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(54) **ORGANIC LIGHT EMITTING DISPLAY APPARATUS AND METHOD FOR MANUFACTURING THE SAME**

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USPC **257/40**; 438/34

(57) **ABSTRACT**

An organic light emitting display apparatus includes a plurality of first electrodes disposed in each of a plurality of pixels on a substrate, a plurality of lower auxiliary electrodes insulated from the first electrodes and in which the lower auxiliary electrodes are disposed in a first direction, an organic layer disposed on the first electrodes, and a second electrode facing the first electrodes and covering the organic layer. The second electrode is disposed on substantially an entire surface of the substrate. The organic light emitting display apparatus further includes a plurality of upper auxiliary electrodes disposed on the second electrode in a second direction.

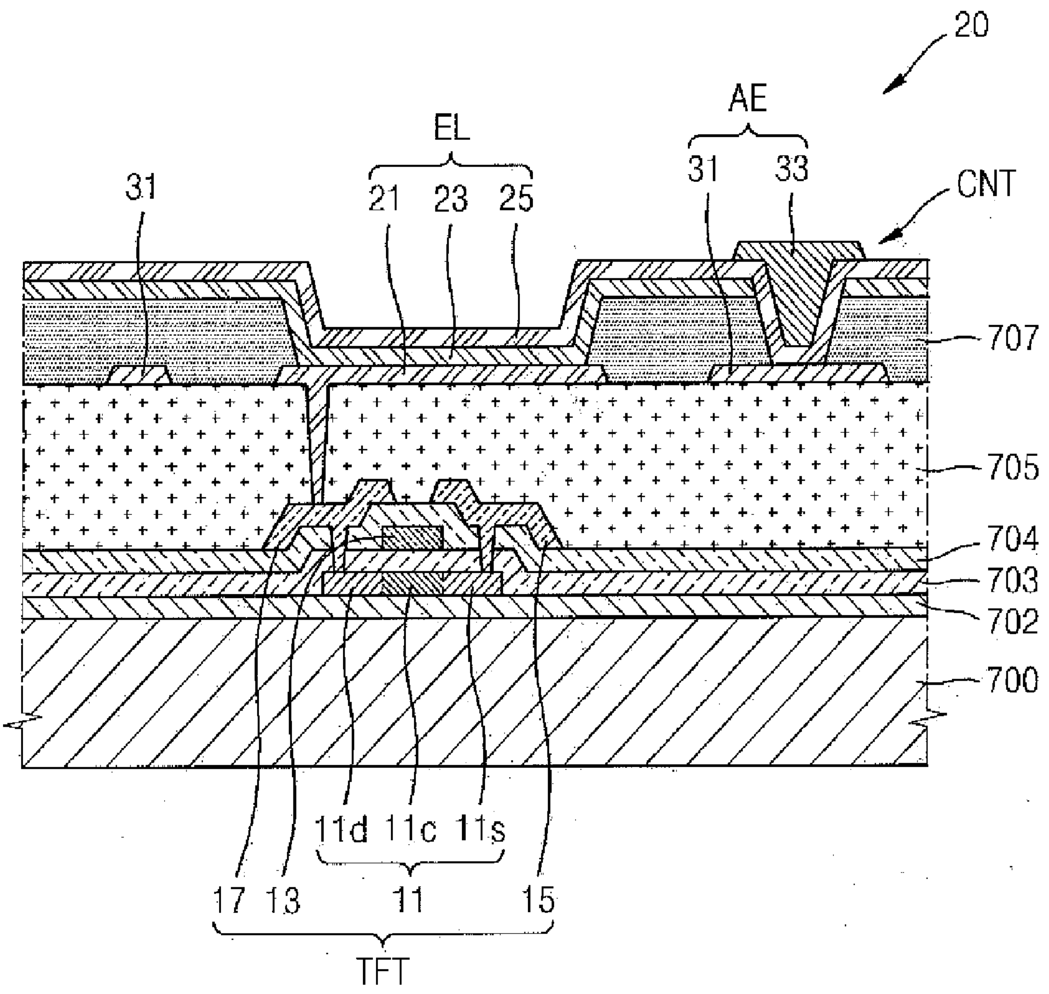


FIG. 1

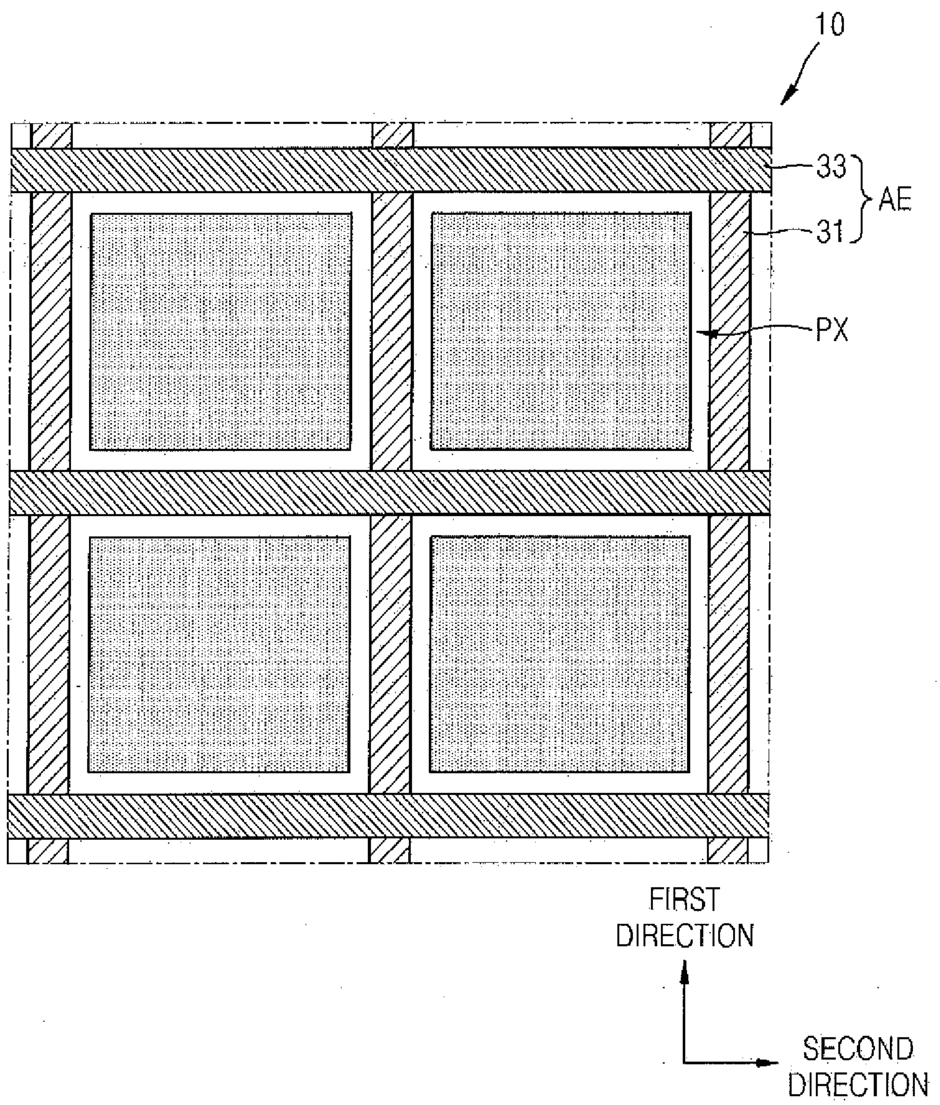


FIG. 2

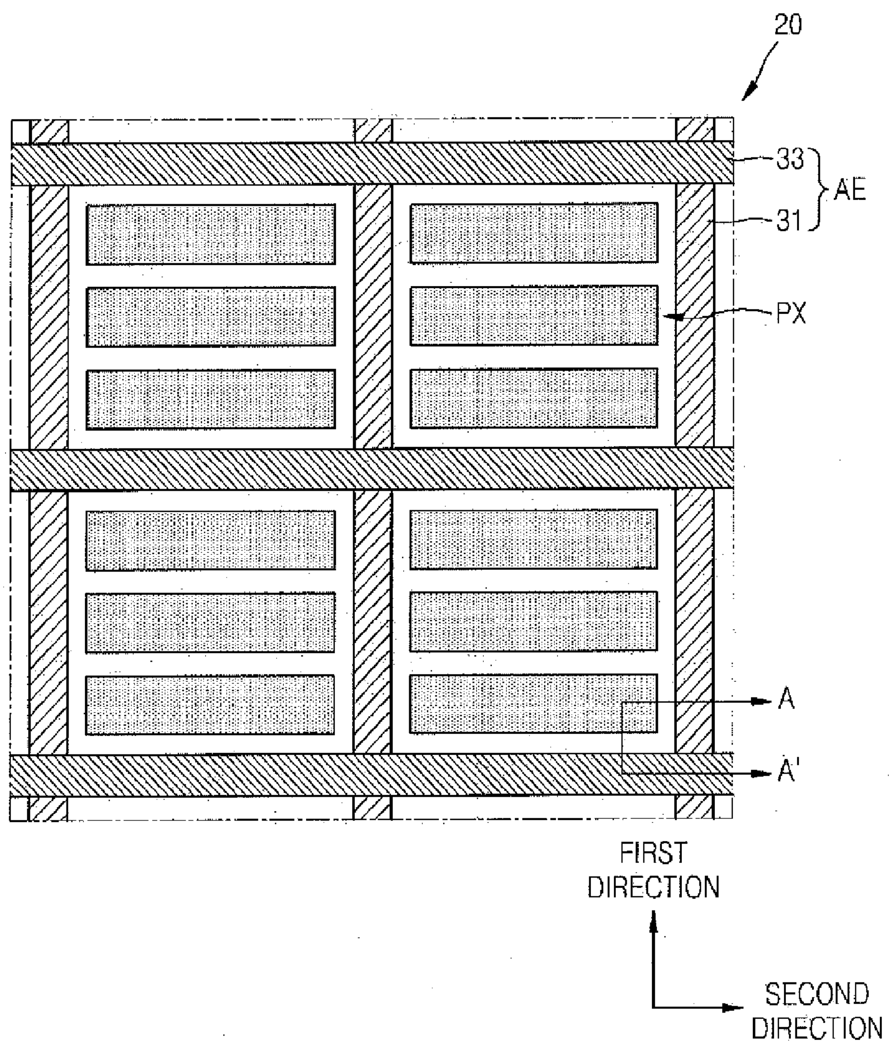


FIG. 3

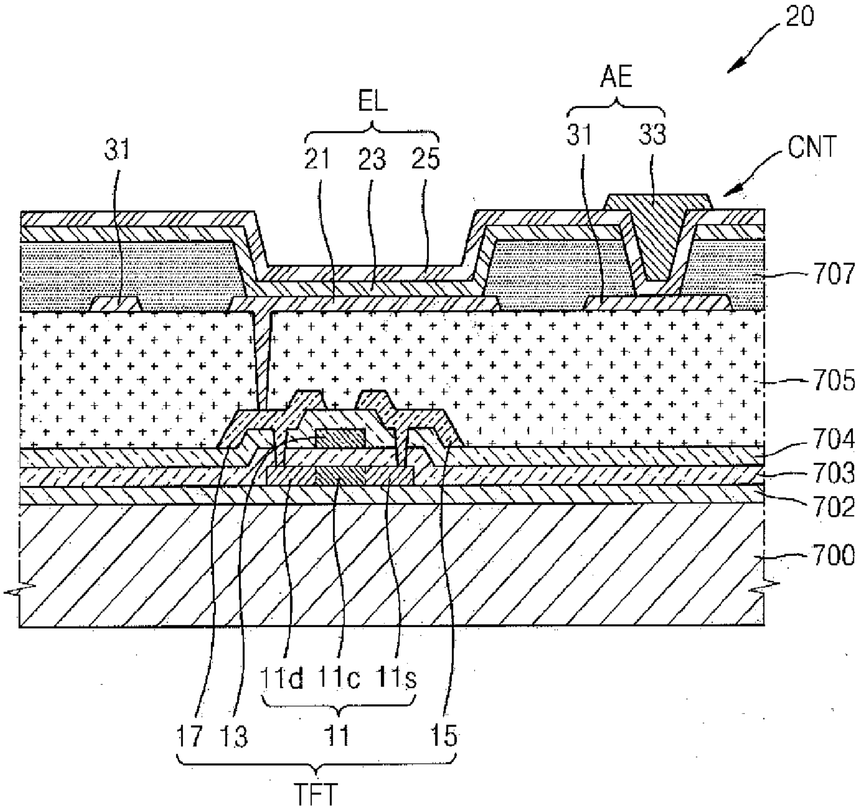

20
AE
EL
31
33
CNT
31
21
23
25
707
705
704
703
702
700
11d
11c
11s
17
13
11
15
TFT

FIG. 4

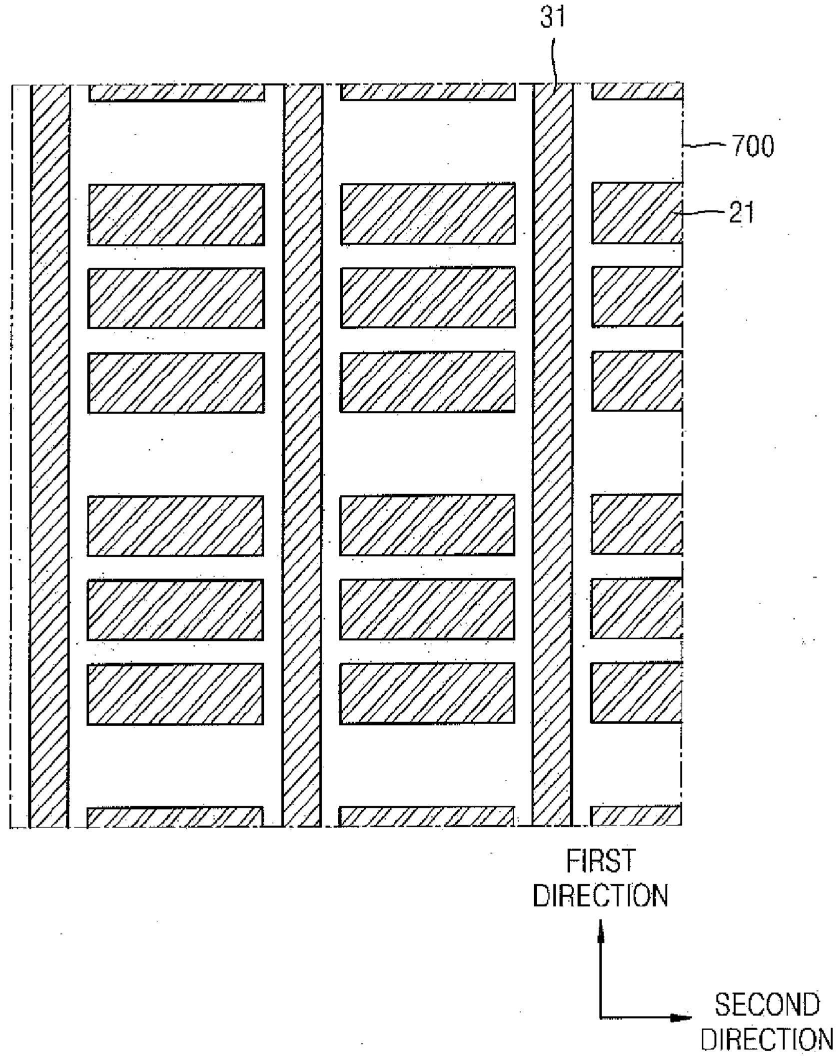


FIG. 5

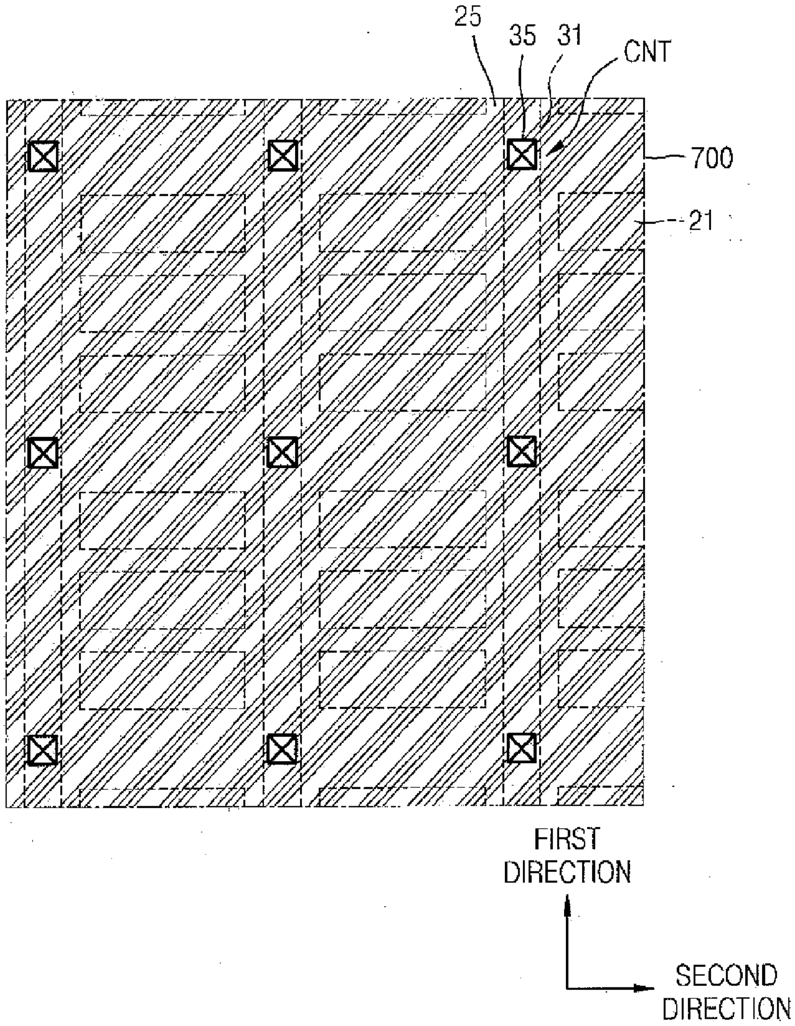


FIG. 6

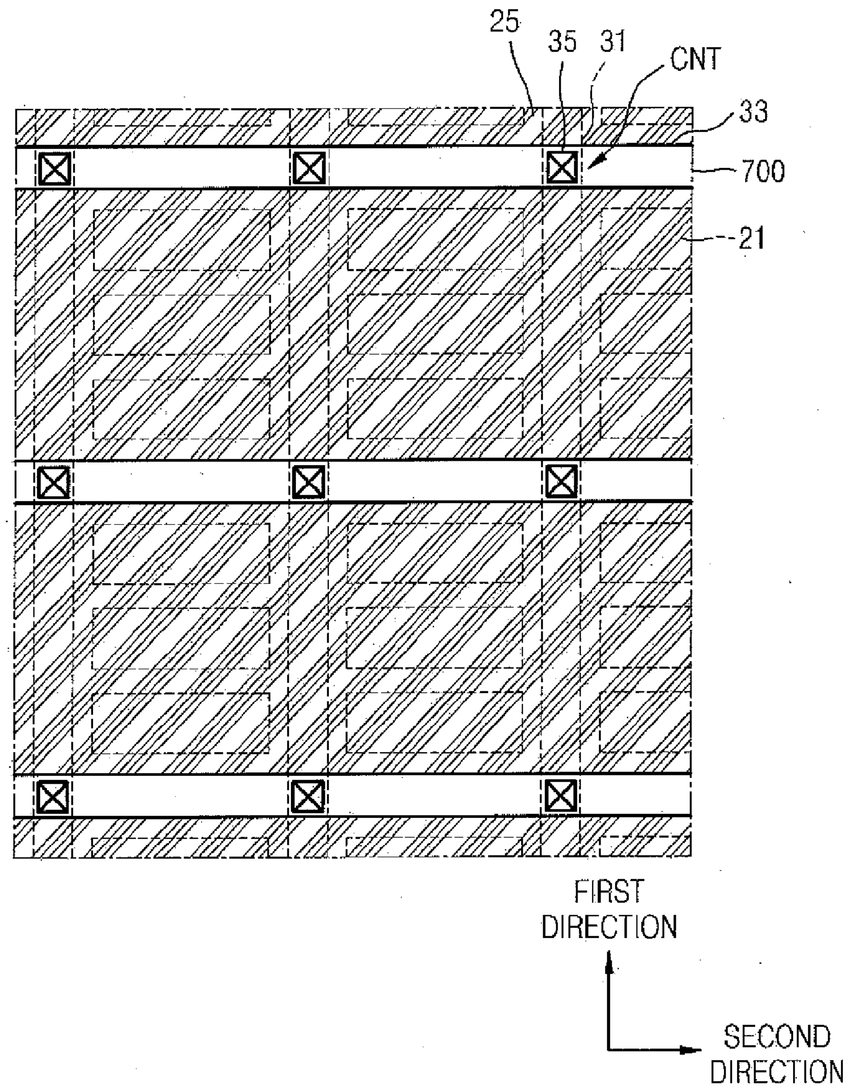


FIG. 7

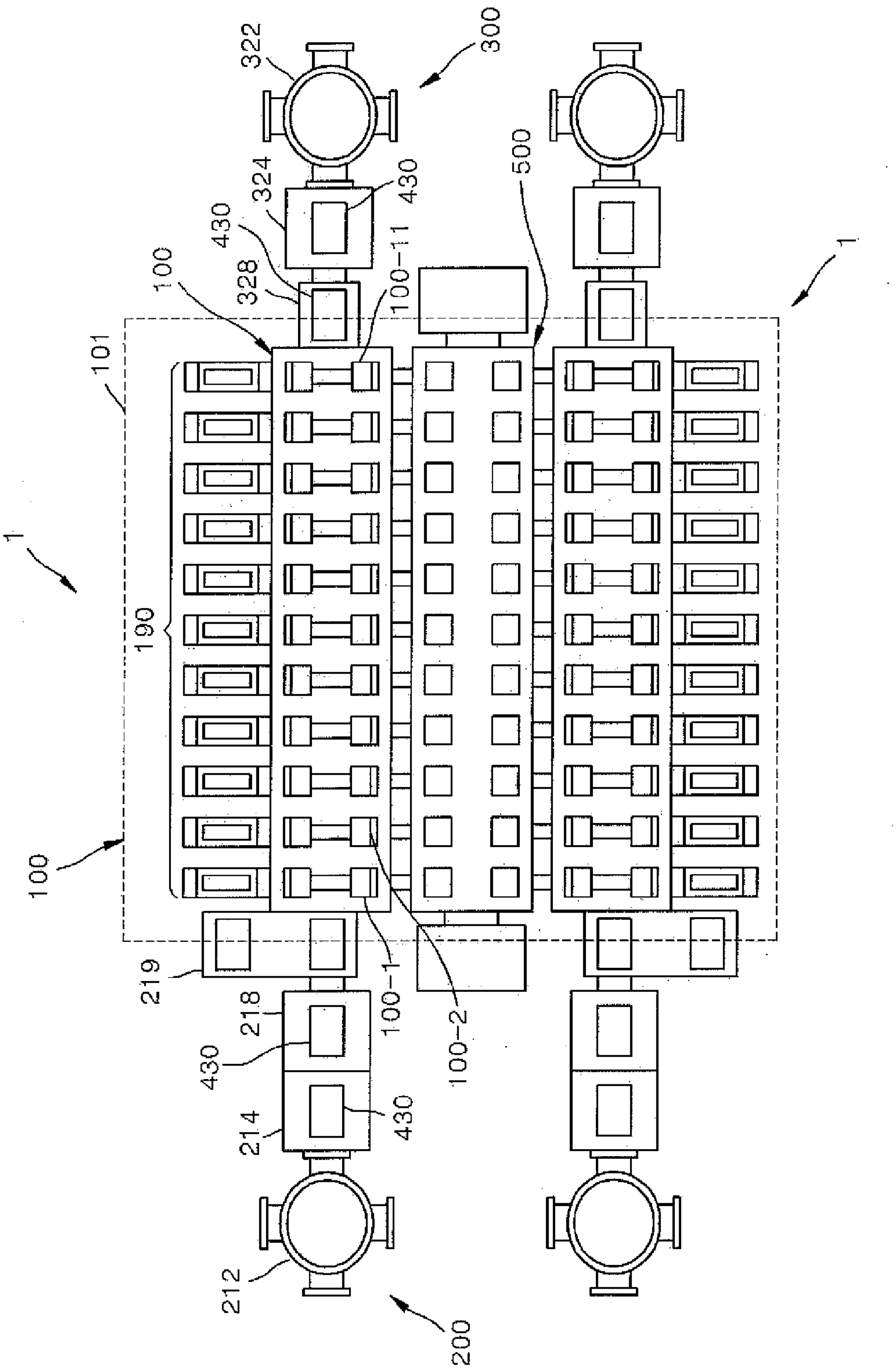

322
300
500
324
430
430
328
100
100-11
1
101
1
190
100
219
218
100-1
100-2
430
214
430
212
200

