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(54) **RESTRICTION UNIT, VAPOR DEPOSITION DEVICE, PRODUCTION METHOD FOR VAPOR DEPOSITION FILM, PRODUCTION METHOD FOR ELECTROLUMINESCENCE DISPLAY DEVICE, AND ELECTROLUMINESCENCE DISPLAY DEVICE**

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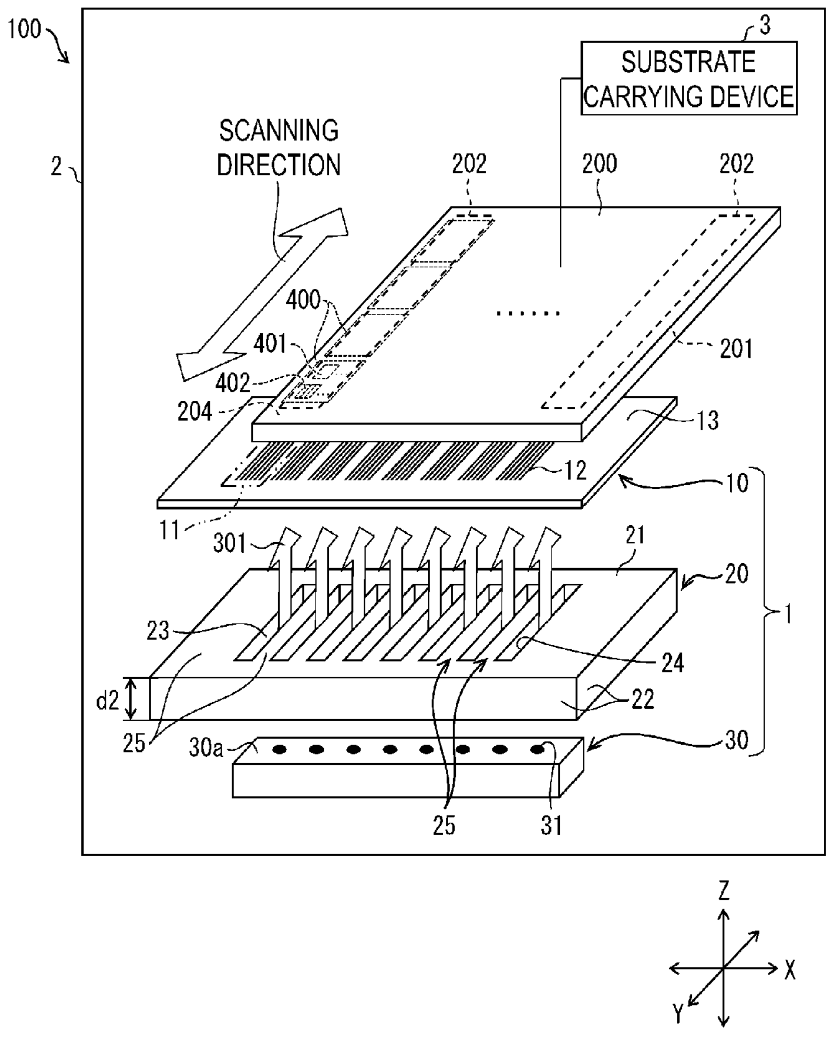
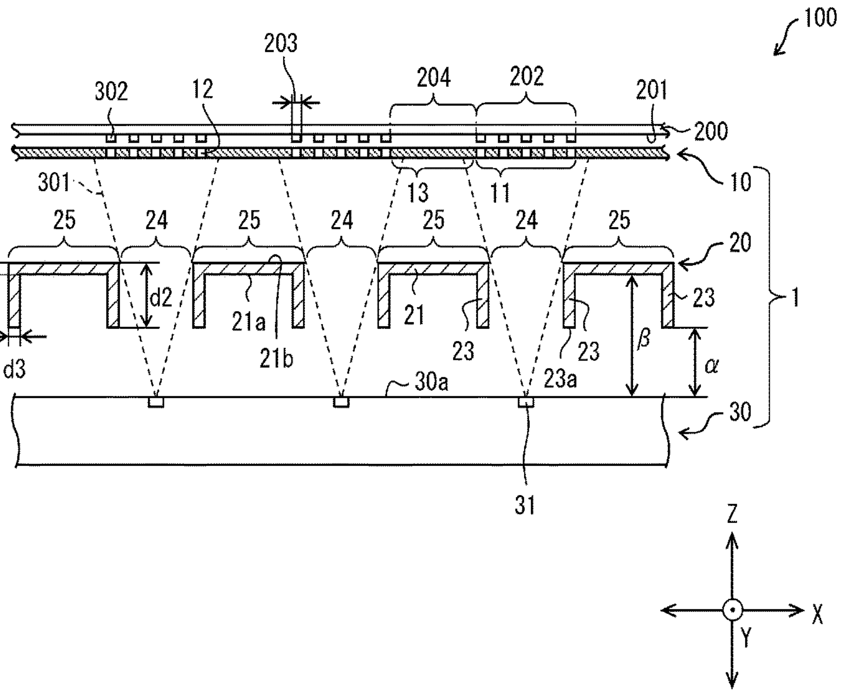
(57) **ABSTRACT**

