS), the growth substrate **21** is removed from the light emitting structures by LLO and the like, as shown in FIG. **8**C.

Thereafter, as shown in FIG. **8**D, since the stretchable sheet (SS) can be two-dimensionally stretched or compressed, the separation distances between the light emitting structures **123** can be adjusted by stretching or compressing the stretchable sheet (SS). FIG. **8**D shows one example in which the separation distances between the light emitting structures **123** are enlarged by stretching the stretchable sheet (SS). In one embodiment, the stretchable sheet (SS) may be a blue sheet.

In this way, the stretchable sheet (SS) is turned upside down in a stretched state and coupled to a fixing sheet (FS) via the light emitting structures **123** such that the light emitting structures **123** are coupled to the fixing sheet. This state is shown in FIG. **8**E, and after the plurality of light emitting structures **123** is coupled to the fixing sheet (FS), the stretchable sheet (SS) is removed from the upper surfaces of the plurality of light emitting structures **123**. In this exemplary embodiment, since the stretchable sheet (SS) can be uniformly stretchable in two dimensions, the distances between the plural light emitting structures **123** can be uniformly widened. The distances between the plural light emitting structures **123** can be adjusted in various ways as needed. The fixing sheet (FS) serves to fix the locations of the light emitting structure **123** in order to maintain the distances between the plural light emitting structures **123** adjusted by the stretchable sheet (SS).

After each of the light emitting structures **123** is coupled to the fixing sheet (FS), the plurality of light emitting structures **123** is coupled to the support substrate **37** and the fixing sheet (FS) is removed from the light emitting structures, as shown in FIG. **8**F. In this exemplary embodiment, the support substrate **37** includes conductive patterns or interconnection circuits, and may be a general PCB, a flexible substrate, or a stretchable substrate like the stretchable sheet (SS).

As described above, since the separation distances between the plural light emitting structures **123** may be adjusted using the stretchable sheet (SS), the light emitting structures **123** may be simultaneously transferred to the support substrate after uniformly increasing the distances therebetween. Accordingly, the plurality of light emitting structures **123** used in the display apparatus according to the present disclosure may also be used not only in a small wearable apparatus, but also in a large display.

Although certain exemplary embodiments and implementations have been described herein, other embodiments and modifications will be apparent from this description. Accordingly, the inventive concept is not limited to such embodiments, but rather to the broader scope of the presented claims and various obvious modifications and equivalent arrangements.

What is claimed is:

1. A display apparatus, comprising:

a first substrate comprising a plurality of light emitting diodes regularly arranged on the first substrate; and

a second substrate comprising a TFT panel unit comprising a plurality of TFTs driving the light emitting diodes,

wherein the first substrate and the second substrate are coupled to each other so as to face each other such that the light emitting diodes are electrically connected to the TFTs, respectively,

wherein the first substrate comprises:

a support substrate;

a plurality of blue light emitting diodes arranged on an upper surface of the support substrate;

a plurality of green light emitting diodes arranged on the upper surface of the support substrate to be placed adjacent the blue light emitting diodes; and

a plurality of red light emitting diodes arranged on the upper surface of the support substrate to be placed adjacent either the blue light emitting diodes or the green

light emitting diodes,

and further comprising:

a first bonding portion bonding the blue light emitting diodes to the support substrate;

a second bonding portion bonding the green light emitting diodes to the support substrate; and

a third bonding portion bonding the red light emitting diodes to the support substrate,

the first to third bonding portions having different melting points.

2. The display apparatus according to claim **1**, wherein each of the blue light emitting diodes, the green light emitting diodes and the red 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;

a p-type electrode coupled to the p-type semiconductor layer; and

a wall surrounding the p-type electrode.

3. The display apparatus according to claim **1**, further comprising:

an anisotropic conductive film electrically connecting the first substrate to the second substrate.

4. A display apparatus, comprising:

a first substrate comprising a plurality of light emitting diodes regularly arranged on an upper surface of a support substrate; and

a second substrate comprising a TFT panel unit comprising a plurality of TFTs driving the light emitting diodes,

wherein the first substrate and the second substrate are coupled to each other so as to face each other such that the light emitting diodes are electrically connected to the TFTs, respectively, wherein the light emitting diodes comprises blue light emitting diodes emitting blue light,

the display apparatus further comprising: a wavelength conversion part comprising at least one of a blue light portion emitting the blue light, a green light portion emitting green light through conversion of the blue light into the green light, and a red light portion emitting red light through conversion of the blue light into the red light, wherein:

the support substrate comprises a first bonding portion, a second bonding portion, and a third bonding portion,

each of the first, second, and third bonding portion is configured for coupling the plurality of light emitting diodes thereto, and

the first, the second, and the third bonding portions have different melting points.

5. The display apparatus according to claim **4**, wherein the wavelength conversion part is disposed on a third substrate, and the first substrate is coupled to the third substrate to allow wavelength conversion of light emitted from the light emitting diodes.

6. The display apparatus according to claim **4**, wherein the green light portion comprises nitride phosphors and the red light portion comprises nitride or fluoride phosphors (KSF).

7. The display apparatus according to claim **4**, wherein at least one of the first, second, and third substrates is a transparent substrate or an opaque flexible substrate.

