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Kwon

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(54) **DEVICE AND METHODS FOR MANUFACTURING AN ORGANIC LIGHT-EMITTING DISPLAY APPARATUS**

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H01L 51/50	(2006.01)
H01L 51/52	(2006.01)
H01L 51/56	(2006.01)

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

CPC ***H01L 51/005*** (2013.01); ***H01L 27/3211*** (2013.01); ***H01L 27/3246*** (2013.01); ***H01L 27/3262*** (2013.01); ***H01L 51/0026*** (2013.01); ***H01L 51/0096*** (2013.01); ***H01L 51/5056*** (2013.01); ***H01L 51/5072*** (2013.01); ***H01L 51/5088*** (2013.01); ***H01L 51/5092*** (2013.01); ***H01L 51/5221*** (2013.01); ***H01L 51/5256*** (2013.01); ***H01L 51/56*** (2013.01); *H01L 2227/323* (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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(57) **ABSTRACT**

A method of manufacturing an organic light-emitting display apparatus includes: arranging a mask on a substrate, the mask having an opening corresponding to a pattern of an organic emission layer; forming the organic emission layer by disposing an inkjet roller on the mask, and discharging inks from ink headers mounted in the inkjet roller through the opening of the mask, by rotating the inkjet roller; and curing the organic emission layer.