FIG. 8

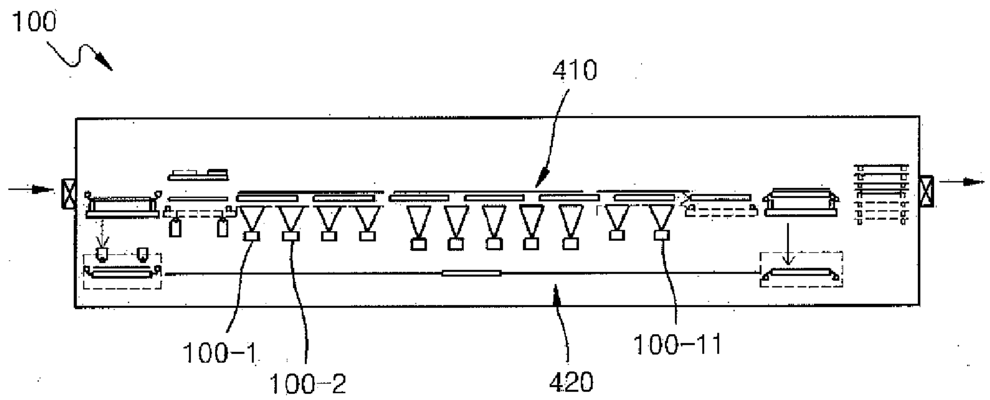


FIG. 9

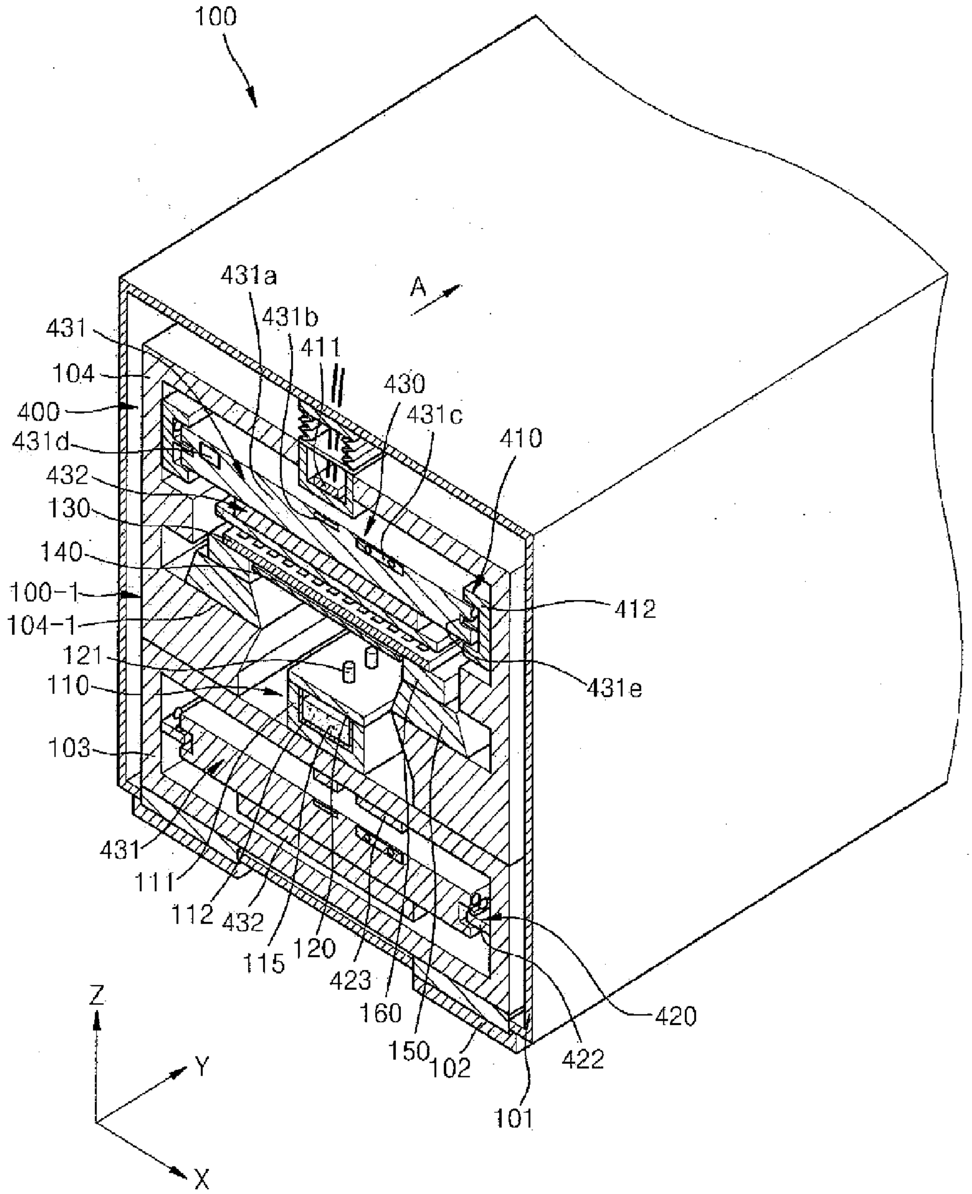
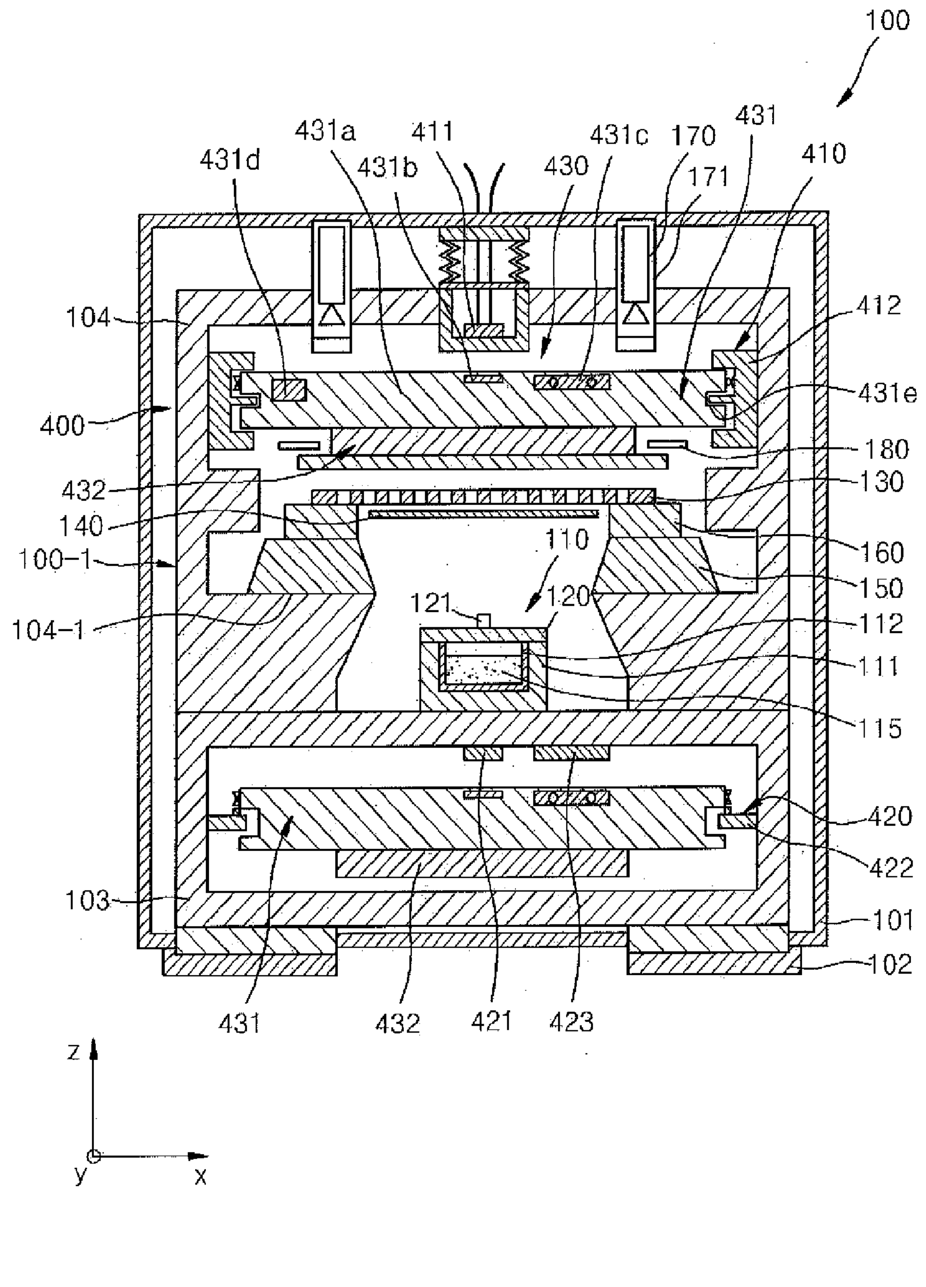

100
431a
A
431b
431
411
104
430
400
431c
431d
410
432
130
140
412
100-1
104-1
121
431e
110
103
431
111
112
432
115
120
423
160
150
102
422
420
101
Z
Y
X

FIG. 10


100
431a
411
431d
431b
430
431c
170
431
171
410
104
412
431e
400
180
432
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100-1
110
150
121
120
104-1
112
111
115
420
422
103
101
102
431
432
421
423
z
y
x

FIG. 11

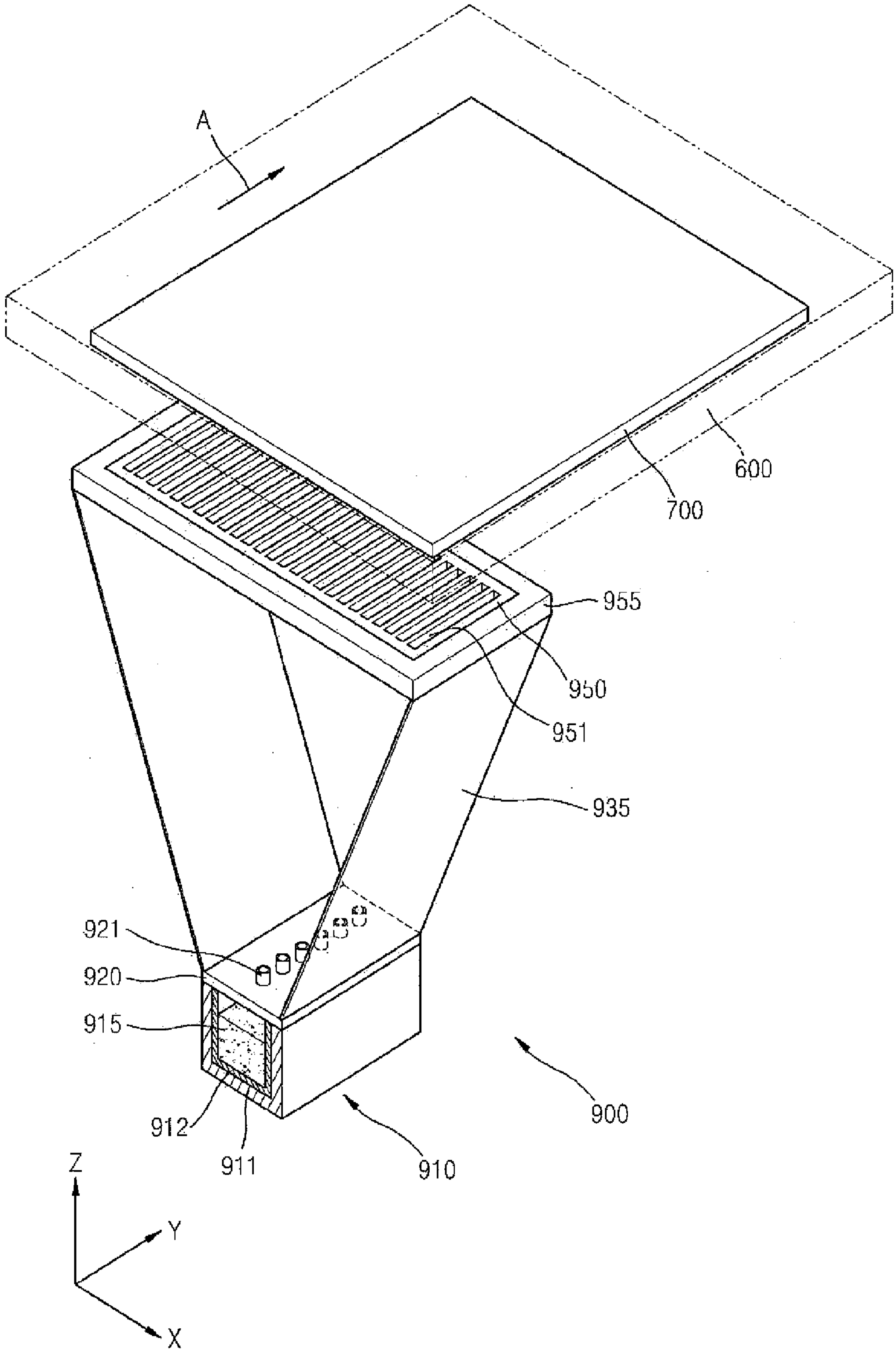
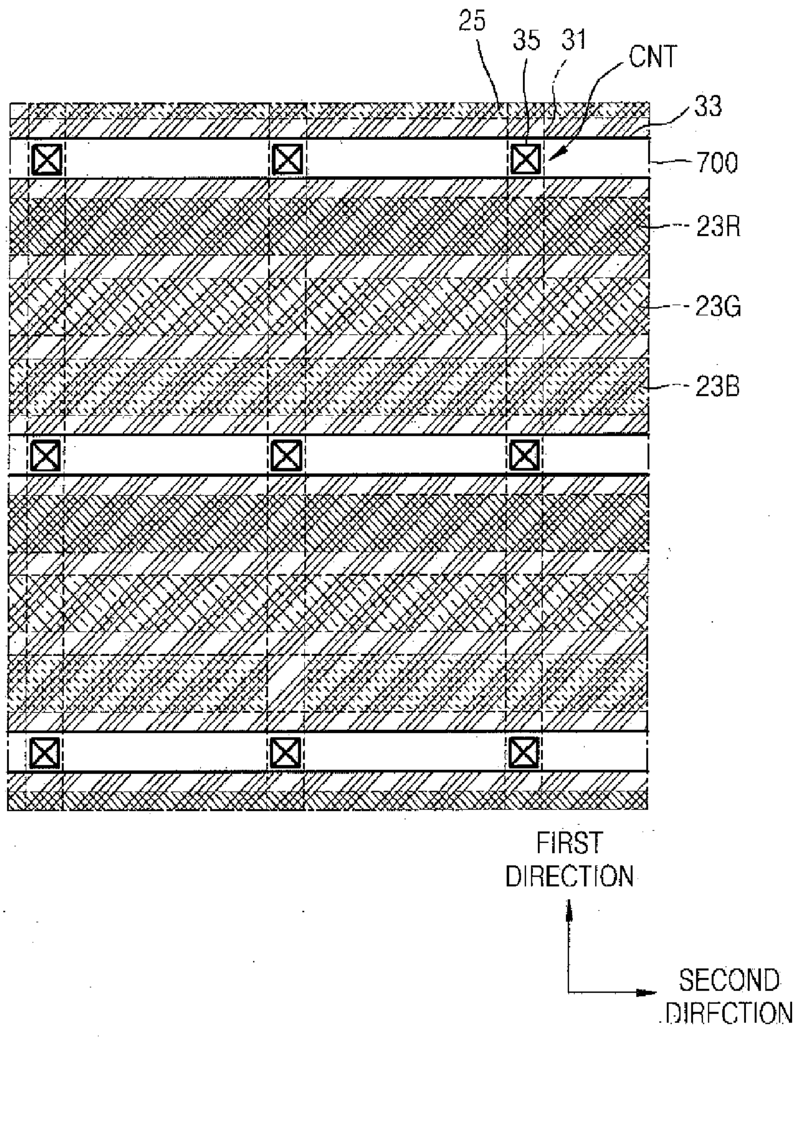


