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

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(57) **ABSTRACT**

An organic layer deposition apparatus including: a deposition source configured to discharge a deposition material; a deposition source nozzle unit arranged 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, the patterning slit sheet being smaller than the substrate in at least one of a first direction or a second direction perpendicular to the first direction; a blocking member configured to be disposed between the substrate and the deposition source to block at least a portion of the substrate; and a heating member on the blocking member and configured to heat the blocking member, and the substrate is spaced apart from the organic layer deposition apparatus by a predetermined distance, and the substrate or the organic layer deposition apparatus is movable relative to the other.

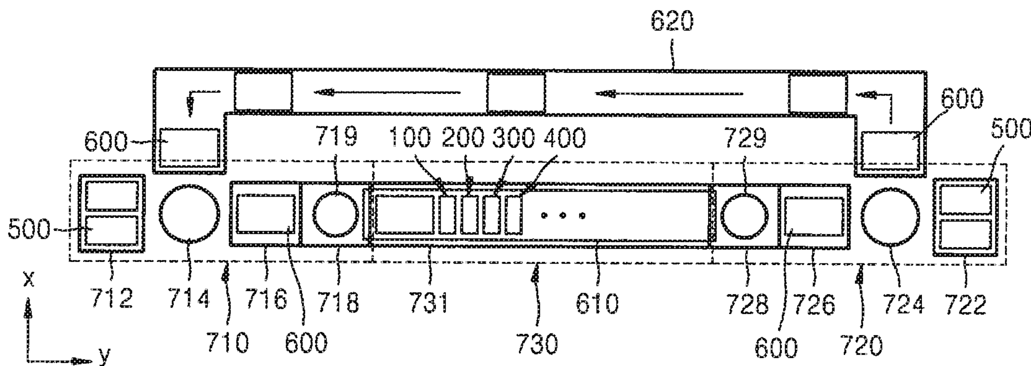


FIG. 1

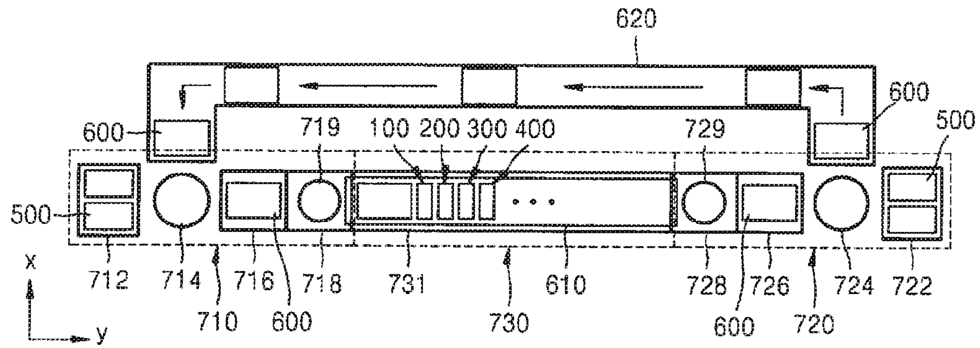


FIG. 2

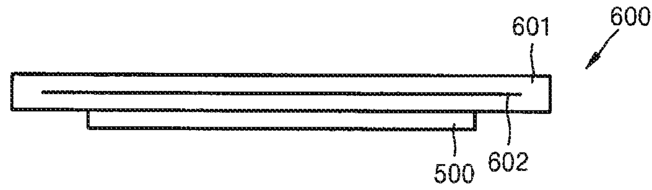


FIG. 3

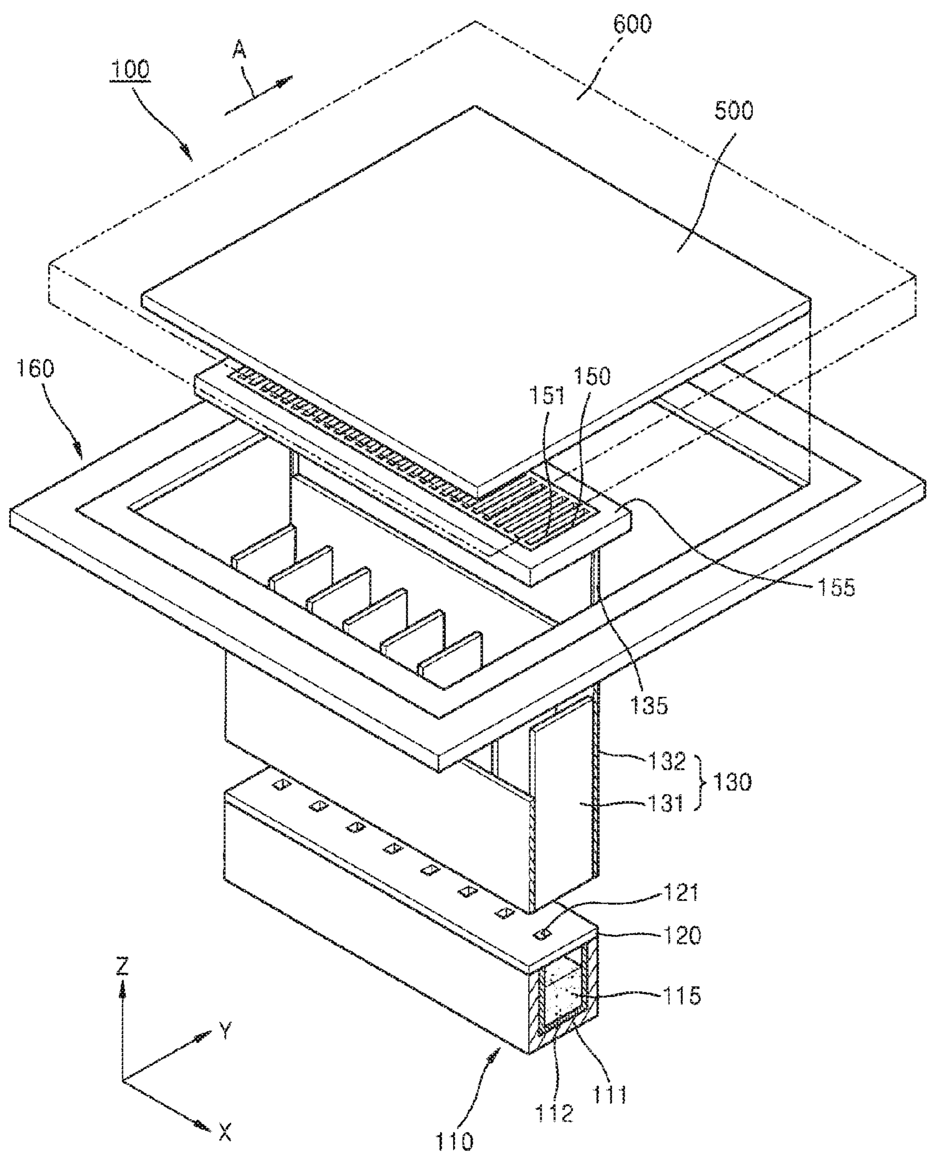


FIG. 4

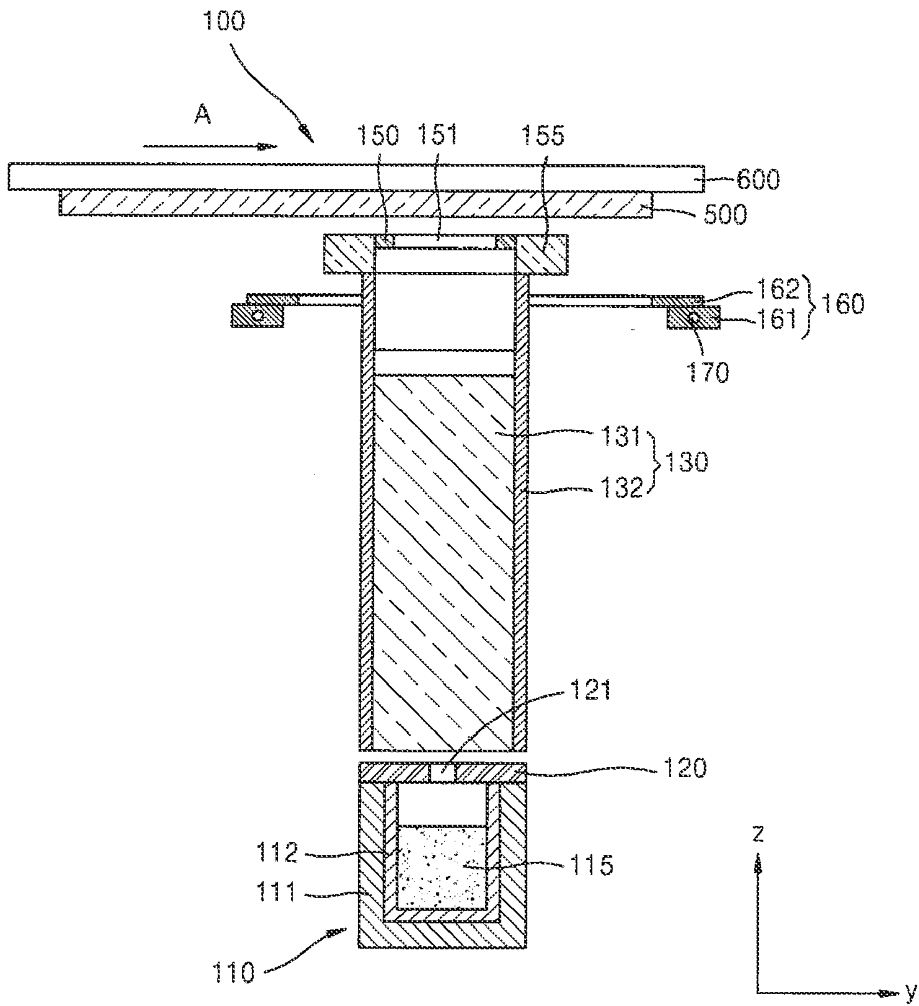


FIG. 5

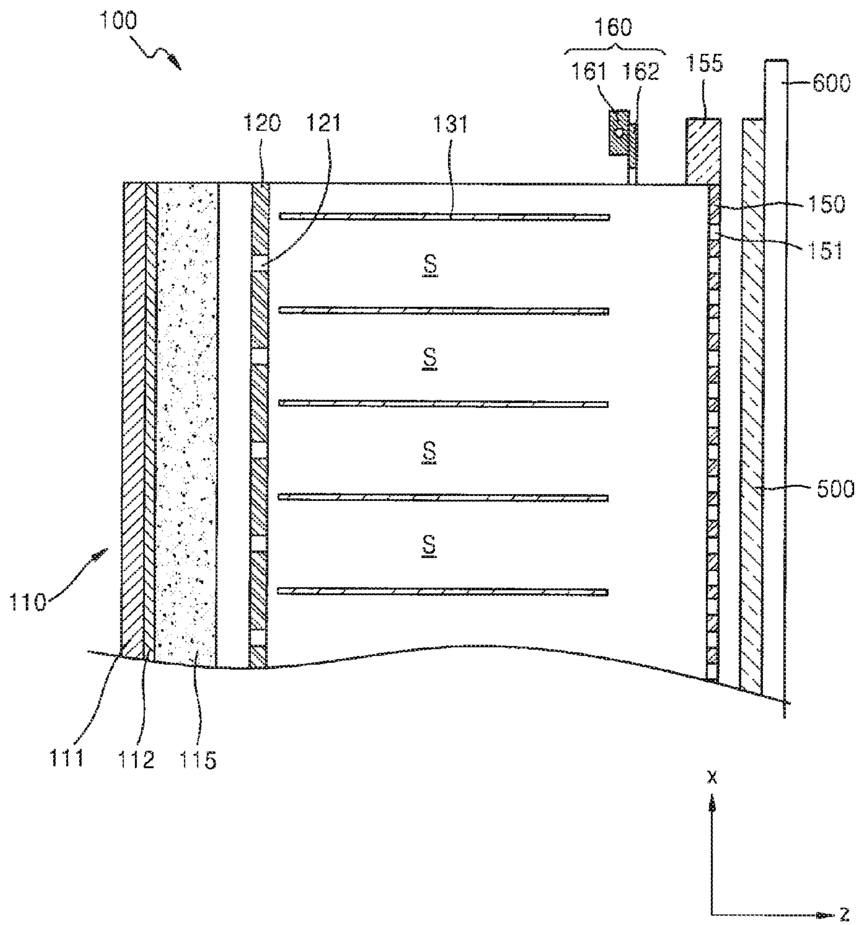


FIG. 6

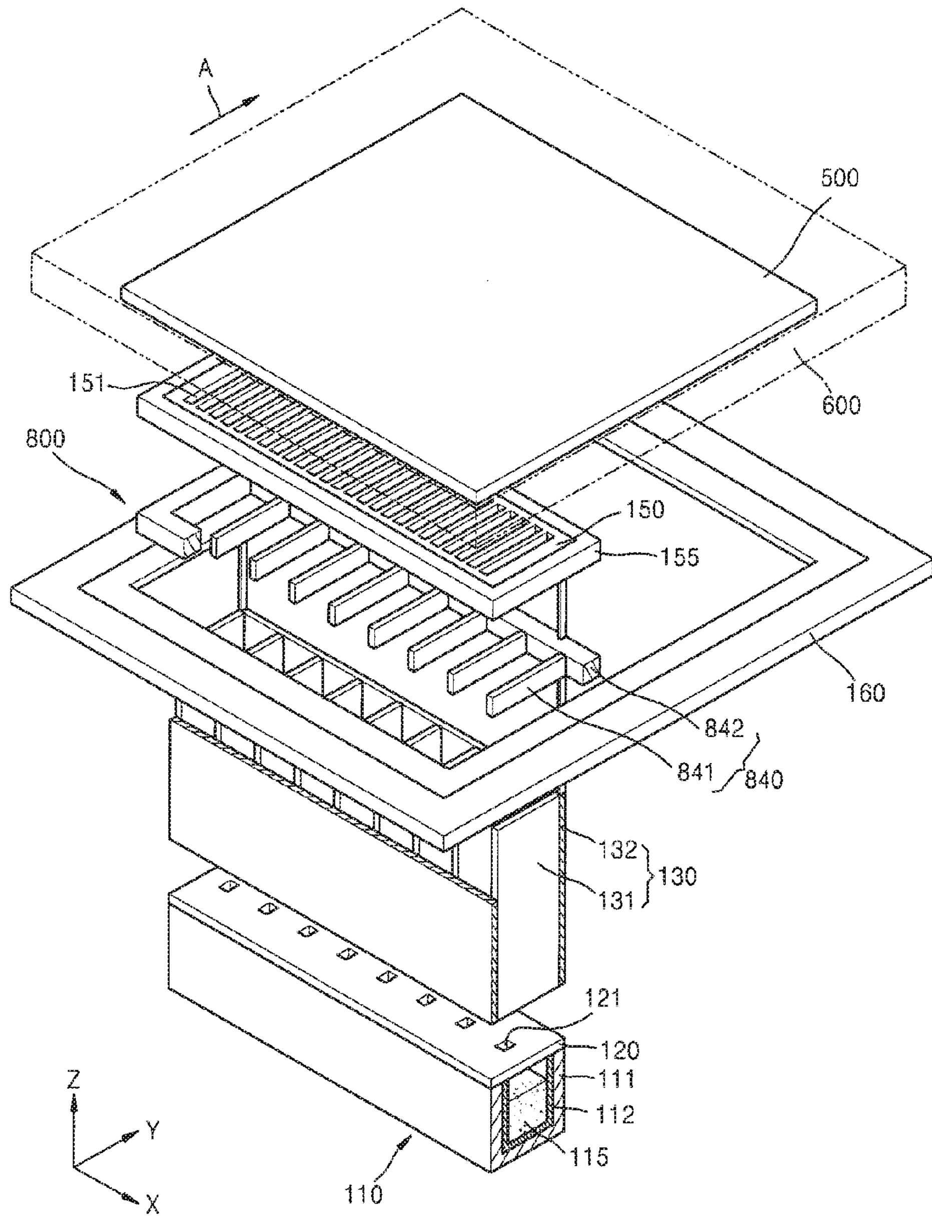


FIG. 7

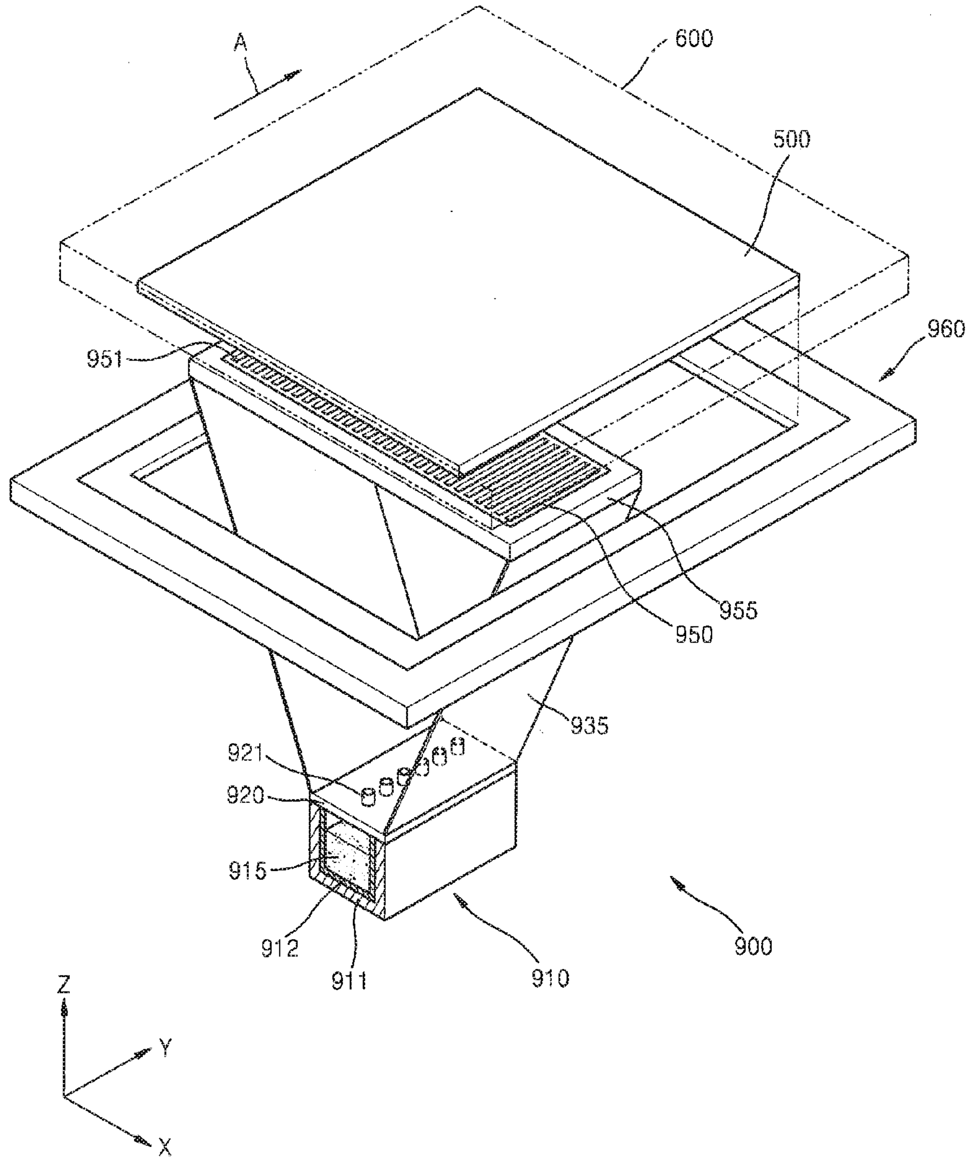


FIG. 8

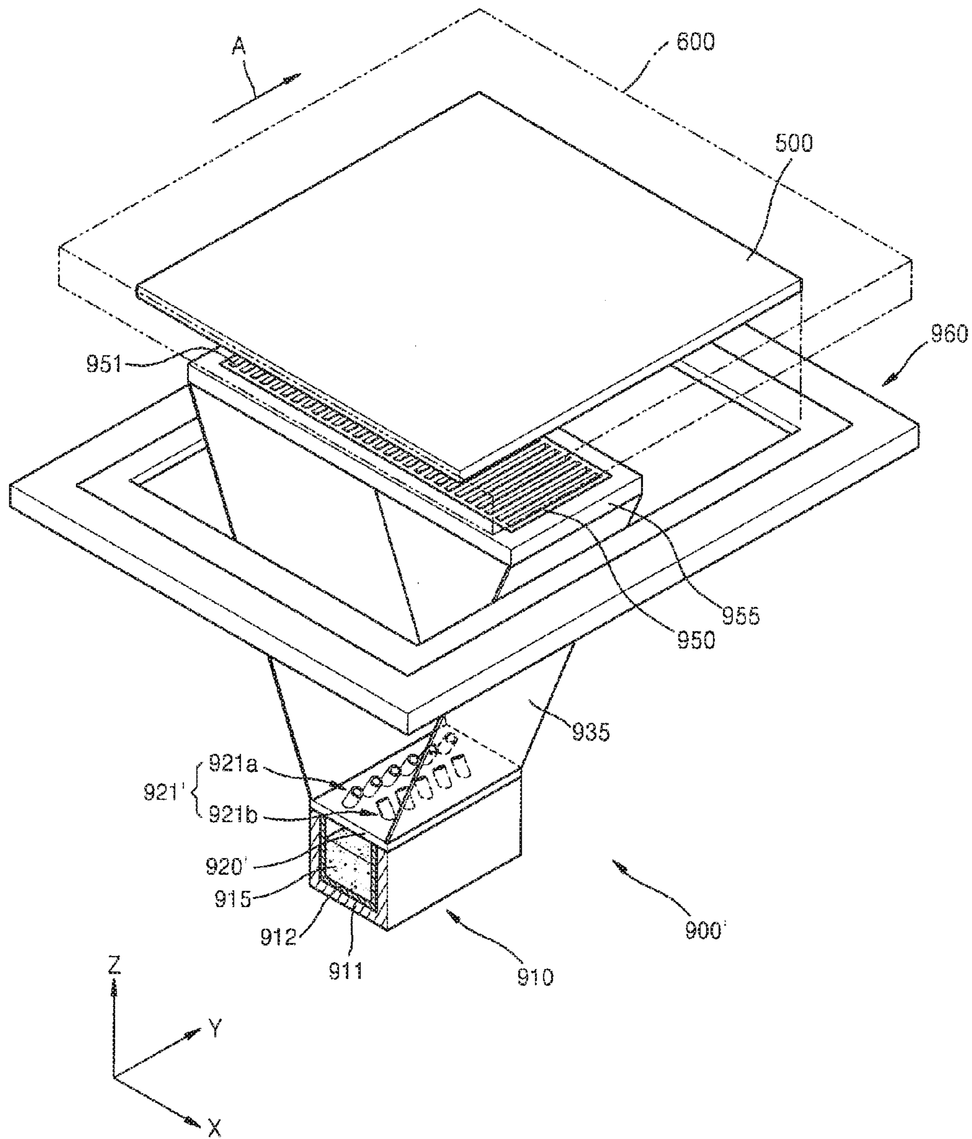


FIG. 9

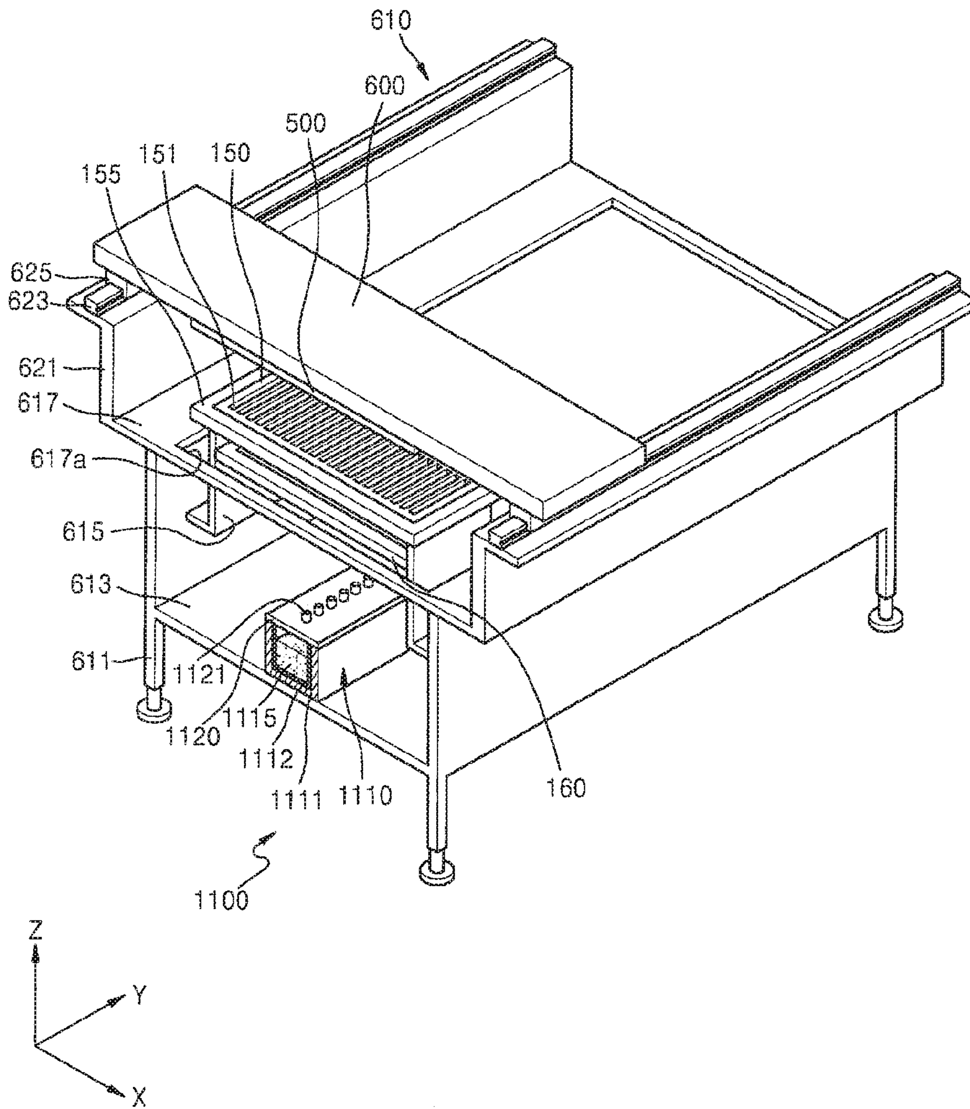


FIG. 10

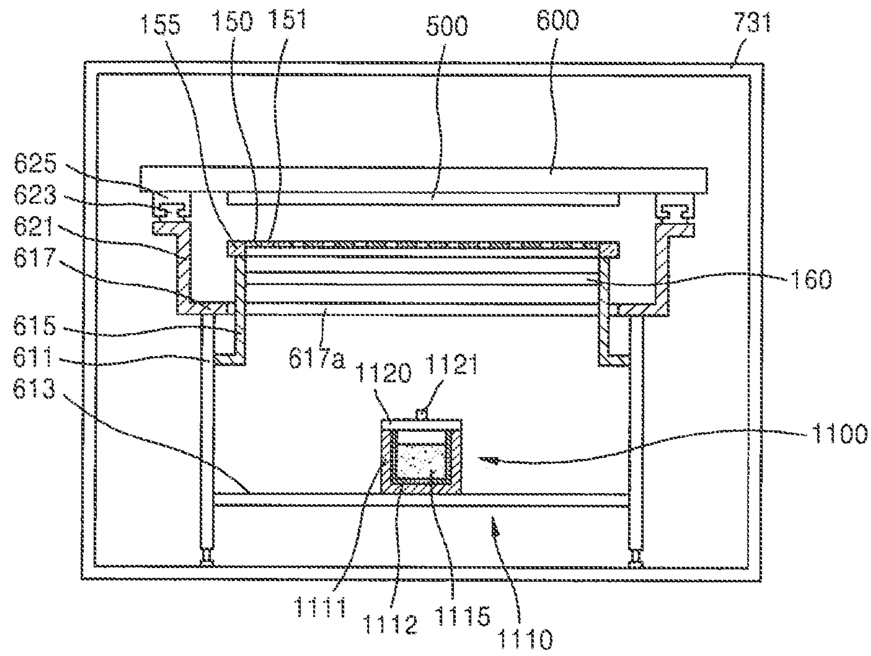
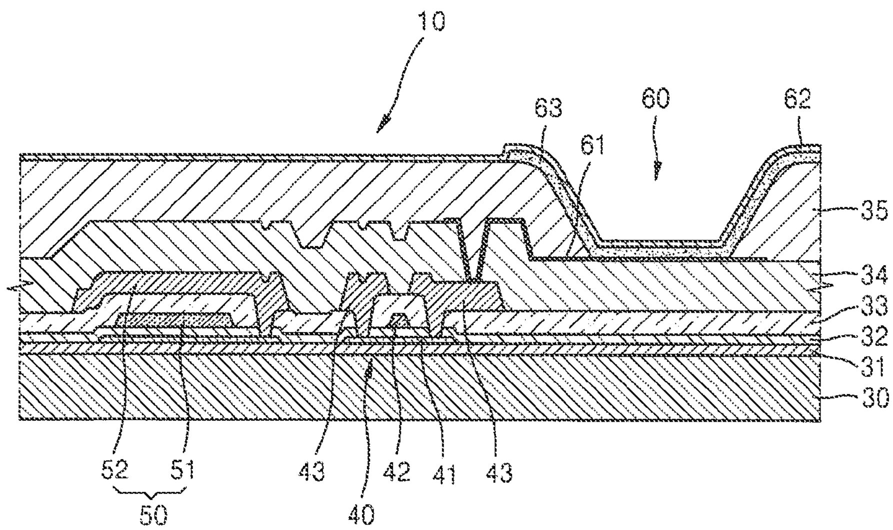


FIG. 11



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

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to and the benefit of Korean Patent Application No. 10-2011-0049794, filed on May 25, 2011 in the Korean Intellectual Property Office, the entire content of which is incorporated herein by reference.

BACKGROUND

[0002] 1. Field

[0003] Aspects of embodiments of the present invention relate to an organic layer deposition apparatus and a method of manufacturing an organic light-emitting display apparatus by using the same.

[0004] 2. Description of the Related Art

[0005] Organic light-emitting display apparatuses typically have a larger viewing angle, better contrast characteristics, and a faster response rate than other display apparatuses, and thus have drawn attention as a next-generation display apparatus.

