An embodiment of this document provides a deposition apparatus for an organic electroluminescent display device, comprising a vacuum chamber, a deposition source placed on a bottom within the vacuum chamber, a mask configured to mask a source generated by the deposition source, a target substrate on which the source passing through the mask is deposited, a first plate placed on an upper side within the vacuum chamber, wherein magnets are arranged with them being spaced apart from each other on one side of the first plate, and a second plate placed below the first plate, wherein grooves into which the respective magnets are inserted are formed in the second plate.

135 shall be pointed to other magnets in Figs. 2-3 and Figs. 5-15.
135 shall be pointed to other magnets in Figs. 2-3 and Figs. 5-15.
### Fig. 4

<table>
<thead>
<tr>
<th>Case</th>
<th>Valid Area</th>
<th>Number of Magnets</th>
<th>Magnet Area Ratio</th>
<th>Total Number of Magnets</th>
<th>Surface Magnetic Force</th>
<th>Unit MDF (3 mm)</th>
<th>Total Force</th>
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</table>
Fig. 7

case 3

Fig. 8

case 4
Fig. 11

case 7

Fig. 12

case 8
Fig. 13

case 9

Fig. 14

case 10
### Fig. 18

<table>
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<tr>
<th>Unit:um</th>
<th>Case1</th>
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<td>L2</td>
<td>L1</td>
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DEPOSITION APPARATUS FOR ORGANIC ELECTROLUMINESCENT DISPLAY DEVICE

RELATED APPLICATIONS

[0001] This application claims the benefit of Korean Patent Application No. 10-2009-0004844 filed on Jan. 21, 2009, which is hereby incorporated by reference.

BACKGROUND

[0002] 1. Field
[0003] An embodiment of this document relates to a deposition apparatus for an organic electroluminescent display device.
[0004] 2. Related Art
[0005] An organic electroluminescent display device is a display device using an organic electroluminescent element in which a light-emitting layer is formed between two electrodes. The organic electroluminescent element is an emissive display configured to display an image by driving N×M organic light-emitting diodes (OLEDs) arranged in a matrix form. The organic electroluminescent display device may be divided into a passive matrix-type display and an active matrix-type display using thin film transistors.
[0006] The organic electroluminescent element may be fabricated by performing a process of forming wirings and electrodes, a process of forming an insulating layer, a process of depositing an organic material, etc., and then performing an encapsulation process including a process of forming a passivation layer, and so on. The process of forming the electrodes, the process of depositing the organic material, etc., are for the most part performed within a vacuum chamber. Here, in order to deposit material only on a specific portion of a target substrate, an apparatus, such as a mask, is generally used. When the deposition process is performed, an apparatus, such as a plate in which magnets are arranged, is used so that the target substrate is closely adhered to the mask.
[0007] However, a conventional deposition apparatus requires a scheme capable of solving a problem that, because of a difference in the intensity of magnetism of the magnets arranged in the plate, apparatuses are deformed when the target substrate is attached to or detached from the mask or shadowing is generated because of a weaken force to pull the mask.

BRIEF SUMMARY

[0008] An embodiment of this document provides a deposition apparatus for an organic electroluminescent display device. The deposition apparatus comprises a vacuum chamber, a deposition source placed on a bottom within the vacuum chamber, a mask configured to mask a source generated by the deposition source, a target substrate on which the source passes through the mask is deposited, a first plate placed on an upper side within the vacuum chamber, wherein magnets are arranged with them being spaced apart from each other on one side of the first plate, and a second plate placed below the first plate, wherein grooves into which the respective magnets are inserted are formed in the second plate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The accompany drawings, which are included to provide a further understanding of this document and are incorporated on and constitute a part of this specification illustrate embodiments of this document and together with the description serve to explain the principles of this document.