FIG. 12


25
35
31
CNT
33
700
23R
23G
23B
FIRST DIRECTION
SECOND DIRECTION

ORGANIC LIGHT EMITTING DISPLAY APPARATUS AND METHOD FOR MANUFACTURING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to Korean Patent Application No. 10-2013-0086259, filed on Jul. 22, 2013, the disclosure of which is hereby incorporated by reference herein in its entirety.

1. TECHNICAL FIELD

[0002] Exemplary embodiments of the present invention relate to an organic light emitting display apparatus and a method for manufacturing the same.

2. DISCUSSION OF THE RELATED ART

[0003] Organic light emitting display apparatuses may 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 apparatus.

[0004] Such an organic light emitting display apparatus includes an organic layer including an emissive layer between first and second electrodes that are opposite to each other. The second electrode may serve as a common electrode, which should apply the same voltage to all pixels. However, different levels of voltages may be applied to the pixels according to positions of the pixels due to voltage drop (e.g., IR drop) caused by high resistivity of the second electrode.

[0005] Particularly, in top-emission type organic light emitting display apparatuses, the second electrode may function as a transmitting layer. Thus, the second electrode may be formed of a transparent material having high resistivity and a thin thickness to increase light transmittance. As a result, the voltage drop in the second electrode may increase due to the high resistivity. Particularly, in case of large-sized top-emission type organic light emitting display apparatuses, the voltage drop in the second electrode may be more intensified to cause non-uniformity in image quality and characteristics in the display apparatuses.

SUMMARY

[0006] Exemplary embodiments of the present invention include an organic light emitting display apparatus that is suitable for use in the mass production of a large substrate and reduces voltage drop in a second electrode while giving benefits of top emission.

[0007] According to an embodiment of the present invention, an organic light emitting display apparatus includes: a plurality of first electrodes disposed in each of a plurality of pixels on a substrate, a plurality of lower auxiliary electrodes insulated from the first electrodes, and in which the lower auxiliary electrodes are disposed in a first direction, an organic layer disposed on the first electrodes, and a second electrode facing the first electrodes and covering the organic layer. The second electrode is disposed on substantially an entire surface of the substrate. In addition, the organic light emitting display apparatus further includes a plurality of upper auxiliary electrodes disposed on the second electrode in a second direction.

[0008] The second direction may be perpendicular to the first direction.

[0009] The lower auxiliary electrodes may be disposed in a line shape in the first direction, and the upper auxiliary electrodes may be disposed in a line shape in the second direction to cross the lower auxiliary electrodes.

[0010] The lower auxiliary electrodes may contact the second electrode in a region in which the lower auxiliary electrodes cross the upper auxiliary electrodes.

[0011] The lower auxiliary electrodes may be disposed on a same layer as the first electrodes.

[0012] The organic light emitting display apparatus may further include a pixel define layer disposed between the first electrodes, and the second electrode may contact each of the lower auxiliary electrodes through a contact hole in the pixel define layer.

[0013] The organic layer may be a plurality of organic layers disposed on the first electrodes in a line shape, and the lower auxiliary electrodes may be disposed in a line shape in a direction crossing the organic layers, and the upper auxiliary electrodes may be disposed in a line shape between the organic layers adjacent to each other.

[0014] According to an embodiment of the present invention, an organic light emitting display apparatus includes: a plurality of pixels each including a first electrode, a second electrode opposite to the first electrode, and an organic layer disposed between the first and second electrodes, a plurality of lower auxiliary electrodes disposed under the second electrode and contacting the second electrode, and in which the lower auxiliary electrodes are disposed between at least one pixel column. The organic light emitting display further includes a plurality of upper auxiliary electrodes disposed on the second electrode and contacting the second electrode. The upper auxiliary electrodes are disposed between at least one pixel row.

[0015] The lower auxiliary electrodes may be disposed in a line shape between the at least one pixel column, and the upper auxiliary electrodes may cross the lower auxiliary electrodes and be disposed in a line shape between the at least one pixel row.

[0016] The lower auxiliary electrodes may be disposed on a same layer as the first electrode, and the second electrode may contact each of the lower auxiliary electrodes through a contact hole in an insulating layer that is disposed on the first electrode and the lower auxiliary electrodes.

[0017] According to an embodiment of the present invention, a method for manufacturing an organic light emitting display apparatus includes: forming a plurality of first electrodes in each of a plurality of pixels on a substrate, forming a plurality of lower auxiliary electrodes insulated from the first electrodes and in a first direction, forming a plurality of organic layers on the first electrodes, forming a second electrode facing the first electrodes and covering the organic layer on substantially an entire surface of the substrate, and forming a plurality of upper auxiliary electrodes on the second electrode in a second direction.

[0018] The second direction may be perpendicular to the first direction.

[0019] The lower auxiliary electrodes may be disposed in a line shape in the first direction, and the upper auxiliary electrodes may be disposed in a line shape in the second direction and cross the lower auxiliary electrodes.

[0020] The lower auxiliary electrodes may contact the second electrode in a region in which the lower auxiliary electrodes cross the upper auxiliary electrodes.

[0021] The lower auxiliary electrodes may be disposed on a same layer as the first electrodes.

[0022] The method may further include forming a pixel define layer between the first electrodes, and the second electrode may contact each of the lower auxiliary electrodes through a contact hole in the pixel define layer.

[0023] The forming of the organic layers may include continuously forming organic layers on the first electrodes, in which the forming of the lower auxiliary electrodes may include forming the lower auxiliary electrodes in a line shape in a direction crossing the organic layers, and the forming of the upper auxiliary electrodes may include forming the upper auxiliary electrodes in a line shape between the organic layers adjacent to each other.

[0024] The forming of the organic layers may include: disposing the substrate so that the substrate is spaced a distance from an organic layer deposition apparatus, and patterning a deposition material sprayed from the organic layer deposition apparatus on the substrate through a pattern slit sheet to form the organic layers while one of the organic layer deposition apparatus and the substrate is moved with respect to the pattern slit sheet.

[0025] The forming of the lower auxiliary electrodes may include patterning a deposition material sprayed from the organic layer deposition apparatus on the substrate through a pattern slit sheet to form the lower auxiliary electrodes while one of the organic layer deposition apparatus and the substrate is moved with respect to the pattern slit sheet.

[0026] The forming of the upper auxiliary electrodes nay include: rotating the substrate in a vertical direction, and patterning a deposition material sprayed from the organic layer deposition apparatus on the substrate through a pattern slit sheet to form the upper auxiliary electrodes while one of the organic layer deposition apparatus and the substrate is moved with respect to the pattern slit sheet.

[0027] In accordance with an exemplary embodiment of the present invention, an organic light emitting display apparatus is provided. The organic light emitting display apparatus includes a substrate, an auxiliary layer disposed on the substrate which is configured to prevent impurities from penetrating into the substrate, and a thin film transistor (TFT) disposed on the auxiliary layer.

[0028] The TFT includes an active layer, a gate electrode disposed on the active layer, wherein the active layer includes a source region and a drain region corresponding to opposing sides of the gate electrode and a channel region disposed between the source and drain regions, and a source electrode and a drain electrode disposed on the gate electrode.

[0029] In addition, the organic light emitting display apparatus further includes a first insulating layer disposed between the gate electrode and the active layer, a second insulating layer disposed between the gate electrode and the source and drain electrodes, a third insulating layer disposed on the second insulating layer and the source and drain electrodes of the TFT, a light emitting device disposed on the third insulating layer above the TFT and including a first electrode electrically connected to one of the source and drain electrodes of the TFT, a second electrode facing the first electrode, and an organic layer disposed between the first electrode and the second electrode, a fourth insulating layer covering an edge region of the first electrode and an auxiliary electrode disposed around the light emitting device in a mesh shape. The auxiliary electrode includes a plurality of lower auxiliary electrodes disposed on a same layer as the first electrode in a first direction and which are insulated from the first electrode and a plurality of upper auxiliary electrodes disposed above the lower auxiliary electrodes in a second direction perpendicular to the first direction and contacting the second electrode. The second electrode contacts an upper portion of the lower auxiliary electrodes exposed through a contact unit in the fourth insulating layer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] Exemplary embodiments of the present invention can be understood in more detail from the following detailed description, taken in conjunction with the accompanying drawings in which:

[0031] FIGS. **1** and **2** are schematic cross-sectional views of an organic light emitting display apparatus according to an embodiment of the present invention;

[0032] FIG. **3** is a cross-sectional view taken along line A-A' of FIG. **2**;

[0033] FIGS. **4** to **6** are views illustrating a method for manufacturing an organic light emitting display apparatus according to an embodiment of the present invention;

[0034] FIG. **7** is a schematic plan view of an organic layer deposition apparatus according to an embodiment of the present invention;

[0035] FIG. **8** is a schematic side view illustrating a deposition unit of the organic layer deposition apparatus of FIG. **7**;

[0036] FIG. **9** is a schematic perspective view of the deposition unit of FIG. **7**;

[0037] FIG. **10** is a schematic cross-sectional view of the deposition unit of FIG. **9**;

[0038] FIG. **11** is a schematic perspective view of an organic layer deposition assembly according to act embodiment of the present invention; and

[0039] FIG. **12** is a view illustrating a method for manufacturing an organic light emitting display apparatus by using the organic layer deposition apparatus of FIGS. **7** to **11**.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0040] Hereinafter, exemplary embodiments of the present invention will be described in detail by explaining exemplary embodiments of the invention with reference to the attached drawings. Exemplary embodiments of the invention may, however, be embodied in many different forms and should not be construed as being limited to exemplary embodiments set forth herein.

[0041] It will be understood that although the terms of first and second are used herein to describe various elements, these elements should not be limited by these terms. Terms are only used to distinguish one component from other components.

[0042] The terms of a singular form may include plural forms unless referred to the contrary. The meaning of 'include' or 'comprise' specifies a property, a region, a fixed number, a step, a process, an element and/or a component but does not exclude other properties, regions, fixed numbers, steps, processes, elements and/or components.

[0043] As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

[0044] Exemplary embodiments of the present invention will now be described in detail with reference to the accompanying drawings.

[0045] FIGS. **1** and **2** are schematic cross-sectional views of an organic light emitting display apparatus according to an embodiment of the present invention.

[0046] Referring to FIGS. **1** and **2**, each of organic light emitting display apparatuses **10** and **20** may include, for example, a plurality of pixels PX that are arranged on a substrate in a matrix form in a first direction and a second direction perpendicular to the first direction. However, the pixel arrangement according to an embodiment of the present invention is not limited to the above-described structure. For example, the pixels PX are dislocated with various patterns such as a zigzag pattern. Each of the pixels PX may emit a single color such as, for example, one color of red, blue, green, and white colors. However, embodiments of the present invention are not limited thereto. For example, the pixels PX may emit other colors in addition to the red, blue, green, and white colors. The pixel PX may include, for example, a driving circuit and a light emitting device that is connected to the driving circuit to emit light. The driving circuit may include, for example, at least one thin film transistor and capacitor. The light emitting device may include, for example, a first electrode, a second electrode facing the first electrode, and an organic layer including an emissive layer between the first and second electrodes.

[0047] Auxiliary electrodes AE which are spaced apart and insulated from the first electrode may be disposed around the pixel PX. In a case of a top-emission type organic light emitting display apparatus, as light should be emitted toward the second electrode, and light transmittance should be maintained at a predetermined level or more, the second electrode may have a thin thickness. For example, in a case of a metal, a layer thickness and resistance are in inverse proportion to each other. Thus, when the top-emission type organic light emitting display apparatus is manufactured, a voltage drop may occur due to resistance of the second electrode. To solve this limitation, the auxiliary electrodes AE may be provided. The auxiliary electrodes AE may include, for example, a lower auxiliary electrode **31** and an upper auxiliary electrode **33**.