[0006] Organic light-emitting display apparatuses generally have a stacked structure including an anode, a cathode, and an emission layer interposed between the anode and the cathode. The apparatuses display images in color when holes and electrons, injected respectively from the anode and the cathode, recombine in the emission layer and emit light. However, it is difficult to achieve high light-emission efficiency with such a structure, and thus intermediate layers, including an electron injection layer, an electron transport layer, a hole transport layer, a hole injection layer, etc., may be optionally additionally interposed between the emission layer and each of the electrodes.

[0007] However, it is very difficult to form fine patterns of an organic thin layer such as an organic light emitting layer or an organic intermediate layer, and red, green, and blue luminous efficiency varies according to the organic thin layer. Thus, it is very difficult to pattern the organic thin layer in a large area by using a conventional organic layer deposition apparatus, and a large-sized organic light-emitting display apparatus having satisfactory driving voltage, current density, brightness, color purity, luminous efficiency and life-span may not be manufactured.

[0008] The above information disclosed in this Background section is only for enhancement of understanding of the background of the described technology and, therefore, it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

SUMMARY

[0009] According to aspects of embodiments of the present invention, an organic layer deposition apparatus may be easily manufactured, may be simply applied to manufacture large-sized display apparatuses on a mass scale and improves manufacturing yield and deposition efficiency. According to another aspect of embodiments of the present invention, a method of manufacturing an organic light-emitting display apparatus uses the organic layer deposition apparatus. According to another aspect of embodiments of the present invention, an organic light-emitting display apparatus may be manufactured on a mass scale and having improved manufacturing yield and deposition efficiency using the organic layer deposition apparatus according to embodiments of the present invention.

