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(54) **ORGANIC LAYER DEPOSITION APPARATUS, METHOD OF MANUFACTURING ORGANIC LIGHT-EMITTING DISPLAY APPARATUS BY USING THE SAME, AND ORGANIC LIGHT-EMITTING DISPLAY APPARATUS MANUFACTURED BY THE METHOD**

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(57) **ABSTRACT**

An organic layer deposition apparatus includes: a conveyer unit including a transfer unit for attaching a substrate, a first conveyer unit, and a second conveyer unit; and a deposition unit including a vacuum chamber and an organic layer deposition assembly for depositing an organic layer on the substrate. The organic layer deposition assembly includes: a deposition source for discharging a deposition material; a deposition source nozzle unit including a plurality of deposition source nozzles; a patterning slit sheet including a plurality of patterning slits that are arranged in a first direction; and a deposition source shutter that moves in the first direction, and selectively blocks the deposition material that is vaporized in the deposition source. The transfer unit moves between the first and second conveyer units. The transfer unit keeps the attached substrate spaced apart from the organic layer deposition assembly while being transferred by the first conveyer unit.

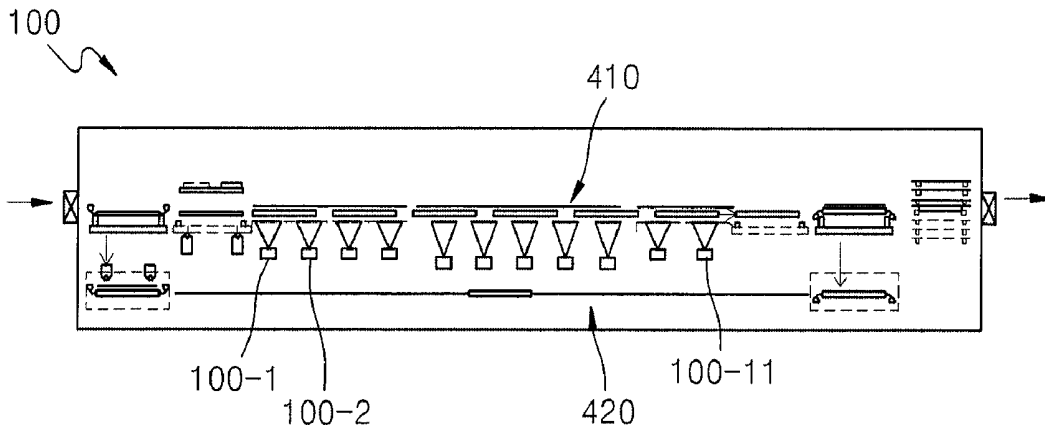


FIG. 1

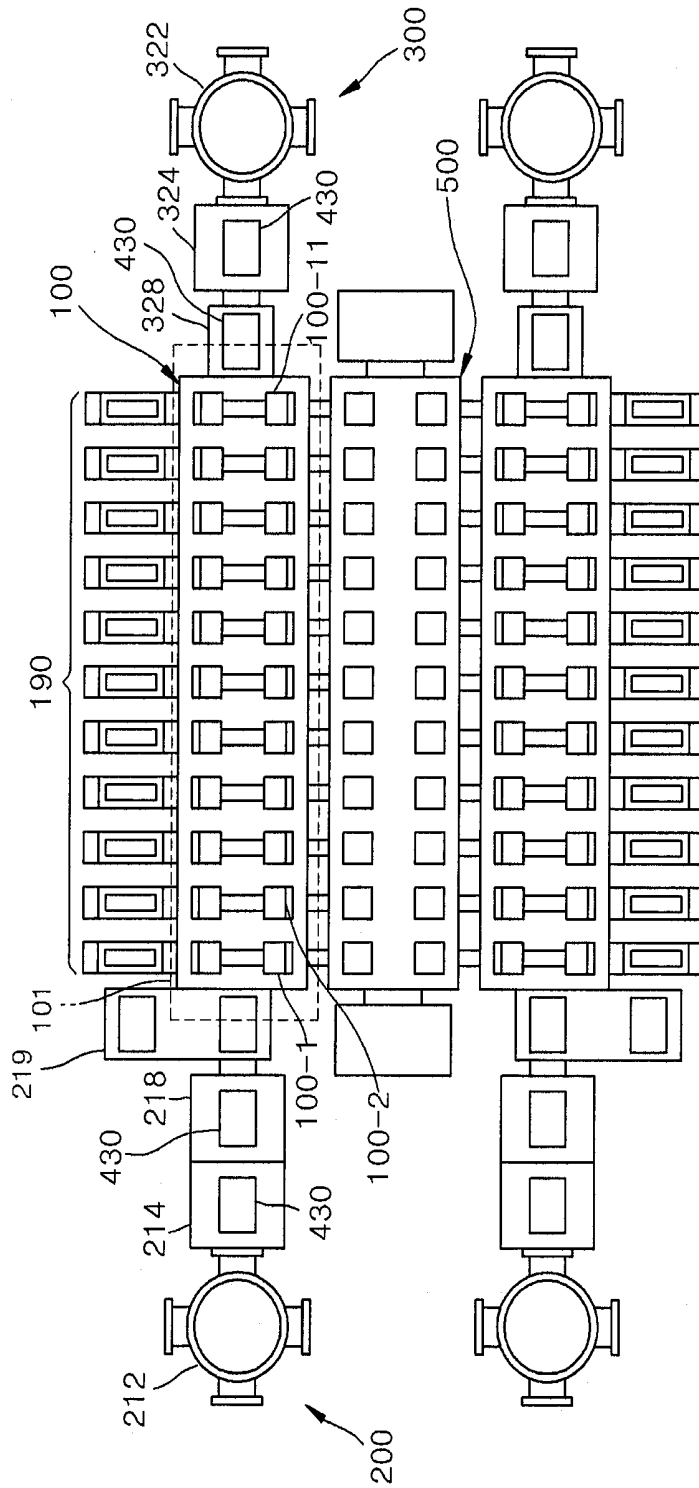


FIG. 2

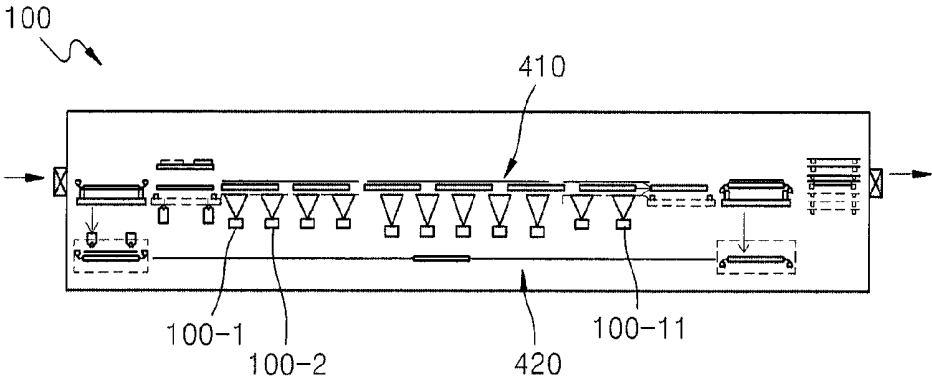


FIG. 3

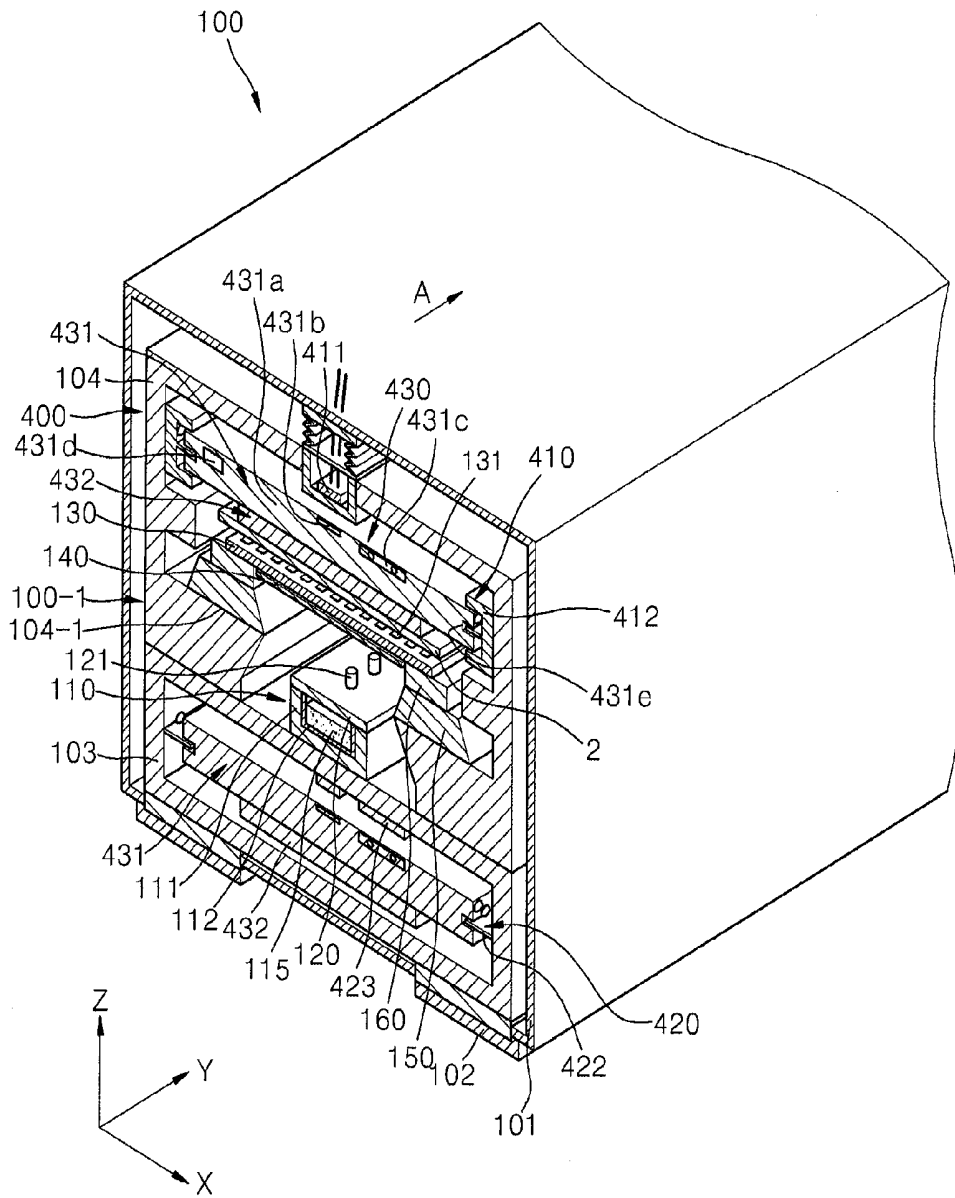


FIG. 4

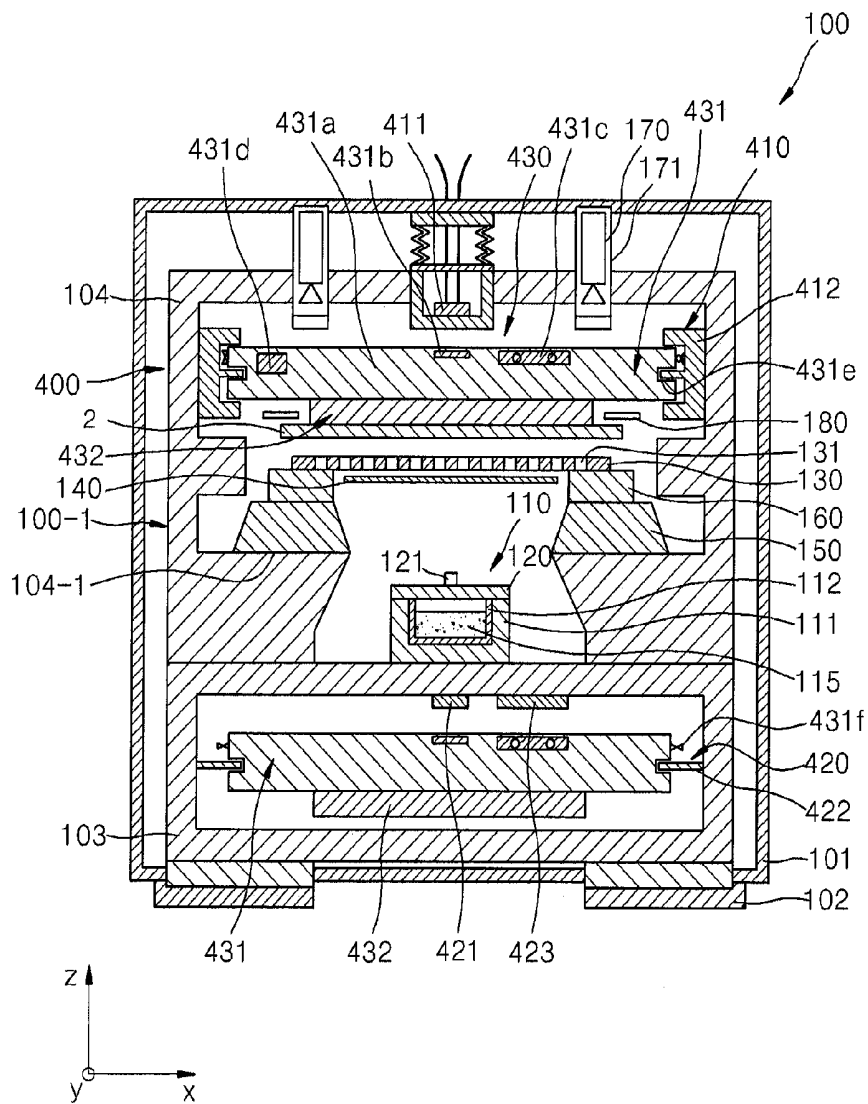


FIG. 6A

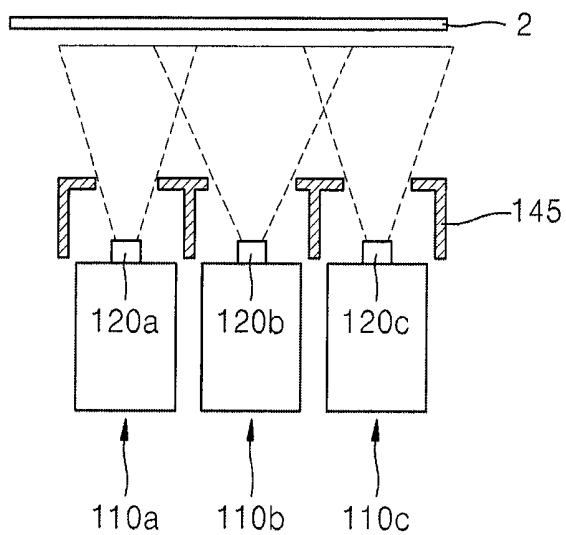


FIG. 6B

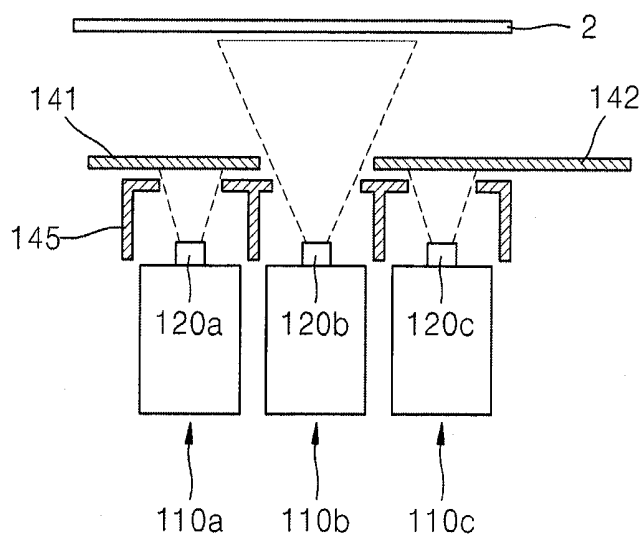


FIG. 6C

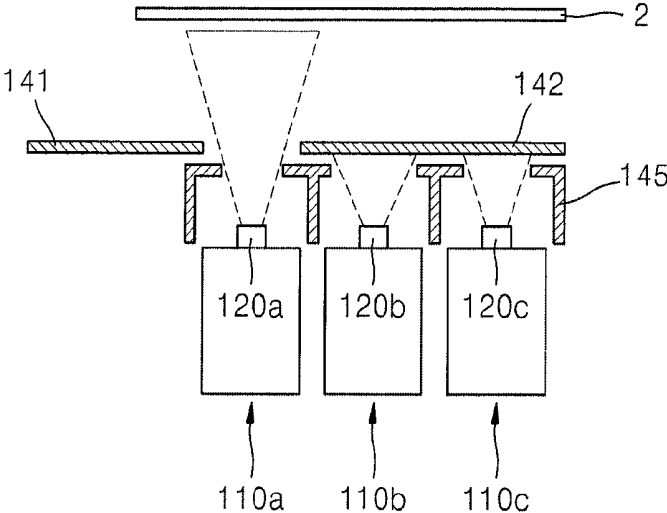


FIG. 7A

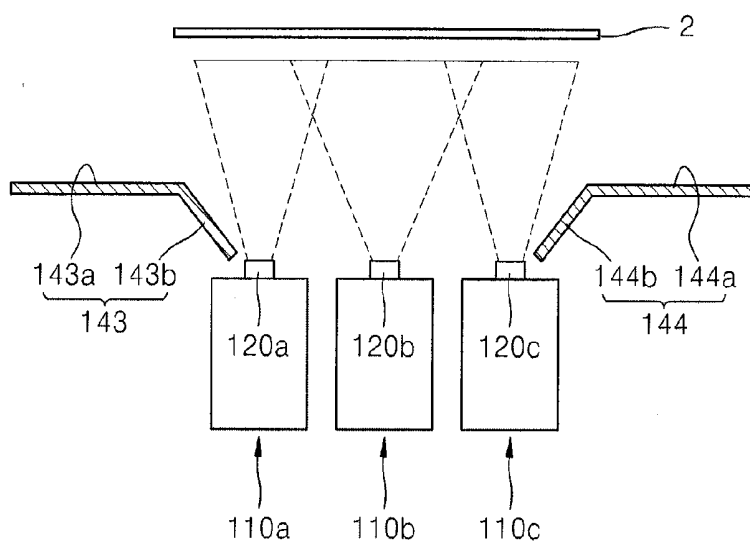


FIG. 7B

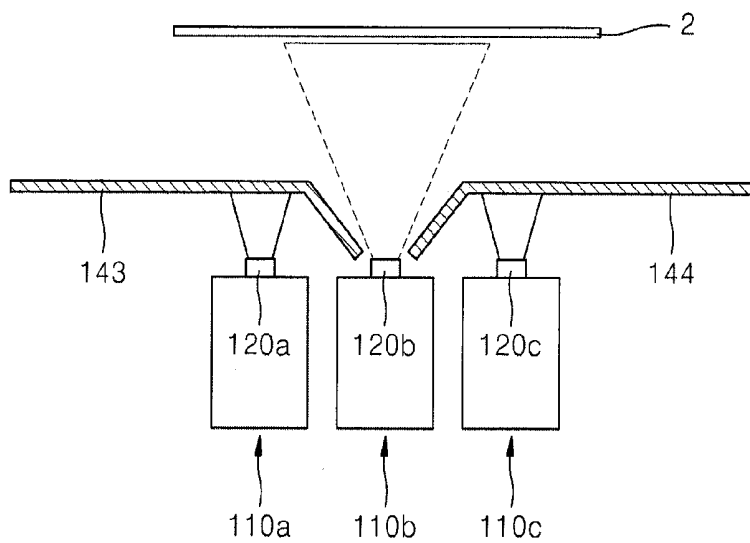


FIG. 7C

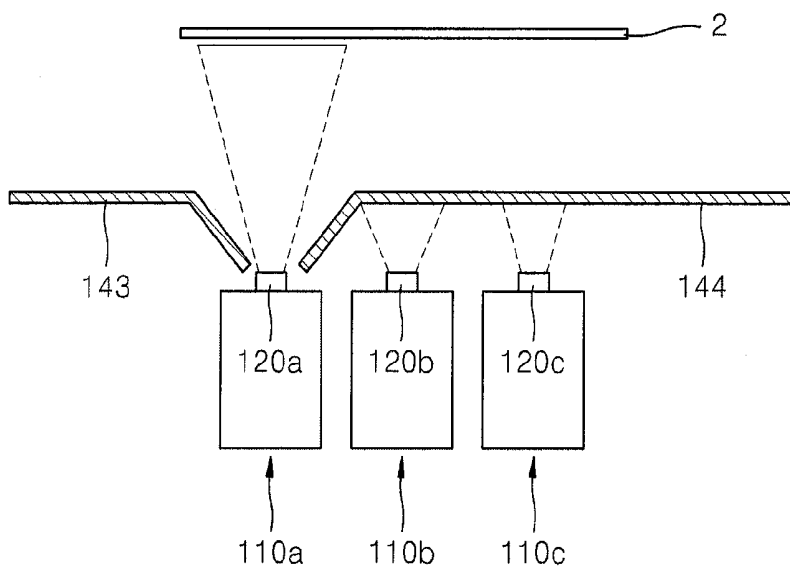


FIG. 7D

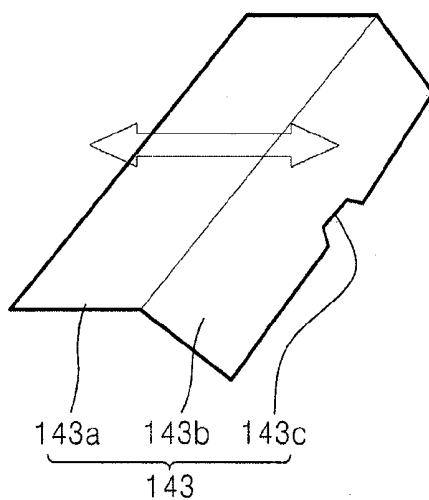


FIG. 8

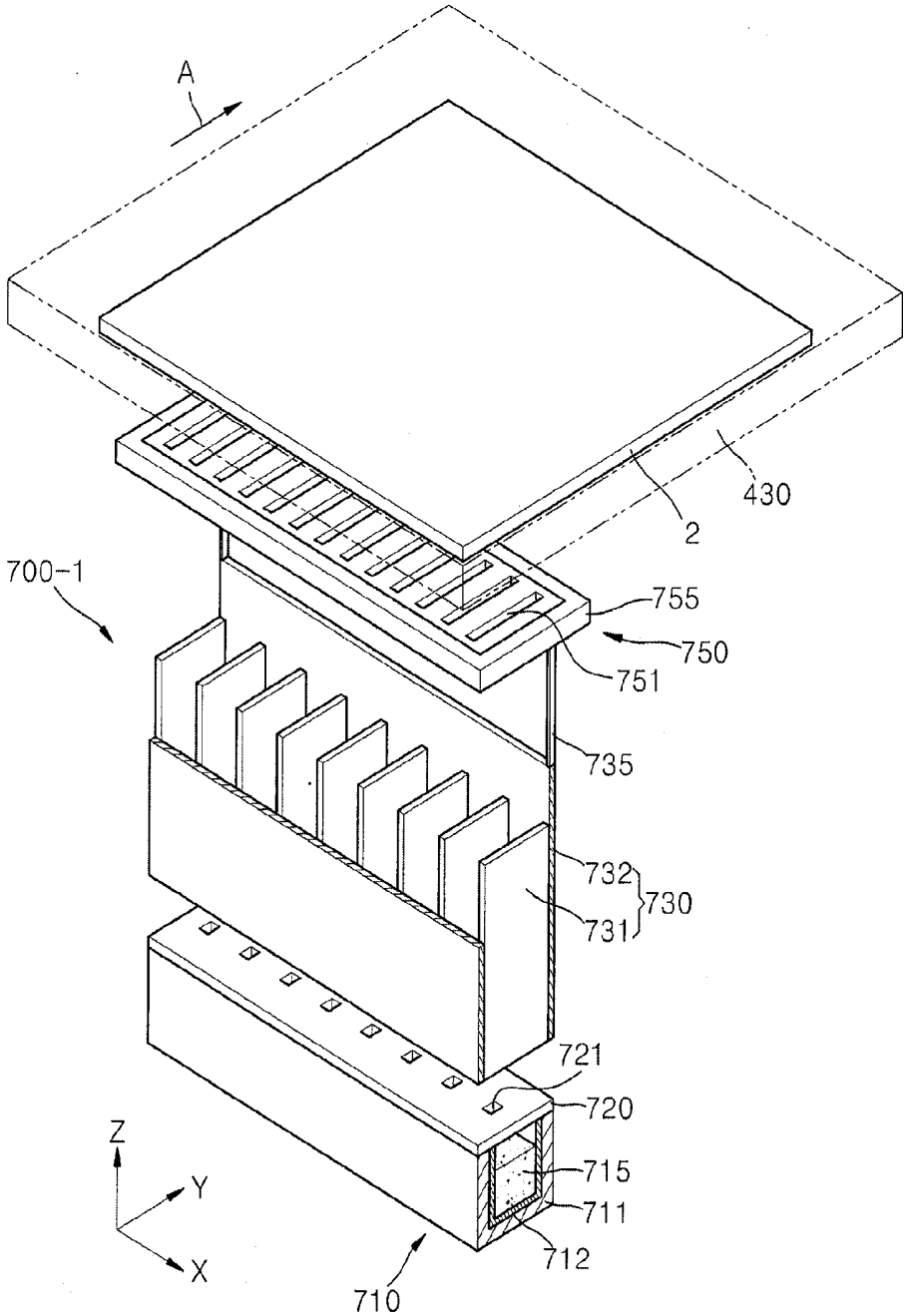


FIG. 9

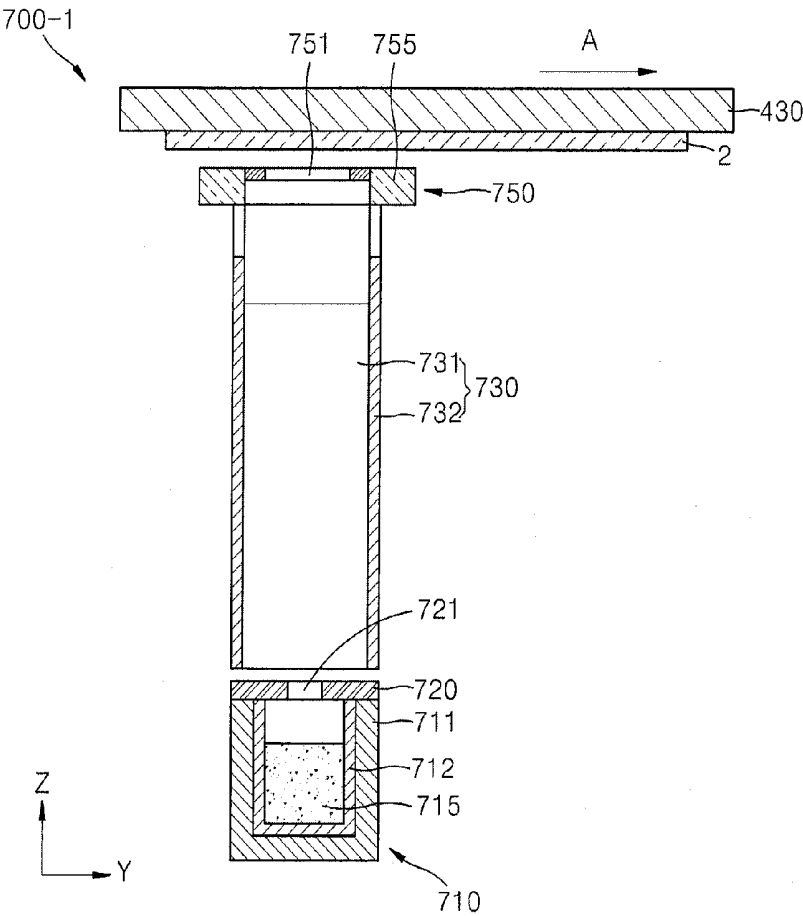


FIG. 10

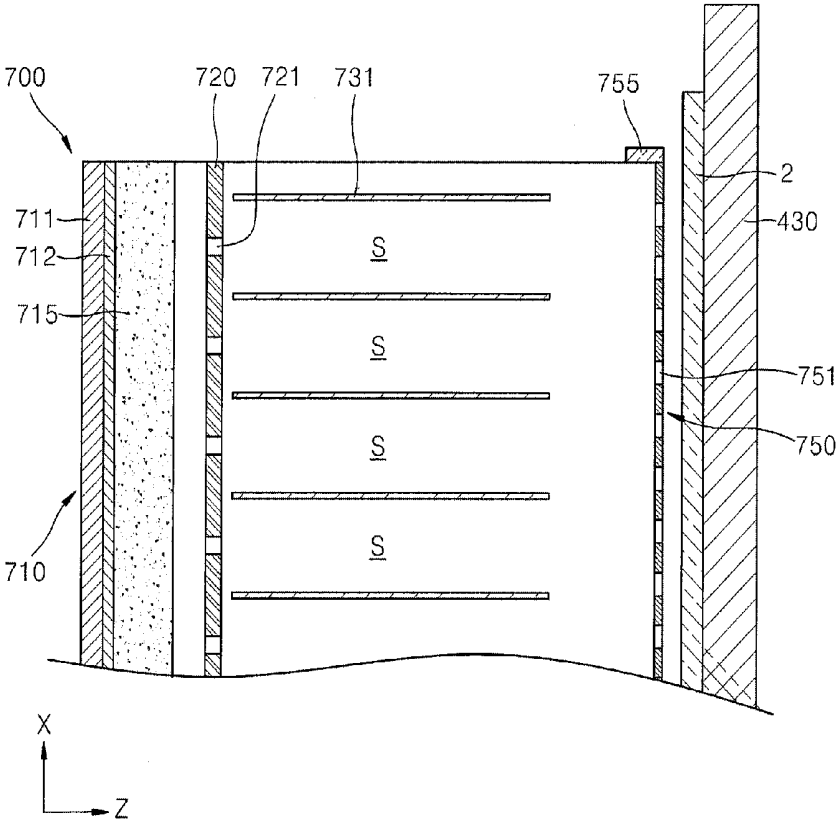


FIG. 11

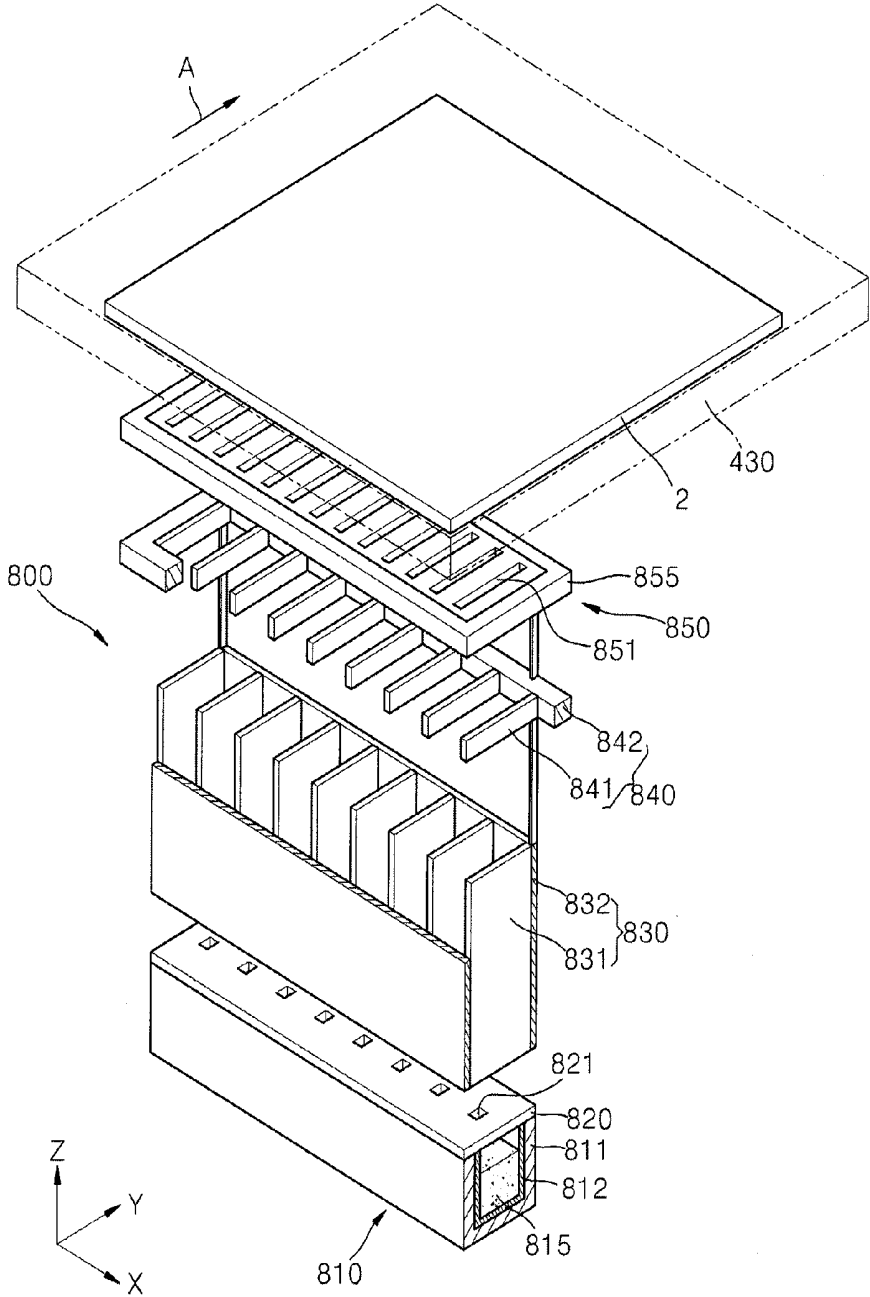


FIG. 12

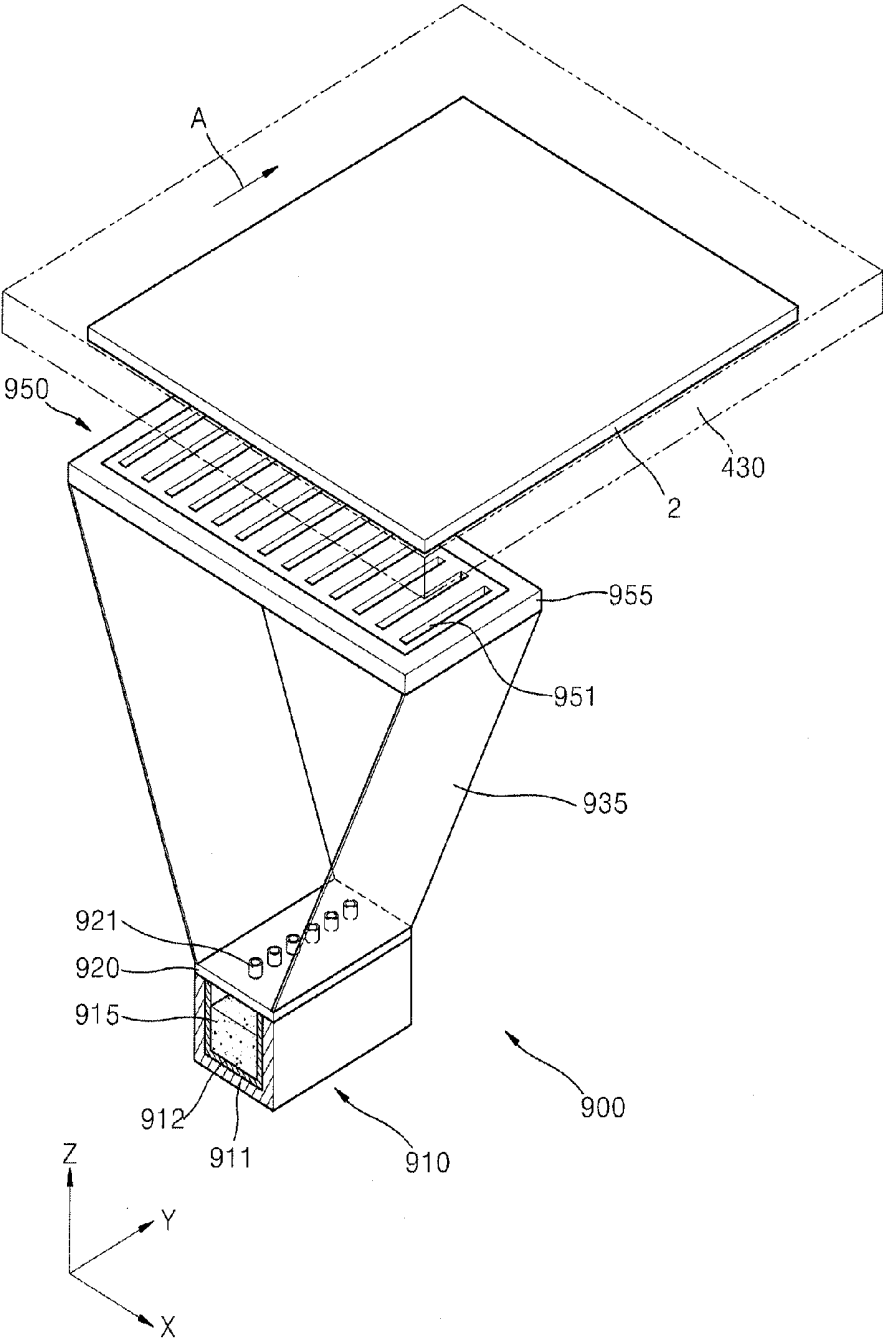


FIG. 13

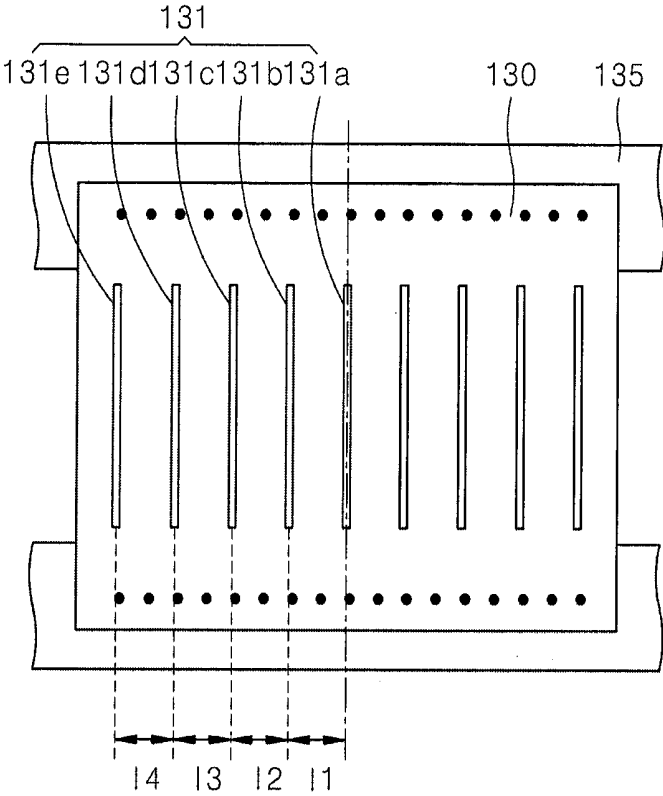


FIG. 14

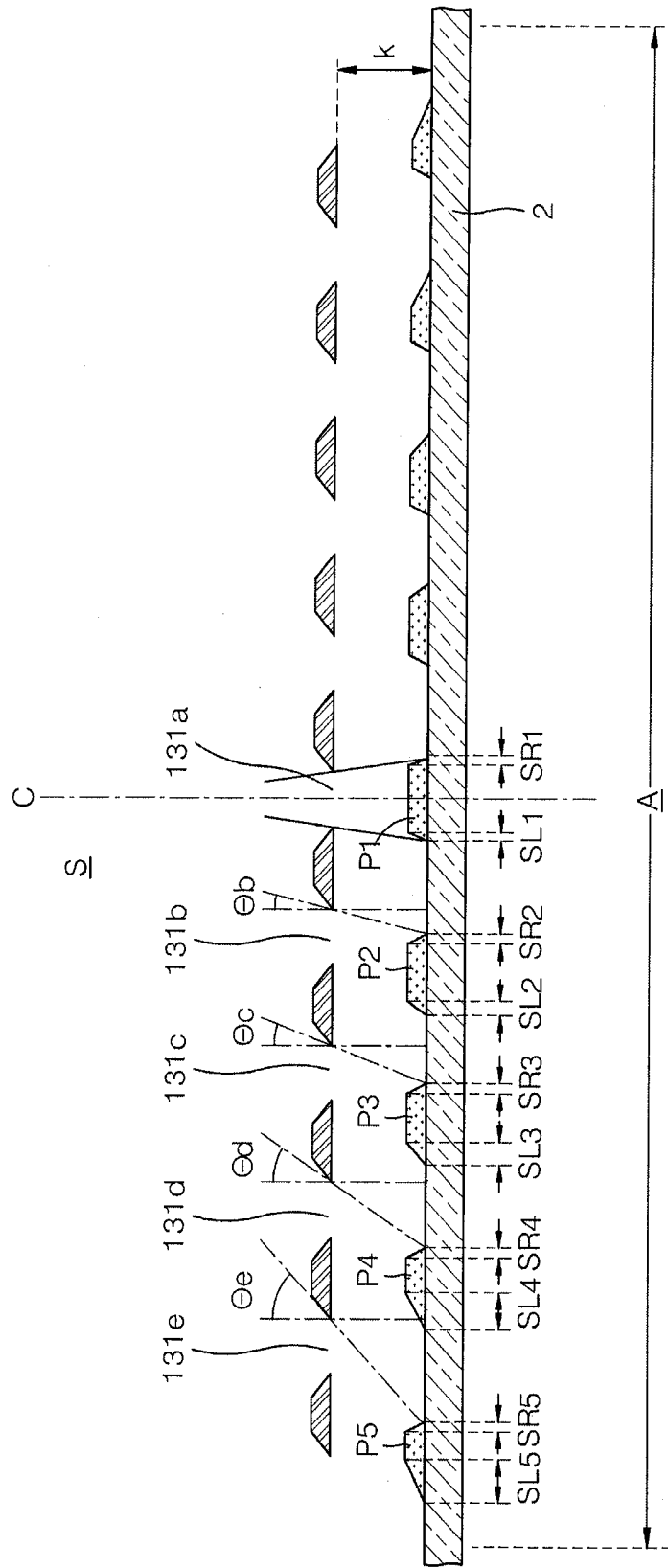
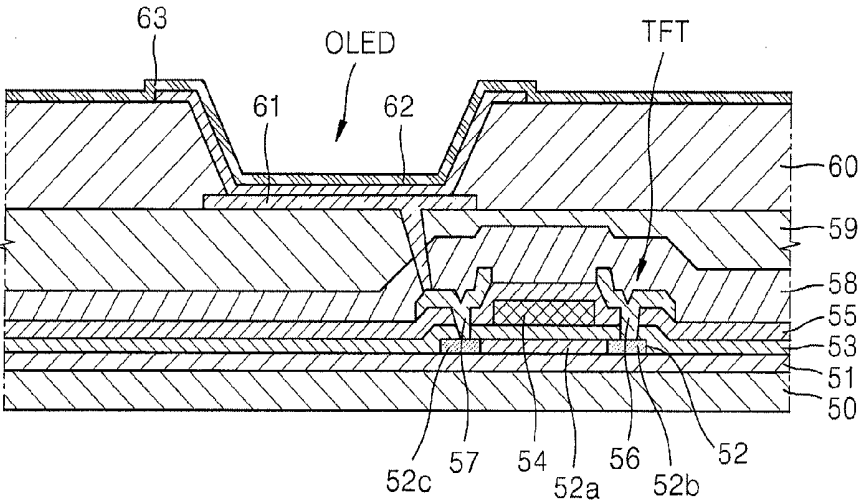


FIG. 15



**ORGANIC LAYER DEPOSITION
APPARATUS, METHOD OF