[0048] The lower auxiliary electrode **31** may be provided in, for example, a line shape between at least one pixel column in one direction of the first and second directions. The upper auxiliary electrode **33** may be provided in, for example, a line shape between at least one pixel row in a direction which is perpendicular to the direction of the lower auxiliary electrode **31**. FIG. **1** illustrates the lower auxiliary electrode **31** disposed in the first direction and the upper auxiliary electrode **33** disposed in the second direction which is perpendicular to the first direction. A second electrode of the light emitting device may be disposed between the lower auxiliary electrode **31** and the upper auxiliary electrode **33** to electrically connect the second electrode, the lower auxiliary electrode **31**, and the upper auxiliary electrode **33** to each other.

[0049] In the organic light emitting display apparatus **10** of FIG. **1**, the lower auxiliary electrode **31** is disposed between unit pixels PX, e.g., the pixel columns in the first direction, and the upper auxiliary electrode **33** is disposed between the unit pixels PX, e.g., the pixel rows in the second direction. On the other hand, in the organic light emitting display apparatus **20** of FIG. **2**, the lower auxiliary electrode **31** is disposed between three unit pixels PX, e.g., the pixel columns in the first direction, and the upper auxiliary electrode **33** is disposed between three pixel rows in the second direction.

[0050] An embodiment of the present invention is not limited to the arrangement of the auxiliary electrodes AE illustrated in FIGS. **1** and **2**. For example, an arrangement distance between the lower auxiliary electrodes **31** and an arrangement distance between the upper auxiliary electrodes **33** may be variously determined.

[0051] FIG. **3** is a cross-sectional view taken along line A-A' of FIG. **2**.

[0052] The cross-sectional view of FIG. **3** may be equally applied to the organic light emitting display apparatus **10** of FIG. **1**.

[0053] Referring to FIG. **3**, the organic light emitting display apparatus **20** may include, for example, a thin film transistor TFT that is a portion of the driving circuit, a light emitting device EL, and a contact unit CNT. Although only one thin film transistor TFT is illustrated in FIG. **3**, this is merely for convenience of description and exemplary embodiments of the present invention are not limited thereto. For example, the driving circuit may include a plurality of thin film transistors TFT and a plurality of capacitors.

[0054] The thin film transistor TFT includes, for example, an active layer **11**, a gate electrode **13**, and source/drain electrodes **15** and **17** which are disposed on a substrate **700**.

[0055] The substrate **700** may be formed of, for example, a transparent glass material that contains silicon oxide (SiO_2) as a main component, but exemplary embodiments of the present invention are not to limited the above-described substrate **700**. For example, the substrate **700** may be formed of various materials such as a transparent plastic material, a quartz material or a metal material. For example, in an embodiment, the substrate **700** may be a flexible substrate formed of a plastic material, such as, for example, polyethyeleneterepthalate (PET), polyethyelenennapthalate (PEN), polycarbonate (PC), polyallylate, polyetherimide (PEI), polyethersulphone (PES), polyimide (PI), or the like,

[0056] An auxiliary layer **702** such as, for example, a barrier layer, a blocking layer, and/or a buffer layer which prevent impurity ions from being diffused into the substrate **700**, prevent moisture or external air from being penetrated into the substrate **700**, and planarize a surface of the substrate **700** may be disposed on a top surface of the substrate **700**. The auxiliary layer **702** may be formed by, for example, using SiO_2, SiN_x and/or silicon oxynitride (SiON) through various deposition methods.

[0057] The active layer **11** disposed on the auxiliary layer **702** may be formed by, for example, patterning a polycrystalline silicon layer. The active layer **11** may be formed of, for example, a semiconductor. Also, the active layer **11** may contain, for example, ion impurities to be doped later. Also, the active layer **11** may be formed of, for example, an oxide semiconductor. The active layer **11** may include, for example, source/drain regions **11***s* and **11***d*, corresponding to both sides of the gate electrode **13**, in which n-type or p-type impurities are doped by using the gate electrode **13** as a self-align mask and a channel region **11***c* defined between the source/drain regions **11***s* and **11***d*.

[0058] The gate electrode **13** may be disposed above the active layer **11**. The gate electrode **13** may be formed of various conductive materials. For example, the gate electrode **13** may be formed of, for example, at least one material selected from the group consisting of silver (Ag), magnesium (Mg), aluminum (Al), platinum (Pt), palladium (Pd), gold (Au), nickel (Ni), neodymium (Nd), iridium (Ir), chromium (Cr), lithium (Li), calcium (Ca), molybdenum (Mo), titanium

(Ti), tungsten (W), molybdenum tungsten (MoW), copper (Cu), zinc (Zn), cobalt (Co), manganese (Mn), rhodium (Rh), osmium (Os), and tantalum (Ta). Also, the gate electrode **13** may have a single layer or multilayered structure.

[0059] A first insulating layer **703** that is a gate insulating layer for insulating the gate electrode **13** from the active layer **11** may be disposed between the gate electrode **13** and the active layer **11**. An inorganic insulating layer including a material such as, for example, silicon nitride (SiN_x), silicon oxide (SiO_x), silicon oxynitride (SiON), aluminum oxide (AlOx), yttrium oxide (Y_2O_3), hafnium oxide (HfOx), zirconium oxide (ZrOx), aluminum nitride (AlN), aluminum oxynitride (AlNO), titanium oxide (TiOx), barium titanate (BaTiO3), lead titanate ($PbTiO_3$), or a combination thereof may be deposited on an entire surface of the substrate **700** by using, for example, a plasma-enhanced chemical vapor deposition (PECVD) process, an atmospheric pressure chemical vapor deposition (APCVD) process, or a low-pressure chemical vapor deposition (LPCVD) process to form the first insulating layer **703**.

[0060] The source/drain electrodes **15** and **17** may be disposed above the gate electrode **13**. The source/drain electrodes **15** and **17** may be formed of, for example, a material selected from the conductive materials for forming the above-described gate electrode **13**. For example, in an embodiment, the source/drain electrodes **15** and **17** may be formed at least one material selected from the group consisting of silver (Ag), magnesium (Mg), aluminum (Al), platinum (Pt), palladium (Pd), gold (Au), nickel (Ni), neodymium (Nd), iridium (Ir), chromium (Cr), lithium (Li), calcium (Ca), molybdenum (Mo), titanium (Ti), tungsten (W), molybdenum tungsten (MoW), and copper (Cu), zinc (Zn), cobalt (Co), manganese (Mn), rhodium (Rh), osmium (Os), and tantalum (Ta). Also, the source/drain electrodes **15** and **17** may have a single layer or multilayered structure. However, exemplary embodiments of the present invention are not limited thereto. For example, the source/drain electrodes **15** and **17** may be formed of various conductive materials. The source/drain electrodes **15** and **17** may be electrically connected to the source/drain regions **11***s* and **11***d* of the active layer **11** through contact holes of the first insulating layer **703** and a second insulating layers layer **704**, respectively.

[0061] The second insulating layer **704** may function as an interlayer insulating layer between the gate electrode **13** and the source/drain electrodes **15** and **17** of the thin film transistor TFT. The second insulating layer **704** may be formed of, for example, at least one organic insulting material selected from the group consisting of polyimide, polyamide, acrylic resin, benzocyclobutene, and phenol resin in addition to the inorganic insulating material of the first insulating layer **703**. Alternatively, in an embodiment, the organic insulating material and the inorganic insulating material may be alternately stacked to form the second insulating layer **704**.

[0062] A third insulating layer **705** that functions as a planarization layer for protecting and planarizing the thin film transistor TFT may be disposed above the thin film transistor TFT. The third insulating layer **705** may be formed of, for example, at least one organic insulting material selected from the group consisting of polyimide, polyamide, acrylic resin, benzocyclobutene, and phenol resin by using a spin coating method. The third insulating layer **705** may be formed of, for example, an inorganic insulating material selected from the group consisting of silicon oxide (SiO_2), silicon nitride (SiN_x), aluminum oxide (Al_2O_3), copper oxide (CuO_x), terbium oxide (Tb_4O_7), yttrium oxide (Y_2O_3), niobium pentoxide (Nb_2O_5), and praseodymium oxide (Pr_2O_3) in addition to the organic insulating materials. Also, the third insulating layer **705** may have, for example, a multilayered structure in which the organic insulating material and the inorganic insulating material are alternately stacked on each other.

[0063] The light emitting device EL may include, for example, a first electrode **21** electrically connected to one of the source/drain electrodes **15** and **17** of the thin film transistor TFT on the third insulating layer **705** disposed above the thin film transistor TFT, a second electrode **25** facing the first electrode **21**, and an organic layer **23** disposed between the first electrode **21** and the second electrode **25**.

[0064] The first electrode **21** may have, for example, a double-layered structure including a lower layer formed of a metal material having superior reflection efficiency such as, for example, at least one metal selected from the group consisting of Ag, Mg, Al, Pt, Pd, Au, Ni, Nd, Ir, Cr, Li, Ca, and a compound thereof and an upper layer formed of a transparent conductive material having a relatively high work function such as, for example, indium tin oxide (ITO), indium zinc oxide (IZO), zinc oxide (ZnO), indium gallium oxide (IGO), or indium oxide (In_2O_3).

[0065] A fourth insulating layer **707** is disposed between the first electrodes **21** adjacent to each other. The fourth insulating layer **707** may cover an edge region of the first electrode **21**.

[0066] The fourth insulating layer **707** may function as a pixel define layer (PDL). The fourth insulating layer **707** may be formed of, for example, at least one organic insulating material selected from the group consisting of polyimide, polyamide, acrylic resin, benzocyclobutene, and phenol resin. The fourth insulating layer **707** may be formed of, for example, an inorganic insulating material selected from the group consisting of SiO_2, SiN_x, Al_2O_3, CuO_x, Tb_4O_7, Y_2O_3, Nb_2O_5, and Pr_2O_3 in addition to the organic insulating materials. Also, the fourth insulating layer **707** may have, for example, a multilayered structure in which the organic insulating material and the inorganic insulating material are alternately stacked on each other.

[0067] The organic layer **23** may include, for example, an emissive layer (EML) and at least one functional layer of a hole transport layer (HTL), a hole injection layer (NIL), an electron transport layer (ETL), and an electron injection layer (EIL) in a single or composite structure. The EML may be formed of, for example, an organic material having a low molecular weight or a high molecular weight. For example, if the EML emits light having each of red, green, and blue colors, the EML may be patterned into a red EML, a green EML, and a blue EML. If the EML emits white light, the EML may have a multilayered structure in which the red EML, the green EML, and the blue EML are stacked on each other or a single layer structure including a red emission material, a green emission material, and a blue emission material to emit the white light. In this case, a color converting layer for converting the white light into light having a predetermined color or a color filter may be applied. The functional layer may be a common layer disposed on the entire surface of the substrate **700**.

[0068] The second electrode **25** may be deposited on the entire surface of the substrate **700** to form a common electrode. Here, the second electrode **25** may face the first electrode **21**. The second electrode **25** may be formed of, for example, a transparent conductive material. For example, the second electrode **25** may include a semi-transparent reflection film that is provided with a thin film formed of Ag, Mg, Al, Pt, Pd, Au, Ni, Nd, Ir, Cr, Li, or Ca, or an optical transparent metal oxide such as ITO, IZO, or ZnO.

[0069] An auxiliary electrode AE is disposed around a light emitting device EL in, for example, a mesh shape. The auxiliary electrode AE may include, for example, lower auxiliary electrodes **31** disposed at a predetermined distance in a first direction and upper auxiliary electrodes **33** disposed above the lower auxiliary electrode **31** at a predetermined distance in a second direction. The fourth insulating layer **707** and the organic layer **23** which are disposed on each of the lower auxiliary electrodes **31** may be removed to expose a portion of the lower auxiliary electrode **31** in the contact unit CNT in which each of the lower auxiliary electrodes **31** and each of the upper auxiliary electrodes **33** cross each other.

[0070] The lower auxiliary electrode **31** may be disposed on, for example, the same layer as the first electrode **21** and be insulated from the first electrode **21**. The lower auxiliary electrode **31** may be formed of a material which is the same as or different from the material of the first electrode **21** and/or the second electrode **25**. The second electrode **25** contacts an upper portion of the exposed lower auxiliary electrode **31**, The upper auxiliary electrode **33** may be disposed on the second electrode **25** and contact the second electrode **25**. Thus, the auxiliary electrode AE and the second electrode **25** may be electrically connected to each other. The upper auxiliary electrode **33** may be formed of, for example, a material which is the same as or different from the material of the lower auxiliary electrode **31**. For example, the upper auxiliary electrode **33** may be formed of Al, AlNd, Cu, or copper alloy which has low-resistance properties.

[0071] FIGS. **4** to **6** are views illustrating a method for manufacturing an organic light emitting display apparatus according to an embodiment of the present invention.

[0072] A driving circuit including a thin film transistor TFT is formed on a substrate **700**.