[0010] According to an embodiment of the present invention, an organic layer deposition apparatus for forming an organic layer on a substrate includes: a deposition source configured to discharge a deposition material; a deposition source nozzle unit arranged 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, the patterning slit sheet being smaller than the substrate in at least one of a first direction or a second direction perpendicular to the first direction; a blocking member configured to be disposed between the substrate and the deposition source to block at least a portion of the substrate; and a heating member on the blocking member and configured to heat the blocking member, and the substrate is spaced apart from the organic layer deposition apparatus by a predetermined distance, and at least one of the substrate or the organic layer deposition apparatus is movable relative to the other.

[0011] The blocking member may be shaped as an open mask.

[0012] The blocking member may be fixed on the deposition source.

[0013] The blocking member may be configured to block a non-layer-formation region of the substrate.

[0014] The blocking member may include a blocking member frame having a hollow window frame and an open mask sheet being thin and disposed inside the blocking member frame.

[0015] The blocking member frame and the open mask sheet may be integrally formed as one body.

[0016] The heating member may be accommodated in the blocking member frame.

[0017] The heating member may heat the blocking member frame and may transfer heat applied to the blocking member frame to the open mask sheet.

[0018] The heating member may be configured to heat the blocking member such that the deposition material is not deposited on the blocking member.

[0019] The heating member may be configured to heat the blocking member at a greater temperature than a temperature at which the deposition material is vaporized.

[0020] The heating member may include a coil heater or a thin layer heater.

[0021] The patterning slit sheet of the organic layer deposition apparatus may be formed to be smaller than the substrate.

[0022] Deposition source nozzles of the plurality of deposition source nozzles may be arranged in the first direction, and patterning slits of the plurality of patterning slits may be arranged in the second direction.