MANUFACTURING ORGANIC
LIGHT-EMITTING DISPLAY APPARATUS BY
USING THE SAME, AND ORGANIC
LIGHT-EMITTING DISPLAY APPARATUS
MANUFACTURED BY THE METHOD**

CROSS-REFERENCE TO RELATED PATENT
APPLICATION

[0001] This application claims priority to and the benefit of Korean Patent Application No. 10-2012-0077361, filed on Jul. 16, 2012, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND

[0002] 1. Field

[0003] The present invention relates to an organic layer deposition apparatus, a method of manufacturing an organic light-emitting display apparatus by using the same, and an organic light-emitting display apparatus manufactured by the method.

[0004] 2. Description of the Related Art

[0005] Organic light-emitting display devices have wider viewing angles, better contrast characteristics, and faster response speeds than other display devices, and thus have drawn attention as a next-generation display device.

[0006] An organic light-emitting display device includes intermediate layers (including an emission layer) located between a first electrode and a second electrode. The electrodes and the intermediate layers may be formed using various methods, one of which is an independent deposition method. When an organic light-emitting display device is manufactured by using the deposition method, a fine metal mask (FMM) having the same pattern as that of an organic layer to be formed is typically positioned to closely contact a substrate on which the organic layer and the like are formed, and an organic layer material is deposited through the FMM to form the organic layer having a desired pattern.

[0007] However, the deposition method using such an FMM presents difficulties in manufacturing larger organic light-emitting display devices using a large mother glass. For example, when such a large mask is used, the mask may bend due to its own weight, thereby distorting a pattern. Such disadvantages might make the FMM method undesirable in view of the recent trend towards high-definition patterns.

[0008] Moreover, processes of aligning a substrate and an FMM to closely contact each other, performing deposition thereon, and separating the FMM from the substrate are time-consuming, resulting in a long manufacturing time and low production efficiency.