[0073] As illustrated in FIG. **4**, a lower auxiliary electrode **31** having a line shape is formed in a first direction while a first electrode **21** is formed. Alternatively, in an embodiment, the lower auxiliary electrode **31** having the line shape in the first direction may be formed after the first electrode **21** is formed. The lower auxiliary electrode **31** may be formed, for example, on the same layer as the first electrode **21**.

[0074] As illustrated in FIG. **5**, a second electrode **25** that is a common electrode is formed on the lower auxiliary electrode **31** and the first electrode **21**.

[0075] For example, a fourth insulating layer (see reference numeral **707** of FIG. **3**) that functions as a pixel define layer is formed on the auxiliary electrode **31** and the first electrode **21**. An opening for exposing the first electrode **21** and a contact hole **35** for exposing the lower auxiliary electrode **31** in a contact unit CNT are formed in the fourth insulating layer **707**. An organic layer (see reference numeral **23** of FIG. **3**) is formed on the fourth insulating layer **707**. For example, when the organic layer **23** is formed, the contact hole **35** may be covered by using a mask, or the organic layer **23** within the contact hole **35** of the contact unit CNT may be removed by using laser beams so that the organic layer **23** may not remain in the contact hole **35** of the contact unit CNT.

[0076] Also, the second electrode **25** is formed above the fourth insulating layer **707**, the organic layer **23**, and the lower auxiliary electrode **31**. The second electrode **25** may directly contact the lower auxiliary electrode **31** through the contact hole **35** in the contact unit CNT.

[0077] As illustrated in FIG. **6**, an upper auxiliary electrode **33** having, for example, a line shape is formed on the second electrode **25** in a second direction. The upper auxiliary electrode **33** directly contacts the second electrode **25** in the contact unit CNT. Therefore, the auxiliary electrode AE according to an embodiment of the present invention may have the mesh structure by the lower and upper auxiliary electrodes **31** and **33** which cross each other in the first and second directions to effectively reduce voltage drop.

[0078] FIG. **7** is a schematic plan view of an organic layer deposition apparatus according to an embodiment of the present invention, and FIG. **8** is a schematic side view illustrating a deposition unit of the organic layer deposition apparatus of FIG. **7**.

[0079] Referring to FIGS. **7** and **8**, an organic layer deposition apparatus **1** includes, for example, a deposition unit **100**, a loading unit **200**, an unloading unit **300**, and a conveyer unit **400**.

[0080] The loading unit **200** may include, for example, a first rack **212**, a transport chamber **214**, a first inversion chamber **218**, and a buffer chamber **219**.

[0081] A plurality of substrates **700** onto which a deposition material has not yet been applied are stacked up on the first rack **212**. For example, a transport robot provided in the transport chamber **214** picks up one of the substrates **700** from the first rack **212**, disposes the substrate **700** on a moving unit **430** transferred by a second conveyer unit **420**, and moves the moving unit **430** on which the substrate **700** is disposed into the first inversion chamber **218**.

[0082] The first inversion chamber **218** is disposed adjacent to the transport chamber **214**. A first inversion robot disposed in the first inversion chamber **218** inverts the moving unit **430** and then loads the moving unit **430** on a first conveyer unit **410** of the deposition unit **100**.

[0083] Referring to FIG. **7**, the transport robot of the transport chamber **214** places one of the substrates **700** on a top surface of the moving unit **430**. In this state, the moving unit **430** on which the substrate **700** is disposed is transferred into the first inversion chamber **218**. The first inversion robot of the first inversion chamber **218** inverts the first inversion chamber **218** so that the substrate **700** is turned upside down in the deposition unit **100**.

[0084] The unloading unit **300** is configured to operate in an opposite manner to the loading unit **200** described above. That is, a second inversion robot in a second inversion chamber **328** inverts the moving unit **430**, which has passed through the deposition unit **100** while the substrate **700** is disposed on the moving unit **430**, and then moves the moving unit **430** on which the substrate **700** is disposed into an ejection chamber **324**. Then, an ejection robot takes the moving unit **430** on which the substrate **700** is disposed out of the ejection chamber **324**, separates the substrate **700** from the moving unit **430**, and then loads the substrate **700** on a second rack **322**. The moving unit **430** separated from the substrate **700** returns to the loading unit **200** via the second conveyer unit **420**.

[0085] However, the present embodiment of the present invention is not limited to the above example. For example, when the substrate **700** is initially fixed to the moving unit **430**, the substrate **700** may be fixed onto a bottom surface of the moving unit **430** and then moved into the deposition unit **100**. In this case, 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.

[0086] The deposition unit **100** may include, for example, at least one chamber **101** for deposition. According to an embodiment of the present invention, as illustrated in FIGS. **7** and **8**, the deposition unit **100** includes, for example, a chamber **101** in which a plurality of organic layer deposition assemblies (**100-1**) (**100-2**) . . . (**100-***n*) may be disposed. For example, referring to FIG. **8**, eleven organic layer deposition assemblies, a first organic layer deposition assembly (**100-1**), a second organic layer deposition assembly (**100-2**), . . . and an eleventh organic layer deposition assembly (**100-11**), are disposed 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, for example, in vacuum during the deposition process.

[0087] Referring to FIG. **7**, the moving unit **430** with the substrate **700** fixed thereon 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 moving unit **430** that is separated from the substrate **700** in the unloading unit **300** may be moved back to the loading unit **200** by the second conveyer unit **420**.

[0088] The first conveyer unit **410** passes through the chamber **101** when passing through the deposition unit **100**, and the second conveyer unit **420** conveys the moving unit **430** from which the substrate **700** is separated.

[0089] Here, the organic layer deposition apparatus **1** is configured such that the first conveyer unit **410** is disposed above the second conveyer unit **420** so that after the moving unit **430**, on which deposition has been completed while passing through the first conveyer unit **410**, is separated from the substrate **700** in the unloading unit **300**, the moving unit **430** returns to the loading unit **200** via the second conveyer unit **420** formed below the first conveyer unit **410**, thereby increasing space utilization efficiency.

[0090] The deposition unit **100** of FIG. **7** may further include, for example, a deposition source replacement unit **190** disposed at a side of each organic layer deposition assembly. In an embodiment, the deposition source replacement unit **190** may be formed as, for example, a cassette-type that may be drawn to the outside from each organic layer deposition assembly. Thus, a deposition source **110** (see reference numeral **110** of FIG. **3**) of the organic layer deposition assembly **100-1** may be relatively easily replaced.

[0091] FIG. **7** illustrates the organic layer deposition apparatus **1** in which two sets of structures each including, for example, the loading unit **200**, the deposition unit **100**, the unloading unit **300**, and the conveyer unit **400** are arranged in parallel. That is, it may be seen that two organic layer deposition apparatuses **1** are arranged such that one organic layer deposition apparatus **1** is disposed above the other organic layer deposition apparatus **1** (above and below in FIG. **7**). In this case, a mask replacement unit **500** may be disposed between the two organic layer deposition apparatuses **1**. That is, due to this configuration of structures, the two organic layer deposition apparatuses **1** share the mask replacement unit **500**, thereby resulting in increased space utilization efficiency, as compared to a case where each organic layer deposition apparatus **1** includes the mask replacement unit **500**. The mask replacement unit **500** may replace an open mask and a patterning slit sheet.

[0092] FIG. **9** is a schematic perspective view of the deposition unit of FIG. **7**, and FIG. **10** is a schematic cross-sectional view of the deposition unit of FIG. **9**.

[0093] Referring to FIGS. **9** and **10**, the deposition unit **100** of the organic layer deposition apparatus **1** includes, for example, at least one organic layer deposition assembly **100-1** and a conveyer unit **400**.

[0094] Hereinafter, a structure of the deposition unit **100** including, for example, a patterning slit sheet **130** will be described.

[0095] The chamber **101** may be formed as, for example, a hollow box type and accommodate the at least one organic layer deposition assembly **100-1** and the moving unit **430**. For example, a foot **102** is formed so as to fix the deposition unit **100** on the ground, a lower housing **103** is disposed on the foot **102**, and an upper housing **104** is disposed on the lower housing **103**. The chamber **101** accommodates both the lower housing **103** and the upper housing **104**. Here, 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 disposed 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**.

[0096] The upper housing **104** includes, for example, the organic layer deposition assembly **100-1** and the first conveyer unit **410** of the conveyer unit **400**, and the lower housing **103** includes, for example, the second conveyer unit **420** of the conveyer unit **400**. While the moving unit **430** is cyclically moving between the first conveyer unit **410** and the second conveyer unit **420**, a deposition process is continuously performed.

[0097] Hereinafter, constituents of the organic layer deposition assembly **100-1** are described in detail.

[0098] The first organic layer deposition assembly **100-1** includes, for example, the deposition source **110**, a deposition source nozzle unit **120**, the patterning slit sheet **130**, a shielding member **140**, a first stage **150**, a second stage **160**, a camera **170**, and a sensor **180**. In this regard, all the elements illustrated in FIGS. **9** and **10** may be arranged in the chamber **101** maintained in an appropriate vacuum state. This structure may be needed to achieve the linearity of a deposition material.

[0099] For example, 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 **700** in a desired pattern, the chamber should be maintained in the same vacuum state as the vacuum state 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 the temperature of the deposition source **110** because thermal expansion of the patterning slit sheet **130** may be minimized when the temperature of the patterning slit sheet **130** is sufficiently low.

[0100] The substrate **700** on which the deposition material **115** is to be deposited is arranged in the chamber **101**. The substrate **700** may be, for example, a substrate for a flat panel display device. For example, a large substrate having a size of about 40 inches or more, such as a mother glass, for manufacturing a plurality of flat panel displays, may be used as the substrate **700**.

[0101] According to an embodiment of the present invention, the deposition process may be performed with the substrate **700** being moved relative to the organic layer deposition assembly **100-1**.

[0102] For example, in a typical deposition method using an FMM, the size of the FMM should be the same as the size of a substrate. Thus, as the size of the substrate increases, the FMM should also be larger in size. Due to these limitations, it may be difficult to fabricate the FMM and to align the FMM in a precise pattern by elongation of the FMM.

[0103] To address these limitations, 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 **700** are moved relative to each other. In other words, deposition may be continuously performed while, for example, the substrate **700**, 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 **700** is moved in a direction of arrow A illustrated in FIG. **9**. Although the substrate **700** is illustrated as being moved in the Y-axis direction in the chamber **101** in FIG. **9** when deposition is performed, it is noted that exemplary embodiments of the present invention are 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 **700** is held in a fixed position.

[0104] Thus, in the organic layer deposition assembly **100-1**, the patterning slit sheet **130** may be significantly smaller than an FMM used in a conventional deposition method. That is, in the organic layer deposition assembly **100-1**, deposition is continuously performed, e.g., in a scanning manner while the substrate **700** 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 significantly less than a length of the substrate **700**. As the patterning slit sheet **130** may be formed significantly smaller than the FMM used in a typical deposition method, it may be relatively easy to manufacture the patterning slit sheet **130**. That is, the small patterning slit sheet **130** is more effective in the manufacturing processes which include etching followed by precise elongation, welding, transferring, and washing processes, than the FMM used in a conventional deposition method. In addition, using the patterning slit sheet **130** of exemplary embodiments of the present invention is more effective for manufacturing a relatively large display device.

[0105] To perform deposition while the organic layer deposition assembly **100-1** and the substrate **700** are moved relative to each other as described above, the organic layer deposition assembly **100-1** and the substrate **700** may be spaced apart from each other by a certain distance. This is described below in more detail.

[0106] The deposition source **110** that contains and heats the deposition material **115** is disposed at a side opposite to (facing) a side in which the substrate **700** is disposed in the chamber. As the deposition material **115** contained in the deposition source **110** is vaporized, deposition is performed on the substrate **700**.

[0107] The deposition source **110** includes, for example, 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**, and in particular toward the deposition source nozzle unit **120**.

[0108] A deposition source nozzle unit **120** is disposed on one side of the deposition source **10**, e.g., a side toward the substrate **700** from the deposition source **110**. Here, the organic layer deposition assemblies according to the present embodiment of the present invention each may include, for example, different deposition nozzles in performing deposition for forming common layers and pattern layers. That is, for example, a plurality of deposition source nozzles **121** may be provided in the deposition source nozzle unit **120** for forming a pattern layer in the Y-axis direction, e.g., along the scanning direction of the substrate **700**. Thus, the deposition source nozzles **121** are formed such that, for example, only one line of the deposition source nozzles **121** is formed in the X-axis direction, to significantly reduce the occurrence of shadows. Alternatively, the plurality of deposition source nozzles **121** may be provided, for example, in the deposition source nozzle unit **120** for forming a common layer along the X-axis direction. Thus, uniformity in thickness of the common layer may be increased.

[0109] The patterning slit sheet **130** may be further disposed between the deposition source **110** and the substrate **700**. The patterning slit sheet **130** may further include, for example, a frame having a shape similar to a window frame. The patterning slit sheet **130** includes, for example, a plurality of patterning slits arranged in 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 **700**. Here, the patterning slit sheet **130** may be formed using, for example, the same method as that used to form an FMM, and in particular a stripe-type mask, e.g., etching. In this regard, a total number of patterning slits may be, for example, more than a total number of deposition source nozzles **121**.

[0110] 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.

[0111] As described above, deposition is performed while the organic layer deposition assembly **100-1** is moved relative to the substrate **700**. For the organic layer deposition assembly **100-1** to be moved relative to the substrate **700**, the patterning slit sheet **130** is disposed spaced apart from the substrate **700** by a predetermined distance.