[0010] FIG. 1 shows the construction of a deposition apparatus according to an embodiment of this document;
[0011] FIGS. 2 and 3 are partially enlarged views of elements shown in FIG. 1;
[0012] FIG. 4 shows experimental data according to the arrangement of magnets;
[0013] FIGS. 5 to 15 are exemplary views showing the arrangement of magnets every case in FIG. 4;
[0014] FIG. 16 is a graph showing the property of MDF according to FIGS. 5 to 8;
[0015] FIG. 17 is a graph showing the property of MDF according to FIGS. 9 to 15;
[0016] FIG. 18 is a diagram showing deposition pattern data according to the arrangement of magnet polarities;
[0017] FIG. 19 is an exemplary view showing the configuration of a mask according to a measurement criterion;
[0018] FIG. 20 is an exemplary view showing measurement positions; and
[0019] FIGS. 21 and 22 are exemplary views showing the arrangement of magnets according to the embodiment of this document.

DETAILED DESCRIPTION OF THE DRAWINGS AND THE PRESENTLY PREFERRED EMBODIMENTS

[0020] Reference will now be made in detail embodiments of this document examples of which are illustrated in the accompanying drawings.

[0021] A specific embodiment of this document is described below with reference to the accompanying drawings.

[0022] Referring to FIGS. 1 to 3, a deposition apparatus according to an embodiment of this document may comprise a vacuum chamber 110, a deposition source 120, a mask 160, a target substrate 150, a second plate 140, and a first plate 130.

[0023] The deposition source 120 may be placed on the bottom within the vacuum chamber 110. A source S contained within the deposition source 120 may be heated by heating means, etc., and evaporated and sublimated.

[0024] The mask 160 may comprise openings and cutoff units so that the source S, evaporated or sublimated from the deposition source 120 placed under the vacuum chamber 110, is selectively deposited on the target substrate 150. The number of openings may correspond to the number of subpixels to be deposited on the target substrate 150, but not limited thereto. For example, the mask 160 may further comprise dummy openings for increasing deposition efficiency. Meanwhile, the above-described mask 160 may be assembled with a frame and then arranged along with the target substrate 150. The mask 160 and the frame may be made of material which reacts on magnetic force.

[0025] The target substrate 150 may comprise a magnetic substrate or material which reacts on magnetic force. For example, SUS 430 (i.e., Stainless Steel Material (SUS) such as one of materials of magnetic substrates) may be effectively adhered to magnets 135 arranged in the first plate 130 and functions to shield magnetic force. 36Alloy Invar, 42Alloy, SUS410, or SUS420 may be used as the magnetic substrate.

[0026] Meanwhile, elements formed in the target substrate 150 may comprise passive matrix-type or active matrix-type organic electroluminescent elements.
The first plate 130 is placed at the top within the vacuum chamber 110, and the magnets 135 spaced apart from each other are arranged on one side of the first plate 130. The first plate 130 may have a yoke shape in order to improve magnetic force.

The second plate 140 is placed below the first plate 130. Grooves H into which the respective magnets 135 are inserted are formed in the second plate 140. The shape of each of the grooves H formed in the second plate 140 may be identical to that of the magnets 135. The second plate 140 functions to support the target substrate 150 pulled by the magnets 135. If the thickness of the second plate 140 is too thin, the second plate 140 may be deformed too easily. If the thickness of the second plate 140 is too thick, the second plate 140 may not function to pull the mask 160 because the distance between the magnets 135 and the mask 160 is too wide. Accordingly, in order to prevent the deformation of the second plate 140 and maintain magnetic force to the extent that the mask 160 may be pulled, the grooves H into which the respective magnets 135 are inserted are formed in the second plate 140. Here, the grooves H formed in the second plate 140 may only have a size and shape which enable the magnets 135 to be inserted into the magnets 135.

The arrangement of the magnets is described below.

In experimental data, cases 1 to 4 show data according to the distance between the magnets, and cases 5 to 11 show data according to the number of magnets.

From the data of the cases 1 to 4, it can be seen that surface magnetic force decreases when the distance between the magnets increases. It can also be seen that magnet detach force (MDF) to detach the magnets is proportional to the number of the magnets, but is not related to the distance between the magnets. However, the MDF may differ when the magnets are arranged with them being brought in contact with each other.