[0009] Information disclosed in this Background section was known to the inventors of the present invention before achieving the present invention or is technical information acquired in the process of achieving the present invention. Therefore, it may contain information that does not form the prior art or information that was already known in this country to a person of ordinary skill in the art prior to the time the present invention was made by the inventors.

SUMMARY

[0010] Embodiments of the present invention provide an organic layer deposition apparatus that is suitable for use in a mass production of organic light-emitting display apparatuses on a large substrate and enables high-definition patterning. A method of manufacturing an organic light-emitting display apparatus by using the organic layer deposition apparatus, and an organic light-emitting display apparatus manufactured by the method, are also provided.

[0011] An organic layer deposition apparatus includes: a conveyer unit including a transfer unit for attaching a substrate, the transfer unit being configured to move along with the substrate, a first conveyer unit for moving in a first direction the transfer unit to which the substrate is attached, and a second conveyer unit for moving in a direction opposite to the first direction the transfer unit from which the substrate is separated after deposition has been completed; and a deposition unit including a chamber configured to be maintained in a vacuum state and an organic layer deposition assembly for depositing an organic layer on the substrate attached to the transfer unit. The organic layer deposition assembly includes: a deposition source for discharging a deposition material; a deposition source nozzle unit at a side of the deposition source, and including a plurality of deposition source nozzles; a patterning slit sheet facing the deposition source nozzle unit, and including a plurality of patterning slits that are arranged in a first direction; and a deposition source shutter that is movable in the first direction, and configured to selectively block the deposition material that is vaporized in the deposition source. The transfer unit is configured to move between the first conveyer unit and the second conveyer unit, and to keep the attached substrate spaced apart from the organic layer deposition assembly while being transferred by the first conveyer unit.