[0023] The deposition source and the deposition source nozzle unit may be connected to the patterning slit sheet by a connection member.

[0024] The connection member may form a flow path of the deposition material.

[0025] The connection member may seal a space between the deposition source nozzle unit and the patterning slit sheet.

[0026] Deposition source nozzles of the plurality of deposition source nozzles may be tilted at a predetermined angle.

[0027] The plurality of deposition source nozzles may include deposition source nozzles arranged in two rows extending in the first direction, and the deposition source nozzles in the two rows may be tilted toward each other.

[0028] The plurality of deposition source nozzles may include deposition source nozzles arranged in two rows extending in the first direction, and the deposition source nozzles of a row located at a first side of the patterning slit sheet may be arranged to face a second side of the patterning slit sheet, and the deposition source nozzles of the other row located at the second side of the patterning slit sheet may be arranged to face the first side of the patterning slit sheet.

[0029] Deposition source nozzles of the plurality of deposition source nozzles are arranged in the first direction, and patterning slits of the plurality of patterning slits are arranged in the first direction, and the organic layer deposition apparatus may further include a barrier plate assembly including a plurality of barrier plates arranged between the deposition source nozzle unit and the patterning slit sheet in the first direction and partitioning a space between the deposition source nozzle unit and the patterning slit sheet into a plurality of sub-deposition spaces.

[0030] Barrier plates of the plurality of barrier plates may extend in the second direction.

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

[0032] Each of the plurality of first barrier plates and each of the second barrier plates may extend in the second direction and partition the space between the deposition source nozzle unit and the patterning slit sheet into the plurality of sub-deposition spaces.

[0033] The apparatus may further include a chamber, deposition source nozzles of the plurality of deposition source nozzles may be arranged in the first direction, the patterning slit sheet may be bound inside the chamber, and patterning slits of the plurality of patterning slits may be arranged in the second direction.

[0034] The apparatus may further include a first conveyor unit configured to move an electrostatic chuck on which the substrate is disposed along the first direction.

[0035] The first conveyor unit may include: a frame in which the deposition source is accommodated; and a sheet supporting member protruding from an inside of the frame and supporting the patterning slit sheet.

[0036] The apparatus may further include: a loading unit configured to fix the substrate to the electrostatic chuck; and an unloading unit configured to separate the substrate on which the deposition material has been deposited from the electrostatic chuck.

[0037] According to another embodiment of the present invention, a method of manufacturing an organic light-emitting display apparatus using an organic layer deposition apparatus including a deposition source, a deposition source nozzle unit arranged 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, a blocking member, and a heating member on the blocking member includes: spacing a substrate which constitutes a target on which the deposition material is to be deposited apart from the organic layer deposition apparatus by a predetermined distance, the blocking member being between the substrate and the deposition source and blocking at least a portion of the substrate, the patterning slit sheet being smaller than the substrate in at least one of a first direction or a second direction perpendicular to the first direction; heating the blocking member using the heating member; discharging a deposition material from the organic layer deposition apparatus; depositing the deposition material onto the substrate while moving at least one of the organic layer deposition apparatus or the substrate relative to the other.

[0038] The blocking member may be shaped as an open mask.

[0039] The blocking member may be fixed on the deposition source.

[0040] The blocking member may block a non-layer-formation region of the substrate.

[0041] The blocking member may include a blocking member frame having a hollow window frame and an open mask sheet being thin and disposed inside the blocking member frame.

[0042] The blocking member frame and the open mask sheet may be integrally formed as one body.

[0043] The heating member may be accommodated in the blocking member frame.

[0044] The blocking member frame may be heated using the heating member, and heat applied to the blocking member frame may be transferred to the open mask sheet.

[0045] Heating the blocking member may include heating the blocking member such that the deposition material is not deposited on the blocking member.

[0046] Heating the blocking member may include heating the blocking member at a greater temperature than a temperature at which the deposition material is vaporized.

[0047] In one embodiment, the heating member may include a coil heater or a thin layer heater.

[0048] The patterning slit sheet of the organic layer deposition apparatus may be formed to be smaller than the substrate.

[0049] Deposition source nozzles of the plurality of deposition source nozzles may be arranged in the first direction, and patterning slits of the plurality of patterning slits may be arranged in the second direction.

[0050] Deposition source nozzles of the plurality of deposition source nozzles may be arranged in the first direction, and patterning slits of the plurality of patterning slits may be arranged in the first direction, and the organic layer deposition apparatus may further include a barrier plate assembly including a plurality of barrier plates arranged between the deposition source nozzle unit and the patterning slit sheet in the first direction and partitioning a space between the deposition source nozzle unit and the patterning slit sheet into a plurality of sub-deposition spaces.

[0051] The organic layer deposition apparatus may further include a chamber, and the patterning slit sheet may be bound inside the chamber, and deposition source nozzles of the plurality of deposition source nozzles may be arranged in the first direction, and patterning slits of the plurality of patterning slits may be arranged in the second direction.

[0052] According to another embodiment of the present invention, an organic light-emitting display apparatus is manufactured using the above-described organic layer deposition apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0053] The above and other features and advantages of the present invention will become more apparent by describing in

further detail some exemplary embodiments thereof with reference to the attached drawings in which:

[0054] FIG. **1** is a schematic diagram of an organic layer deposition apparatus according to an embodiment of the present invention;

[0055] FIG. **2** is a schematic side view of an electrostatic chuck of the organic layer deposition apparatus of FIG. **1**, according to an embodiment of the present invention;

[0056] FIG. **3** is a schematic perspective view of an organic layer deposition assembly of the organic layer deposition apparatus of FIG. **1**, according to an embodiment of the present invention;

[0057] FIG. **4** is a schematic side sectional view of the organic layer deposition assembly of FIG. **3**;

[0058] FIG. **5** is a schematic front sectional view of the organic layer deposition assembly of FIG. **3**;

[0059] FIG. **6** is a schematic perspective view of an organic layer deposition assembly, according to another embodiment of the present invention;

[0060] FIG. **7** is a schematic perspective view of an organic layer deposition assembly, according to another embodiment of the present invention;

[0061] FIG. **8** is a schematic perspective view of an organic layer deposition assembly, according to another embodiment of the present invention;

[0062] FIG. **9** is a schematic perspective view of an organic layer deposition assembly, according to another embodiment of the present invention;

[0063] FIG. **10** is a schematic front view of the organic layer deposition assembly of FIG. **9**; and

[0064] FIG. **11** is a schematic cross-sectional view of an active matrix organic light-emitting display apparatus manufactured by using an organic layer deposition apparatus, according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0065] Some exemplary embodiments of the present invention will be described more fully hereinafter with reference to the accompanying drawings; however, embodiments of the present invention may be embodied in different forms and should not be construed as limited to the exemplary embodiments illustrated and set forth herein. Rather, these exemplary embodiments are provided by way of example for understanding of the invention and to convey the scope of the invention to those skilled in the art. As those skilled in the art would realize, the described embodiments may be modified in various ways, all without departing from the spirit or scope of the present invention.

[0066] FIG. **1** is a schematic diagram of an organic layer deposition apparatus according to an embodiment of the present invention.

[0067] Referring to FIG. **1**, the organic layer deposition apparatus according to an embodiment of the present invention includes a loading unit **710**, a deposition unit **730**, an unloading unit **720**, a first conveyor unit **610**, and a second conveyor unit **620**.

[0068] The loading unit **710**, in one embodiment, includes a first rack **712**, a transport robot **714**, a transport chamber **716**, and a first inversion chamber **718**.

[0069] A plurality of substrates **500** on which a deposition material has not been applied are stacked on the first rack **712**. The transport robot **714** picks up a substrate **500** from the first rack **712**, disposes it on an electrostatic chuck **600** transferred by the second conveyor unit **620**, and moves the electrostatic chuck **600** on which the substrate **500** is disposed into the transport chamber **716**.

[0070] The first inversion chamber **718** is disposed adjacent to the transport chamber **716**. A first inversion robot **719** disposed in the first inversion chamber **718** inverts the electrostatic chuck **600** and then loads it into the first conveyor unit **610** of the deposition unit **730**.

[0071] Referring to FIG. **2**, the electrostatic chuck **600** may include an electrode **602** embedded in a main body **601** formed of ceramic, wherein the electrode **602** is supplied with power. The electrostatic chuck **600** may fix the substrate **500** on a surface of the main body **601** as a voltage (e.g., a high voltage) is applied to the electrode **602**.

[0072] Referring to FIG. **1**, the transport robot **714** places one of the substrates **500** on a top surface of the electrostatic chuck **600**, and the electrostatic chuck **600** on which the substrate **500** is disposed is loaded into the transport chamber **716**. The first inversion robot **719** inverts the electrostatic chuck **600** such that the substrate **500** is turned upside down in the deposition unit **730**.

[0073] The unloading unit **720**, in one embodiment, is configured to operate in an opposite manner to the loading unit **710** described above. In one embodiment, a second inversion robot **729** in a second inversion chamber **728** inverts the electrostatic chuck **600**, which has passed through the deposition unit **730** while the substrate **500** is disposed on the electrostatic chuck **600**, and then moves the electrostatic chuck **600** on which the substrate **500** is disposed into an ejection chamber **726**. Then, an ejection robot **724** removes the electrostatic chuck **600** on which the substrate **500** is disposed from the ejection chamber **726**, separates the substrate **500** from the electrostatic chuck **600**, and then loads the substrate **500** into a second rack **722**. The electrostatic chuck **600** separated from the substrate **500** is returned to the loading unit **710** via the second conveyor unit **620**.

[0074] However, aspects of the present invention are not limited to the above description. For example, in one embodiment, when disposing the substrate **500** on the electrostatic chuck **600**, the substrate **500** may be fixed onto a bottom surface of the electrostatic chuck **600** and then moved into the deposition unit **730**. In such an embodiment, for example, the first inversion chamber **718**, the first inversion robot **719**, the second inversion chamber **728**, and the second inversion robot **729** may be omitted.

[0075] The deposition unit **730** may include at least one deposition chamber. In one embodiment, as illustrated in FIG. **1** the deposition unit **730** may include a chamber **731** in which first to fourth organic layer deposition assemblies **100**, **200**, **300**, and **400** may be disposed.

[0076] However, although FIG. **1** depicts four organic layer deposition assemblies, i.e. the first to fourth organic layer deposition assemblies **100**, **200**, **300**, and **400** installed in the chamber **731**, the total number of organic layer deposition assemblies that may be installed in the chamber **731** may be varied in other embodiments, such as according to a deposition material and deposition conditions. The chamber **731**, in one embodiment, is maintained in a vacuum state during a deposition process.

[0077] In the embodiment illustrated in FIG. **1**, the electrostatic chuck **600** on which the substrate **500** is disposed may be moved at least to the deposition unit **730** or may be moved sequentially to the loading unit **710**, the deposition unit **730**, and the unloading unit **720**, by the first conveyor unit **610**. The

electrostatic chuck **600** that is separated from the substrate **500** in the unloading unit **720** is moved back to the loading unit **710** by the second conveyor unit **620**.

[0078] The organic layer deposition assembly **100** of the organic layer deposition apparatus, according to an embodiment of the present invention, will now be described. FIG. **3** is a schematic perspective view of the organic layer deposition assembly **100** of the organic layer deposition apparatus of FIG. **1**, according to an embodiment of the present invention; FIG. **4** is a schematic side sectional view of the organic layer deposition assembly **100**; and FIG. **5** is a schematic front sectional view of the organic layer deposition assembly **100**.