A restriction unit includes at least one restriction opening configured to allow vapor deposition particles to pass through and a plurality of restriction sections prepared at both sides of the restriction opening. The restriction section has a cross-sectional shape of an inverse concave formed of a top wall and opening walls.





100
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202
302
12
201
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301
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d1
d2
21a
21
23
1
d3
21b
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23
β
α
30a
23a
30
31
Z
X
Y

FIG. 1

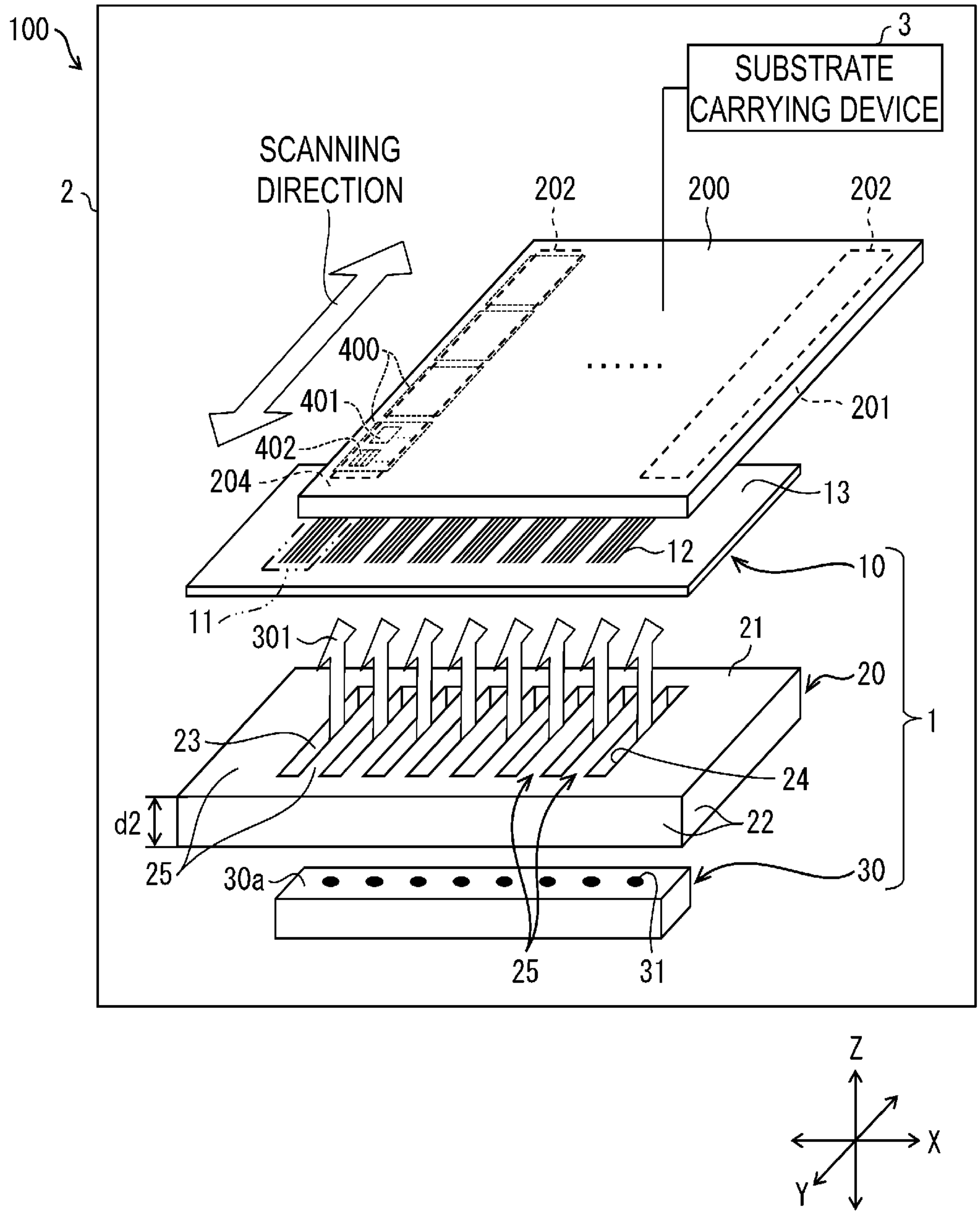

100
3
SUBSTRATE CARRYING DEVICE
SCANNING DIRECTION
2
202
200
202
400
401
402
204
201
13
12
10
11
301
21
20
23
24
1
d2
22
25
30a
30
25
31
Z
X
Y

FIG. 2

FIG. 3A

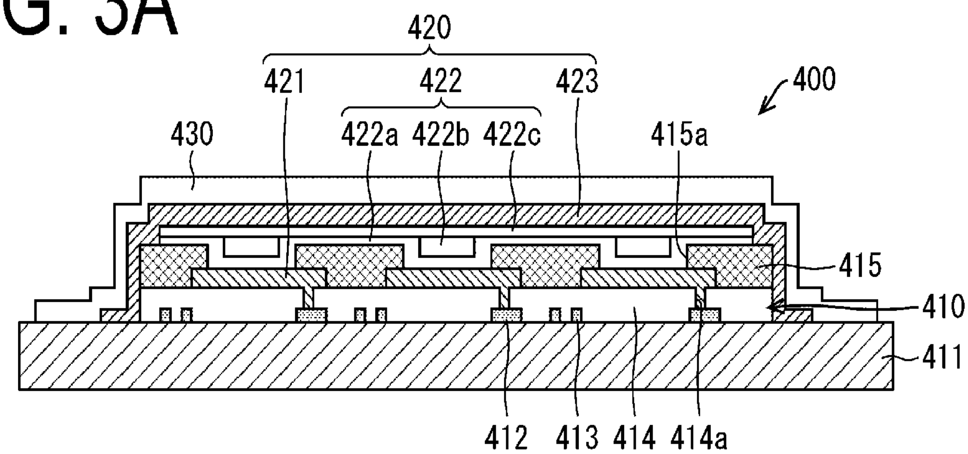
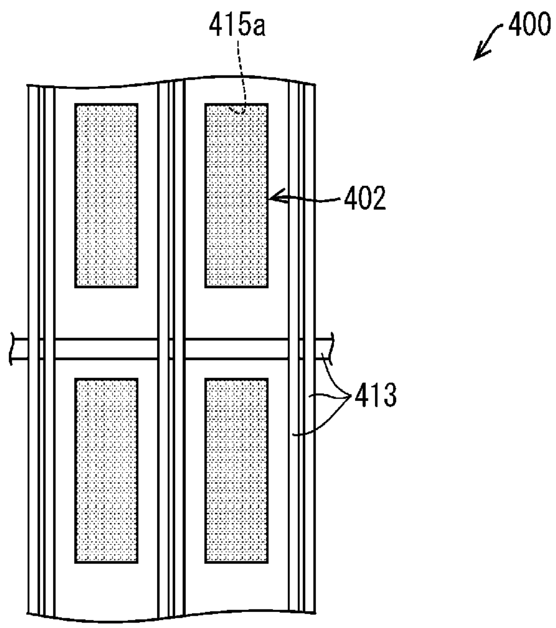