11 Claims, 6 Drawing Sheets

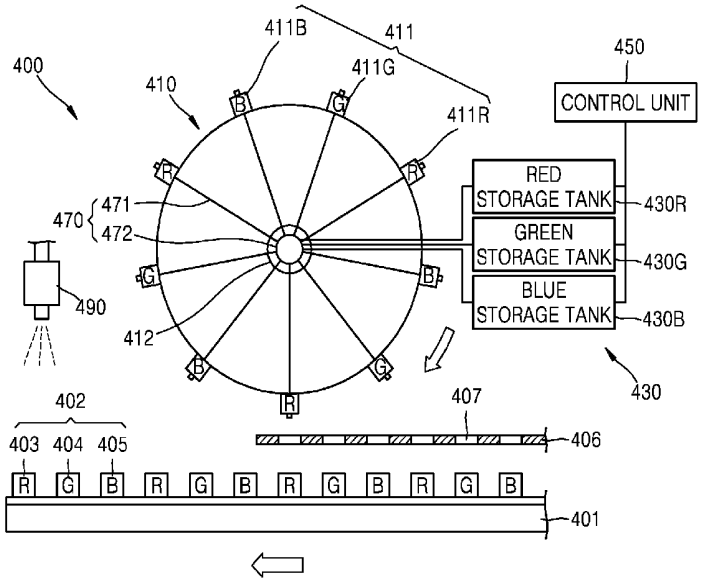

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FIG. 1

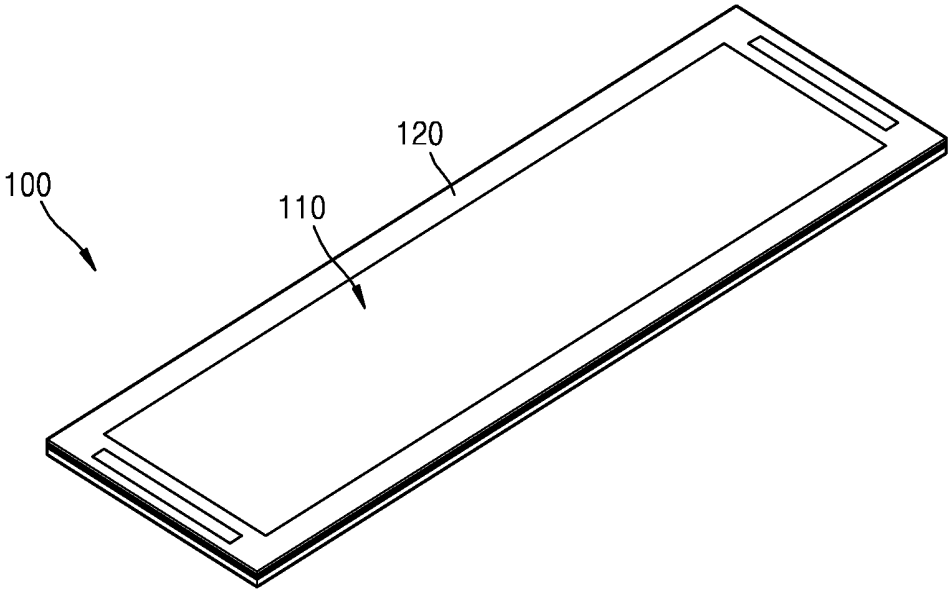


FIG. 2

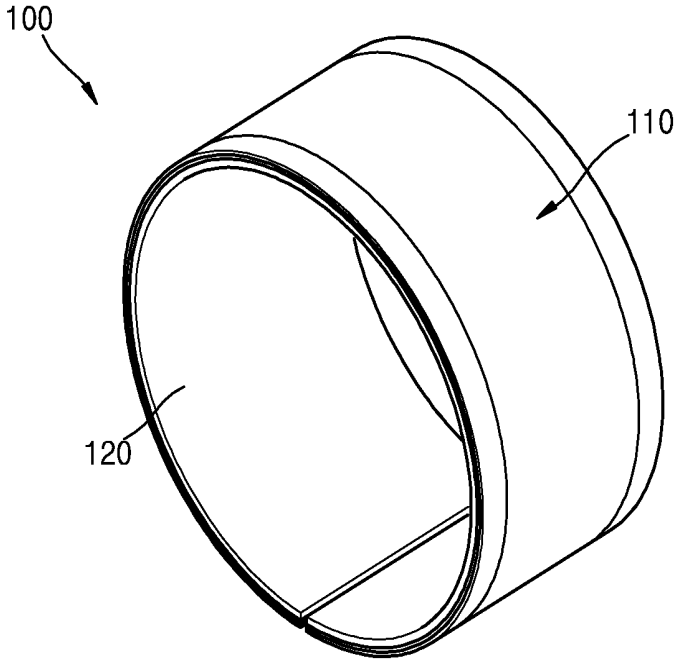


FIG. 3

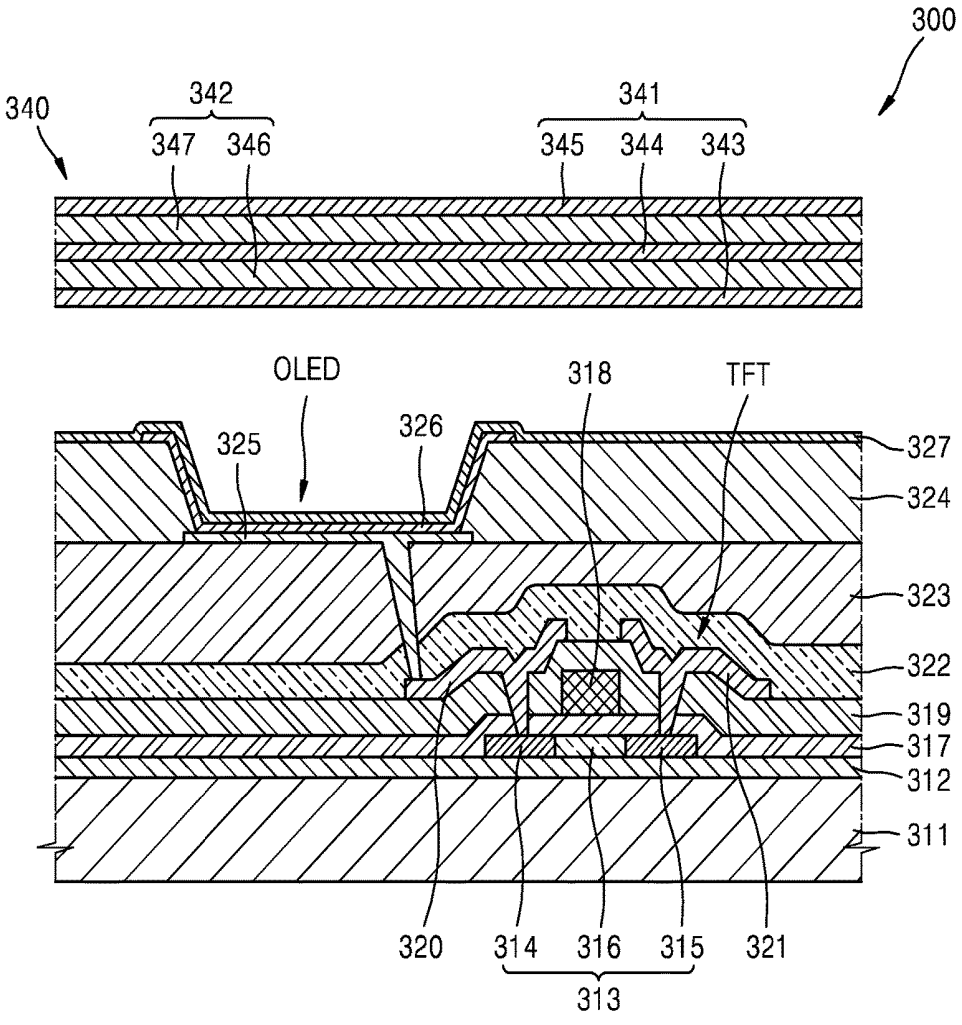

300
340
342
347
346
341
345
344
343
OLED
325
326
318
TFT
327
324
323
322
319