[0012] The organic layer deposition assembly may further include an angle limiting plate at a side of the deposition source to guide a flow path of the deposition material that is vaporized in the deposition source.

[0013] The angle limiting plate may surround a portion of the deposition source.

[0014] The deposition source shutter may include a first deposition source shutter and a second deposition source shutter that have a flat plate shape, and the deposition source may be opened or closed due to movement of the first deposition source shutter and the second deposition source shutter.

[0015] The deposition source shutter may include a first deposition source shutter and a second deposition source shutter, and each of the first deposition source shutter and the second deposition source shutter may include a flat-plate portion and an inclination portion that is bent from the flat-plate portion.

[0016] A groove may be at an end of the inclination portion and may correspond to one of the plurality of deposition source nozzles.

[0017] The inclination portion may be configured to guide a flow path of the deposition material that is vaporized in the deposition source.

[0018] The deposition source may be opened or closed due to movement of the first deposition source shutter and the second deposition source shutter.

[0019] The organic layer deposition apparatus may further include a control sensor at a side of the deposition source to measure a deposition rate of the deposition material that is vaporized in the deposition source.

[0020] The control sensor may be configured to measure the deposition rate of the deposition material while the transfer unit moves along with the substrate, and a vaporization amount of the deposition material that is vaporized in the deposition source may be controlled using the deposition rate.

[0021] The deposition rate of the deposition source which is measured by the control sensor may be controlled to deposit the deposition material on the substrate by a target thickness.

[0022] The first conveyer unit and the second conveyer unit may pass through the deposition unit.

[0023] The first conveyer unit and the second conveyer unit may be arranged one over the other in parallel.

[0024] The organic layer deposition apparatus may further include: a loading unit for attaching the substrate to the transfer unit; and an unloading unit for separating, from the transfer unit, the substrate on which the deposition has been completed while passing through the deposition unit.

[0025] The first conveyer unit may be configured to sequentially transport the transfer unit into the loading unit, the deposition unit, and the unloading unit.

[0026] The second conveyer unit may be configured to sequentially transport the transfer unit into the unloading unit, the deposition unit, and the loading unit.

[0027] The organic layer deposition assembly may be configured such that the deposition material that is discharged from the deposition source passes through the patterning slit sheet and is then deposited on the substrate while the deposition material forms a pattern on the substrate.

[0028] The patterning slit sheet of the organic layer deposition assembly may be smaller than the substrate in at least one of the first direction or a second direction perpendicular to the first direction.

[0029] The plurality of deposition source nozzles of the deposition source nozzle unit may be arranged along the first direction, the plurality of patterning slits of the patterning slit sheet may be arranged along the first direction, and the organic layer deposition apparatus may further include a shielding plate assembly including a plurality of shielding plates that are arranged along the first direction between the deposition source nozzle unit and the patterning slit sheet and that partition a space between the deposition source nozzle unit and the patterning slit sheet into a plurality of deposition spaces.

[0030] Each of the plurality of shielding plates may extend along a second direction that is substantially perpendicular to the first direction.

[0031] The shielding plate assembly may include a first shielding plate assembly including a plurality of first shielding plates, and a second shielding plate assembly including a plurality of second shielding plates.

[0032] 22. The organic layer deposition apparatus of claim 21, wherein each of the plurality of first shielding plates and each of the plurality of second shielding plates are arranged along a second direction that is substantially perpendicular to the first direction, and partition the space between the deposition source nozzle unit and the patterning slit sheet into the plurality of deposition spaces.

[0033] The plurality of deposition source nozzles of the deposition source nozzle unit may be arranged along the first direction, and the plurality of patterning slits of the patterning slit sheet may be arranged along a second direction that is perpendicular to the first direction.

[0034] The deposition source and the deposition source nozzle unit, and the patterning slit sheet may be integrally combined by using connection members.

[0035] The connection members may be configured to guide a flow path of the deposition material.

[0036] The connection members may seal a space among the deposition source, the deposition source nozzle unit, and the patterning slit sheet from an outside.

[0037] In another embodiment according to the present invention, a method of manufacturing an organic light-emitting display apparatus is provided. The method includes: moving a transfer unit to which the substrate is attached into a chamber, using a first conveyer unit passing through the chamber; while the substrate and a plurality of organic layer deposition assemblies in the chamber are spaced apart from each other, and the substrate relatively moves with respect to the organic layer deposition assemblies, depositing deposition materials discharged from the organic layer deposition assemblies on the substrate to form organic layers; and moving the transfer unit, from which the substrate is separated, using a second conveyer unit passing through the chamber. Each of the organic layer deposition assemblies includes: a deposition source for discharging the deposition material; a deposition source nozzle unit at a side of the deposition source, and including a plurality of deposition source nozzles; a patterning slit sheet facing the deposition source nozzle unit, and including a plurality of patterning slits; and a deposition source shutter that is movable in a first direction, and configured to selectively block the deposition material that is vaporized in the deposition source. The depositing the deposition materials includes measuring a deposition rate of each of a plurality of the deposition sources by sequentially opening or closing the plurality of the deposition sources using the deposition source shutter.

[0038] Each of the organic layer deposition assemblies may further include an angle limiting plate at a side of the deposition source to guide a flow path of the deposition material that is vaporized in the deposition source.

[0039] The deposition source shutter may include a first deposition source shutter and a second deposition source shutter that have a flat plate shape, and the plurality of the deposition sources may be opened or closed due to movement of the first deposition source shutter and the second deposition source shutter.

[0040] The deposition source shutter may include a first deposition source shutter and a second deposition source shutter, and each of the first deposition source shutter and the second deposition source shutter may include a flat-plate portion and an inclination portion that is bent from the flat-plate portion.

[0041] A groove may be at an end of the inclination portion and correspond to one of the plurality of deposition source nozzles.

[0042] The inclination portion may be configured to guide a flow path of the deposition material that is vaporized in the deposition source.

[0043] The plurality of the deposition sources may be opened or closed due to movement of the first deposition source shutter and the second deposition source shutter.

[0044] The organic layer deposition apparatus may further include a control sensor at a side of the deposition source to measure a deposition rate of the deposition material that is vaporized in the deposition source.

[0045] The deposition rate of the deposition material may be measured by the control sensor while the transfer unit moves along with the substrate, and a vaporization amount of the deposition material that is vaporized in the deposition source may be controlled using the deposition rate.

[0046] The method may further include, before moving the transfer unit using the first conveyer unit, attaching the substrate to the transfer unit using a loading unit; and before moving the transfer unit using the second conveyer unit, separating the substrate from the transfer unit using an unloading unit after the deposition has been completed on the substrate.

[0047] The transfer unit may be configured to move between the first conveyer unit and the second conveyer unit.

[0048] The first conveyer unit and the second conveyer unit may be arranged one over the other in parallel.

[0049] The patterning slit sheet of the organic layer deposition assembly may be smaller than the substrate in at least one of the first direction or a second direction.

[0050] In another exemplary embodiment according to the present invention, an organic light-emitting display device includes: a substrate; a plurality of thin film transistors on the substrate, each of the thin film transistors including a semiconductor active layer, a gate electrode insulated from the semiconductor active layer, and source and drain electrodes each contacting the semiconductor active layer; a plurality of pixel electrodes respectively on the thin film transistors; a plurality of organic layers respectively on the plurality of pixel electrodes; and a counter electrode on the plurality of organic layers. A length of a slanted side between top and bottom sides of at least one of the plurality of organic layers on the substrate farther from a center of a deposition region may be larger than lengths of slanted sides respectively between top and bottom sides of those other organic layers closer to the center of the deposition region, and the at least one of the plurality of organic layers on the substrate is a linearly-patterned organic layer formed using any suitable organic layer deposition apparatus described above.

[0051] The plurality of organic layers may include at least an emission layer.

[0052] The plurality of organic layers may have a non-uniform thickness.

[0053] In each of the organic layers that is farther from the center of the deposition region, the slanted side that is farther from the center of the deposition region may be larger than the other slanted side.

[0054] The farther one of the plurality of organic layers in the deposition region is from the center of the deposition region, the narrower an overlapped region of two sides of the one of the plurality of organic layers may be formed.

[0055] The slanted sides of the organic layer at the center of the deposition region may have substantially the same length as each other.

[0056] The plurality of organic layers in the deposition region may be symmetrically arranged about the center of the deposition region.

[0057] The substrate may have a size of 40 inches or more.

BRIEF DESCRIPTION OF THE DRAWINGS

[0058] The above and other features and aspects of the present invention will become more apparent by describing in detail exemplary embodiments thereof with reference to the attached drawings in which:

[0059] FIG. 1 is a schematic plan view illustrating a structure of an organic layer deposition apparatus according to an embodiment of the present invention;

[0060] FIG. 2 is a schematic side view of a deposition unit of the organic layer deposition apparatus of FIG. 1, according to an embodiment of the present invention;

[0061] FIG. 3 is a schematic perspective view of the deposition unit of the organic layer deposition apparatus of FIG. 1, according to an embodiment of the present invention;

[0062] FIG. 4 is a schematic cross-sectional view of the deposition unit of FIG. 3, according to an embodiment of the present invention;

[0063] FIG. 5 is a cross-sectional view schematically illustrating a first conveyer unit and a transfer unit of the deposition unit of FIG. 3, according to an embodiment of the present invention;

[0064] FIGS. 6A, 6B, and 6C illustrate a deposition source of FIG. 3, an angle limiting plate, and a deposition source shutter, according to an embodiment of the present invention;

[0065] FIGS. 7A, 7B, 7C, and 7D illustrate a deposition source of FIG. 3, an angle limiting plate, and a deposition source shutter, according to another embodiment of the present invention;

[0066] FIG. 8 is a schematic perspective view of an organic layer deposition assembly according to another embodiment of the present invention;

[0067] FIG. 9 is a schematic cross-sectional side view of the organic layer deposition assembly of FIG. 8;

[0068] FIG. 10 is a schematic cross-sectional plan view of the organic layer deposition assembly of FIG. 8;

[0069] FIG. 11 is a schematic perspective view of an organic layer deposition assembly according to another embodiment of the present invention;

[0070] FIG. 12 is a schematic perspective view of an organic layer deposition assembly according to another embodiment of the present invention;

[0071] FIG. 13 is a diagram schematically illustrating a structure in which patterning slits are arranged at equal intervals in a patterning slit sheet of the organic layer deposition apparatus, according to an embodiment of the present invention;

[0072] FIG. 14 is a diagram schematically illustrating organic layers formed on the substrate by using the patterning slit sheet of FIG. 13, according to an embodiment of the present invention; and

[0073] FIG. 15 is a schematic cross-sectional view of an active matrix-type organic light-emitting display device manufactured by using the organic layer deposition apparatus, according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0074] Hereinafter, embodiments of the present invention will be described in detail by explaining exemplary embodiments of the invention with reference to the attached drawings. Like reference numerals in the drawings denote like elements.

[0075] Reference will now be made in detail to the embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below in order to explain aspects of the present invention by referring to the figures. Expressions such

as “at least one of,” when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list.

[0076] FIG. 1 is a schematic plan view illustrating a structure of an organic layer deposition apparatus 1 according to an embodiment of the present invention. FIG. 2 is a schematic side view of a deposition unit 100 of the organic layer deposition apparatus 1 of FIG. 1, according to an embodiment of the present invention.

[0077] Referring to FIGS. 1 and 2, the organic layer deposition apparatus 1 includes the deposition unit 100, a loading unit 200, an unloading unit 300, and a conveyer unit 400 (also see for example, FIGS. 3 and 4).

[0078] The loading unit 200 may include a first rack 212, a transport chamber 214, a first inversion chamber 218, and a buffer chamber 219.

[0079] A plurality of substrates 2 (for example, one substrate 2 is shown in FIGS. 3 and 4) onto which a deposition material has not yet been applied are stacked up on the first rack 212. A transport robot included in the transport chamber 214 picks up one of the substrates 2 from the first rack 212, places it on a transfer unit 430 transferred by a second conveyer unit 420, and moves the transfer unit 430 on which the substrate 2 is placed into the first inversion chamber 218.

[0080] The first inversion chamber 218 is located adjacent to the transport chamber 214. The first inversion chamber 218 includes a first inversion robot that inverts the transfer unit 430 and then loads it on a first conveyer unit 410 of the deposition unit 100.

[0081] Referring to FIG. 1, the transport robot of the transport chamber 214 places one of the substrates 2 on a top surface of the transfer unit 430, and the transfer unit 430 on which the substrate 2 is placed is then transferred into the first inversion chamber 218. The first inversion robot of the first inversion chamber 218 inverts the transfer unit 430 so that the substrate 2 is turned upside down in the deposition unit 100.

[0082] The unloading unit 300 is configured to operate in an opposite manner to the loading unit 200 described above. Specifically, a second inversion robot in a second inversion chamber 328 inverts the transfer unit 430, which has passed through the deposition unit 100 while the substrate 2 is placed on the transfer unit 430, and then moves the transfer unit 430 on which the substrate 2 is placed into an ejection chamber 324. Then, an ejection robot takes the transfer unit 430 on which the substrate 2 is placed out of the ejection chamber 324, separates the substrate 2 from the transfer unit 430, and then loads the substrate 2 on a second rack 322. The transfer unit 430, separated from the substrate 2, is returned to the loading unit 200 via the second conveyer unit 420.

[0083] However, the present invention is not limited to the above example. For example, when placing the substrate 2 on the transfer unit 430, the substrate 2 may be fixed (or attached) onto a bottom surface of the transfer unit 430 and then moved into the deposition unit 100. In such an embodiment, for example, the first inversion robot of the first inversion chamber 218 and the second inversion robot of the second inversion chamber 328 may be omitted.

[0084] The deposition unit 100 may include at least one chamber for deposition. In one embodiment, as illustrated in FIGS. 1 and 2, the deposition unit 100 includes a chamber 101 in which a plurality of organic layer deposition assemblies 100-1, 100-2, . . . , 100-n may be located. Referring to FIG. 1, 11 organic layer deposition assemblies, i.e., a first organic layer deposition assembly 100-1, a second organic layer

deposition assembly 100-2 through an eleventh organic layer deposition assembly 100-11, are located in the chamber 101, but the number of organic layer deposition assemblies may vary with a desired deposition material and deposition conditions. The chamber 101 is maintained in vacuum during the deposition process.

[0085] In the embodiment illustrated in FIG. 1, the transfer unit 430 with the substrate 2 fixed thereon (or attached thereto) may be moved at least to the deposition unit 100 or may be moved sequentially to the loading unit 200, the deposition unit 100, and the unloading unit 300, by the first conveyer unit 410, and the transfer unit 430 that is separated from the substrate 2 in the unloading unit 300 may be moved back to the loading unit 200 by the second conveyer unit 420.

[0086] The first conveyer unit 410 passes through the chamber 101 when passing through the deposition unit 100, and the second conveyer unit 420 conveys (or transports) the transfer unit 430 from which the substrate 2 is separated.

[0087] In the present embodiment, the organic layer deposition apparatus 1 is configured such that the first conveyer unit 410 and the second conveyer unit 420 are respectively disposed above and below so that after the transfer unit 430, on which deposition has been completed while passing through the first conveyer unit 410, is separated from the substrate 2 in the unloading unit 300, the transfer unit 430 is returned to the loading unit 200 via the second conveyer unit 420 formed below the first conveyer unit 410, whereby the organic layer deposition apparatus 1 may have an improved space utilization efficiency.

[0088] In an embodiment, the deposition unit 100 of FIG. 1 may further include a deposition source replacement unit 190 located at a side of each organic layer deposition assembly. Although not particularly illustrated in the drawings, the deposition source replacement unit 190 may be formed as a cassette-type that may be drawn to the outside from each organic layer deposition assembly. Thus, a deposition source 110 (refer to FIG. 3) of the organic layer deposition assembly 100-1 may be easily replaced.