[0112] In a typical deposition method using an FMM, deposition is performed with the FMM in close contact with a substrate 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, as it may be difficult to move the mask with respect to the substrate, the mask and the substrate may need to be formed having the same size as each other. Accordingly, the mask may need to be larger as the size of a display device increases. However, it may be difficult to form a large mask.

[0113] To address these limitations, 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 from the substrate **700** on which a deposition material **115** is to be deposited.

[0114] 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 may be relatively easy to manufacture the mask. In addition, defects due to contact between the substrate and the mask may be prevented. In addition, as it is unnecessary to closely contact the substrate with the mask during a deposition process, a manufacturing speed may be increased.

[0115] Hereinafter, particular disposition of each element of the upper housing **104** will be described.

[0116] The deposition source **110** and the deposition source nozzle unit **120** are disposed on a bottom portion of the upper housing **104**. Accommodation portions **104-1** are respectively formed on both sides of the deposition source **100** and the deposition source nozzle unit **120** to have, for example, a protruding shape. The first stage **150**, the second stage **160**, and the patterning slit sheet **130** are sequentially formed on the accommodation portions **104-1** in this order.

[0117] Here, 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, for example, 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**.

[0118] 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, for example, a plurality of actuators and is formed to move in the Z-axis direction with respect to the first stage **150**.

[0119] The patterning slit sheet **130** is disposed on the second stage **160**. As described above, the patterning slit sheet **130** is disposed 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 (e.g., a real-time alignment) between the substrate **700** and the patterning slit sheet **130** may be performed.

[0120] 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.

[0121] The shielding member **140** may be further disposed between the patterning slit sheet **130** and the deposition source **110**. For example, an anode or cathode pattern is formed on an edge portion of the substrate **700** and is used as a terminal for inspecting a product or in manufacturing a product. If an organic material is applied on a region of the substrate **700**, the anode or the cathode may not sufficiently perform its function. Thus, the edge portion of the substrate **700** is formed to be a non-film-forming region on which an organic material or the like is not applied. As described above, however, in the organic layer deposition apparatus, deposition is performed in a scanning manner while the substrate **700** is moved relative to the organic layer deposition apparatus, and thus, it may not be easy to prevent the organic material from being deposited on the non-film-forming region of the substrate **700**.

[0122] Therefore, to prevent the organic material from being deposited on the non-film-forming region of the substrate **700**, in the organic layer deposition apparatus, the shielding member **140** may be disposed on the edge portion of the substrate **700**. For example, in an embodiment, the shielding member **140** may include two adjacent plates.

[0123] When the substrate **700** does not pass through the organic layer deposition assembly **100-1**, the shielding member **140** screens the deposition source **110**, and thus, the deposition material **115** discharged from the deposition source **110** does not reach the patterning slit sheet **130**. When the substrate **700** enters into the organic layer deposition assembly **100-1** with the shielding member **140** screening the deposition source **110**, a front part of the shielding member **140** which screens the deposition source **110** moves along with the movement of the substrate **700**, and thus, the flow path of the deposition material **115** is opened and the deposition material **115** discharged from the deposition source **110** passes through the patterning slit sheet **130** and is deposited on the substrate **700**. Also, while the substrate **700** passes through the organic layer deposition assembly **100-1**, a rear part of the shielding member **140** moves along with the movement of the substrate **700** to screen the deposition source **110** so that the flow path of the deposition material **115** is closed. Accordingly, the deposition material **115** discharged from the deposition source **110** does not reach the patterning slit sheet **130**.

[0124] As described above, the non-film-forming region of the substrate **700** is screened by the shielding member **140**, and thus, it may be relatively easy to prevent the organic material from being deposited on the non-film-forming region of the substrate **700** without using a separate structure.

[0125] Hereinafter, the conveyer unit **400** that conveys the substrate **700**, on which the deposition material **115** is to be deposited, is described in more detail. Referring to FIGS. **9** and **10**, the conveyer unit **400** includes, for example, the first conveyer unit **410**, the second conveyer unit **420**, and the moving unit **430**.

[0126] The first conveyer unit **410** conveys in an in-line manner the moving unit **430**, including the carrier **431** and an electrostatic chuck **432** attached thereto, and the substrate **700** attached to the moving unit **430** so that an organic layer may be formed on the substrate **700** by the organic layer deposition assembly **100-1**. The first conveyer unit **410** includes, for example, a coil **411**, guide members **412**, upper magnetically suspended bearings, side magnetically suspended bearings, and gap sensors.

[0127] The second conveyer unit **420** returns to the loading unit **200** the moving unit **430** from which the substrate **700** has been separated in the unloading unit **300** after one deposition cycle is completed while the moving unit **430** is passing through the deposition unit **100**. The second conveyer unit **420** includes, for example, a coil **421**, roller guides **422**, and a charging track **423**.

[0128] The moving unit **430** includes, for example, the carrier **431** that is conveyed along the first conveyer unit **410** and the second conveyer unit **420** and the electrostatic chuck **432** that is combined on a surface of the carrier **431** and to which the substrate **700** is attached.

[0129] Hereinafter, each element of the conveyer unit **400** will be described in more detail.

[0130] The carrier **431** of the moving unit **430** will now be described in detail.

[0131] The carrier **431** includes, for example, a main body part **431***a*, a magnetic rail **431***b*, contactless power supply (CPS) modules **431***c*, a power supply unit **431***d*, and guide grooves **431***e*.

[0132] The main body part **431***a* constitutes a base part of the carrier **431** and may be formed of, for example, a magnetic material such as iron. Here, due to a repulsive force between the main body part **431***a* and the respective upper and side magnetically suspended bearings, which are described below, the carrier **431** may be maintained spaced apart from the guide members **412** by a certain distance.

[0133] The guide grooves **431***e* may be respectively formed at, for example, both sides of the main body part **431***a* and each may accommodate a guide protrusion of the guide member **412**.

[0134] The magnetic rail **431***b* may be formed, for example, along a center line of the main body part **431***a* in a direction where the main body part **431***a* proceeds. The magnetic rail **431***b* 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 in an arrow A direction by the linear motor.

[0135] The CPS modules **431***c* and the power supply unit **431***d* may be respectively formed, for example, on both sides of the magnetic rail **431***b* in the main body part **431***a*. The power supply unit **431***d* includes a battery (e.g., a rechargeable battery) that provides power so that the electrostatic chuck **432** can chuck the substrate **700** and maintains operation. The CPS modules **431***c* are, for example, wireless charging modules that charge the power supply unit **431***d*. For example, the charging track **423** formed in the second conveyer unit **420**, which are 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 **431***c* so as to supply power to the CPS module **431***c*. The power supplied to the CPS modules **431***c* is used to charge the power supply unit **431***d*.

[0136] The electrostatic chuck **432** may include, for example, an electrode embedded in a main body formed of ceramic, in which the electrode is supplied with power. The substrate **700** is attached onto a surface of the main body of the electrostatic chuck **432** as a high voltage is applied to the electrode.

[0137] Hereinafter, an operation of the moving unit **430** is described in more detail.

[0138] The magnetic rail **431***b* of the main body part **431***a* and the coil **411** may be combined with each other to constitute an operation unit. Here, the operation unit may be, for example, a linear motor. The linear motor has a small frictional coefficient, little position error, and a very high degree of position determination, as compared to a conventional slide guide system. As described above, the linear motor may include, for example, the coil **411** and the magnetic rail **431***b*. The magnetic rail **431***b* is, for example, linearly disposed on the carrier **431**, and a plurality of the coils **411** may be disposed, for example, at an inner side of the chamber **101** by a certain distance so as to face the magnetic rail **431***b*, As the magnetic rail **431***b* is disposed on the carrier **431** instead of the coil **411**, the carrier **431** may be operable without power being supplied thereto. Here, the coil **411** is included in the ATM box (atmosphere box) in an air atmosphere and the carrier **431** to which the magnetic rail **431***b* is attached may be moved in the chamber **101** maintained in a vacuum state.

[0139] Hereinafter, the first conveyer unit **410** and the moving unit **430** are described in detail.

[0140] Referring to FIG. **10**, the first conveyer unit **410** conveys the electrostatic chuck **432** that fixes the substrate **700** and conveys the carrier **431** that conveys the electrostatic chuck **432**. Here, the first conveyer unit **410** includes, for example, the coil **411**, the guide members **412**, the upper magnetically suspended bearings, the side magnetically suspended bearings, and the gap sensors (not shown).

[0141] The coil **411** and the guide members **412** are formed inside the upper housing **104**. For example, the coil **411** is formed in an upper portion of the upper housing **104**, and the guide members **412** are respectively formed on both inner sides of the upper housing **104**.

[0142] The guide members **412** guide the carrier **431** to move in a direction. Here, the guide members **412** are formed to pass through the deposition unit **100**.

[0143] The side magnetically suspended bearings are each disposed in the guide member **412** so as to respectively correspond to both sides of the carrier **431**. The side magnetically suspended bearings cause a distance 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 the guide members **412**. That is, a repulsive force R1 occurring between the side magnetically suspended bearing on the left side in FIG. **10** and the carrier **431**, which is a magnetic material, and a repulsive force R2 occurring between the side magnetically suspended bearing on the right side in FIG. **10** and the carrier **431**, which is a magnetic material, maintain equilibrium. Thus, as a result, there is a constant distance between the carrier **431** and the respective parts of the guide member **412**.

[0144] Each of the upper magnetically suspended bearings may be disposed in the guide member **412** so as to be above the carrier **431**. The upper magnetically suspended bearings allow the carrier **431** to be moved along the guide members **412** in a non-contact state with the accommodation parts and with a distance therebetween maintained constant. That is, a repulsive force R3 occurring between the upper magnetically suspended bearing and the carrier **431**, which is a magnetic material, and gravity maintain equilibrium, and thus, there is a constant distance between the carrier **431** and the respective guide members **412**.

[0145] Each guide member **412** may further include, for example, the gap sensor. The gap sensor may measure a distance between the carrier **431** and the guide member **412**. The gap sensor may be disposed at, for example, a side of the side magnetically suspended bearing. The gap sensor may measure a distance between a side surface of the carrier **431** and the side magnetically suspended bearing.

[0146] Magnetic forces of the upper and side magnetically suspended bearings may vary according to values measured by the gap sensors, 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 and the gap sensors.

[0147] Hereinafter, the second conveyer unit **420** and the moving unit **430** are described in detail.

[0148] Referring back to FIG. **10**, the second conveyer unit **420** returns the electrostatic chuck **432** from which the substrate **700** has been separated in the unloading unit **300** and the carrier **431** that carries the electrostatic chuck **432** to the loading unit **200**. Here, the second conveyer unit **420** includes, for example, the coil **421**, the roller guides **422**, and the charging track **423**.

[0149] For example, 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 disposed on a top inner surface of the lower housing **103**, and the roller guides **422** may be disposed on both inner sides of the lower housing **103**. Here, the coil **421** may be disposed in an ATM box, as the coil **411** of the first conveyer unit **410**.

[0150] Like the first conveyer unit **410**, the second conveyer unit **420** may include, for example, the coil **421**. Also, the Magnetic rail **431***b* of the main body part **431***a* 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, for example, 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. **9**.

[0151] The roller guides **422** guide the carrier **431** to move in a direction. Here, the roller guides **422** are formed to pass through the deposition unit **100**.

[0152] As a result, the second conveyer unit **420** is used in a process of returning the carrier **431** from which the substrate **700** has been separated and not in a process of depositing an organic material on the substrate **700**, and thus, position accuracy thereof is not needed as by the first conveyer unit **410**. Therefore, magnetic suspension is applied to the first conveyer unit **410** that may require 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. In addition, the magnetic suspension may also be applied to the second conveyer unit **420** as in the first conveyer unit **410**.

[0153] The organic layer deposition assembly **100-1** of the organic layer deposition apparatus **1** according to the present embodiment may further include, for example, the camera **170** and the sensor **180** for an aligning process. For example, the camera **170** may align in real time a first alignment mark formed in the frame **135** of the patterning slit sheet **130** and a second alignment mark (not formed on the substrate **700**. Here, the camera **170** is disposed to more accurately view in the chamber **101** maintained in the vacuum state during deposition. For this, the camera **170** may be installed in a camera accommodation unit **171** in an atmospheric state.

[0154] As the substrate **700** and the patterning slit sheet **130** are spaced apart from each other by a certain distance, distances to the substrate **700** and the patterning slit sheet **130** that are disposed at different positions should be both measured using the camera **170**. For this operation, the organic layer deposition assembly **100-1** of the organic layer deposition apparatus **1** may include, for example, the sensor **180**. Here, the sensor **180** may be, for example, a confocal sensor. The confocal sensor may scan an object to be measured by, for example, using laser beams that rotate at high speed and a scanning mirror and then measuring a distance to the object by using fluorescent or reflected rays emitted by the laser beams. The confocal sensor may measure a distance by, for example, sensing a boundary interface between different media.

[0155] As a distance between the substrate **700** and the patterning slit sheet **130** is measurable in real time using the camera **170** and the sensor **180**, the substrate **700** may be aligned with the patterning slit sheet **130** in real time, thereby significantly increasing the positional accuracy of a pattern.