317
312
311
320
314
316
315
321
313

FIG. 4

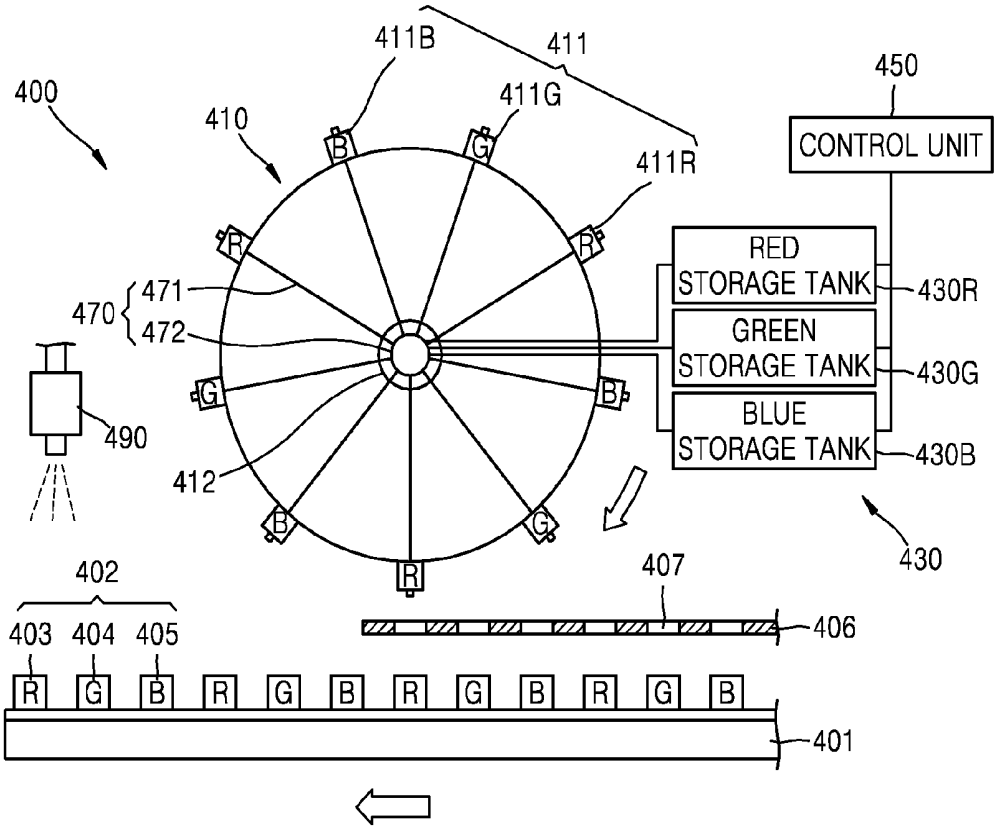

400
410
411B
411
411G
411R
450
CONTROL UNIT
RED STORAGE TANK
430R
GREEN STORAGE TANK
430G
BLUE STORAGE TANK
430B
430
470
471
472
490
412
402
403
404
405
407
406
401
R
G
B

FIG. 5

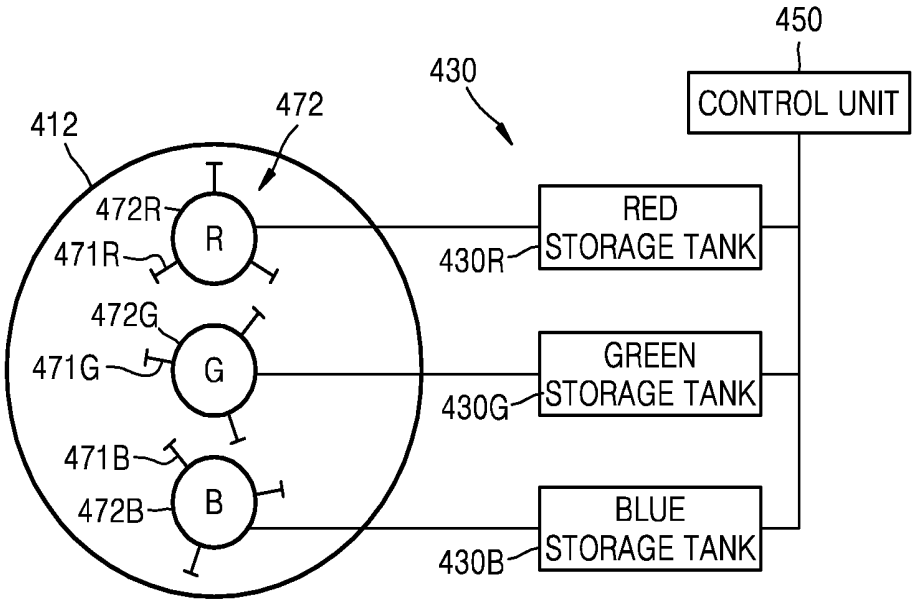
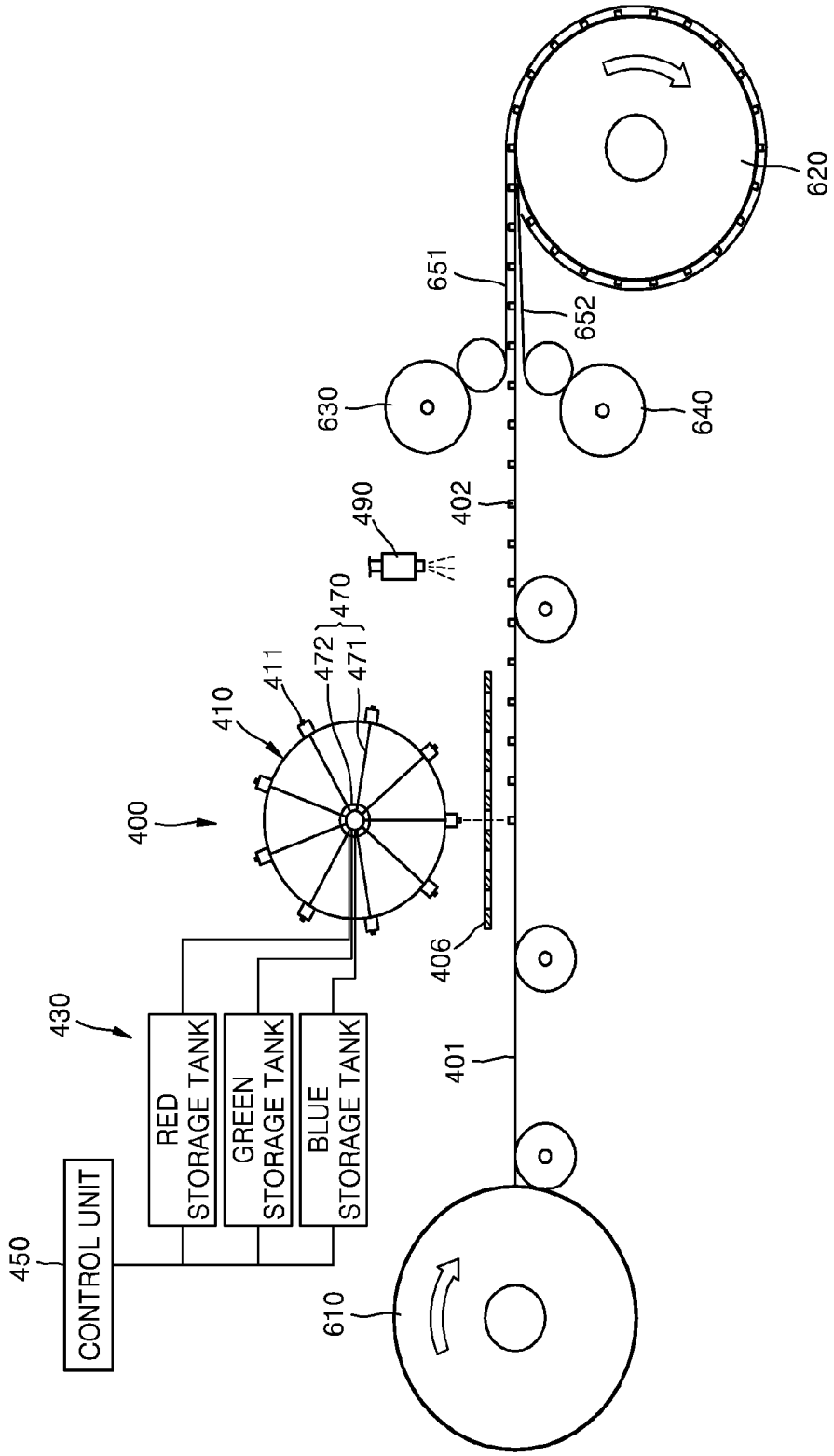