[0089] FIG. 3 is a schematic perspective view of the deposition unit 100 of the organic layer deposition apparatus 1 of FIG. 1, according to an embodiment of the present invention. FIG. 4 is a schematic cross-sectional view of the deposition unit 100 of FIG. 3, according to an embodiment of the present invention. FIG. 5 is a cross-sectional view schematically illustrating a first conveyer unit 410 and a transfer unit 430 of the deposition unit 100 of FIG. 3, according to an embodiment of the present invention.

[0090] Referring to FIGS. 3 and 4, the deposition unit 100 of the organic layer deposition apparatus 1 includes at least one organic layer deposition assembly 100-1 and a conveyer unit 400.

[0091] Hereinafter, an overall structure of the deposition unit 100 will be described.

[0092] The chamber 101 may be formed as a hollow box type and accommodate the at least one organic layer deposition assembly 100-1 and the transfer unit 430. In another descriptive manner, a foot 102 is formed so as to fix the deposition unit 100 on the ground, a lower housing 103 is located on the foot 102, and an upper housing 104 is located on the lower housing 103. The chamber 101 accommodates both the lower housing 103 and the upper housing 104. In this regard, a connection part of the lower housing 103 and the chamber 101 is sealed so that the inside of the chamber 101 is completely isolated from the outside. Due to the structure in

which the lower housing **103** and the upper housing **104** are located on the foot **102** fixed on the ground, the lower housing **103** and the upper housing **104** may be maintained in a fixed position even though the chamber **101** is repeatedly contracted and expanded. Thus, the lower housing **103** and the upper housing **104** may serve as a reference frame in the deposition unit **100**.

[0093] The upper housing **104** includes the organic layer deposition assembly **100-1** and the first conveyer unit **410** of the conveyer unit **400**, and the lower housing **103** includes the second conveyer unit **420** of the conveyer unit **400**. While the transfer unit **430** is cyclically moving between the first conveyer unit **410** and the second conveyer unit **420**, a deposition process is continuously performed.

[0094] Hereinafter, constituents of the organic layer deposition assembly **100-1** are described in detail.

[0095] The first organic layer deposition assembly **100-1** includes the deposition source **110**, a deposition source nozzle unit **120**, a patterning slit sheet **130**, a shielding member **140**, a first stage **150**, a second stage **160**, a camera (or cameras) **170**, and a sensor (or sensors) **180**. In this regard, all the elements illustrated in FIGS. **3** and **4** may be arranged in the chamber **101** maintained in an appropriate vacuum state. This structure is used to achieve the linearity of a deposition material.

[0096] For example, in order to deposit a deposition material **115** that has been discharged from the deposition source **110** and passed through the deposition source nozzle unit **120** and the patterning slit sheet **130**, onto the substrate **2** in a desired pattern, it is desirable to maintain the chamber in the same vacuum state as that used in a deposition method using a fine metal mask (FMM). In addition, the temperature of the patterning slit sheet **130** should be sufficiently lower than that of the deposition source **110** (e.g., about 100° C. or less) because thermal expansion of the patterning slit sheet **130** is reduced or minimized when the temperature of the patterning slit sheet **130** is sufficiently low.

[0097] The substrate **2** on which the deposition material **115** is to be deposited is arranged in the chamber **101**. The substrate **2** may be a substrate for a flat panel display device. For example, a large substrate (e.g., having a size of 40 inches or more), such as a mother glass, for manufacturing a plurality of flat panel displays, may be used as the substrate **2**.

[0098] According to the present embodiment, the deposition process may be performed with the substrate **2** being moved relative to the organic layer deposition assembly **100-1**.

[0099] In a conventional deposition method using an FMM, the size of the FMM is the same as that of a substrate. Thus, as the size of the substrate increases, the size of the FMM also increases. Due to these problems, it is difficult to fabricate the FMM and to align the FMM in a precise pattern by elongation of the FMM.

[0100] To address these problems, in the organic layer deposition assembly **100-1** according to the present embodiment, deposition may be performed while the organic layer deposition assembly **100-1** and the substrate **2** are moved relative to each other. In other words, deposition may be continuously performed while the substrate **2**, which faces the organic layer deposition assembly **100-1**, is moved in a Y-axis direction. That is, deposition is performed in a scanning manner while the substrate **2** is moved in a direction of arrow **A** illustrated in FIG. **3**. Although the substrate **2** is illustrated as being moved in the Y-axis direction in the chamber **101** in

FIG. **3** when deposition is performed, the present invention is not limited thereto. For example, deposition may be performed while the organic layer deposition assembly **100-1** is moved in the Y-axis direction and the substrate **2** is held in a fixed position.

[0101] Thus, in the organic layer deposition assembly **100-1**, the patterning slit sheet **130** may be smaller (e.g., much smaller) than an FMM used in a conventional deposition method. In other words, in the organic layer deposition assembly **100-1**, deposition is continuously performed, i.e., in a scanning manner while the substrate **2** is moved in the Y-axis direction. Thus, at least one of the lengths of the patterning slit sheet **130** in X-axis and Y-axis directions may be less (e.g., much less) than a length of the substrate **2**. Because the patterning slit sheet **130** may be formed smaller (e.g., much smaller) than the FMM used in a conventional deposition method, it is relatively easy to manufacture the patterning slit sheet **130**. That is, the small patterning slit sheet **130** is more suitable in view of the manufacturing processes, including etching followed by precise elongation, welding, transferring, and washing processes, than the FMM used in a conventional deposition method. In addition, this is more suitable for manufacturing a relatively large display device.

[0102] In order to perform deposition while the organic layer deposition assembly **100-1** and the substrate **2** are moved relative to each other as described above, the organic layer deposition assembly **100-1** and the substrate **2** may be spaced apart from each other by a certain distance (e.g., a gap). This is described below in more detail.

[0103] The deposition source **110** that contains and heats the deposition material **115** is located at a side opposite to (facing) a side in which the substrate **2** is located in the chamber. As the deposition material **115** contained in the deposition source **110** is vaporized, deposition is performed on the substrate **2**.

[0104] The deposition source **110** includes a crucible **111** that is filled with the deposition material **115** and a heater **112** that heats the crucible **111** so as to vaporize the deposition material **115** toward a side of the crucible **111** filled with the deposition material **115**, in particular, toward the deposition source nozzle unit **120**.

[0105] The deposition source **110**, in one embodiment, is located at a side of the deposition source **110** facing the substrate **2**. In this regard, the organic layer deposition assemblies according to the present embodiment each may include different deposition nozzles in performing deposition for forming common layers and pattern layers. That is, a plurality of deposition source nozzles **121** may be arranged along the Y-axis direction, i.e., a scanning direction of the substrate **2**, at the deposition source nozzle unit **120** so as to form a pattern layer. Accordingly, only one deposition source nozzle **121** is formed or arranged along the X-axis direction, so that the occurrence of shadows may be reduced (e.g., significantly reduced). On the other hand, the plurality of deposition source nozzles **121** may be arranged along the X-axis direction at the deposition source nozzle unit **120** so as to form a common layer. By doing so, a thickness uniformity of the common layer may be improved.

[0106] In one embodiment, the patterning slit sheet **130** may be located between the deposition source **110** and the substrate **2**. The patterning slit sheet **130** may further include a frame having a shape similar to a window frame. The patterning slit sheet **130** includes a plurality of patterning slits

131 arranged along the X-axis direction. The deposition material **115** that has been vaporized in the deposition source **110** passes through the deposition source nozzle unit **120** and the patterning slit sheet **130** and is then deposited onto the substrate **2**. In this regard, the patterning slit sheet **130** may be formed using the same method as that used to form an FMM, in particular, a stripe-type mask, e.g., etching. In this regard, a total number of patterning slits **131** may be more than a total number of deposition source nozzles **121**.

[0107] In one embodiment, the deposition source **110** (and the deposition source nozzle unit **120** combined thereto) and the patterning slit sheet **130** may be spaced apart from each other by a certain distance (e.g., a gap).

[0108] As described above, deposition is performed while the organic layer deposition assembly **100-1** is moved relative to the substrate **2**. In order for the organic layer deposition assembly **100-1** to be moved relative to the substrate **2**, the patterning slit sheet **130** is spaced apart from the substrate **2** by a certain distance (e.g., a gap).

[0109] In a conventional deposition method using an FMM, deposition is typically performed with the FMM in close contact with a substrate in order to prevent formation of shadows on the substrate. However, when the FMM is formed in close contact with the substrate, defects due to the contact between the substrate and the FMM may occur. In addition, because it is difficult to move the mask with respect to the substrate, the mask and the substrate have the same size. Accordingly, the mask becomes larger as the size of a display device increases. However, it is difficult to form a large mask.

[0110] To address these problems, in the organic layer deposition assembly **100-1** according to the present embodiment, the patterning slit sheet **130** is formed spaced apart by a certain distance (e.g., a gap) from the substrate **2** on which a deposition material is to be deposited.

[0111] According to the present embodiment, deposition may be performed while a mask formed smaller than a substrate is moved with respect to the substrate, and thus, it is relatively easy to manufacture the mask. In addition, defects due to contact between the substrate and the mask may be prevented. In addition, because it is unnecessary to closely contact the substrate with the mask during a deposition process, a manufacturing speed may be improved.

[0112] Hereinafter, particular disposition of each element of the upper housing **104** will be described.

[0113] The deposition source **110** and the deposition source nozzle unit **120** are located at a bottom portion of the upper housing **104**. Accommodation portions **104-1** are respectively formed on both sides of the deposition source **110** and the deposition source nozzle unit **120** to have a protruding shape. The first stage **150**, the second stage **160**, and the patterning slit sheet **130** are sequentially formed (or located) on the accommodation portions **104-1** in this order.

[0114] In this regard, the first stage **150** is formed to move in X-axis and Y-axis directions so that the first stage **150** aligns the patterning slit sheet **130** in the X-axis and Y-axis directions. That is, the first stage **150** includes a plurality of actuators so that the first stage **150** is moved in the X-axis and Y-axis directions with respect to the upper housing **104**.

[0115] The second stage **160** is formed to move in a Z-axis direction so as to align the patterning slit sheet **130** in the Z-axis direction. That is, the second stage **160** includes a plurality of actuators and is formed to move in the Z-axis direction with respect to the first stage **150**.

[0116] The patterning slit sheet **130** is located on the second stage **160**. The patterning slit sheet **130** is located on the first stage **150** and the second stage **160** so as to move in the X-axis, Y-axis, and Z-axis directions, and thus, an alignment, in particular, a real-time alignment, between the substrate **2** and the patterning slit sheet **130**, may be performed.

[0117] In addition, the upper housing **104**, the first stage **150**, and the second stage **160** may guide a flow path of the deposition material **115** such that the deposition material **115** discharged through the deposition source nozzles **121** is not dispersed outside the flow path. That is, the flow path of the deposition material **115** is sealed by the upper housing **104**, the first stage **150**, and the second stage **160**, and thus, the movement of the deposition material **115** in the X-axis and Y-axis directions may be thereby concurrently or simultaneously guided.

[0118] The shielding member **140** may be located between the patterning slit sheet **130** and the deposition source **110** so as to prevent an organic material from being deposited on a non-film-forming region of the substrate **2**. Although not illustrated, the shielding member **140** may include two adjacent plates. Since the non-film-forming region of the substrate **2** is screened by the shielding member **140**, it may be easy to prevent the organic material from being deposited on the non-film-forming region of the substrate **2** without using a separate structure.

[0119] Hereinafter, the conveyer unit **400** that conveys (e.g., transports) the substrate **2**, on which the deposition material **115** is to be deposited, is described in more detail. Referring to FIGS. **3** and **4**, the conveyer unit **400** includes the first conveyer unit **410**, the second conveyer unit **420**, and the transfer unit **430**.

[0120] The first conveyer unit **410** conveys (or transports) in an in-line manner the transfer unit **430**, including the carrier **431** and an electrostatic chuck **432** attached thereto, and the substrate **2** attached to the transfer unit **430** so that an organic layer may be formed on the substrate **2** by the organic layer deposition assembly **100-1**. The first conveyer unit **410** includes a coil **411**, guide members **412**, upper magnetically suspended bearings (e.g., magnetically levitating or magnetic levitation bearings) **413**, side magnetically suspended bearings (e.g., magnetically levitating or magnetic levitation bearings) **414**, and gap sensors **415** and **416** (for example, also see FIG. **5**).

[0121] The second conveyer unit **420** returns to the loading unit **200** the transfer unit **430** from which the substrate **2** has been separated in the unloading unit **300** after one deposition cycle is completed while the transfer unit **430** is passing through the deposition unit **100**. The second conveyer unit **420** includes a coil **421**, roller guides **422**, and a charging track **423**.

[0122] The transfer unit **430** includes the carrier **431** that is conveyed (or transported) along the first conveyer unit **410** and the second conveyer unit **420** and the electrostatic chuck **432** that is combined on (or attached to) a surface of the carrier **431**. The substrate **2** is attached to the electrostatic chuck **432**.

[0123] Hereinafter, each element of the conveyer unit **400** will be described in more detail.

[0124] The carrier **431** of the transfer unit **430** will now be described in detail.

[0125] The carrier **431** includes a main body part **431a**, a magnetic rail (or a linear motor system (LMS) magnet) **431b**, contactless power supply (CPS) modules **431c**, a power sup-

ply unit **431d**, and guide grooves **431e**. The carrier **431** may further include cam followers **431f**.

[0126] The main body part **431a** constitutes a base part of the carrier **431** and may be formed of a magnetic material such as iron. In this regard, due to a magnetic repulsive force (and/or a magnetic attractive force) between the main body part **431a** and the respective upper and side magnetically suspended bearings (e.g., magnetic levitation bearings) **413** and **414**, which are described below, the carrier **431** may be maintained spaced apart from the guide members **412** by a certain distance (e.g., a gap).

[0127] The guide grooves **431e** may be respectively formed at both sides of the main body part **431a** and each may accommodate a guide protrusion **412e** of the guide member **412**.

[0128] The magnetic rail **431b** may be formed along a center line of the main body part **431a** in a direction where the main body part **431a** proceeds. The magnetic rail **431b** and the coil **411**, which are described below in more detail, may be combined with each other to constitute a linear motor, and the carrier **431** may be conveyed (or transported) in an arrow A direction by the linear motor.

[0129] The CPS modules **431c** and the power supply unit **431d** may be respectively formed on both sides of the magnetic rail **431b** in the main body part **431a**. The power supply unit **431d** includes a battery (e.g., a rechargeable battery) that provides power so that the electrostatic chuck **432** can chuck (e.g., fix or hold) the substrate **2** and maintains operation. The CPS modules **431c** are wireless charging modules that charge the power supply unit **431d**. For example, the charging track **423** formed in the second conveyer unit **420**, which is described below, is connected to an inverter (not shown), and thus, when the carrier **431** is transferred into the second conveyer unit **420**, a magnetic field is formed between the charging track **423** and the CPS modules **431c** so as to supply power to the CPS module **431c**. The power supplied to the CPS modules **431c** is used to charge the power supply unit **431d**.

[0130] The electrostatic chuck **432** may include an electrode embedded in a main body formed of ceramic, wherein the electrode is supplied with power. The substrate **2** is attached onto a surface of the main body of the electrostatic chuck **432** as a suitable voltage (e.g., a high voltage or a relatively high voltage) is applied to the electrode.

[0131] Hereinafter, an operation of the transfer unit **430** is described in more detail.

[0132] The magnetic rail **431b** of the main body part **431a** and the coil **411** may be combined with each other to constitute an operation unit. In this regard, the operation unit may be a linear motor. The linear motor has a small frictional coefficient, little position error, and a high degree (e.g., a very high degree) of position determination, as compared to a conventional slide guide system. As described above, the linear motor may include the coil **411** and the magnetic rail **431b**. The magnetic rail **431b** is linearly located (or arranged) on the carrier **431**, and a plurality of the coils **411** may be located at an inner side of the chamber **101** by a certain distance so as to face the magnetic rail **431b**. Because the magnetic rail **431b** is located at the carrier **431** instead of the coil **411**, the carrier **431** may be operable without power being supplied thereto. In this regard, the coil **411** may be formed in an atmosphere (ATM) box in an air atmosphere, and the carrier **431** to which the magnetic rail **431b** is attached may be moved in the chamber **101** maintained in vacuum.