420
421
422
423
400
430
422a 422b 422c
415a
415
410
411
412 413 414 414a

FIG. 3B


415a
400
402
413

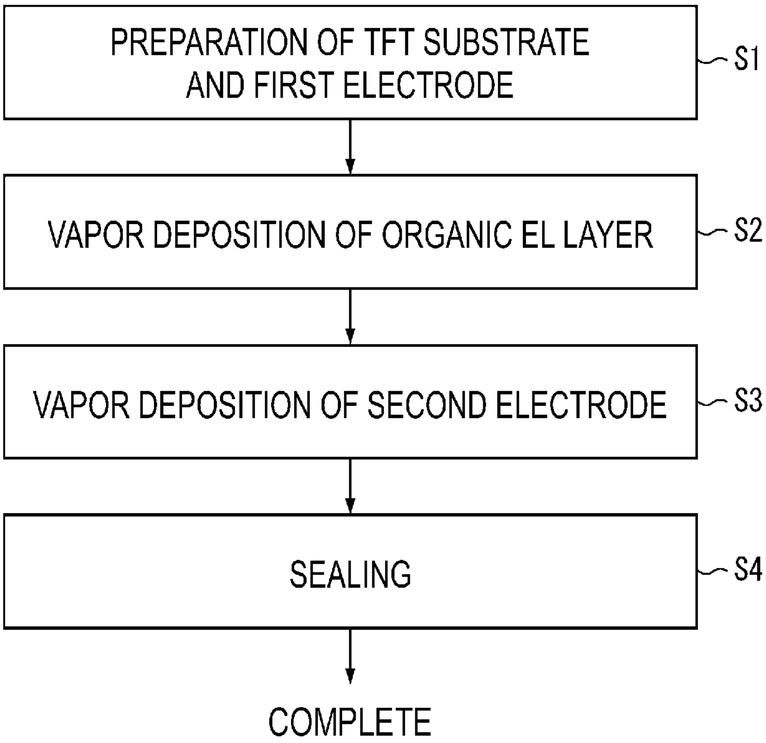
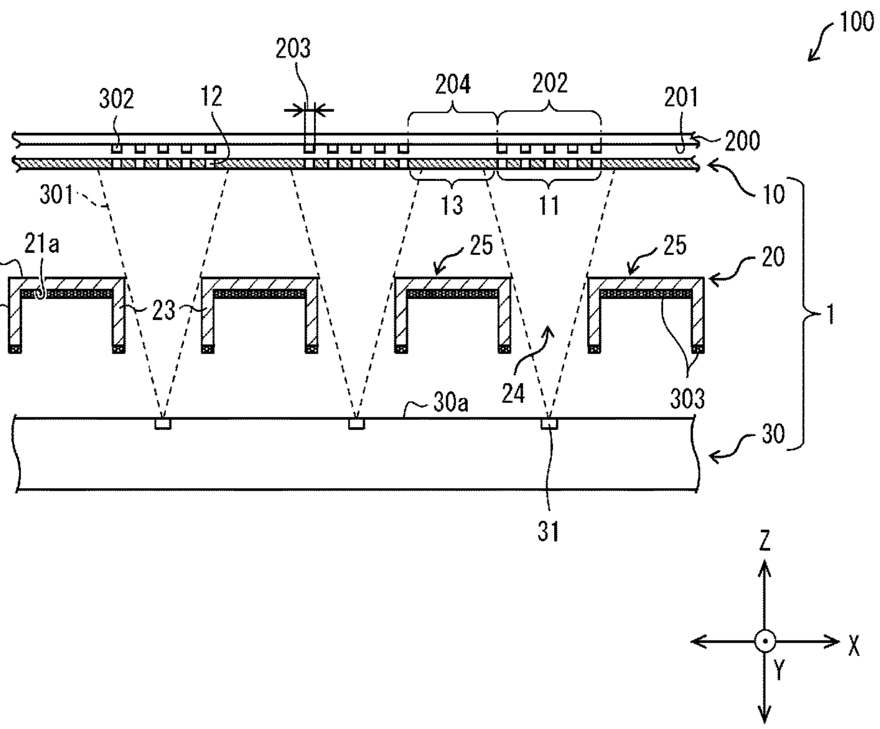

PREPARATION OF TFT SUBSTRATE
AND FIRST ELECTRODE
S1
VAPOR DEPOSITION OF ORGANIC EL LAYER
S2
VAPOR DEPOSITION OF SECOND ELECTRODE
S3
SEALING
S4
COMPLETE

FIG. 4



100
203
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12
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301
13
11
21b
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21
23
1
24
303
30a
30
31
Z
X
Y