450
CONTROL UNIT
430
412
472
472R
R
471R
RED
STORAGE TANK
430R
472G
G
471G
GREEN
STORAGE TANK
430G
471B
B
472B
BLUE
STORAGE TANK
430B

FIG. 6


620
651
652
630
640
490
402
470
472
471
411
410
400
406
430
RED STORAGE TANK
GREEN STORAGE TANK
BLUE STORAGE TANK
401
450
CONTROL UNIT
610

DEVICE AND METHODS FOR MANUFACTURING AN ORGANIC LIGHT-EMITTING DISPLAY APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority from and the benefit of Korean Patent Application No. 10-2015-0139106, filed on Oct. 2, 2015, which is hereby incorporated by reference for all purposes as if fully set forth herein.

BACKGROUND

Field

Exemplary embodiments relate a device and methods for to manufacturing an organic light-emitting display apparatus.

Discussion of the Background

Generally, display apparatuses may be used in mobile devices, such as smart phones, laptop computers, digital cameras, camcorders, personal digital assistants (PDAs), and tablet personal computers, or other electronic devices, such as desktop computers, televisions, or outdoor billboards.

Flexible display apparatuses have drawn attention as next generation display apparatuses, since flexible display apparatuses are portable and may be applied to electronic devices of various shapes. Among the flexible display apparatuses, a flexible display apparatus having an organic light-emitting display technique is one of the most attractive display devices. The organic light-emitting display apparatus includes an organic emission layer to realize an image. The organic emission layer may be formed on a substrate by various methods.

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 methods and a device for manufacturing an organic light-emitting display apparatus.

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 includes a method of manufacturing an organic light-emitting display apparatus. The method includes: arranging a mask on a substrate, the mask having an opening corresponding to a pattern of an organic emission layer; forming the organic emission layer by disposing an inkjet roller on the mask, and discharging inks from ink headers mounted in the inkjet roller through the opening of the mask by rotating the inkjet roller; and curing the organic emission layer.

An exemplary embodiment also includes a device for manufacturing an organic light-emitting display apparatus. The device includes a mask mounted on a substrate, an inkjet roller arranged on the substrate, the inkjet roller including an ink header configured to discharge ink onto the substrate through an opening of the mask; an ink storage tank connected to the ink header by a connection unit; and a control unit configured to control the ink discharged onto the substrate from the ink header.

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 inventive concept, and are incorporated in and constitute a part of this specification, illustrate exemplary embodiments of the inventive concept, and, together with the description, serve to explain principles of the inventive concept.

FIG. **1** is a perspective view of an unrolled state of a display apparatus according to an exemplary embodiment.

FIG. **2** is a perspective view of a rolled state of the display apparatus of FIG. **1**.

FIG. **3** is a cross-sectional view of a sub-pixel of an organic light-emitting display apparatus according to an exemplary embodiment.

FIG. **4** is a diagram for describing a method of forming an organic emission layer on a substrate by using an inkjet roller device, according to an exemplary embodiment.

FIG. **5** is a side view of a center of the inkjet roller device of FIG. **4**.

FIG. **6** is a diagram for describing a method of forming an organic emission layer on a substrate by a roll-to-roll method by using the inkjet roller device of FIG. **4**.

DETAILED DESCRIPTION

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. 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, compo-

nent, 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. For example, an implanted region illustrated as a rectangle will, typically, have rounded or curved features and/or a gradient of implant concentration at its edges rather than a binary change from implanted to non-implanted region. Likewise, a buried region formed by implantation may result in some implantation in the region between the buried region and the surface through which the implantation takes place. Thus, the 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.

FIG. **1** is a perspective view of an unrolled state of an organic light-emitting display apparatus according to an exemplary embodiment. FIG. **2** is a perspective view of a rolled state of the organic light-emitting display apparatus of FIG. **1**.

As shown in FIG. **1**, an organic light-emitting display apparatus **100** may be a flexible display apparatus including a flexible film. However, the organic light-emitting display apparatus **100** may also be a rigid display apparatus including a glass substrate.

Referring to FIG. **1** and FIG. **2**, the organic light-emitting display apparatus **100** may include a display panel **110** for displaying an image and a housing **120** for accommodating the display panel **110**. The display panel **110** may include not only a display substrate, but also various films, such as a touch screen, a polarization plate, a cover window, etc.