[0133] Hereinafter, the first conveyer unit **410** and the transfer unit **430** are described in detail.

[0134] Referring to FIGS. **4** and **5**, the first conveyer unit **410** conveys (or transports) the electrostatic chuck **432** that fixes (or attaches to) the substrate **2** and the carrier **431** that conveys (or transports) the electrostatic chuck **432**. In this regard, the first conveyer unit **410** includes the coil **411**, the guide members **412**, the upper magnetically suspended (e.g., magnetic levitation) bearings **413**, the side magnetically suspended (e.g., magnetic levitation) bearings **414**, and the gap sensors **415** and **416**.

[0135] The coil **411** and the guide members **412** are formed (or located) inside the upper housing **104**. The coil **411** is formed (or located) in an upper portion of the upper housing **104**, and the guide members **421** are respectively formed on both inner sides of the upper housing **104**.

[0136] The guide members **412** guide the carrier **431** to move in a direction. In this regard, the guide members **412** are formed to pass through the deposition unit **100**.

[0137] For example, the guide members **412** accommodate both sides of the carrier **431** to guide the carrier **431** to move along in the direction of arrow A illustrated in FIG. **3**. In this regard, each of the guide members **412** may include a first accommodation part **412a** located below the carrier **431**, a second accommodation part **412b** located above the carrier **431**, and a connection part **412c** that connects the first accommodation part **412a** and the second accommodation part **412b** to each other. An accommodation groove **412d** is formed by the first accommodation part **412a**, the second accommodation part **412b**, and the connection part **412c**. Both sides of the carrier **431** are respectively accommodated in the accommodation grooves **412d**, and the carrier **431** is moved along the accommodation grooves **412d**.

[0138] The side magnetically suspended (e.g., magnetic levitation) bearings **414** are each located at the connection part **412c** of the guide member **412** so as to respectively correspond to both sides of the carrier **431**. The side magnetically suspended (e.g., magnetic levitation) bearings **414** cause a distance (e.g., a gap) between the carrier **431** and the guide member **412** so that the carrier **431** is moved along the guide members **412** in non-contact with (i.e., without contacting) the guide members **412**. That is, a repulsive force R1 occurring between the side magnetically suspended (e.g., magnetic levitation) bearing **414** on the left side in FIG. **5** and the carrier **431**, which is a magnetic material, and a repulsive force R2 occurring between the side magnetically suspended (e.g., magnetic levitation) bearing **414** on the right side in FIG. **5** and the carrier **431**, which is a magnetic material, maintain equilibrium, and thus, there is a constant (or substantially constant) distance between the carrier **431** and the respective parts of the guide member **412**.

[0139] Each upper magnetically suspended (e.g., magnetic levitation) bearing **413** may be located at the second accommodation part **412b** so as to be above the carrier **431**. The upper magnetically suspended bearings **413** enable the carrier **431** to be moved along the guide members **412** in non-contact with (i.e., without contacting) the first and second accommodation parts **412a** and **412b** and with a distance (e.g., a gap) therebetween maintained constant (or substantially constant). That is, an attractive force A3 occurring between the upper magnetically suspended (e.g., magnetic levitation) bearing **413** and the carrier **431**, which is made of a magnetic material, and gravity G maintain equilibrium, and thus, there is a con-

stant (or substantially constant) distance between the carrier 431 and the respective guide members 412.

[0140] Each guide member 412 may further include the gap sensor 415. The gap sensor 415 may measure a distance between the carrier 431 and the guide member 412. Referring to FIG. 5, the gap sensor 415 may be located at the first accommodation part 412a so as to correspond to a bottom portion of the carrier 431. The gap sensor 415 located at the first accommodation part 412a may measure a distance between the first accommodation part 412a and the carrier 431. The gap sensor 416 may be located at a side of the side magnetically suspended bearing (e.g., magnetic levitation bearing) 414. The gap sensor 416 may measure a distance between a side surface of the carrier 431 and the side magnetically suspended bearing 414. The present invention is not limited to the above example, and the gap sensor 416 may be located at the connection part 412c.

[0141] Magnetic forces of the upper and side magnetically suspended bearings (e.g., magnetic levitation bearings) 413 and 414 may vary according to values measured by the gap sensors 415 and 416, and thus, distances between the carrier 431 and the respective guide members 412 may be adjusted in real time. That is, a precise transfer of the carrier 431 may be feedback controlled using the upper and side magnetically suspended bearings (e.g., magnetic levitation bearings) 413 and 414 and the gap sensors 415 and 416.

[0142] Hereinafter, the second conveyer unit 420 and the transfer unit 430 are described in detail.

[0143] Referring back to FIG. 4, the second conveyer unit 420 returns the electrostatic chuck 432 from which the substrate 2 has been separated in the unloading unit 300 and the carrier 431 that carries the electrostatic chuck 432, to the loading unit 200. In this regard, the second conveyer unit 420 includes the coil 421, the roller guides 422, and the charging track 423.

[0144] In particular, the coil 421, the roller guides 422, and the charging track 423 may be positioned inside the lower housing 103. The coil 421 and the charging track 423 may be located at a top inner surface of the lower housing 103, and the roller guides 422 may be located at both inner sides of the lower housing 103. Although not specifically illustrated in FIG. 4, the coil 421 may be located in an ATM box, similar to the coil 411 of the first conveyer unit 410.

[0145] Similar to the first conveyer unit 410, the second conveyer unit 420 may include the coil 421. Also, the magnetic rail (e.g., the LMS magnet) 431b of the main body part 431a of the carrier 431 and the coil 421 are combined with each other to constitute an operation unit. In this regard, the operation unit may be a linear motor. The carrier 431 may be moved by the linear motor along a direction opposite to the direction of arrow A illustrated in FIG. 3.

[0146] The roller guides 422 guide the carrier 431 to move in a direction. In this regard, the roller guides 422 are formed to pass through the deposition unit 100. In particular, the roller guides 422 support cam followers 431f (for example, see FIG. 5) respectively formed on both sides of the carrier 431 to guide the carrier 431 to move along a direction opposite to the direction of arrow A illustrated in FIG. 3. That is, the carrier 431 is moved with the cam followers 431f/located at both sides of the carrier 431 respectively rotating along the roller guides 422. In this regard, the cam followers 431f are utilized as bearings used to accurately repeat a particular operation. In an embodiment, a plurality of the cam followers 431f are formed on (or located at) a side surface of the carrier

431 and serve as a wheel for conveying (or transporting) the carrier 431 in the second conveyer unit 420. A detailed description of the cam followers 431f is not provided herein.

[0147] The second conveyer unit 420 is used in a process of returning the carrier 431 from which the substrate 2 has been separated and not in a process of depositing an organic material on the substrate 2, and thus, position accuracy (e.g., positional accuracy) thereof is not needed as by the first conveyer unit 410. Therefore, magnetic suspension is applied to the first conveyer unit 410 that requires high position accuracy, thereby obtaining position accuracy, and a conventional roller method is applied to the second conveyer unit 420 that requires relatively low position accuracy, thereby reducing manufacturing costs and simplifying a structure of the organic layer deposition apparatus. Although not illustrated in FIG. 4, the magnetic suspension (or magnetic levitation) may also be applied to the second conveyer unit 420 as in the first conveyer unit 410.

[0148] The organic layer deposition assembly 100-1 of the organic layer deposition apparatus 1 according to the present embodiment may further include the cameras 170 and the sensors 180 for an aligning process. In more detail, the cameras 170 may align in real time a first alignment mark (not shown) formed in the frame 135 of the patterning slit sheet 130 and a second alignment mark (not shown) formed on the substrate 2. The sensors 180 may be confocal sensors. Because a distance between the substrate 2 and the patterning slit sheet 130 is measurable in real time using the cameras 170 and the sensors 180, the substrate 2 may be aligned with the patterning slit sheet 130 in real time, whereby position accuracy of a pattern may be improved (e.g., significantly improved).

[0149] Hereinafter, the deposition source 110, an angle limiting plate 145, and a deposition source shutter of the organic layer deposition apparatus 1 are described in detail.

[0150] FIGS. 6A, 6B, and 6C illustrate the deposition source 110 of FIG. 3, the angle limiting plate 145, and a deposition source shutter, according to an embodiment of the present invention.

[0151] Referring to FIGS. 6A, 6B, and 6C, the angle limiting plate 145 may surround a portion of the deposition source 110 so as to guide a flow path of a deposition material that is vaporized in the deposition source 110. The angle limiting plate 145 having a (e.g., letter 'L' rotated by 180 degrees) shape is formed at both sides of the deposition source 110, so that the angle limiting plate 145 limits a discharge path of the deposition material that is vaporized in the deposition source 110, and increases linearity of the deposition material. That is, the deposition material that is vaporized in the deposition source 110 and that moves with an angle close to 90 degrees moves toward the substrate 2 without bumping into the angle limiting plate 145, whereas a deposition material that is vaporized in the deposition source 110 and that diagonally moves with an angle less than or equal to a predetermined angle bumps into the angle limiting plate 145 and thus is deposited on the angle limiting plate 145. By arranging the angle limiting plate 145, the linearity of the deposition material may be improved or achieved, so that the occurrence of shadows may be reduced (e.g., significantly reduced).

[0152] The deposition source shutter may be further arranged at a side of the angle limiting plate 145, i.e., between the angle limiting plate 145 and the patterning slit sheet 130 (referring to FIG. 4). The deposition source shutter may

include a first deposition source shutter **141** and a second deposition source shutter **142** that have a flat plate shape and that are movable in the same direction (i.e., the direction of arrow A illustrated in FIG. 3) as a movement direction of the substrate **2**. The first and second deposition source shutters **141** and **142** may block a deposition material from another deposition source in a tooling operation. This is described in detail.

[0153] For example, a characteristic of an organic light-emitting device considerably (or substantively) depends on a thickness of an organic layer. Thus, in order to manufacture an organic light-emitting display apparatus having a high quality, it is essential to perform the tooling operation so as to adjust thicknesses of all organic layers before a film-forming operation is performed. Here, the tooling operation refers to a process in which deposition with respect to a target organic layer is performed by a predetermined deposition rate on a substrate whereon a device (e.g., a TFT) is not deposited, a thickness of the substrate whereon the organic layer is deposited is measured by using an analysis equipment such as an ellipsometer capable of measuring a thickness, and then a tooling factor (TF) of the organic layer is changed or the deposition rate is adjusted by using the measured thickness. In this regard, the TF indicates a control parameter in the tooling operation based on a ratio of the thickness of the organic layer, which is actually measured by using a sensor, to a target thickness of the organic layer.

[0154] When the tooling operation is performed on the organic layer formed on the substrate, the tooling operation is separately performed according to each of types of target organic layers, each of deposition sources, and/or each of deposition assemblies. For example, the organic layer deposition apparatus **1** of FIG. 1 has the organic layer deposition assemblies **100-1** through **100-11**, and each of the organic layer deposition assemblies **100-1** through **100-11** has three deposition sources, so that a total of 33 tooling operations typically proceed so as to perform the tooling operation on all deposition sources. Here, in order to perform the tooling operation on each of three deposition sources in one organic layer deposition assembly, when deposition proceeds in one deposition source, deposition materials from other two deposition sources are blocked.

[0155] To do so, the organic layer deposition apparatus **1** according to the present embodiment includes the first and second deposition source shutters **141** and **142**, so that deposition materials from other deposition sources, other than a deposition material from a target deposition source, are blocked in the tooling operation.

[0156] That is, as illustrated in FIG. 6A, in a general deposition process, the first and second deposition source shutters (not shown) are entirely or completely opened so that an organic layer is deposited on the substrate **2** by all of three deposition sources **110a**, **110b**, and **110c** in the organic layer deposition assembly **100-1**.

[0157] However, as illustrated in FIGS. 6B and 6C, when the tooling operation is performed on one of the three deposition sources **110a**, **110b**, and **110c** in the organic layer deposition assembly **100-1**, only a target deposition source to which the tooling operation is performed is opened and other two deposition sources are closed by controlling the first and second deposition source shutters **141** and **142**.

[0158] As described above, by separately controlling the deposition source **110**, the angle limiting plate **145**, and the deposition source shutters **141** and **142**, it is possible to pre-

cisely measure a thickness with respect to each deposition source in the tooling operation, so that film-forming uniformity may be improved.

[0159] FIGS. 7A, 7B, 7C, and 7D illustrate the deposition source **110** of FIG. 3, an angle limiting plate, and a deposition source shutter, according to another embodiment of the present invention.

[0160] Referring to FIGS. 7A, 7B, 7C, and 7D, the present embodiment is characterized in that one deposition source shutter having functions of both angle limiting plate and deposition source shutter according to the previous embodiment of FIGS. 6A, 6B, and 6C is used. This is described in detail.

[0161] In a case of using the angle limiting plate according to the previous embodiment, nozzles are primarily located at a center of a deposition source such that a deposition material is excessively deposited at the angle limiting plate near the nozzles at the center of the deposition source according to flow of time. The excessively-deposited deposition material may prevent a flow path of a deposition material from the deposition source, thereby affecting a film-forming profile of the deposition material formed on a substrate.

[0162] In order to solve this problem, according to the present embodiment, the deposition source shutter may be arranged between a deposition source (refer to the deposition source **110** of FIG. 3) and a patterning slit sheet (refer to the patterning slit sheet **130** of FIG. 3). The deposition source shutter may include a first deposition source shutter **143** and a second deposition source shutter **144** that are movable in the same direction (i.e., the direction of arrow A illustrated in FIG. 3) as a movement direction of the substrate **2**. The first and second deposition source shutters **143** and **144** may block deposition materials from other deposition sources in a tooling operation. Furthermore, the first and second deposition source shutters **143** and **144** may surround the deposition source **110**, thereby guiding a flow path of a deposition material that is vaporized in a deposition source.

[0163] Referring to FIG. 7D that is a perspective view of the first deposition source shutter **143** according to the present embodiment, the first deposition source shutter **143** may include a flat-plate portion **143a** and an inclination portion **143b**, and a groove **143c** may be further formed (e.g., positioned or located) at an end of the inclination portion **143b**. That is, because the groove **143c** to function as an angle limiting plate is formed at the end of the inclination portion **143b** that functions as the deposition source shutter of the previous embodiment, one deposition source shutter having functions of both angle limiting plate and deposition source shutter may be arranged.

[0164] That is, as illustrated in FIG. 7A, in a general deposition process, the first and second deposition source shutters **143** and **144** are entirely or completely opened so that an organic layer is deposited on the substrate **2** by all of three deposition sources **110a**, **110b**, and **110c** in the organic layer deposition assembly **100-1**. Here, inclination portions **143b** and **144b** of the first and second deposition source shutters **143** and **144** function as angle limiting plates, so that the inclination portions **143b** and **144b** limit flow paths of deposition materials vaporized in the deposition source **110**, and increase or improve linearity of the deposition material. That is, the deposition material that is vaporized in the deposition source **110** and that moves with an angle close to 90 degrees moves toward the substrate **2** without bumping into the inclination portions **143b** and **144b** of the first and second depo-

sition source shutters **143** and **144**, whereas a deposition material that is vaporized in the deposition source **110** and that diagonally moves with an angle less than or equal to a predetermined angle bumps into the inclination portions **143b** and **144b** of the first and second deposition source shutters **143** and **144** and thus is deposited on the inclination portions **143b** and **144b**. By arranging the first and second deposition source shutters **143** and **144**, the linearity of the deposition material may be achieved, so that the occurrence of shadows may be significantly reduced.

[0165] However, as illustrated in FIGS. 7B and 7C, when the tooling operation is performed on one of the three deposition sources **110a**, **110b**, and **110c** in the organic layer deposition assembly **100-1**, only a target deposition source to which the tooling operation is performed is opened and other two deposition sources are closed by controlling the first and second deposition source shutters **143** and **144**.