[0079] Referring to FIGS. **3** through **5**, the organic layer deposition assembly **100** according to an embodiment of the present invention includes a deposition source **110**, a deposition source nozzle unit **120**, a barrier plate assembly **130**, a patterning slit sheet **150**, a blocking member **160**, and a heating member **170**.

[0080] Although a chamber is not illustrated in FIGS. **3** through **5** for purposes of illustration, the components of the organic layer deposition assembly **100** may be disposed within a chamber that is maintained at an appropriate degree of vacuum. The chamber may be maintained at an appropriate vacuum in order to allow a deposition material to move in a substantially straight line through the organic layer deposition assembly **100**.

[0081] In the chamber **731** (see FIG. **1**) in which the organic layer deposition assembly **100** is disposed, the substrate **500**, which constitutes a deposition target on which a deposition material **115** is to be deposited, is transferred by the electrostatic chuck **600**. The substrate **500** may be a substrate for flat panel displays. A large substrate, such as a mother glass for manufacturing a plurality of flat panel displays, may be used as the substrate **500**. Other substrates may also be used.

[0082] In an embodiment of the present invention, the substrate **500** or the organic layer deposition assembly **100** may be moved relative to the other. For example, as illustrated in FIGS. **3** and **4**, the substrate **500** may be moved in a direction of arrow "A" relative to the organic layer deposition assembly **100**.

[0083] In a conventional deposition method using a fine metal mask (FMM), the size of the FMM has to be greater than or equal to the size of a substrate. Thus, the size of the FMM has to be increased as the substrate becomes larger. However, it is neither straightforward to manufacture a large FMM nor to extend an FMM to be accurately aligned with a pattern.

[0084] The above-described problem is overcome in the organic layer deposition assembly **100** according to an embodiment of the present invention, as deposition may be performed while the organic layer deposition assembly **100** or the substrate **500** is moved relative to the other. In other words, in one embodiment, deposition may be continuously performed while the substrate **500**, which is disposed such as to face the organic layer deposition assembly **100**, is moved in a Y-axis direction (i.e. in the direction of the arrow "A"). That is, deposition may be performed in a scanning manner while the substrate **500** is moved in the direction of arrow "A" in FIGS. **3** and **4**. Although the substrate **500** is illustrated as being moved within the chamber (see **731** of FIG. **1**) in the Y-axis direction when deposition is performed, the present invention is not limited thereto. For example, in another embodiment, deposition may be performed while the organic layer deposition assembly **100** is moved in the Y-axis direction, while the substrate **500** is fixed.

[0085] In the organic layer deposition assembly **100** according to an embodiment of the present invention, the patterning slit sheet **150** may be significantly smaller than a FMM used in a conventional deposition method. In the organic layer deposition apparatus **100**, deposition may be continuously performed, such as in a scanning manner, while the substrate **500** is moved in the Y-axis direction. Thus, a length of the patterning slit sheet **150** in the Y-axis direction may be less (e.g., significantly less) than a length of the substrate **500**, and a width of the patterning slit sheet **150** in the X-axis direction and a width of the substrate **500** in the X-axis direction may be substantially equal to each other. However, in another embodiment, the width of the patterning slit sheet **150** in the X-axis direction may be less than the width of the substrate **500** in the X-axis direction, and deposition may be performed on the entire substrate **500** in a scanning manner while the substrate **500** or the organic layer deposition assembly **100** is moved relative to the other.

[0086] As described above, since the patterning slit sheet **150** may be formed to be significantly smaller than a FMM used in a conventional deposition method, it is relatively easy to manufacture the patterning slit sheet **150** of the present invention. As such, using the patterning slit sheet **150**, which is smaller than a FMM used in a conventional deposition method, is more convenient in many or all processes, including etching and other subsequent processes, such as precise extension, welding, moving, and cleaning processes, compared to the conventional deposition method using the larger FMM. Therefore, embodiments of the present invention are advantageous for manufacturing of a relatively large display apparatus.

[0087] In order to perform deposition while the organic layer deposition assembly **100** or the substrate **500** is moved relative to the other as described above, the organic layer deposition assembly **100** and the substrate **500** may be separated from each other by a predetermined distance. This is described in further detail later herein.

[0088] The deposition source **110** that contains and heats the deposition material **115** is disposed at a side of the chamber opposite to a side in which the substrate **500** is disposed.

[0089] The deposition source **110**, in one embodiment, includes a crucible **112** that is filled with the deposition material **115**, and a cooling block **111** surrounding the crucible **112**. The cooling block **111** prevents or substantially prevents radiation of heat from the crucible **112** to the outside (i.e. into the chamber **731**). The cooling block **111** may include a heater (not shown) that heats the crucible **112**.

[0090] The deposition source nozzle unit **120**, in one embodiment, is disposed at a side of the deposition source **110** facing the substrate **500**. The deposition source nozzle unit **120**, in one embodiment, includes a plurality of deposition source nozzles **121** arranged at intervals (e.g. equal intervals) in the X-axis direction. The deposition material **115** that is vaporized in the deposition source **110** passes through the deposition source nozzles **121** of the deposition source nozzle unit **120** toward the substrate **500**, which constitutes a target on which the deposition material **115** is to be deposited.

[0091] In one embodiment, the barrier plate assembly **130** is disposed at a side of the deposition source nozzle unit **120**. The barrier plate assembly **130** includes a plurality of barrier plates **131**, and a barrier plate frame **132** that covers sides of the barrier plates **131**. The plurality of barrier plates **131**, in

one embodiment, may be arranged parallel to each other at intervals (e.g., equal intervals) in the X-axis direction. In one embodiment, each of the barrier plates **131** may be arranged parallel to a Y-Z plane in FIG. **4**. In one embodiment, each of the barrier plates **131** may have a generally rectangular shape. The plurality of barrier plates **131** partition the space between the deposition source nozzle unit **120** and the patterning slit sheet **150** into a plurality of sub-deposition spaces S (see FIG. **5**). In the organic layer deposition assembly **100** according to an embodiment of the present invention, as illustrated in FIG. **5**, the deposition space is divided by the barrier plates **131** into the sub-deposition spaces S that respectively correspond to the deposition source nozzles **121** through which the deposition material **115** is discharged.

[0092] The barrier plates **131** may be respectively disposed between adjacent deposition source nozzles **121**. In one embodiment, each of the deposition source nozzles **121** may be disposed between two adjacent barrier plates **131**. In one embodiment, the deposition source nozzles **121** may be respectively located at or about the midpoint between two adjacent barrier plates **131**. However, the present invention is not limited to this structure. For example, in another embodiment, a plurality of deposition source nozzles **121** may be disposed between two adjacent barrier plates **131**. In this case, the deposition source nozzles **121** may be respectively located at or about the midpoint between two adjacent barrier plates **131**.

[0093] In one embodiment, since the barrier plates **131** partition the space between the deposition source nozzle unit **120** and the patterning slit sheet **150** into the plurality of sub-deposition spaces S, the deposition material **115** discharged through each of the deposition source nozzles **121** is not mixed with the deposition material **115** discharged through the other deposition source nozzles **121**, and passes through patterning slits **151** of the patterning slit sheet **150** so as to be deposited on the substrate **500**. That is, in one embodiment, the barrier plates **131** guide the deposition material **115** which is discharged through the deposition source nozzles **121** to move straight, and not flow in the X-axis direction.

[0094] As described above, in one embodiment, the deposition material **115** is restricted to move straight by installing the barrier plates **131**, such that a smaller shadow zone may be formed on the substrate **500** compared to an assembly in which no barrier plates are installed. Thus, in one embodiment, the organic layer deposition assembly **100** and the substrate **500** may be separated from each other by a predetermined distance, as is described in further detail later herein.

[0095] The patterning slit sheet **150** and a frame **155** in which the patterning slit sheet **150** is bound are disposed between the deposition source **110** and the substrate **500**. The frame **155** may be formed in a lattice shape, similar to a window frame. The patterning slit sheet **150** is bound inside the frame **155**. The patterning slit sheet **150** includes a plurality of patterning slits **151** arranged, or spaced from one another, in the X-axis direction. The patterning slits **151** extend in the Y-axis direction. The deposition material **115** that has been vaporized in the deposition source **110** and passed through the deposition source nozzle **121** passes through the patterning slits **151** toward the substrate **500**.

[0096] The patterning slit sheet **150** may be formed of a metal thin film. The patterning slit sheet **150**, in one embodiment, is fixed to the frame **150** such that a tensile force is exerted thereon. The patterning slits **151**, in one embodiment, may be formed by etching the patterning slit sheet **150** in a stripe pattern. The number of patterning slits **151**, in one embodiment, may be equal to the number of deposition patterns to be formed on the substrate **500**.

[0097] In one embodiment, the barrier plate assembly **130** and the patterning slit sheet **150** may be disposed to be separated from each other by a predetermined distance. Alternatively, the barrier plate assembly **130** and the patterning slit sheet **150** may be connected by a connection member **135**.

[0098] The blocking member **160** is disposed between the barrier plate assembly **130** and the patterning slit sheet **150**. The heating member **170** is disposed on the blocking member **160**. The blocking member **160**, in one embodiment, is shaped as an open mask and is fixed on the substrate **500** to prevent or substantially prevent an organic material from being deposited on a non-layer-formation region of the substrate **500** in which no layer is to be formed. The heating member **170** may be disposed inside or at a side of the blocking member **160** to heat the blocking member **160** at a temperature (e.g., a predetermined temperature). In the organic layer deposition assembly **100** according to an embodiment of the present invention, the heating member **170** is disposed on the blocking member **160** in such a way that the deposition material **115** is not deposited on the blocking member **160**, and a period for replacing or cleaning the blocking member **160** is thereby increased and product yield is improved. This is described in further detail later herein.

[0099] As described above, the organic layer deposition assembly **100** according to an embodiment of the present invention performs deposition while being moved relative to the substrate **500**. In order to move the organic layer deposition assembly **100** relative to the substrate **500**, the patterning slit sheet **150** is separated from the substrate **500** by a predetermined distance. In addition, in order to prevent or substantially prevent the formation of a relatively large shadow zone on the substrate **500** when the patterning slit sheet **150** and the substrate **500** are separated from each other, the barrier plates **131** are arranged between the deposition source nozzle unit **120** and the patterning slit sheet **150** to direct the deposition material **115** to move in a straight direction. Thus, the size of a shadow zone that may otherwise be formed on the substrate **500** is substantially reduced.

[0100] In a conventional deposition method using a FMM, deposition is performed with the FMM in close contact with a substrate in order to prevent formation of a shadow zone on the substrate. However, when the FMM is used in close contact with the substrate, the contact may cause defects, such as scratches on patterns formed on the substrate. In addition, in the conventional deposition method, the size of the mask has to be the same as the size of the substrate since the mask cannot be moved relative to the substrate. Thus, the size of the mask has to be increased as display apparatuses become larger. However, it is not easy to manufacture such a large mask.

[0101] In the organic layer deposition apparatus **100** according to an embodiment of the present invention, the patterning slit sheet **150** is disposed to be separated from the substrate **500** by a predetermined distance. This may be facilitated by installing the barrier plates **131** to reduce the size of the shadow zone formed on the substrate **500**.

[0102] A thin layer, such as an organic layer, of an organic light-emitting display apparatus may be formed by using the

organic layer deposition apparatus according to the present invention, and will be described in further detail later herein with reference to FIG. **11**.