The organic light-emitting display apparatus **100** may display an image at various angles. For example, the organic light-emitting display apparatus **100** may display an image while in a rolled state, an unrolled state, a curved state, or some combination thereof.

FIG. **3** illustrates a sub-pixel of an organic light-emitting display apparatus **300** according to an exemplary embodiment.

As shown in FIG. **3**, the sub-pixel may include at least one thin film transistor (TFT) and an organic light-emitting device (OLED). However, the numbers and structures of TFTs may vary without departing from the scope of the present embodiments.

Referring to FIG. **3**, the organic light-emitting display apparatus **300** may include a display substrate **311** and an encapsulation portion **340** disposed on the display substrate **311**.

The display substrate **311** may include at least one of a polymer substrate, a glass substrate, and a metal substrate. The display substrate **311** may be a flexible substrate, a rigid substrate, or some combination thereof. The display substrate **311** may be transparent, non-transparent, partially transparent, or some combination thereof.

According to an exemplary embodiment, the polymer substrate may include at least one of polyimide (PI), polyethylene terephthalate (PET), polymethyl methacrylate (PMMA), polycarbonate (PC), and polypropylene (PP).

The polymer substrate may have a thickness that is equal to or greater than 20 μm. The glass substrate may have a thickness that is equal to or greater than 0.05 mm. The metal substrate may include at least one of aluminum, zinc, nickel, and chrome. The metal substrate may have a thickness that is equal to or greater than 0.1 mm.

A buffer layer **312** may be arranged on the display substrate **311**. The buffer layer **312** may completely cover an upper surface of the display substrate **311**. The buffer layer **312** may include at least one of an inorganic material and an organic material. The buffer layer **312** may include a single layer or multiple layers.

A TFT may be arranged on the buffer layer **312**. The TFT may be a top gate transistor. However, the TFT may also be a bottom gate transistor.

A semiconductor active layer **313** may be arranged on the buffer layer **312**.

The semiconductor active layer **313** may include a source area **314** and a drain area **315**, which are doped with n-type impurity ions or p-type impurity ions. An area between the source area **314** and the drain area **315** may be a channel area **316**, which is not doped with impurities. The semiconductor active layer **313** may include at least one of an organic semiconductor and an inorganic semiconductor. For example, the semiconductor active layer **313** may include

amorphous silicon. As another example, the semiconductor active layer **313** may include an oxide semiconductor.

A gate insulating layer **317** may be arranged on the semiconductor active layer **313**. The gate insulating layer **317** may include an inorganic layer. The gate insulating layer **317** may include a single layer or multiple layers.

A gate electrode **318** may be arranged on the gate insulating layer **317**. The gate electrode **318** may include a metal material having a high conductivity such as silver, copper, gold, or aluminum. The gate electrode **318** may include a single layer or multiple layers.

An interlayer insulating layer **319** may be arranged on the gate electrode **318**. The interlayer insulating layer **319** may include at least one of an inorganic layer and an organic layer.

A source electrode **320** and a drain electrode **321** may be arranged on the interlayer insulating layer **319**. In detail, a contact hole may be formed in the gate insulating layer **317** and the interlayer insulating layer **319** by partially removing the gate insulating layer **317** and the interlayer insulating layer **319**. The source electrode **320** may be electrically connected to the source area **314** and the drain electrode **321** may be electrically connected to the drain area **315** through the contact hole.

A passivation layer **322** may be arranged on the source electrode **320** and the drain electrode **321**. The passivation layer **322** may include at least one of an inorganic layer and an organic layer. A planarization layer **323** may be arranged on the passivation layer **322**. The planarization layer **323** includes an organic layer. Any one of the passivation layer **322** and the planarization layer **323** may be omitted.

The TFT may be electrically connected to the OLED.

The OLED may be arranged on the planarization layer **323**. The OLED includes a first electrode **325**, an intermediate layer **326**, and a second electrode **327**.

The first electrode **325** may function as an anode and may include various conductive materials. The first electrode **325** may include a transparent electrode or a reflection electrode. For example, when the first electrode **325** includes a transparent electrode, the first electrode **325** may include a transparent conductive layer. When the first electrode **325** includes a reflection electrode, the first electrode **325** may include a reflective layer and a transparent conductive layer on the reflective layer.

A pixel-defining layer **324** may be arranged on the planarization layer **323**. The pixel-defining layer **324** may cover a portion of the first electrode **325**. In detail, the pixel-defining layer **324** may define an emission area of each of sub-pixels by surrounding an edge of the first electrode **325**. The first electrode **325** may be patterned in each sub-pixel.

The pixel-defining layer **324** may include an organic layer or an inorganic layer. The pixel-defining layer **324** may include a single layer or multiple layers.

The intermediate layer **326** may be arranged on an area of the first electrode **325**, the area being exposed by etching a portion of the pixel-defining layer **324**. The intermediate layer **326** may be formed by deposition.

The intermediate layer **326** may include an organic emission layer.

According to a selective embodiment, the intermediate layer **326** may include an organic emission layer and may further include at least one of a hole injection layer (HIL), a hole transport layer (HTL), an electron transport layer (ETL), and an electron injection layer (EIL). However, exemplary embodiments are not limited to an intermediate layer **326** having HIL, HTL, ETL, and EIL layers. The intermediate layer **326** may include an organic emission layer along with various other functional layers.

The second electrode **327** may be arranged on the intermediate layer **326**.

The second electrode **327** may function as a cathode. The second electrode **327** may include a transparent electrode or a reflection electrode. For example, when the second electrode **327** includes a transparent electrode, the second electrode **327** may include a metal layer and a transparent conductive layer on the metal layer. When the second electrode **327** includes a reflection electrode, the second electrode **327** may include a metal layer.