[0166] As described above, by separately controlling the deposition source **110** and the deposition source shutter, it is possible to precisely measure a thickness with respect to each deposition source in the tooling operation, so that film-forming uniformity may be improved.

[0167] Although not illustrated, the organic layer deposition assembly **100-1** of the organic layer deposition apparatus **1** may further include a control sensor, an adjustment sensor, and a sensor shutter so as to control a thickness of an organic layer to be formed on the substrate **2** and thus may monitor and adjust in real-time the thickness of the organic layer. That is, layers are formed with respect to organic materials, respectively, in an initial film-forming operation by using the control sensor, the adjustment sensor, and the sensor shutter, and thicknesses of the layers are checked by using an analysis equipment such as an ellipsometer. Afterward, a TF is reflected to respective deposition sources containing respective organic materials, deposition rates thereof are checked via a monitoring sensor, and then the deposition rates via the monitoring sensor may be reference values for a monitoring operation during a film-forming operation at a later time.

[0168] FIG. 8 is a schematic perspective view of an organic layer deposition assembly **700** according to another embodiment of the present invention. FIG. 9 is a schematic cross-sectional side view of the organic layer deposition assembly **700** of FIG. 8. FIG. 10 is a schematic cross-sectional plan view of the organic layer deposition assembly **700** of FIG. 8.

[0169] Referring to FIGS. 8 through 10, the organic layer deposition assembly **700** includes a deposition source **710**, a deposition source nozzle unit **720**, a shielding plate assembly (e.g., a barrier assembly or a barrier plate assembly) **730**, and a patterning slit sheet **750**.

[0170] The deposition source **710** includes a crucible **711** that is filled with the deposition material **715** and a heater **712** that heats the crucible **711** so as to vaporize the deposition material **715** included in the crucible **711** toward the deposition source nozzle unit **720**. The deposition source nozzle unit **720** is located at a side of the deposition source **710**, and a plurality of deposition source nozzles **721** are formed (or arranged) on the deposition source nozzle unit **720** along the X-axis direction.

[0171] The shielding plate assembly **730** is arranged (or located) at a side of the deposition source nozzle unit **720**. The shielding plate assembly **730** includes a plurality of shielding plates (or barrier plates) **731** and a shielding plate frame **732** located on an outer side of (e.g., around or surrounding) the shielding plates **731**. The shielding plates **731** may be

arranged in parallel to each other along the X-axis direction. Here, the shielding plates **731** may be located at regular intervals. Also, each of the shielding plates **731** may extend along an Y-Z plane and may have a rectangular shape. The shielding plates **731** that are arranged in the aforementioned manner define (e.g., partition or divide) a space between the deposition source nozzle unit **720** and the patterning slit sheet **750** into a plurality of deposition spaces S, so that a deposition material that is exhausted (e.g., ejected or discharged) from one deposition source nozzle **721** is not mixed with deposition materials that are exhausted (e.g., ejected or discharged) from other deposition source nozzles **721**, but passes through the patterning slit **751** and then is deposited onto the substrate **2** (attached to the transfer unit **430**). That is, each of the shielding plates **731** functions to guide a movement path of the deposition material, so that the deposition material exhausted from each of the deposition source nozzles **721** goes straight in a Z-axis direction without (or substantially without) spreading.

[0172] As described above, a linearity of the deposition material may be improved or achieved by arrangement of the shielding plates **731**, so that a size of shadows formed on the substrate **2** may be reduced (e.g., significantly reduced), and thus the organic layer deposition assembly **700** and the substrate **2** may be spaced apart from each other by a certain distance (e.g., a gap).

[0173] The patterning slit sheet **750** is further located (or positioned) between the deposition source **710** and the substrate **2**. The patterning slit sheet **750** further includes a frame **755** having a shape similar to a window frame. Also, the patterning slit sheet **750** includes a plurality of patterning slits **751** arranged along an X-axis direction. The deposition material **715** that is vaporized in the deposition source **710** passes through the deposition source nozzle unit **720** and the patterning slit sheet **750** and then moves toward the substrate **2** that is a deposition target.

[0174] FIG. 11 is a schematic perspective view of an organic layer deposition assembly **800** according to another embodiment of the present invention.

[0175] Referring to FIG. 11, the organic layer deposition assembly **800** includes a deposition source **810**, a deposition source nozzle unit **820**, a first shielding plate assembly (e.g., a first barrier plate assembly) **830**, a second shielding plate assembly (e.g., a second barrier plate assembly) **840**, and a patterning slit sheet **850**. Here, configurations of the deposition source **810**, the first shielding plate assembly **830**, and the patterning slit sheet **850** are the same (or substantially the same) as those described above with reference to FIG. 8, thus, detailed descriptions thereof are omitted. The patterning slit sheet **850** includes a plurality of patterning slits **851** arranged along the X-direction. An intermediate region is between each pair of adjacent patterning slits **851**. The present embodiment is different from the previous embodiments in that the second shielding plate assembly **840** is arranged at a side of the first shielding plate assembly **830**.

[0176] In more detail, the second shielding plate assembly **840** includes a plurality of second shielding plates (e.g., second barrier plates) **841** and a second shielding plate frame **842** located on an outer side of (e.g., around or surrounding) the second shielding plates **841**. The second shielding plates **841** may be arranged in parallel with each other along the X-axis direction. Also, the second shielding plates **841** may be arranged at regular intervals. Also, each of the second shield-

ing plates **841** may extend along an Y-Z plane, i.e., may be perpendicular to the X-axis direction.

[0177] A plurality of first shielding plates **831** and the second shielding plates **841**, which are arranged in the aforementioned manner, define (e.g., divide or partition) a space between the deposition source nozzle unit **820** and the patterning slit sheet **850**. That is, the present embodiment is characterized in that deposition spaces are defined respectively with respect to a plurality of deposition source nozzles **821** that spray deposition material, due to the first shielding plates **831** and the second shielding plates **841**.

[0178] Here, the first shielding plates **831** and the second shielding plates **841** may be arranged to correspond to each other. In other words, the first shielding plates **831** may align with the second shielding plates **841**, respectively, and thus may be in parallel with each other. That is, the first shielding plate **831** and the second shielding plate **841** that correspond to each other may be positioned on the same plane (or substantially the same plane). Referring to FIG. 10, a width or thickness of each first shielding plate **831** is equal to (or substantially the same as) an X-axis direction width of each second shielding plate **841** but aspects of the present invention are not limited thereto. That is, the second shielding plates **841** that are accurately (or precisely) aligned with the adjacent patterning slits **851** may be relatively thin whereas the first shielding plates **831** that are not necessarily accurately (or precisely) aligned with the adjacent patterning slits **851** may be relatively thick for ease of manufacturing.

[0179] FIG. 12 is a schematic perspective view of an organic layer deposition assembly **900** according to another embodiment of the present invention.

[0180] Referring to FIG. 12, the organic layer deposition assembly **900** includes a deposition source **910**, a deposition source nozzle unit **920**, and a patterning slit sheet **950**.

[0181] The deposition source **910** includes a crucible **911** that is filled with a deposition material **915** and a heater **912** that heats the crucible **911** so as to vaporize a deposition material **915** included in the crucible **911** toward the deposition source nozzle unit **920**. The deposition source nozzle unit **920** is located at a side of the deposition source **910**, and a plurality of deposition source nozzles **921** are formed (or arranged) on the deposition source nozzle unit **920** along a Y-axis direction. Also, the patterning slit sheet **950** and a frame **955** are further positioned or arranged between the deposition source **910** and the substrate **2**, and a plurality of patterning slits **951** are formed or arranged at the patterning slit sheet **950** along an X-axis direction. A spacer (or an intermediate region) is located between each pair of adjacent patterning slits **951**. The deposition source **910** and the deposition source nozzle unit **920**, and the patterning slit sheet **950** are combined by using connection members **935**.

[0182] The present embodiment is different from the previous embodiments in an array of the deposition source nozzles **921** formed or arranged at the deposition source nozzle unit **920**. Hereinafter, the difference is described as below.

[0183] The deposition source nozzle unit **920** is located at a side of the deposition source **910** so as to face the substrate **2**. The deposition source nozzles **921** are formed or arranged on the deposition source nozzle unit **920** along the Y-axis direction, i.e., along a scanning direction of the substrate **2**. Here, the deposition source nozzles **921** may be located or arranged at regular intervals. The deposition material **915** that has been vaporized in the deposition source **910** passes through the

deposition source nozzle unit **920** and then moves toward the substrate **2** that is a deposition target. To that end, in the organic layer deposition assembly **900**, the deposition source nozzles **921** are formed or arranged along the scanning direction of the substrate **2**. In this regard, if the deposition source nozzles **921** were formed along the X-axis direction, distances between the respective deposition source nozzles **921** and the respective patterning slits **951** would differ from each other, so that shadows would occur due to a deposition material that has been discharged from the deposition source nozzle **921** that is distant from the corresponding patterning slit **951**. Thus, in the present embodiment, only one deposition source nozzle **921** is formed or arranged along the X-axis direction, and thus the occurrence of shadows may be reduced (e.g., significantly reduced). Also, since the deposition source nozzles **921** are formed along the scanning direction of the substrate **2**, a difference in flux occurring between the deposition source nozzles **921** may be compensated for and deposition uniformity may be maintained constant (or substantially constant).

[0184] FIG. 13 is a diagram illustrating a structure in which the patterning slits **131** are arranged at equal intervals in the patterning slit sheet **130** of the organic layer deposition apparatus **1**, according to an embodiment of the present invention. FIG. 14 is a diagram illustrating organic layers formed on the substrate **2** by using the patterning slit sheet **130** of FIG. 13, according to an embodiment of the present invention.

[0185] FIGS. 13 and 14 schematically illustrate the patterning slit sheet **130** in which the patterning slits **131** are arranged at equal intervals. That is, in FIG. 13, the patterning slits **131** satisfy the following condition: $I_1=I_2=I_3=I_4$.

[0186] In this embodiment, an incident angle of a deposition material discharged along a center line **C** of a deposition space **S** is substantially perpendicular to the substrate **2**. Thus, an organic layer P_1 formed using the deposition material that has passed through a patterning slit $131a$ has a minimum (or reduced) size of a shadow, and a right-side shadow SR_1 and a left-side shadow SL_1 are formed symmetrical to (or symmetrically with) each other.

[0187] However, a critical incident angle θ of the deposition material that passes through patterning slits located farther from the center line **C** of the deposition space **S** gradually increases, and thus, in one embodiment, the critical incident angle θ of the deposition material that passes through the outermost patterning slit $131e$ is approximately 55° . Accordingly, the deposition material is incident at an inclination with respect to the patterning slit $131e$, and an organic layer P_5 formed using the deposition material that has passed through the patterning slit $131e$ has the largest shadow. For example, a left-side shadow SL_5 is larger than a right-side shadow SR_5 .

[0188] That is, as the critical incident angle θ of the deposition material increases, the size of the shadow also increases. For example, the size of the shadow at a position farther from the center line **C** of the deposition space **S** increases. In addition, the critical incident angle θ of the deposition material increases as a distance between the center line **C** of the deposition space **S** and the respective patterning slits increases. Thus, organic layers formed using the deposition material that passes through the patterning slits located farther from the center line **C** of the deposition space **S** have a relatively larger shadow size. For example, of the shadows on both sides of the respective organic layers, the size of the shadow at a position farther from the center line **C** of the deposition space **S** is larger than that of the other.

[0189] That is, referring to FIG. 14, the organic layers formed on the left side of the center line C of the deposition space S have a structure in which a left hypotenuse (a slanted side on the left between top and bottom sides) is larger than a right hypotenuse (a slanted side on the right between the top and bottom sides), and the organic layers formed on the right side of the center line C of the deposition space S have a structure in which a right hypotenuse (e.g., a right slanted side) is larger than a left hypotenuse (e.g., a left slanted side).

[0190] Also, in the organic layers formed on the left side of the center line C of the deposition space S, the length of the left hypotenuse (e.g., the left slanted side) increases towards the left. In the organic layers formed on the right side of the center line C of the deposition space S, the length of the right hypotenuse (e.g., the right slanted side) increases towards the right. Consequently, the organic layers formed in the deposition space S may be formed symmetrical to each other about the center line C of the deposition space S.

[0191] This structure will now be described in more detail.

[0192] The deposition material that passes through a patterning slit 131b passes through the patterning slit 131b at a critical incident angle of θ_b , and an organic layer P₂ formed using the deposition material that has passed through the patterning slit 131b has a left-side shadow having a size of SL₂. Similarly, the deposition material that passes through a patterning slit 131c passes through the patterning slit 131c at a critical incident angle of θ_c , and an organic layer P₃ formed using the deposition material that has passed through the patterning slit 131c has a left-side shadow having a size of SL₃. Similarly, the deposition material that passes through a patterning slit 131d passes through the patterning slit 131d at a critical incident angle of θ_d , and an organic layer P₄ formed using the deposition material that has passed through the patterning slit 131d has a left-side shadow having a size of SL₄. Similarly, the deposition material that passes through the patterning slit 131e passes through the patterning slit 131e at a critical incident angle of θ_e , and an organic layer P₅ formed using the deposition material that has passed through the patterning slit 131e has a left-side shadow having a size of SL₅.

[0193] In this regard, the critical incident angles satisfy the following condition: $\theta_b < \theta_c < \theta_d < \theta_e$, and thus, the sizes of the shadows of the organic layers also satisfy the following condition: $SL_1 < SL_2 < SL_3 < SL_4 < SL_5$.

[0194] FIG. 15 is a schematic cross-sectional view of an active matrix-type organic light-emitting display device manufactured using the organic layer deposition apparatus 1, according to an embodiment of the present invention.

[0195] Referring to FIG. 15, the active matrix organic light-emitting display device 10 according to the current embodiment is formed on the substrate 50. The substrate 2 may be formed of a transparent material, for example, glass, plastic, or metal. An insulating layer 51, such as a buffer layer, is formed on an entire surface of the substrate 2. The insulating layer 15 may be omitted in other embodiments.

[0196] A thin film transistor (TFT) and an organic light-emitting diode (OLED) are formed on the insulating layer 51, as illustrated in FIG. 15.

[0197] A semiconductor active layer 52 is formed on an upper surface of the insulating layer 51 in a set or predetermined pattern. A gate insulating layer 53 is formed to cover the semiconductor active layer 52. The semiconductor active layer 52 may include a p-type or n-type semiconductor material.

[0198] A gate electrode 54 of the TFT is formed in a region of the gate insulating layer 53 corresponding to the semiconductor active layer 52. An interlayer insulating layer 55 is formed to cover the gate electrode 54. The interlayer insulating layer 55 and the gate insulating layer 53 are etched by, for example, dry etching, to form contact holes respectively exposing parts of the semiconductor active layer 52.

[0199] Source and drain electrodes 56 and 57 are formed on the interlayer insulating layer 55 to contact the semiconductor active layer 52 through the respective contact holes. A passivation layer 58 is formed to cover the source and drain electrodes 56 and 57, and is etched to expose a part of one of the source and drain electrodes 56 and 57. An insulating layer 59 may be further formed on the passivation layer 58 so as to planarize the passivation layer 58.

[0200] In addition, the OLED displays image information (e.g., set or predetermined image information) by emitting red, green, or blue light according to current. The OLED includes a first electrode 61 located on the insulating layer 59. The first electrode 61 is electrically connected to the exposed one of the source and drain electrodes 56 and 57 of the TFT 40.

[0201] A pixel-defining layer 60 is formed to cover the first electrode 61. An opening is formed in the pixel-defining layer 60, and an organic layer 62 including an emission layer (EML) is formed in a region defined by the opening. A second electrode 63 is formed on the organic layer 62.

[0202] The pixel-defining layer 60, which defines individual pixels, may be formed of an organic material. The pixel-defining layer 60 also planarizes the surface of a region of the substrate 50 in which the first electrode 61 is formed, and in particular, the surface of the insulating layer 59.

[0203] The first electrode 61 and the second electrode 63 are electrically insulated from each other, and respectively apply voltages of opposite polarities to the organic layer 62 to induce light emission.