[0103] In the organic layer deposition assembly **100** according to an embodiment of the present invention, the heating member **170** is disposed on the blocking member **160** in such a way that the deposition material **115** is not deposited on the blocking member **160** and a period for replacing or cleaning the blocking member **160** is increased and product yield is improved.

[0104] Since an anode pattern or a cathode pattern may be formed on edges of the substrate **500**, a region to be used as a terminal exists in the edges of the substrate **500** when a product is to be inspected or manufactured. When an organic layer is formed in the region, an anode or a cathode does not act as itself. Thus, in one embodiment, the edges of the substrate **500** are to formed as a non-layer-formation region in which no organic layer is to be formed. As described above, the organic layer deposition apparatus according to the present invention performs deposition in a scanning manner while the substrate **500** is moved relative to the organic layer deposition apparatus, and, in one embodiment, an organic material is to be prevented or substantially prevented from being deposited on the non-layer-formation region of the substrate **500**.

[0105] In order to prevent or substantially prevent the organic material from being deposited on the non-layer-formation region of the substrate **500**, the organic layer deposition apparatus according to embodiments of the present invention include the blocking member **160** disposed so as to cover the edges of the substrate **500**.

[0106] Referring to FIGS. **3** through **5**, in one embodiment, the blocking member **160** that is shaped as an open mask is disposed in a lower portion of the substrate **500** (i.e. in a lower portion of a bottom surface of the substrate **500** that faces the deposition source **110**), such that the blocking member **160** is fixed on the substrate **500**. In this regard, the blocking member **160** may be shaped as an open mask in the form of a hollow window frame. The deposition material **115** that has been vaporized in the deposition source **110** is blocked by the blocking member **160** and is not deposited on a portion (i.e. a non-layer-formation region) of the substrate **500** that has passed through the deposition source **110**.

[0107] In one embodiment, the blocking member **160** may include at least one metal selected from the group consisting of carbon (C), iron (Fe), chromium (Cr), manganese (Mn), nickel (Ni), titanium (Ti), molybdenum (Mo), stainless steel (SUS), an Invar alloy, an Inconel alloy, and a Kovar alloy. However, embodiments of the blocking member **160** according to the present invention are not limited thereto. In one embodiment, the blocking member **160** may include an Invar alloy having a lower thermal expansion coefficient than that of SUS and which may be less susceptible to becoming wrinkled. In addition, a tensile force to be applied to the Invar alloy may not be greatly reduced even at a high temperature and thus, the Invar alloy may not adversely affect the blocking member **160**.

[0108] In one embodiment, the blocking member **160** may include a blocking member frame **161** and an open mask sheet **162**. The blocking member **160** may include a blocking member frame **161** having a hollow window frame shape and an open mask sheet **162** which is thin and disposed inside the blocking member frame **161**. The blocking member frame **161** and the open mask sheet **162** may be integrally formed as one body. In one embodiment, the blocking member frame **161** and the open mask sheet **162** are integrally formed as one body such that the blocking member frame **161** may be heated and the temperature of the open mask sheet **162** may rise.

[0109] The heating member **170** may be accommodated in the blocking member **160** or may be connected to a side of the blocking member **160** and is configured to heat the blocking member **160** at a predetermined temperature. The blocking member **170** may heat the blocking member **160** to prevent or substantially prevent the deposition material **115** from being deposited on the blocking member **160** or to remove the deposition material **115** that has already been deposited on the blocking member **160**.

[0110] In one embodiment, according to a deposition process performed using the organic layer deposition apparatus according to an embodiment of the present invention, the deposition material **115** discharged through the deposition source **110** passes through the blocking member **160** and the patterning slit sheet **150** and is deposited on the substrate **500**, which constitutes a deposition target on which the deposition material **115** is to be deposited, and a portion of the deposition material **115** may be deposited on the open mask sheet **162** of the blocking member **160**. However, when the deposition material **115** is deposited on the open mask sheet **162** of the blocking member **160**, a portion of a deposition path of the deposition material **115** may be blocked such that a desired shape of a pattern to be deposited on the substrate **500** may not be formed.

[0111] This problem is overcome according to an embodiment of the present invention in which the organic layer deposition assembly **100** includes the heating member **170** disposed on the blocking member **160**, thereby preventing or substantially preventing the deposition material **115** from being deposited on the blocking member **160** or removing the deposition material **115** that has already been deposited on the blocking member **160**. In one embodiment, while the deposition material **115** is deposited, the heating member **170** may heat the blocking member **160** at a temperature (e.g., a predetermined temperature) or greater, such as at a higher temperature than a temperature at which the deposition material **115** is vaporized, so as to prevent or substantially prevent the deposition material **115** from being deposited on the blocking member **160**. In one embodiment, while the deposition material **115** is not being discharged through the deposition source **110**, the heating member **170** may heat the blocking member **160** at a greater temperature than a temperature at which the deposition material **115** is vaporized, so as to remove the deposition material **115** that has already been deposited on the open mask sheet **162**. In one embodiment, in the organic layer deposition apparatus according to an embodiment of the present invention, after the deposition material **115** is stopped from being discharged during the deposition process, the blocking member **160** is heated by the heating member **170** within the chamber (see **731** of FIG. **1**), thereby vaporizing and removing the deposition material **115** deposited on the open mask sheet **162**, and discharging the deposition material **115** again and depositing the deposition material **115** on the substrate **500**.

[0112] Thus, since the organic layer deposition apparatus according to an embodiment of the present invention is configured to remove the deposition material **115** deposited on the blocking member **160** within the chamber (see **731** of FIG. **1**), an additional cleaning process for cleaning the blocking member **160** by removing the blocking member **160** is not

required such that an organic layer deposition process may be simply performed. In addition, since the deposition material **115** may be prevented or substantially prevented from being deposited on the blocking member **160** during the deposition process, the open mask sheet **162** of the blocking member **160** may be efficiently prevented from being clogged. In one embodiment, the deposition material **115** that has been vaporized by heating performed by the heating member **170** is deposited on the barrier plate assembly **130** and may be recovered and re-used such that utilization efficiency of the deposition material **115** may be improved.

[0113] In one embodiment, the heating member **170** may be inserted in the blocking member frame **161** of the blocking member **160** in a form of a coil heater, as illustrated in FIG. **4**. However, the present invention is not limited thereto. For example, in another embodiment, the heating member **170** may be implemented as a thin layer heater connected to a side of the blocking member **160** and may be formed in various shapes in various positions where thermal energy (e.g., predetermined thermal energy) may be supplied to the blocking member **160**.

[0114] In one embodiment, the blocking member frame **161** and the open mask sheet **162** may be integrally formed as one body. If the blocking member frame **161** and the open mask sheet **162** are formed of different materials and are combined with each other, the blocking member frame **161** may be heated and the open mask sheet **162** may be bent. In one embodiment, the blocking member frame **161** and the open mask sheet **162** are integrally formed as one body from at least one metal selected from the group consisting of carbon (C), iron (Fe), chromium (Cr), manganese (Mn), nickel (Ni), titanium (Ti), molybdenum (Mo), stainless steel (SUS), an Invar alloy, an Inconel alloy, and a Kovar alloy described above. Thus, even when only the blocking member frame **161** is heated, heat may be easily transferred to the open mask sheet **162**. When the open mask sheet **162** is heated simultaneously with the blocking member frame **161**, the open mask sheet **162** may be prevented or substantially prevented from being bent.

[0115] According to embodiments of the present invention, a period for cleaning and replacing the blocking member **160** is increased and the frequency at which a manufacturing process has to be stopped is reduced, and manufacturing yield is improved. Also, an occurrence of a portion of the blocking member **160** being covered by the deposition material **115** may be prevented such that uniformity of thicknesses of organic layers to be deposited on the substrate **500** may be improved.

[0116] FIG. **6** is a schematic perspective view of an organic layer deposition assembly **800**, according to another embodiment of the present invention.

[0117] Referring to FIG. **6**, the organic layer deposition assembly **800** according to another embodiment of the present invention includes the deposition source **110**, the deposition source nozzle unit **120**, the first barrier plate assembly **130**, a second barrier plate assembly **840**, the patterning slit sheet **150**, the blocking member **160**, and the heating member **170** (not shown). Structures of the deposition source **110**, the deposition source nozzle unit **120**, the first barrier plate assembly **130**, the patterning slit sheet **150**, the blocking member **160**, and the heating member **170** may be the same as those of the organic layer deposition assembly **100** described above, and thus description thereof will not be repeated. The organic layer deposition assembly **800** differs from the organic layer deposition assembly **100** described above in that the second barrier plate assembly **840** is disposed at a side of the first barrier plate assembly **130**.

[0118] In one embodiment, the second barrier plate assembly **840** includes a plurality of second barrier plates **841**, and a second barrier plate frame **842** that covers sides of the second barrier plates **841**. The plurality of second barrier plates **841**, in one embodiment, may be arranged parallel to each other at intervals (e.g., equal intervals) in the X-axis direction. In addition, each of the second barrier plates **841** may be formed to extend in the Y-Z plane (i.e. perpendicular to the X-axis direction), as shown in FIG. **6**.

[0119] The plurality of first barrier plates **131** and the second barrier plates **841** arranged as described above partition the space between the deposition source nozzle unit **120** and the patterning slit sheet **150**. In one embodiment, the deposition space is divided by the first barrier plates **131** and the second barrier plates **841** into sub-deposition spaces that respectively correspond to the deposition source nozzles **121** through which the deposition material **115** is discharged.

[0120] The second barrier plates **841** may be disposed to correspond respectively to the first barrier plates **131**. The second barrier plates **841** may be respectively aligned with the first barrier plates **131** to be parallel thereto on the same plane as the first barrier plates **131**. Each pair of the corresponding first and second barrier plates **131** and **841** may be located on the same plane. Although the first barrier plates **131** and the second barrier plates **841** are respectively illustrated as having the same thickness in the X-axis direction, aspects of the present invention are not limited thereto. In one embodiment, the second barrier plates **841**, which are aligned with the patterning slits **151**, may be formed to be relatively thin, whereas the first barrier plates **131**, which do not need to be as accurately aligned with the patterning slits **151**, may be formed to be relatively thick. This simplifies manufacturing of the organic layer deposition assembly **800**.

[0121] FIG. **7** is a schematic perspective view of an organic layer deposition assembly **900**, according to another embodiment of the present invention.

[0122] Referring to FIG. **7**, the organic layer deposition assembly **900** according to another embodiment of the present invention includes a deposition source **910**, a deposition source nozzle unit **920**, a patterning slit sheet **950**, a blocking member **960**, and a heating member (not shown) in the blocking member **960**.

[0123] In one embodiment, 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** to vaporize the deposition material **915** which is contained in the crucible **911**, so as to move the vaporized deposition material **915** to the deposition source nozzle unit **920**. The deposition source nozzle unit **920** is disposed at a side of the deposition source **910**. The deposition source nozzle unit **920** includes a plurality of deposition source nozzles **921** arranged in the Y-axis direction. The patterning slit sheet **950** and a frame **955** are disposed between the deposition source **910** and the substrate **500**, and the patterning slit sheet **950** includes a plurality of patterning slits **951** arranged in the X-axis direction. In one embodiment, the deposition source **910** and the deposition source nozzle unit **920** may be connected to the patterning slit sheet **950** by a connection member **935**. The blocking member **960** is disposed at a side of the patterning slit sheet **950**, and the heating member (not shown) is disposed inside or at

a side of the blocking member **960**, and may be configured the same or similar to the heating member **170** described above.