According to an exemplary embodiment, a plurality of sub-pixels may be arranged on the display substrate **311**. For example, at least some sub-pixels may realize at least one of a red, green, blue, and white color. However, the present inventive concept is not limited thereto.

The encapsulation portion **340** may cover the OLED. The encapsulation portion **340** may include an inorganic layer **341** and an organic layer **342**, which are alternately stacked. For example, the inorganic layer **341** may include a first inorganic layer **343**, a second inorganic layer **344**, and a third inorganic layer **345**. The organic layer **342** may include a first organic layer **346** and a second organic layer **347**.

The organic emission layer may be formed on the intermediate layer **326** by various methods. For example, organic emission layers of different colors may be deposited on pixels of a substrate by using a chemical vapor deposition (CVD) device. However, it may be difficult to form the organic emission layers evenly on the substrate by using the CVD, due to surface tension deposition materials passing through an opening of a mask. Also, according to the CVD, the mask is located on a deposition source. Thus, the mask may be deformed due to its own weight.

According to exemplary embodiment, an organic emission layer is formed on a substrate by an inkjet roller method.

FIG. **4** is a diagram for describing a method of forming an organic emission layer **402** on a substrate by using an inkjet roller device according to an exemplary embodiment. FIG. **5** is a side view of a center of the inkjet roller device of FIG. **4**.

Referring to FIGS. **4** and **5**, an inkjet roller device **400** includes an inkjet roller **410**, an ink storage tank **430**, and a control unit **450**.

The inkjet roller **410** may be mounted on a substrate **401**. A mask **406** may be mounted between the substrate **401** and the inkjet roller **410**. The mask **406** may include an opening **407** corresponding to a pattern of a organic emission layer **402** formed on the substrate **401**. According to an exemplary embodiment, the organic emission layer **402** includes a red R emission layer **403**, a green G emission layer **404**, and a blue B emission layer **405**.

The inkjet roller **410** may include a plurality of ink headers **411**. The ink headers **411** may discharge ink of a color corresponding to the organic emission layer **402**, onto the substrate **401**, through the opening **407** of the mask **406**.

The ink headers **411** include a red ink header **411**R for discharging ink for the red R emission layer **403**, a green ink header **411**G for discharging ink for the green G emission layer **404**, and a blue ink header **411**B for discharging ink for the blue B emission layer **405**.

The red ink header **411**R, the green ink header **411**G, and the blue ink header **411**B may be spaced apart from each other along an outer circumferential surface of the inkjet roller **410**. When the inkjet roller **410** rotates, the red ink header **411**R, the green ink header **411**G, and the blue ink

header **411**B may sequentially discharge the inks of the colors corresponding to the red emission layer **403**, the green emission layer **404**, and the blue emission layer **405** onto the substrate **401**.

According to an exemplary embodiment, the inkjet roller **410** has a cylindrical shape. The plurality of ink headers **411** may be arranged in the inkjet roller **410** to discharge ink of the same color onto the same line in a length direction of the inkjet roller **410**. Ink of the same color may be simultaneously discharged onto sub-pixels that are arranged apart from one another in the same line in a direction of the substrate **401**, for example, a width direction.

According to an exemplary embodiment, the plurality of ink headers **411** are arranged in the inkjet roller **410** to discharge inks of different colors, onto the same line in a length direction of the inkjet roller **410**. Inks of different colors may be simultaneously discharged onto sub-pixels of different colors, which are spaced apart from one another in the same line in a direction of the substrate **401**.

The ink headers **411** may be connected to the ink storage tank **430** for storing inks corresponding to colors of the organic emission layer **402**, by a connection unit **470**. The connection unit **470** may include a plurality of connection pipes **471** and a plurality of connection tanks **472** respectively connected to the connection pipes **471**.

The connection pipes **471** may be mounted in an inner space of the inkjet roller **410**. The connection pipes **471** may be connected to the red ink header **411**R, the green ink header **411**G, and the blue ink header **411**B. The connection pipes **471** may include a red connection pipe **471**R connected to the red ink header **411**R, a green connection pipe **471**G connected to the green ink header **411**G, and a blue connection pipe **471**B connected to the blue ink header **411**B.

The plurality of connection pipes **471** may be respectively connected to the connection tanks **472**, which are prepared for each color. The connection tanks **472** may be mounted inside a central axis **412** of the inkjet roller **410**. The connection tanks **472** may include a red connection tank **472**R, a green connection tank **472**G, and a blue connection tank **472**B.

The plurality of red connection pipes **471**R may be connected to the red connection tank **472**R, the plurality of green connection pipes **471**G may be connected to the green connection tank **472**G, and the plurality of blue connection pipes **471**B may be connected to the blue connection tank **472**B.

The connection tanks **472** may be connected to the ink storage tank **430**. The ink storage tank **430** includes a red ink storage tank **430**R, a green ink storage tank **430**G, and a blue ink storage tank **430**B.

The red ink storage tank **430**R, the green ink storage tank **430**G, and the blue ink storage tank **430**B may respectively store inks of colors corresponding to the red emission layer **403**, the green emission layer **404**, and the blue emission layer **405**, which are formed on the substrate **401**.

The red connection tank **472**R, the green connection tank **472**G, and the blue connection tank **472**B may be connected to the red ink storage tank **430**R, the green ink storage tank **430**G, and the blue ink storage tank **430**B, respectively, so as to be supplied with the ink colors corresponding to the organic emission layer **402**.