8. The display apparatus according to claim **4**, wherein the wavelength conversion part comprises:

a white phosphor portion converting the blue light emitted from the blue light emitting diodes into white light; and

a color filter comprising a blue light portion configured to allow blue light of the white light emitted through the white phosphor portion to pass therethrough, a green light portion configured to allow green light of the white light emitted through the white phosphor portion to pass therethrough, and a red light portion configured to allow red light of the white light emitted through the white phosphor portion to pass therethrough.

9. The display apparatus according to claim **1**, wherein each of the light emitting diodes comprises an n-type semiconductor layer, a p-type semiconductor layer, and an active layer interposed between the n-type semiconductor layer and the p-type semiconductor layer, and a wall is formed on the p-type semiconductor layer.

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

forming a light emitting diode part such that a plurality of light emitting diodes are regularly arranged on a support substrate; and

coupling the light emitting diode part to a TFT panel unit,

wherein forming the light emitting diode part comprises:

forming the light emitting diodes on a first substrate to be regularly arranged thereon;

transferring the light emitting diodes to a stretchable substrate;

two-dimensionally enlarging the stretchable substrate to enlarge a separation distance between the light emitting diodes; and

coupling at least one of the light emitting diodes to the support substrate, with the separation distance between the light emitting diodes enlarged by the stretchable substrate, wherein:

the support substrate comprises a first bonding portion, a second bonding portion, and a third bonding portion,

each of the first, second, and third bonding portion is configured for coupling the plurality of light emitting diodes thereto, and

the first, the second, and the third bonding portions have different melting points.

11. The method of manufacturing a display apparatus according to claim **10**, wherein the separation distance between the light emitting diodes enlarged by the stretchable substrate is twice a width of the light emitting diodes.

12. The method of manufacturing a display apparatus according to claim **10**, wherein coupling the light emitting diode part to the TFT panel unit is performed using an anisotropic conductive film.

13. The method of manufacturing a display apparatus according to claim **10**, wherein the plurality of light emitting diodes comprises a plurality of first color light emitting diodes, a plurality of second color light emitting diodes, and a plurality of third color light emitting diodes, and coupling the light emitting diodes to the support substrate further comprising mounting the first, the second, and the third color light emitting diodes on the first, the second, and the third bonding portions, respectively.

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

forming a light emitting diode part such that a plurality of light emitting diodes are regularly arranged on a support substrate, each of the light emitting diodes having a p-type electrode; and

coupling the light emitting diode part to a TFT panel unit,

wherein forming the light emitting diode part comprises forming the light emitting diodes on a growth substrate to be regularly arranged thereon and exposing the p-type electrode of each light emitting diode;

transferring the light emitting diodes to a stretchable substrate;

two-dimensionally enlarging the stretchable substrate to enlarge a separation distance between the light emitting diodes;

coupling the light emitting diodes to the support substrate, with the separation distance between the light emitting diodes enlarged by the stretchable substrate, to re-expose the p-type electrode of each of the light emitting diodes;

wherein the support substrate comprises a first bonding portion, a second bonding portion, and a third bonding portion and the first to third bonding portions have different melting points.

15. The method of manufacturing a display apparatus according to claim **14**, wherein coupling the light emitting diode part to the TFT panel unit is performed using an anisotropic conductive film to electrically connect the p-type electrode of each of the light emitting diodes to the TFT panel.

16. The method of manufacturing a display apparatus according to claim **14**, wherein the plurality of light emitting diodes comprises a plurality of blue color light emitting diodes, a plurality of green color light emitting diodes, and a plurality of third color light emitting diodes, and coupling the light emitting diodes to the support substrate further comprises mounting the blue, the green, and the red color light emitting diodes on the first, the second, and the third bonding portions, respectively.

* * * * *

patsnap

专利名称(译)	显示装置及其制造方法		
公开(公告)号	US9887184	公开(公告)日	2018-02-06
申请号	US15/218514	申请日	2016-07-25
[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 KIM YOUNG HYUN		
发明人	TAKEYA, MOTONOBU KIM, YOUNG HYUN		
IPC分类号	H01L27/14 H01L33/06 H01L33/00 H01L33/38 H01L33/50 H01L33/58 H01L33/62 H05B33/12 H01L23/00 H01L21/683 H01L33/32 H01L25/16 H01L25/075 H01L27/12 G09G3/32		
CPC分类号	H01L25/167 H01L24/19 H01L24/97 H01L25/0753 H01L27/1214 H01L33/0079 H01L33/06 H01L33/325 H01L33/38 H01L33/502 H01L33/58 H01L33/62 H05B33/12 H01L21/6835 H01L2933/0066 G09G3/32 G09G2300/04 G09G2300/0452 G09G2300/08 H01L2221/68322 H01L2221/68327 H01L2221/68336 H01L2221/68354 H01L2221/68368 H01L2924/12041 G09F9/33 H01L27/156 H01L33/501 H01L33/504 H05B33/14 H01L33/0093 H01L2224/45099 H01L2224/4911 H01L2924/00 H01L2924/00014		
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外部链接	Espacenet USPTO		

摘要(译)

公开了一种显示装置及其制造方法。该显示设备包括：第一基板，包括发光二极管部件，该发光二极管部件包括规则地布置在第一基板上的多个发光二极管;以及包括TFT面板单元的第二基板，所述TFT面板单元包括驱动所述发光二极管的多个TFT。第一基板和第二基板彼此耦合以便彼此面对，使得发光二极管分别电连接到TFT。该显示装置使用由氮化物半导体形成的微型发光二极管来实现，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。