From the data of the cases 5 to 11, it can be seen that surface magnetic force increases when the number of magnets increases and the MDF also increases when the number of magnets increases. It can be seen that the MDF increases when the arrangement of the magnets is close to a regular quadrilateral.

It can be seen that a difference between the MDF according to the distance between the magnets and the MDF according to the number of magnets, as in the above-described cases 1 to 4, has a tendency as shown in FIGS. 16 and 17.

FIG. 18 is a diagram showing deposition pattern data in the case where the magnets having the N polarity and the S polarity are alternately arranged with them being spaced apart from each other. From the data shown in FIG. 18, it can be seen that, if the magnets having the N polarity and the S polarity are alternately arranged with them being spaced apart from each other, the shadowing problem can be solved because coalescence between the plates and the mask increases. From the data of FIG. 18, it can be seen that a case 1 has the best condition. Although not shown in the drawing, it was found that in the case where the magnets having either the N polarity or the S polarity were arranged with them being spaced apart from each other, a mask was lifted off because of local polarity formed by the magnetism of the mask, resulting in a severe shadowing problem upon deposition.

A method of arranging the magnets based on the experimental results is described below.

Referring to FIGS. 21 and 22, when the magnets 135 are arranged on one side of the first plate 130, the shape of the magnet may have a tetrahedron, a polyhedron, or a cylinder. Here, the magnets 135 having opposite polarities are alternately arranged with them being spaced apart from each other.

According to the above-described experimental data, force applied to the second plate 140 when the target substrate 150 is detached therefrom is proportional to the number of magnets 135 arranged on the first plate 130, and the magnetic force of the magnets 135 is related to the arrangement of the magnets. Accordingly, if the arrangement of the magnets 135 is optimized when the target substrate 150 is detached from the second plate 140, force applied to the second plate 140 can be reduced greatly. Consequently, the second plate 140 and other elements can be prevented from being deformed.

Optimized conditions when the magnets are arranged are described below with reference to the conditions obtained according to the experiments.

As described above, the magnetic force of the magnets 135 arranged in the first plate 130 has a great effect on the second plate 140 and other elements. Accordingly, when the magnets 135 are arranged, a condition to minimize the MDF and secure surface magnetic force is required.

As a result of analyzing the experimental data according to the cases 1 to 11, it could be seen that, if the magnets are arranged at a distance of ‘a’ to ‘2a’ when the length of the magnet is ‘a’, the MDF and the surface magnetic force can be performed effectively. Thus, assuming that the length of the magnet is ‘a’, first and second magnets having a distance “L1” or “L2” therebetween may be arranged according to the rules corresponding to the length ‘a’ or ‘2a’. In this experiment, an SUS 430 substrate was used as the target substrate 150, and an optimal condition was obtained when the length ‘a’ of the magnet was 10 mm.

Meanwhile, this experiment showed that, when the distance between the magnets was ‘a’ or less, excessive force was applied to the elements when the target substrate 150 was attached to or detached from the mask 160 because the number of magnets was too many. From this experiment, it could be also seen that, when the distance between the magnets was ‘2a’ or more, it was difficult to secure a process property because the magnets 135 did not have magnetic force enough to pull the mask 160. For the above reasons, when the magnets 135 are arranged in the first plate 130, the magnets 135 are arranged at the distance of ‘a’ to ‘2a’ based on the length ‘a’ corresponding to the length of the magnet.

On the other hand, although not shown in the drawing, according to an experiment using an SUS 430 as the target substrate 150 under the above condition, it was found that, when the thickness of the second plate 140 was set to 15 mm, the depth of the groove H into which the magnet 135 would be inserted was set to 12 mm, and the length of the groove H was set to 11 mm in order to realize the magnetic force of 200 G, the deformation of the second plate 140 could be reduced and an optimal condition capable of securing magnetic force could be obtained.