The red ink storage tank **430**R, the green ink storage tank **430**G, and the blue ink storage tank **430**B may be mounted outside the inkjet roller **410**. The red ink storage tank **430**R, the green ink storage tank **430**G, and the blue ink storage tank **430**B may be connected to the red connection tank **472**R, the green connection tank **472**G, and the blue connection tank **472**B, respectively, at a side surface of the inkjet roller **410**, in order to avoid interference with the inkjet roller **410** that rotates.

The red ink storage tank **430**R, the green ink storage tank **430**G, and the blue ink storage tank **430**B may be connected to the control unit **450**. The control unit **450** may control a color of ink and an amount of ink that is to be discharged onto the substrate **401** from the red ink header **411**R, the green ink header **411**G, and the blue ink header **411**B.

A curing unit **490** for curing the ink discharged onto the substrate **401** may be mounted adjacent to the inkjet roller **410**. The curing unit **490** may be an ultraviolet (UV) curing device. The curing unit **490** may be a heating device that cures the ink by applying a certain amount of heat to the ink.

Multiple curing units **490** may be provided to stabilize the inks discharged onto the substrate **401**. The ink may be cured in a multistage method by using the plurality of curing units **490**.

The organic emission layer **402** may be formed on the substrate **401** by using the inkjet roller **410**, while the substrate **401** is transported by a roll-to-roll method.

Referring to FIG. **6**, a first roller **610** and a second roller **620** may be mounted in a front end and a rear end of the inkjet roller **410**.

The first roller **610** may be mounted on a first side of the inkjet roller **410**. The substrate **401**, which does not have the organic emission layer **402**, may be rolled onto the first roller **610**. The first roller **610** may supply the substrate **401** toward the inkjet roller **410**. The second roller **620** may be mounted on a second side of the inkjet roller **410** and may roll the substrate **401**, on which the organic emission layer **402** is formed. The curing unit **490** may be mounted between the inkjet roller **410** and the second roller **620** for curing ink on the substrate **401**.

A third roller **630** and a fourth roller **640** may further be mounted adjacent to the second roller **620**. Each of the third roller **630** and the fourth roller **640** includes a plurality of rollers.

At least one cover film **651** and **652** may be rolled on the substrate **401**. For example, a third roller **630** may roll the cover film **651**. As another example, a fourth roller **640** may roll the cover film **652**. As a further example, the third roller **630** may roll the cover film **651** and the fourth roller **640** may roll the cover film **652**. The third roller **630** and the fourth roller **640** face each other. The cover films **651** and **652** may be bonded on the substrate **401** proceeding through the third roller **630** and the fourth roller **640**. The cover films **651** and **652** may protect a surface of the substrate **401**.

The process of forming the organic emission layer **402** on the substrate **401** by using the inkjet roller device **400** having the above structure will be described as follows by referring to FIG. **4**, FIG. **5**, and FIG. **6**.

The substrate **401** may be unrolled from the first roller **610**. The substrate **401** unrolled from the first roller **610** may be transported in a direction. The substrate **401** may be transported to the inkjet roller **410**. The mask **406** may be arranged on the transported substrate **401**.

The mask **406** may have the opening **407** corresponding to a pattern of the organic emission layer **402**, which is to be formed on the substrate **401**. The mask **406** may be formed by using a thin plate.

The inkjet roller **410** may be arranged on the mask **406**. The inkjet roller **410** may rotate and when the inkjet roller **410** rotates, inks of colors corresponding to the red emission layer **403**, the green emission layer **404**, and the blue emission layer **405** may be sequentially discharged, from the

red ink header **411**R, the green ink header **411**G, and the blue ink header **411**B. The red ink header **411**R, the green ink header **411**G, and the blue ink header **411**B may be spaced apart from each other along an outer circumferential surface of the inkjet roller **410**.

In detail, the red ink header **411**R, the green ink header **411**G, and the blue ink header **411**B may be connected to the red connection pipe **471**R, the green connection pipe **471**G, and the blue connection pipe **471**B, respectively, which are mounted in the inner space of the inkjet roller **410**.

The red connection pipe **471**R, the green connection pipe **471**G, and the blue connection pipe **471**B may be connected to the red connection tank **472**R, the green connection tank **472**G, and the blue connection tank **472**B, respectively, which are mounted inside the central axis **412** of the inkjet roller **410**.

The red connection tank **472**R, the green connection tank **472**G, and the blue connection tank **472**B may be connected to the red ink storage tank **430**R, the green ink storage tank **430**G, and the blue ink storage tank **430**B, respectively, which are mounted outside the inkjet roller **410**.

When the control unit **450** determines an color and an amount that is to be discharged onto the substrate **401**, the ink storage tank **430** supplies the ink of the corresponding color to the connection tank **472**, according to a signal of the control unit **450**.

In detail, an ink color corresponding to any one organic emission layer **402** from among the red emission layer **403**, the green emission layer **404**, and the blue emission layer **405** that are to be formed on the substrate **401**, may be supplied to any one of the red connection tank **472**R, the green connection tank **472**G, and the blue connection tank **472**B, from any one of the red ink storage tank **430**R, the green ink storage tank **430**G, and the blue ink storage tank **430**B.

The ink supplied to the connection tank **472** may pass through the connection pipe **471** and may be discharged to the outside of the ink headers **411**. The ink discharged from the ink headers **411** may be loaded onto an area of the substrate **401** through the opening **407** of the mask **406**.