[0204] The organic layer 62, including an EML, may be formed of a low-molecular weight organic material or a high-molecular weight organic material. When a low-molecular weight organic material is used, the organic layer 62 may have a single or multi-layer structure including a hole injection layer (HIL), a hole transport layer (HTL), the EML, an electron transport layer (ETL), and/or an electron injection layer (EIL). Non-limiting examples of available organic materials may include copper phthalocyanine (CuPc), N,N'-di(naphthalene-1-yl)-N,N'-diphenyl-benzidine (NPB), and tris-8-hydroxyquinoline aluminum (Alq₃).

[0205] The organic layer 62 including an EML may be formed using any suitable embodiment of the organic layer deposition apparatus 1 illustrated in FIGS. 1 through 14 or any other suitable organic layer deposition apparatus using principles of the present invention. For example, an organic layer deposition apparatus including a deposition source that discharges a deposition material, a deposition source nozzle unit that is located at a side of the deposition source and includes a plurality of deposition source nozzles formed therein, and a patterning slit sheet that faces the deposition source nozzle unit and includes a plurality of patterning slits formed therein is located spaced apart by a set or predetermined distance from a substrate on which the deposition material is to be deposited. In addition, the deposition material discharged from the organic layer deposition apparatus 1 (e.g., refer to FIG. 1) is deposited on the substrate 2 (e.g., refer

to FIG. 1) while the organic layer deposition apparatus 1 and the substrate 2 are moved relative to each other.

[0206] After the organic layer 62 is formed, the second electrode 63 may be formed by the same deposition method as used to form the organic layer 62.

[0207] The first electrode 61 may function as an anode, and the second electrode 63 may function as a cathode. Alternatively, the first electrode 61 may function as a cathode, and the second electrode 63 may function as an anode. The first electrode 61 may be patterned to correspond to individual pixel regions, and the second electrode 63 may be formed to cover all the pixels.

[0208] The first electrode 61 may be formed as a transparent electrode or a reflective electrode. Such a transparent electrode may be formed of indium tin oxide (ITO), indium zinc oxide (IZO), zinc oxide (ZnO), or indium oxide (In_2O_3). Such a reflective electrode may be formed by forming a reflective layer from silver (Ag), magnesium (Mg), aluminum (Al), platinum (Pt), palladium (Pd), gold (Au), nickel (Ni), neodymium (Nd), iridium (Ir), chromium (Cr) or a compound thereof and forming a layer of ITO, IZO, ZnO, or In_2O_3 on the reflective layer. The first electrode 61 may be formed by forming a layer by, for example, sputtering, and then patterning the layer by, for example, photolithography.

[0209] The second electrode 63 may also be formed as a transparent electrode or a reflective electrode. When the second electrode 63 is formed as a transparent electrode, the second electrode 63 may be used as a cathode. To this end, such a transparent electrode may be formed by depositing a metal having a low work function, such as lithium (Li), calcium (Ca), lithium fluoride/calcium (LiF/Ca), lithium fluoride/aluminum (LiF/Al), aluminum (Al), silver (Ag), magnesium (Mg), or a compound thereof on a surface of the organic layer 62 and forming an auxiliary electrode layer or a bus electrode line thereon from ITO, IZO, ZnO, In_2O_3 , or the like. When the second electrode 63 is formed as a reflective electrode, the reflective layer may be formed by depositing Li, Ca, LiF/Ca, LiF/Al, Al, Ag, Mg, or a compound thereof on the entire surface of the organic layer 62. The second electrode 63 may be formed using the same deposition method as used to form the organic layer 62 described above.

[0210] The organic layer deposition apparatuses according to the embodiments of the present invention described above may be applied to form an organic layer or an inorganic layer of an organic TFT, and to form layers from various suitable materials.

[0211] According to one or more embodiments of the present invention, it is possible to embody the organic layer deposition apparatus that is suitable for use in the mass production of a large substrate. Embodiments of the present invention enable high-definition patterning. Also provided according to embodiments of the present invention is a method of manufacturing an organic light-emitting display apparatus by using the organic layer deposition apparatus, and the organic light-emitting display apparatus manufactured using the method.

[0212] While the present invention has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present invention as defined by the following claims and their equivalents.

What is claimed is:

1. An organic layer deposition apparatus comprising:
 - a conveyer unit comprising a transfer unit for attaching a substrate, the transfer unit being configured to move along with the substrate, a first conveyer unit for moving in a first direction the transfer unit to which the substrate is attached, and a second conveyer unit for moving in a direction opposite to the first direction the transfer unit from which the substrate is separated after deposition has been completed; and
 - a deposition unit comprising a chamber configured to be maintained in a vacuum state and an organic layer deposition assembly for depositing an organic layer on the substrate attached to the transfer unit,
 - wherein the organic layer deposition assembly comprises:
 - a deposition source for discharging a deposition material;
 - a deposition source nozzle unit at a side of the deposition source, and comprising a plurality of deposition source nozzles;
 - a patterning slit sheet facing the deposition source nozzle unit, and comprising a plurality of patterning slits that are arranged in a first direction; and
 - a deposition source shutter that is movable in the first direction, and configured to selectively block the deposition material that is vaporized in the deposition source,
 - wherein the transfer unit is configured to move between the first conveyer unit and the second conveyer unit, and to keep the attached substrate spaced apart from the organic layer deposition assembly while being transferred by the first conveyer unit.
2. The organic layer deposition apparatus of claim 1, wherein the organic layer deposition assembly further comprises an angle limiting plate at a side of the deposition source to guide a flow path of the deposition material that is vaporized in the deposition source.
3. The organic layer deposition apparatus of claim 2, wherein the angle limiting plate surrounds a portion of the deposition source.
4. The organic layer deposition apparatus of claim 2, wherein the deposition source shutter comprises a first deposition source shutter and a second deposition source shutter that have a flat plate shape, and the deposition source is opened or closed due to movement of the first deposition source shutter and the second deposition source shutter.
5. The organic layer deposition apparatus of claim 1, wherein the deposition source shutter comprises a first deposition source shutter and a second deposition source shutter, and
 - wherein each of the first deposition source shutter and the second deposition source shutter comprises a flat-plate portion and an inclination portion that is bent from the flat-plate portion.
6. The organic layer deposition apparatus of claim 5, wherein a groove is at an end of the inclination portion and corresponds to one of the plurality of deposition source nozzles.
7. The organic layer deposition apparatus of claim 5, wherein the inclination portion is configured to guide a flow path of the deposition material that is vaporized in the deposition source.

8. The organic layer deposition apparatus of claim 5, wherein the deposition source is opened or closed due to movement of the first deposition source shutter and the second deposition source shutter.

9. The organic layer deposition apparatus of claim 1, further comprising a control sensor at a side of the deposition source to measure a deposition rate of the deposition material that is vaporized in the deposition source.

10. The organic layer deposition apparatus of claim 9, wherein the control sensor is configured to measure the deposition rate of the deposition material while the transfer unit moves along with the substrate, and

wherein a vaporization amount of the deposition material that is vaporized in the deposition source is controlled by using the deposition rate.

11. The organic layer deposition apparatus of claim 10, wherein the deposition rate of the deposition source which is measured by the control sensor is controlled to deposit the deposition material on the substrate by a target thickness.

12. The organic layer deposition apparatus of claim 1, wherein the first conveyer unit and the second conveyer unit pass through the deposition unit.

13. The organic layer deposition apparatus of claim 1, wherein the first conveyer unit and the second conveyer unit are arranged one over the other in parallel.

14. The organic layer deposition apparatus of claim 1, further comprising:

a loading unit for attaching the substrate to the transfer unit; and

an unloading unit for separating, from the transfer unit, the substrate on which the deposition has been completed while passing through the deposition unit.

15. The organic layer deposition apparatus of claim 14, wherein the first conveyer unit is configured to sequentially transport the transfer unit into the loading unit, the deposition unit, and the unloading unit.

16. The organic layer deposition apparatus of claim 14, wherein the second conveyer unit is configured to sequentially transport the transfer unit into the unloading unit, the deposition unit, and the loading unit.

17. The organic layer deposition apparatus of claim 1, wherein the organic layer deposition assembly is configured such that the deposition material that is discharged from the deposition source passes through the patterning slit sheet and is then deposited on the substrate while the deposition material forms a pattern on the substrate.

18. The organic layer deposition apparatus of claim 1, wherein the patterning slit sheet of the organic layer deposition assembly is smaller than the substrate in at least one of the first direction or a second direction perpendicular to the first direction.

19. The organic layer deposition apparatus of claim 1, wherein the plurality of deposition source nozzles of the deposition source nozzle unit are arranged along the first direction,

wherein the plurality of patterning slits of the patterning slit sheet are arranged along the first direction, and

wherein the organic layer deposition apparatus further comprises a shielding plate assembly comprising a plurality of shielding plates that are arranged along the first direction between the deposition source nozzle unit and the patterning slit sheet and that partition a space between the deposition source nozzle unit and the patterning slit sheet into a plurality of deposition spaces.

20. The organic layer deposition apparatus of claim 19, wherein each of the plurality of shielding plates extends along a second direction that is substantially perpendicular to the first direction.

21. The organic layer deposition apparatus of claim 19, wherein the shielding plate assembly comprises a first shielding plate assembly comprising a plurality of first shielding plates, and a second shielding plate assembly comprising a plurality of second shielding plates.

22. The organic layer deposition apparatus of claim 21, wherein each of the plurality of first shielding plates and each of the plurality of second shielding plates are arranged along a second direction that is substantially perpendicular to the first direction, and partition the space between the deposition source nozzle unit and the patterning slit sheet into the plurality of deposition spaces.

23. The organic layer deposition apparatus of claim 1, wherein the plurality of deposition source nozzles of the deposition source nozzle unit are arranged along the first direction, and

wherein the plurality of patterning slits of the patterning slit sheet are arranged along a second direction that is perpendicular to the first direction.

24. The organic layer deposition apparatus of claim 23, wherein the deposition source and the deposition source nozzle unit, and the patterning slit sheet are integrally combined by using connection members.

25. The organic layer deposition apparatus of claim 24, wherein the connection members are configured to guide a flow path of the deposition material.

26. The organic layer deposition apparatus of claim 25, wherein the connection members seal a space among the deposition source, the deposition source nozzle unit, and the patterning slit sheet from an outside.

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

moving a transfer unit to which the substrate is attached into a chamber, using a first conveyer unit passing through the chamber;

while the substrate and a plurality of organic layer deposition assemblies in the chamber are spaced apart from each other, and the substrate relatively moves with respect to the organic layer deposition assemblies, depositing deposition materials discharged from the organic layer deposition assemblies on the substrate to form organic layers; and

moving the transfer unit, from which the substrate is separated, using a second conveyer unit passing through the chamber,

wherein each of the organic layer deposition assemblies comprises:

a deposition source for discharging the deposition material;

a deposition source nozzle unit at a side of the deposition source, and comprising a plurality of deposition source nozzles;

a patterning slit sheet facing the deposition source nozzle unit, and comprising a plurality of patterning slits; and

a deposition source shutter that is movable in a first direction, and configured to selectively block the deposition material that is vaporized in the deposition source, and

wherein the depositing the deposition materials comprises measuring a deposition rate of each of a plurality of the deposition sources by sequentially opening or closing the plurality of the deposition sources using the deposition source shutter.

28. The method of claim **27**, wherein each of the organic layer deposition assemblies further comprises an angle limiting plate at a side of the deposition source to guide a flow path of the deposition material that is vaporized in the deposition source.

29. The method of claim **28**, wherein the deposition source shutter comprises a first deposition source shutter and a second deposition source shutter that have a flat plate shape, and the plurality of the deposition sources are opened or closed due to movement of the first deposition source shutter and the second deposition source shutter.

30. The method of claim **27**, wherein the deposition source shutter comprises a first deposition source shutter and a second deposition source shutter, and

wherein each of the first deposition source shutter and the second deposition source shutter comprises a flat-plate portion and an inclination portion that is bent from the flat-plate portion.

31. The method of claim **30**, wherein a groove is at an end of the inclination portion and corresponds to one of the plurality of deposition source nozzles.

32. The method of claim **30**, wherein the inclination portion is configured to guide a flow path of the deposition material that is vaporized in the deposition source.

33. The method of claim **32**, wherein the plurality of the deposition sources are opened or closed due to movement of the first deposition source shutter and the second deposition source shutter.

34. The method of claim **27**, wherein the organic layer deposition apparatus further comprises a control sensor at a side of the deposition source to measure a deposition rate of the deposition material that is vaporized in the deposition source.

35. The method of claim **34**, wherein the deposition rate of the deposition material is measured by the control sensor while the transfer unit moves along with the substrate, and wherein a vaporization amount of the deposition material that is vaporized in the deposition source is controlled using the deposition rate.

36. The method of claim **27**, further comprising:

before moving the transfer unit using the first conveyer unit, attaching the substrate to the transfer unit using a loading unit; and

before moving the transfer unit using the second conveyer unit, separating the substrate from the transfer unit using an unloading unit after the deposition has been completed on the substrate.

37. The method of claim **27**, wherein the transfer unit is configured to move between the first conveyer unit and the second conveyer unit.

38. The method of claim **27**, wherein the first conveyer unit and the second conveyer unit are arranged one over the other in parallel.

39. The method of claim **27**, wherein the patterning slit sheet of the organic layer deposition assembly is smaller than the substrate in at least one of the first direction or a second direction.

40. An organic light-emitting display device comprising:
a substrate;

a plurality of thin film transistors on the substrate, each of the thin film transistors comprising a semiconductor active layer, a gate electrode insulated from the semiconductor active layer, and source and drain electrodes each contacting the semiconductor active layer;

a plurality of pixel electrodes respectively on the thin film transistors;

a plurality of organic layers respectively on the plurality of pixel electrodes; and

a counter electrode on the plurality of organic layers,

wherein a length of a slanted side between top and bottom sides of at least one of the plurality of organic layers on the substrate farther from a center of a deposition region is larger than lengths of slanted sides respectively between top and bottom sides of those other organic layers closer to the center of the deposition region, and wherein the at least one of the plurality of organic layers on the substrate is a linearly-patterned organic layer formed using the organic layer deposition apparatus of claim **1**

41. The organic light-emitting display device of claim **40**, wherein the plurality of organic layers comprise at least an emission layer.

42. The organic light-emitting display device of claim **40**, wherein the plurality of organic layers have a non-uniform thickness.

43. The organic light-emitting display device of claim **40**, wherein in each of the organic layers that is farther from the center of the deposition region, the slanted side that is farther from the center of the deposition region is larger than the other slanted side.

44. The organic light-emitting display device of claim **40**, wherein the farther one of the plurality of organic layers in the deposition region is from the center of the deposition region, the narrower an overlapped region of two sides of the one of the plurality of organic layers is formed.

45. The organic light-emitting display device of claim **40**, wherein the slanted sides of the organic layer at the center of the deposition region have substantially the same length as each other.

46. The organic light-emitting display device of claim **40**, wherein the plurality of organic layers in the deposition region are symmetrically arranged about the center of the deposition region.

47. The organic light-emitting display device of claim **40**, wherein the substrate has a size of 40 inches or more.

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专利名称(译)	有机层沉积设备，通过使用其制造有机发光显示设备的方法，以及通过该方法制造的有机发光显示设备		
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申请(专利权)人(译)	三星DISPLAY CO., LTD.		
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摘要(译)

一种有机层沉积设备，包括：输送单元，包括用于附接基板的转移单元，第一输送单元和第二输送单元；沉积单元包括真空室和用于在基板上沉积有机层的有机层沉积组件。有机层沉积组件包括：用于排出沉积材料的沉积源；沉积源喷嘴单元，包括多个沉积源喷嘴；图案化缝隙片，包括沿第一方向排列的多个图案化缝隙；沉积源闸门沿第一方向移动，并选择性地阻挡在沉积源中蒸发的沉积材料。传送单元在第一和第二传送器单元之间移动。转移单元使附着的基板与有机层沉积组件间隔开，同时由第一输送单元转移。