As described above, the magnetic force of the magnets 135 arranged in the first plate 130 is concerned with not only the distance between the magnets, but also the polarity between the magnets.
From the analysis result of the experimental data, it was found that, when the magnets 135 were arranged in the lattice structure of the N polarity and the S polarity, the shadowing problem resulting from the mask 160 could be solved because coalescence between the elements arranged within the vacuum chamber 110 was increased, thereby being capable of improving deposition efficiency. However, it was found that, when the magnets 135 having either only the N polarity or the S polarity were arranged in the first plate 130, the mask 160 was lift off because of magnetic force locally formed by the magnetism of the mask 160 and so the shadowing problem resulting from the mask 160 became worse, thereby degrading deposition efficiency. For the above reasons, the magnets 135 having opposite polarities are alternately arranged in the first plate 130 with them being spaced apart from each other.

As described above, the magnetic force of the magnets 135 arranged in the first plate 130 is related to the shape of the magnet.

From the analysis result of the above experimental data, it was found that the MDF is concerned with the shape of the magnet 135. It was found that, when the shape of the magnet was a polyhedron (i.e., a tetrahedron or more), the strength of magnetic force was strong near the edges of the polyhedron. Accordingly, when the shape of the magnet was close to a regular quadrilateral, the MDF was increased and so stronger force was applied to the elements. However, when the shape of the magnet was a cylinder, force applied to the elements was reduced because the surface area of the magnet was reduced and so the MDF could be reduced when the target substrate 150 was attached to or detached from the mask 160. Accordingly, the magnets 135 arranged on the second plate 140 may have a polyhedron (i.e., a tetrahedron or more) or a cylindrical shape. However, the magnets 135 may have a cylindrical shape because the magnets 135 having the cylindrical shape may have better effects than those of the magnets 135 having the tetrahedron.

As described above, the embodiment of this document is advantageous in that it can provide the depression apparatus for an organic electroluminescent display device, which is capable of solving the shadowing problem resulting from the hang of the target substrate when the elements placed in the vacuum chamber are aligned or the deformation problem of the elements.

The foregoing embodiments and advantages are merely exemplary and are not to be construed as limiting this document. The present teaching can be readily applied to other types of apparatuses. The description of the foregoing embodiments is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art. In the claims, means-plus-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents but also equivalent structures. Moreover, unless the term "means" is explicitly recited in a limitation of the claims, such limitation is not intended to be interpreted under 35 USC 112(6).

1. A deposition apparatus for an organic electroluminescent display device, comprising:
   a vacuum chamber;
   a deposition source placed on a bottom within the vacuum chamber;
   a mask configured to mask a source generated by the deposition source;
   a target substrate on which the source passing through the mask is deposited;
   a first plate placed on an upper side within the vacuum chamber, wherein magnets are arranged with them being spaced apart from each other on one side of the first plate; and
   a second plate placed below the first plate, wherein grooves into which the respective magnets are inserted are formed in the second plate.

2. The deposition apparatus of claim 1, wherein when a length of the magnet is 'a', the magnets are arranged at a distance of 'a' to '2a'.

3. The deposition apparatus of claim 2, wherein the length of the magnet 'a' is 10 mm.

4. The deposition apparatus of claim 1, wherein the magnets having opposite polarities are alternately arranged.

5. The deposition apparatus of claim 1, wherein a shape of each of the magnets is a cylinder.

6. The deposition apparatus of claim 1, wherein a shape of each of the magnets is a tetrahedron.

7. The deposition apparatus of claim 1, wherein a shape of each of the magnets is a polyhedron.

8. The deposition apparatus of claim 1, wherein a shape of each of the grooves is identical to that of each of the magnets.

9. The deposition apparatus of claim 1, wherein the target substrate comprises a magnetic substrate.

10. The deposition apparatus of claim 1, wherein in the case where the target substrate is made of SUS 430, a thickness of the second plate is 15 mm, a depth of the groove is 12 mm, and a length of the groove is 11 mm.

* * * * *