In detail, the ink supplied to any connection tank **472** from among the red connection tank **472**R, the green connection tank **472**G, and the blue connection tank **472**B may pass through any connection pipe **471** from among the red connection pipe **471**R, the green connection pipe **471**G, and the blue connection pipe **471**B. The ink may be discharged from any ink header **411** from among the red ink header **411**R, the green ink header **411**G, and the blue ink header **411**B. The ink discharged from any ink header **411** from among the red ink header **411**R, the green ink header **411**G, and the blue ink header **411**B may be loaded onto a sub-pixel area of the substrate **401**, in which any one organic emission layer **402** from among the red emission layer **403**, the green emission layer **404**, and the blue emission layer **405** is formed.

The substrate **401** may be transported in one direction, and at the same time, the inkjet roller **410** rotates, in order to discharge ink of a different color in another sub-pixel area of the substrate **401**. Here, the ink may be discharged from the ink headers **411** at a normal temperature and pressure.

As described above, while the inkjet roller **410** rotates, the inkjet roller **410** may sequentially discharge inks of different colors onto the substrate **401**.

According to an exemplary embodiment, when the substrate **401** is transported in one direction, ink of the same color may be simultaneously loaded onto a plurality of sub-pixels arranged in the same line of the substrate **401**. For example, the ink headers **411** may discharge the ink of the same color in a length direction of the inkjet roller **410**, so that the ink of the same color may be simultaneously loaded onto the sub-pixels of the same color of the substrate **401**.

According to another exemplary embodiment, the ink headers **411** may discharge inks of different colors in a length direction of the inkjet roller **410**, so that the inks of different colors may be simultaneously loaded onto sub-pixels of different colors arranged in the same line.

According to an exemplary embodiment, inks of a plurality of colors may be discharged onto the substrate **401**, while the substrate **401** is fixed and the inkjet roller **410** both rotates and linearly moves.

When the ink is loaded onto the substrate **401**, UV rays may be irradiated onto the substrate **401** from the curing unit **490** mounted adjacent to the inkjet roller **410**. The ink is cured by the curing unit **490** so that the red emission layer **403**, the green emission layer **404**, and the blue emission layer **405** may be formed on the substrate **401**.

According to an exemplary embodiment, multiple curing units **490** may be mounted for stabilizing the ink, and the ink may be cured in a multistage method by using the curing units **490**. Accordingly, the ink having fluidity may be half-hardened or fully hardened.

After the ink is hardened, the substrate **401** may proceed through the third roller **630** and the fourth roller **640**. When the substrate **401** proceeds through the third roller **630** and the fourth roller **640**, the first cover film **651** and the second cover film **652** may be bonded on both surfaces of the substrate **401**.

The substrate **401**, on which the organic emission layer **402** is formed, may be rolled onto the second roller **620**.

As described above, according to various exemplary embodiments, the device for manufacturing an organic light-emitting display apparatus and the method of manufacturing an organic light-emitting display apparatus by using the same may form an organic emission layer on a substrate by a roll-injection method. Thus, a loss of a raw material for the organic emission layer may be reduced, and it is easy to make a large display device.

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 method of manufacturing an organic light-emitting display apparatus, the method comprising:

arranging a mask on a substrate, the mask having an opening corresponding to a pattern of an organic emission layer;

forming the organic emission layer by:

disposing an inkjet roller on the mask;

supplying inks from ink storage tanks external to the inkjet roller to connection tanks;

supplying the inks from the connection tanks mounted inside a central axis of the inkjet roller to ink headers mounted on the inkjet roller via connection pipes;

discharging the inks onto the substrate from the ink headers, through the opening of the mask, by rotating the inkjet roller according to a signal of a control unit; and

curing the organic emission layer,

wherein the connection tanks comprise a plurality of connection tanks respectively corresponding to col-

ors of the organic emission layer and disposed inside the central axis of the inkjet roller and

wherein the plurality of connection tanks supplies the inks comprising the colors of the organic emission layer to corresponding ink headers of the ink headers mounted on the inkjet roller.

2. The method of claim **1**, further comprising discharging the inks onto the substrate by transporting the substrate in one direction.

3. The method of claim **2**, wherein the substrate is rigid.

4. The method of claim **2**, wherein the substrate is flexible.

5. The method of claim **4**, wherein:

a first roller and a second roller are provided at a front end and a rear end of the inkjet roller, and

the substrate is unrolled from the first roller and transported to the inkjet roller,

the inks are discharged onto the substrate by using the inkjet roller, and

the substrate is rolled onto the second roller.

6. The method of claim **1**, wherein inks of different colors are discharged through the ink headers and onto the substrate from the inkjet roller.

7. The method of claim **6**, wherein the inks of different colors correspond to colors of the organic emission layer.

8. The method of claim **7**, wherein:

the ink headers are spaced apart from each other on an outer circumferential surface of the inkjet roller, and

the inks of different colors are sequentially discharged onto the substrate while the inkjet roller rotates.

9. The method of claim **7**, wherein the inks of different colors are discharged from the ink headers, through the opening of the mask, and onto the substrate.

10. The method of claim **7**, wherein an ink of one color is simultaneously loaded onto sub-pixels arranged in one line of the substrate.

11. The method of claim **1**, wherein the inks discharged onto the substrate are cured by ultraviolet light.

* * * * *

专利名称(译)	用于制造有机发光显示装置的装置和方法		
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[标]申请(专利权)人(译)	三星显示有限公司		
申请(专利权)人(译)	三星DISPLAY CO.，LTD.		
当前申请(专利权)人(译)	三星DISPLAY CO.，LTD.		
[标]发明人	KWON SEUNGWOOK		
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摘要(译)

一种制造有机发光显示装置的方法，包括：在基板上设置掩模，所述掩模具有与有机发光层的图案对应的开口;通过旋转喷墨辊，通过在掩模上设置喷墨辊形成有机发光层，并通过掩模的开口从安装在喷墨辊中的墨头中排出墨水;并固化有机发光层。