[0124] In the organic layer deposition assembly **900** according to an embodiment of the present invention, the arrangement of the plurality of deposition source nozzles **921** of the deposition source nozzle unit **920** is different from that in the above-described embodiments. This is described in further detail below.

[0125] The deposition source nozzle unit **920** is disposed at a side of the deposition source **910**, and, in particular, at the side of the deposition source **910** facing the substrate **500**. The deposition source nozzle unit **920** includes a plurality of deposition source nozzles **921** arranged at intervals (e.g., equal intervals) in the Y-axis direction (i.e. a scanning direction of the substrate **500**). The deposition material **915** that is vaporized in the deposition source **910** passes through the deposition source nozzle unit **920** toward the substrate **500**, which constitutes a target on which the deposition material **915** is to be deposited. As described above, when the deposition source nozzle unit **920** includes the plurality of deposition source nozzles **921** arranged in the Y-axis direction, that is, the scanning direction of the substrate **500**, the size of a pattern formed of the deposition material **915** discharged through the patterning slits **951** of the patterning slit sheet **950** is affected by the size of one of the deposition source nozzles **921** since there is only one deposition source nozzle **921** in the X-axis direction, and thus no shadow zone may be formed on the substrate **500**. In one embodiment, since the plurality of deposition source nozzles **921** are arranged in the scanning direction of the substrate **500**, even if there is a difference in flux between the deposition source nozzles **921**, the difference may be compensated for and deposition uniformity may be maintained constant. In the organic layer deposition assembly **900**, the barrier plate assembly that is included in the organic layer deposition assembly **100** described above may be omitted, and the deposition material **915** is not deposited on the barrier plate assembly and utilization efficiency of the deposition material **915** may be improved.

[0126] FIG. **8** is a schematic perspective view of an organic layer deposition assembly **900'**, according to another embodiment of the present invention. Referring to FIG. **8**, the organic layer deposition apparatus **900'** according to an embodiment of the present invention includes the deposition source **910**, a deposition source nozzle unit **920'**, the patterning slit sheet **950**, the blocking member **960**, and a heating member (not shown) in the blocking member.

[0127] In one embodiment, a plurality of deposition source nozzles **921'** formed on the deposition source nozzle unit **920'** are tilted at a predetermined angle, unlike in the deposition source nozzle unit **920** described above and shown in FIG. **7**. In one embodiment, the deposition source nozzles **921'** may include deposition source nozzles **921*a*** and **921*b*** arranged in respective rows. The deposition source nozzles **921*a*** and **921*b*** may be arranged in respective rows to alternate in a zigzag pattern. The deposition source nozzles **921*a*** and **921*b*** may be tilted at a predetermined angle on an XZ plane.

[0128] In one embodiment of the present invention, the deposition source nozzles **921*a*** and **921*b*** are arranged to be tilted at a predetermined angle relative to each other. The deposition source nozzles **921*a*** in the first row and the deposition source nozzles **921*b*** in the second row may be tilted toward each other. That is, in one embodiment, the deposition source nozzles **921*a*** of the first row in a left part of the deposition source nozzle unit **921** are arranged to face a right side portion of the patterning slit sheet **950**, and the deposition source nozzles **921*b*** of the second row in a right part of the deposition source nozzle unit **921'** are arranged to face a left side portion of the patterning slit sheet **950**.

[0129] Due to the structure of the organic layer deposition assembly **900'** according to the above-described embodiment, the amount of deposition of the deposition material **915** may be adjusted to lessen a thickness variation between the center and the end portions of the substrate **500** and improve uniformity of thicknesses of organic layers to be deposited on the substrate **500**. Moreover, utilization efficiency of the deposition material **915** may also be improved.

[0130] FIG. **9** is a schematic perspective view of a first conveyor unit, such as the first conveyor unit **610** of the organic layer deposition apparatus of FIG. **1**, and an organic layer deposition assembly **1100**, according to another embodiment of the present invention, and FIG. **10** is a schematic front view of the first conveyor unit and the organic layer deposition assembly **1100** of FIG. **9**. The chamber **731** of FIG. **1** is not illustrated in FIG. **9** for purposes of illustration.

[0131] Referring to FIGS. **9** through **10**, the organic layer deposition apparatus **1100** according to an embodiment of the present invention includes the first conveyor unit **610** and the organic layer deposition assembly **1100** of the deposition unit **730** of FIG. **1**.

[0132] The organic layer deposition assembly **1100** according to an embodiment of the present invention includes a deposition source **1110**, a deposition source nozzle unit **1120**, the patterning slit sheet **150**, the blocking member **160**, and the heating member **170** (not shown). In one embodiment, the deposition source **1110** includes a crucible **1111** that is filled with a deposition material **1115**, and a heater **1112** that heats the crucible **1111** to vaporize the deposition material **1115** which is contained in the crucible **1111**, so as to move the vaporized deposition material **1115** to the deposition source nozzle unit **1120**. The deposition source nozzle unit **1120** is disposed at a side of the deposition source **1110**. The deposition source nozzle unit **1120**, in one embodiment, includes a plurality of deposition source nozzles **1121** arranged in the Y-axis direction. The patterning slit sheet **150** and the frame **155** are further disposed between the deposition source **1110** and the substrate **500**. The patterning slit sheet **150** includes the plurality of patterning slits **151** arranged in the X-axis direction. In the organic layer deposition assembly **1100** according to an embodiment of the present invention, the deposition source **1110**, the deposition source nozzle unit **1120**, and the patterning slit sheet **150** are not integrally formed as one body, but may be formed as separate members within the deposition unit **730**. This will be described in further detail later herein.

[0133] The first conveyor unit **610** is described in further detail below.

[0134] The first conveyor unit **610** moves the electrostatic chuck **600** on which the substrate **500** is disposed. In one embodiment, the first conveyor unit **610** includes a frame **611** including a lower plate **613** and an upper plate **617**, a sheet supporting member **615** disposed inside the frame **611**, a guide supporting member **621** disposed at a top surface of the frame **611**, a pair of guide rails **623** disposed on the guide supporting member **621**, and a plurality of guide blocks **625** disposed on the pair of guide rails **623**.

[0135] The frame **611**, in one embodiment, constitutes a base portion of the first conveyor unit **610** and has a generally

hollow box shape. In one embodiment, the lower plate **613** constitutes a bottom surface of the frame **611**, and the deposition source **1110** may be disposed on the lower plate **613**. The upper plate **617**, in one embodiment, constitutes a top surface of the frame **611**, and an opening **617***a* may be formed in the upper plate **617** so as to allow the deposition material **1115** that is vaporized in the deposition source **1110** to pass through the patterning slit sheet **150** and to be deposited on the substrate **500**. The elements of the frame **611** may be formed as separate members and may be subsequently connected to one another, or may be integrally formed as one body.

[0136] Although not shown, in one embodiment, the lower plate **613** on which the deposition source **1110** is disposed may be shaped as a cassette and may be removed from the frame **611**. Thus, the deposition source **1110** may be easily replaced.

[0137] In one embodiment, the sheet supporting member **615** may protrude from an inside of the frame **611** and may support the patterning slit sheet **150**. In one embodiment, the sheet support **615** may form or guide a flow path of the deposition material **1115** such that the deposition material **1115** discharged through the deposition source nozzles **1121** is not dispersed outside the flow path.

[0138] As described above, the deposition process is performed while the electrostatic chuck **600** on which the substrate **500** is disposed moves (e.g., moves linearly) within the chamber. In one embodiment, a device, such as a roller or a conveyor, may be used. In one embodiment, a linear motion system including the guide rail **623** and the guide block **625** may be used to transfer the substrate **500** precisely.

[0139] In one embodiment, the guide supporting member **621** disposed on the upper plate **617** and the pair of guide rails **623** disposed on the guide supporting member **621** are installed through the chamber **731** of the deposition unit **730**.

[0140] A top surface of the guide supporting member **621** may be an approximately flat plane, and the pair of guide rails **623** are disposed on the top surface of the guide supporting member **621**. A guide block **625** is inserted in the guide rails **623** and makes a reciprocating motion along the guide rails **623**.

[0141] The guide block **625** may include a driving unit (not shown). The driving unit (not shown) allows the guide block **625** to move along the guide rails **623**. The driving unit (not shown) may itself provide a driving force or may transfer a driving force from an additional driving source to the guide block **625**.

[0142] In one embodiment, the guide rails **623** may be linear motion (LM) rails, and the guide block **625** may be a LM block, and the guide rails **623** and the guide block **625** may constitute a predetermined LM system. The LM system is a transfer system having a very high degree of position determination and has a relatively small coefficient of friction and small position error compared to a conventional sliding guide system. A detailed description of the LM system will not be provided herein.

[0143] As described above, according to embodiments of the present invention, a mask is formed to be smaller than a substrate, and deposition is performed while the mask is moved relative to the substrate. Thus, the mask can be easily manufactured. In addition, defects caused due to contact between a substrate and a FMM, which occurs in the conventional deposition method, may be prevented or substantially prevented. Furthermore, since it is unnecessary to dispose an FMM in close contact with the substrate, as in a conventional deposition process, the manufacturing time may be reduced according to embodiments of the present invention.

[0144] According to an embodiment of the present invention, the deposition source **1110**, the deposition source nozzle unit **1120**, and the patterning slit sheet **150** of the organic layer deposition assembly **1100** are not integrally formed as one body but may be formed as separate members within the deposition unit **730**. According to the above structure, the deposition source **1110** may be easily inserted or removed so as to fill the deposition material **1115**, or the patterning slit sheet **150** may be easily inserted or removed so as to clean or replace the blocking member **160**.

[0145] FIG. **11** is a schematic cross-sectional view of an active matrix organic light-emitting display apparatus **10** manufactured by using an organic layer deposition apparatus, according to an embodiment of the present invention.

[0146] Referring to FIG. **11**, the active matrix organic light-emitting display apparatus **10** according to an embodiment of the present invention is formed on a substrate **30**. The substrate **30** may be formed of a transparent material, such as glass, plastic, or metal, for example. An insulating layer **31**, such as a buffer layer, may be formed on an entire surface of the substrate **30**.

[0147] In one embodiment, a thin film transistor (TFT) **40**, a capacitor **50**, and an organic light-emitting diode (OLED) **60** are disposed on the insulating layer **31**, as illustrated in FIG. **11**.

[0148] In one embodiment, a semiconductor active layer **41** is formed on an upper surface of the insulating layer **31** in a predetermined pattern, and a gate insulating layer **32** is formed to cover the semiconductor active layer **41**. The semiconductor active layer **41** may include a p-type or n-type semiconductor material.

[0149] A gate electrode **42** of the TFT **40** may be formed in a region of the gate insulating layer **32** corresponding to the semiconductor active layer **41**, and an interlayer insulating layer **33** may be formed to cover the gate electrode **42**. After the interlayer insulating layer **33** has been formed, the gate insulating layer **32** and the interlayer insulating layer **33** may be etched, for example (e.g., by dry etching), to form a contact hole exposing parts of the semiconductor active layer **41**.

[0150] Next, a source/drain electrode **43** is formed on the interlayer insulating layer **33** to contact the semiconductor active layer **41** through the contact hole. A passivation layer **34** may be formed to cover the source/drain electrode **43**, and may be etched to expose a part of the drain electrode **43**. An insulating layer (not shown) may be further formed on the passivation layer **34** so as to planarize the passivation layer **34**.