[0156] FIG. **11** is a schematic perspective view of an organic layer deposition assembly according to an embodiment of the present invention.

[0157] Referring to FIG. **11**, an organic layer deposition assembly **900** includes, for example, a deposition source **910**, a deposition source nozzle unit **920**, and a patterning slit sheet **950**.

[0158] The deposition source **910** includes, for example, 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**, toward the deposition source nozzle unit **920**. The deposition source nozzle unit **920** is disposed, for example, at a side of the deposition source **910**. The deposition source nozzle unit **920** includes, for example, a plurality of deposition source nozzles **921** arranged in the Y-axis direction. The patterning slit sheet **950** and a frame **955** are further disposed between the deposition source **910** and a substrate **500**. The patterning slit sheet **950** includes, for example, a plurality of patterning slits **951** that are arranged in the X-axis direction. In addition, the deposition source **910** and the deposition source nozzle unit **920** may be connected to the patterning slit sheet **950** by, for example, a connection member **935**.

[0159] 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 **700**. The deposition source nozzle unit **920** includes, for example, the deposition source nozzles **921** that may be arranged in the Y-axis direction, e.g., a scanning direction of the substrate **700**. Here, the plurality of deposition source nozzles **921** may be arranged, for example, such that the distance between each of adjacent pairs of the deposition source nozzles **921** is the same as one another. The deposition material **915** that is vaporized in the deposition source **910** passes through the deposition source nozzle unit **920** towards the substrate **700** that is a deposition target substrate. As described above, when the deposition source nozzle unit **920** includes the deposition source nozzles **921** arranged in the Y-axis direction, that is, the scanning direction of the substrate **700**, the size of a pattern formed of the deposition material **915** discharged through each of a plurality of patterning slits **951** of the patterning slit sheet **950** is affected by the size of one of the deposition source nozzles **921** (as there is only one line of the deposition source nozzles **921** in the X-axis direction). Thus, no shadow may be formed on the substrate **700**. In addition, as the deposition source nozzles **921** are arranged in the scanning direction of the substrate **700**, 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.

[0160] FIG. **12** is a view illustrating a method for manufacturing an organic light emitting display apparatus by using the organic layer deposition apparatus of FIGS. **7** to **11**.

[0161] A driving circuit including a thin film transistor TFT and a first electrode (see reference numeral **21** of FIG. **3**) are formed on a substrate **700**.

[0162] A lower auxiliary electrode **31** having, for example, a line shape is formed on the same layer as the first electrode **21** in a first direction.

[0163] As described above, an organic layer deposition apparatus **1** according to an embodiment of the present invention includes a patterning slit sheet having a size significantly less than that of a typical FMM. While the organic layer deposition apparatus **1** and the substrate **700** are relatively moved with respect to each other, deposition may be performed. That is, while the substrate **700** is moved in one direction, the deposition may be performed in a scanning manner.

[0164] While the substrate **700** and the organic layer deposition apparatus **1** are moved in a certain direction with respect to each other in a state where the substrate **700** and the organic layer deposition apparatus **1** are spaced a predetermined distance from each other by using the organic layer deposition apparatus **1** that is disclosed in FIGS. **7** to **11**, a lower auxiliary electrode formation material evaporated from a deposition source (see reference numeral **120** of FIG. **7** and reference numeral **910** of FIG. **11**) of the organic layer deposition apparatus may pass through the patterning slit sheet (reference numeral **130** of FIG. **7** and reference numeral **950** of FIG. **11**) and then be deposited on the substrate **700** to form the lower auxiliary electrode **31**.

[0165] An organic layer (see reference numeral **23** of FIG. **3**) and a second electrode **25** that is a common layer are formed above the lower auxiliary electrode **31** and the first electrode **21**.

[0166] For example, a fourth insulating layer (see reference numeral **107** of FIG. **3**) that functions as a pixel define layer is formed on the lower auxiliary electrode **31** and the first electrode **21**. An opening for exposing the first electrode **21** and a contact hole **35** for exposing the lower auxiliary electrode **31** in a contact unit CNT are formed in the fourth insulating layer **107**.

[0167] The organic layer **23** is formed on the first electrode **21** and the fourth insulating layer **107**.

[0168] While the substrate **700** and the organic layer deposition apparatus **1** are moved in a certain direction with respect to each other in a state where the substrate **700** and the organic layer deposition apparatus **1** are spaced a predetermined distance from each other by using the organic layer deposition apparatus **1** that is disclosed in FIGS. **7** to **11**, a deposition material evaporated from the deposition source **120** or **190** of the organic layer deposition apparatus **1** may pass through the patterning slit sheet **130** or **950** and then be deposited on the substrate **700** to form the organic layer **23**. Thus, the organic layer **23** may be continuously formed in, for example, a line shape on the substrate **700** on which the deposition process is performed.

[0169] In an embodiment, for example, an EML may use the patterning slit sheet **130** or **950** as a deposition mask, and the functional layer may use an open mask as a deposition mask. Thus, the functional layer of the organic layer **23** may be formed as a common layer on the substrate **700** on which the deposition process is performed. As illustrated in FIG. **12**, the EML of the organic layer **23** may include, for example, a red EML **23**R, a green EML **23**G, and a blue EML **23**B, each having a line shape, which are continuously formed adjacent to each other.

[0170] The organic layer **23** formed on the contact unit CNT may be removed by using, for example, laser beams. Thus, the organic layer **23** may not remain in the contact hole **35** of the contact unit CNT.

[0171] Also, the second electrode **25** is formed above the fourth insulating layer **107**, the organic layer **23**, and the lower auxiliary electrode **31**. While the substrate **700** and the organic layer deposition apparatus **1** are moved in a certain direction with respect to each other in a state where the substrate **700** and the organic layer deposition apparatus **1** are spaced a predetermined distance from each other by using the organic layer deposition apparatus that is disclosed in FIGS. **7** to **11**, a second electrode formation material evaporated from the deposition source **120** or **190** of the organic layer deposition apparatus may pass through the open mask and then be deposited on the substrate **700** to form the second electrode **25**. The second electrode **25** may directly contact the lower auxiliary electrode **31** through the contact hole **35** in the contact unit CNT.

[0172] An upper auxiliary electrode **33** having, for example, a line shape is formed on the second electrode **25** in a second direction. While the substrate **700** is rotated at an angle of, for example, about 90 degrees with respect to a position thereof when the lower auxiliary electrode **31** is formed, and then, the substrate **700** and the organic layer deposition apparatus are moved in a certain direction with respect to each other in a state where the substrate **700** and the organic layer deposition apparatus are spaced a predetermined distance from each other by using the organic layer deposition apparatus that is disclosed in FIGS. **7** to **11**, an upper electrode formation material evaporated from the deposition source **120** or **190** of the organic layer deposition apparatus may pass through the patterning slit sheet **130** or **950** and then be deposited on the substrate **700** to form the upper auxiliary electrode **33**. The upper auxiliary electrode **33** directly contacts the second electrode **25** in the contact unit CNT.

[0173] According to embodiments of the present invention, the auxiliary electrode may be used to prevent the electrical properties of the display apparatus from be deteriorated. Also, the lower auxiliary electrode disposed under the second electrode and the upper auxiliary electrode disposed on the second electrode are arranged in the mesh shape to reduce the voltage drop of the second electrode.

[0174] Having described exemplary embodiments of the present invention, it is further noted that it is readily apparent to those of ordinary skill in the art that various modifications may be made without departing from the spirit and scope of the invention which is defined by the metes and bounds of the appended claims.

1. An organic light emitting display apparatus comprising:

a plurality of first electrodes disposed in each of a plurality of pixels on a substrate;

a plurality of lower auxiliary electrodes insulated from the first electrodes, wherein the lower auxiliary electrodes are disposed in a first direction;

at least one organic layer disposed on the first electrodes;

a second electrode facing the first electrodes and covering the organic layer, wherein the second electrode is disposed on substantially an entire surface of the substrate; and

a plurality of upper auxiliary electrodes disposed on the second electrode in a second direction.

2. The organic light emitting display apparatus of claim **1**, wherein the second direction is perpendicular to the first direction.

3. The organic light emitting display apparatus of claim **1**, wherein the lower auxiliary electrodes are disposed in a line shape in the first direction, and

wherein the upper auxiliary electrodes are disposed in a line shape in the second direction crossing the lower auxiliary electrodes.

4. The organic light emitting display apparatus of claim **3**, wherein the lower auxiliary electrodes contact the second electrode in a region in which the lower auxiliary electrodes cross the upper auxiliary electrodes.

5. The organic light emitting display apparatus of claim **1**, wherein the lower auxiliary electrodes are disposed on a same layer as the first electrodes.

6. The organic light emitting display apparatus of claim **1**, further comprising a pixel define layer disposed between the first electrodes,

wherein the second electrode contacts each of the lower auxiliary electrodes through a contact hole in the pixel define layer.

7. The organic light emitting display apparatus of claim **1**, further comprising a plurality of organic layers disposed on the first electrodes in a line shape,

wherein the lower auxiliary electrodes are disposed in a line shape in a direction crossing the organic layers, and

wherein the upper auxiliary electrodes are disposed in a line shape between the organic layers adjacent to each other.

8. An organic light emitting display apparatus comprising:

a plurality of pixels each comprising a first electrode, a second electrode opposite to the first electrode, and at least one organic layer disposed between the first and second electrodes;

a plurality of lower auxiliary electrodes disposed under the second electrode and contacting the second electrode, wherein the lower auxiliary electrodes are disposed between at least one pixel column; and

a plurality of upper auxiliary electrodes disposed on the second electrode and contacting the second electrode, wherein the upper auxiliary electrodes are disposed between at least one pixel row.

9. The organic light emitting display apparatus of claim **1**, wherein the lower auxiliary electrodes are disposed in a line shape between the at least one pixel column, and

wherein the upper auxiliary electrodes cross the lower auxiliary electrodes and are disposed in a line shape between the at least one pixel row.

10. The organic light emitting display apparatus of claim **9**, wherein the lower auxiliary electrodes are disposed on a same layer as the first electrode, and

wherein the second electrode contacts each of the lower auxiliary electrodes through a contact hole in an insulating layer that is disposed on the first electrode and the lower auxiliary electrodes.

11. A method for manufacturing an organic light emitting display apparatus, the method comprising:

forming a plurality of first electrodes in each of a plurality of pixels on a substrate;

forming a plurality of lower auxiliary electrodes insulated from the first electrodes and in a first direction;

forming at least one organic layer on the first electrodes;

forming a second electrode facing the first electrodes and covering the organic layer on substantially an entire surface of the substrate; and

forming a plurality of upper auxiliary electrodes on the second electrode in a second direction.

12. The method of claim **11**, wherein the second direction is perpendicular to the first direction.

13. The method of claim **11**, wherein the lower auxiliary electrodes are disposed in a line shape in the first direction, and

wherein the upper auxiliary electrodes are disposed in a line shape in the second direction and cross the lower auxiliary electrodes.

14. The method of claim **11**, wherein the lower auxiliary electrodes contact the second electrode in a region in which the lower auxiliary electrodes cross the upper auxiliary electrodes.

15. The method of claim **11**, wherein the lower auxiliary electrodes are disposed on a same layer as the first electrodes.

16. The method of claim **11**, further comprising forming a pixel define layer between the first electrodes,

wherein the second electrode contacts each of the lower auxiliary electrodes through a contact hole in the pixel define layer.

17. The method of claim **11**, wherein the forming of the organic layer comprises continuously forming a plurality of organic layers on the first electrodes,

wherein the forming of the lower auxiliary electrodes comprises forming the lower auxiliary electrodes in a line shape in a direction crossing the organic layers; and

wherein the forming of the upper auxiliary electrodes comprises forming the upper auxiliary electrodes in a line shape between the organic layers adjacent to each other.

18. The method of claim **11**, wherein the forming of the organic layers comprises:

disposing the substrate so that the substrate is spaced a distance from an organic layer deposition apparatus; and

patterning a deposition material sprayed from the organic layer deposition apparatus on the substrate through a pattern slit sheet to form the organic layers while one of the organic layer deposition apparatus and the substrate is moved with respect to the pattern slit sheet.

19. The method of claim **18**, wherein the forming of the lower auxiliary electrodes comprises patterning a deposition material sprayed from the organic layer deposition apparatus on the substrate through a pattern slit sheet to form the lower auxiliary electrodes while one of the organic layer deposition apparatus and the substrate is moved with respect to the pattern slit sheet.

20. The method of claim **19**, wherein the forming of the upper auxiliary electrodes comprises:

rotating the substrate in a vertical direction; and

patterning a deposition material sprayed from the organic layer deposition apparatus on the substrate through a pattern slit sheet to form the upper auxiliary electrodes while one of the organic layer deposition apparatus and the substrate is moved with respect to the pattern slit sheet.

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摘要(译)

一种有机发光显示装置，包括：多个第一电极，设置在基板上的多个像素中的每个像素中;多个下辅助电极，与第一电极绝缘，并且下辅助电极沿第一方向设置;有机层设置在第一电极上，第二电极面对第一电极并覆盖有机层。第二电极设置在基板的基本上整个表面上。有机发光显示装置还包括沿第二方向设置在第二电极上的多个上辅助电极。