[0151] In addition, the OLED **60** displays predetermined image information by emitting red, green, or blue light as current flows. The OLED **60** includes a first electrode **61** disposed on the passivation layer **34**. The first electrode **61** is electrically connected to the drain electrode **43** of the TFT **40**.

[0152] A pixel defining layer **35** is formed to cover the first electrode **61**. In one embodiment, a predetermined opening is formed in the pixel defining layer **35**, and then an organic layer **63**, including an emission layer, is formed in a region defined by the opening. A second electrode **62** is formed on the organic layer **63**.

[0153] In one embodiment, the pixel defining layer **35**, which defines individual pixels, is formed of an organic material. The pixel defining layer **35** also planarizes the surface of

a region of the substrate **30** where the first electrode **61** is formed, and in particular, the surface of the passivation layer **34**.

[0154] The first electrode **61** and the second electrode **62** are insulated from each other, and respectively apply voltages of opposite polarities to the organic layer **63**, including the emission layer, to induce light emission.

[0155] The organic layer **63** 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 **63** may have a single or multi-layer structure including at least one selected from the group consisting of a hole injection layer (HIL), a hole transport layer (HTL), an emission layer (EML), an electron transport layer (ETL), and an electron injection layer (EIL). Examples of available organic materials may include copper phthalocyanine (CuPc), N,N'-di(naphthalene-1-yl)-N,N'-diphenyl-benzidine (NPB), tris-8-hydroxyquinoline aluminum (Alq3), and the like.

[0156] After the organic layer **63** is formed, the second electrode **62** may be formed by the same deposition method as used to form the organic emission layer **63**.

[0157] The first electrode **61** may function as an anode, and the second electrode **62** may function as a cathode. Alternatively, the first electrode **61** may function as a cathode, and the second electrode **62** may function as an anode. The first electrode **61** may be patterned to correspond to individual pixel regions, and the second electrode **62** may be formed to cover all the pixels.

[0158] The first electrode layer **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), for example. 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, for example, 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, such as by sputtering, for example, and then patterning the layer (e.g., by photolithography).

[0159] The second electrode **62** may also be formed as a transparent electrode or a reflective electrode. In one embodiment, when the second electrode **62** is formed as a transparent electrode, the second electrode **62** functions as a cathode. 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 **63** and forming an auxiliary electrode layer or a bus electrode line thereon from ITO, IZO, ZnO, In_2O_3, or the like.

[0160] In one embodiment, when the second electrode **62** 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 **63**. The second electrode **62** may be formed by using the same deposition method as used to form the organic layer **63** described above.

[0161] The organic layer deposition apparatus according to 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 materials.

[0162] As described above, in an organic layer deposition apparatus and a method of manufacturing an organic light-emitting display apparatus by using the organic layer deposition apparatus according to embodiments of the present invention, the organic layer deposition apparatus may be easily manufactured and may be simply applied to manufacture large-sized display apparatuses on a mass scale, and manufacturing yield and deposition efficiency may be improved.

[0163] While the present invention has been particularly shown and described with reference to some 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.

What is claimed is:

1. An organic layer deposition apparatus for forming an organic layer on a substrate, the apparatus comprising:
- a deposition source configured to discharge a deposition material;
- a deposition source nozzle unit arranged 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, the patterning slit sheet being smaller than the substrate in at least one of a first direction or a second direction perpendicular to the first direction;
- a blocking member configured to be disposed between the substrate and the deposition source to block at least a portion of the substrate; and
- a heating member on the blocking member and configured to heat the blocking member,
- wherein the substrate is spaced apart from the organic layer deposition apparatus by a predetermined distance, and at least one of the substrate or the organic layer deposition apparatus is movable relative to the other.

2. The apparatus of claim **1**, wherein the blocking member is shaped as an open mask.

3. The apparatus of claim **1**, wherein the blocking member is fixed on the deposition source.

4. The apparatus of claim **1**, wherein the blocking member is configured to block a non-layer-formation region of the substrate.

5. The apparatus of claim **1**, wherein the blocking member comprises a blocking member frame having a hollow window frame and an open mask sheet being thin and disposed inside the blocking member frame.

6. The apparatus of claim **5**, wherein the blocking member frame and the open mask sheet are integrally formed as one body.

7. The apparatus of claim **5**, wherein the heating member is accommodated in the blocking member frame.

8. The apparatus of claim **5**, wherein the heating member heats the blocking member frame and transfers heat applied to the blocking member frame to the open mask sheet.

9. The apparatus of claim **1**, wherein the heating member is configured to heat the blocking member such that the deposition material is not deposited on the blocking member.

10. The apparatus of claim **9**, wherein the heating member is configured to heat the blocking member at a greater temperature than a temperature at which the deposition material is vaporized.

11. The apparatus of claim **1**, wherein the heating member comprises a coil heater or a thin layer heater.

12. The apparatus of claim **1**, wherein deposition source nozzles of the plurality of deposition source nozzles are arranged in the first direction, and patterning slits of the plurality of patterning slits are arranged in the second direction.

13. The apparatus of claim **12**, wherein the deposition source and the deposition source nozzle unit are connected to the patterning slit sheet by a connection member.

14. The apparatus of claim **13**, wherein the connection member forms a flow path of the deposition material.

15. The apparatus of claim **14**, wherein the connection member seals a space between the deposition source nozzle unit and the patterning slit sheet.

16. The apparatus of claim **12**, wherein deposition source nozzles of the plurality of deposition source nozzles are tilted at a predetermined angle.

17. The apparatus of claim **16**, wherein the plurality of deposition source nozzles comprises deposition source nozzles arranged in two rows extending in the first direction, and the deposition source nozzles in the two rows are tilted toward each other.

18. The apparatus of claim **16**, wherein the plurality of deposition source nozzles comprises deposition source nozzles arranged in two rows extending in the first direction, and the deposition source nozzles of a row located at a first side of the patterning slit sheet are arranged to face a second side of the patterning slit sheet, and the deposition source nozzles of the other row located at the second side of the patterning slit sheet are arranged to face the first side of the patterning slit sheet.

19. The apparatus of claim **1**,

wherein deposition source nozzles of the plurality of deposition source nozzles are arranged in the first direction, and patterning slits of the plurality of patterning slits are arranged in the first direction, and

wherein the organic layer deposition apparatus further comprises a barrier plate assembly comprising a plurality of barrier plates arranged between the deposition source nozzle unit and the patterning slit sheet in the first direction and partitioning a space between the deposition source nozzle unit and the patterning slit sheet into a plurality of sub-deposition spaces.

20. The apparatus of claim **19**, wherein barrier plates of the plurality of barrier plates extend in the second direction.

21. The apparatus of claim **19**, wherein the barrier plate assembly comprises a first barrier plate assembly comprising a plurality of first barrier plates, and a second barrier plate assembly comprising a plurality of second barrier plates.

22. The apparatus of claim **21**, wherein each of the plurality of first barrier plates and each of the second barrier plates extend in the second direction and partition the space between the deposition source nozzle unit and the patterning slit sheet into the plurality of sub-deposition spaces.

23. The apparatus of claim **1**, further comprising a chamber, wherein deposition source nozzles of the plurality of deposition source nozzles are arranged in the first direction, the patterning slit sheet is bound inside the chamber, and patterning slits of the plurality of patterning slits are arranged in the second direction.

24. The apparatus of claim **23**, further comprising a first conveyor unit configured to move an electrostatic chuck on which the substrate is disposed along the first direction.

25. The apparatus of claim **24**, wherein the first conveyor unit comprises:

a frame in which the deposition source is accommodated; and

a sheet supporting member protruding from an inside of the frame and supporting the patterning slit sheet.

26. The apparatus of claim **24**, further comprising:

a loading unit configured to fix the substrate to the electrostatic chuck; and

an unloading unit configured to separate the substrate on which the deposition material has been deposited from the electrostatic chuck.

27. An organic light-emitting display apparatus manufactured by using the organic layer deposition apparatus of claim **1**.

28. A method of manufacturing an organic light-emitting display apparatus using an organic layer deposition apparatus including a deposition source, a deposition source nozzle unit arranged 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, a blocking member, and a heating member on the blocking member, the method comprising:

spacing a substrate which constitutes a target on which the deposition material is to be deposited apart from the organic layer deposition apparatus by a predetermined distance, the blocking member being between the substrate and the deposition source and blocking at least a portion of the substrate, the patterning slit sheet being smaller than the substrate in at least one of a first direction or a second direction perpendicular to the first direction;

heating the blocking member using the heating member;

discharging a deposition material from the organic layer deposition apparatus;

depositing the deposition material onto the substrate while moving at least one of the organic layer deposition apparatus or the substrate relative to the other.

29. The method of claim **28**, wherein the blocking member is shaped as an open mask.

30. The method of claim **28**, wherein the blocking member is fixed on the deposition source.

31. The method of claim **28**, wherein the blocking member blocks a non-layer-formation region of the substrate.

32. The method of claim **28**, wherein the blocking member comprises a blocking member frame having a hollow window frame and an open mask sheet being thin and disposed inside the blocking member frame.

33. The method of claim **32**, wherein the blocking member frame and the open mask sheet are integrally formed as one body.

34. The method of claim **32**, wherein the heating member is accommodated in the blocking member frame.

35. The method of claim **32**, wherein the blocking member frame is heated using the heating member, and heat applied to the blocking member frame is transferred to the open mask sheet.

36. The method of claim **28**, wherein heating the blocking member comprises heating the blocking member such that the deposition material is not deposited on the blocking member.

37. The method of claim **36**, wherein heating the blocking member comprises heating the blocking member at a greater temperature than a temperature at which the deposition material is vaporized.

38. The method of claim **28**, wherein the heating member comprises a coil heater or a thin layer heater.

39. The method of claim **28**, wherein deposition source nozzles of the plurality of deposition source nozzles are arranged in the first direction, and patterning slits of the plurality of patterning slits are arranged in the second direction.

40. The method of claim **28**,

wherein deposition source nozzles of the plurality of deposition source nozzles are arranged in the first direction, and patterning slits of the plurality of patterning slits are arranged in the first direction, and

wherein the organic layer deposition apparatus further includes a barrier plate assembly comprising a plurality of barrier plates arranged between the deposition source nozzle unit and the patterning slit sheet in the first direction and partitioning a space between the deposition source nozzle unit and the patterning slit sheet into a plurality of sub-deposition spaces.

41. The method of claim **28**,

wherein the organic layer deposition apparatus further includes a chamber, and the patterning slit sheet is bound inside the chamber, and

wherein deposition source nozzles of the plurality of deposition source nozzles are arranged in the first direction, and patterning slits of the plurality of patterning slits are arranged in the second direction.

* * * * *

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摘要(译)

一种有机层沉积设备，包括：沉积源，配置为排出沉积材料;沉积源喷嘴单元，设置在沉积源的一侧并包括多个沉积源喷嘴;图案化缝隙片面向沉积源喷嘴单元并包括多个图案化缝隙，图案化缝隙片在垂直于第一方向的第一方向或第二方向中的至少一个方向上小于基板;阻挡构件，被配置为设置在基板和沉积源之间，以阻挡基板的至少一部分;阻挡构件上的加热构件，用于加热阻挡构件，基板与有机层沉积装置隔开预定距离，基板或有机层沉积装置可相对于另一个移动。