FIG. 5

FIG. 6A

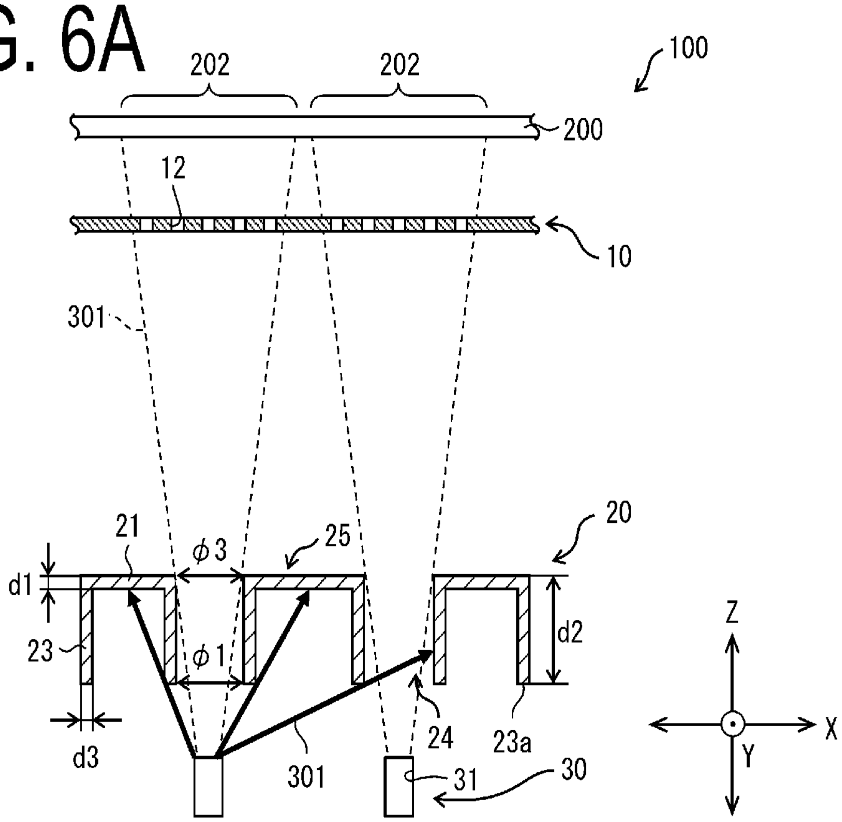
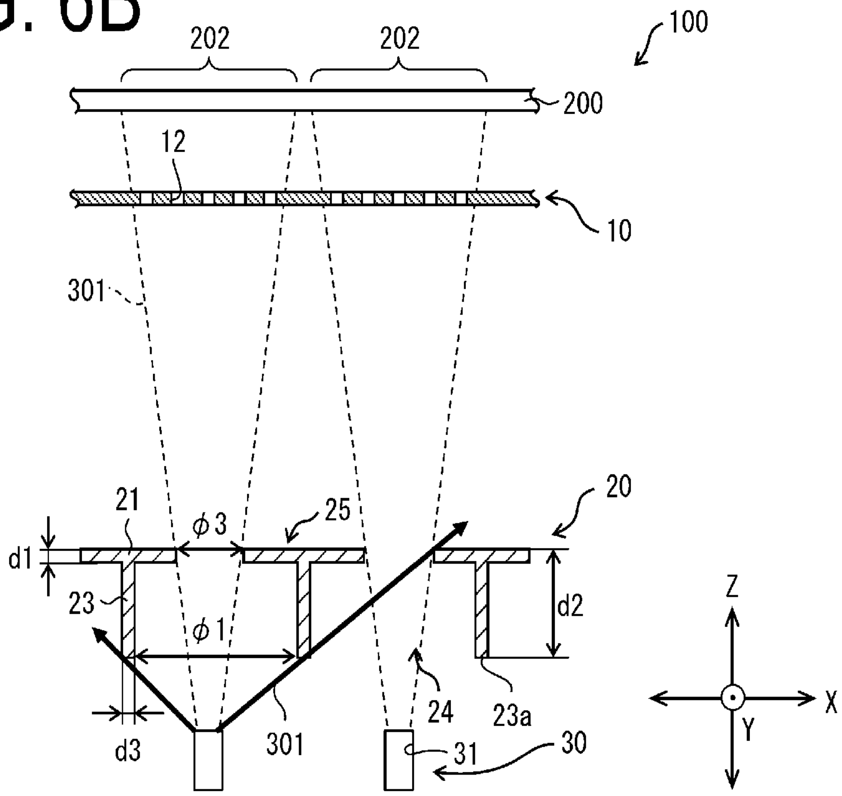

100
202
202
200
12
10
301
20
21
ϕ3
25
d1
d2
23
ϕ1
Z
24
23a
X
d3
Y
301
31
30

FIG. 6B


100
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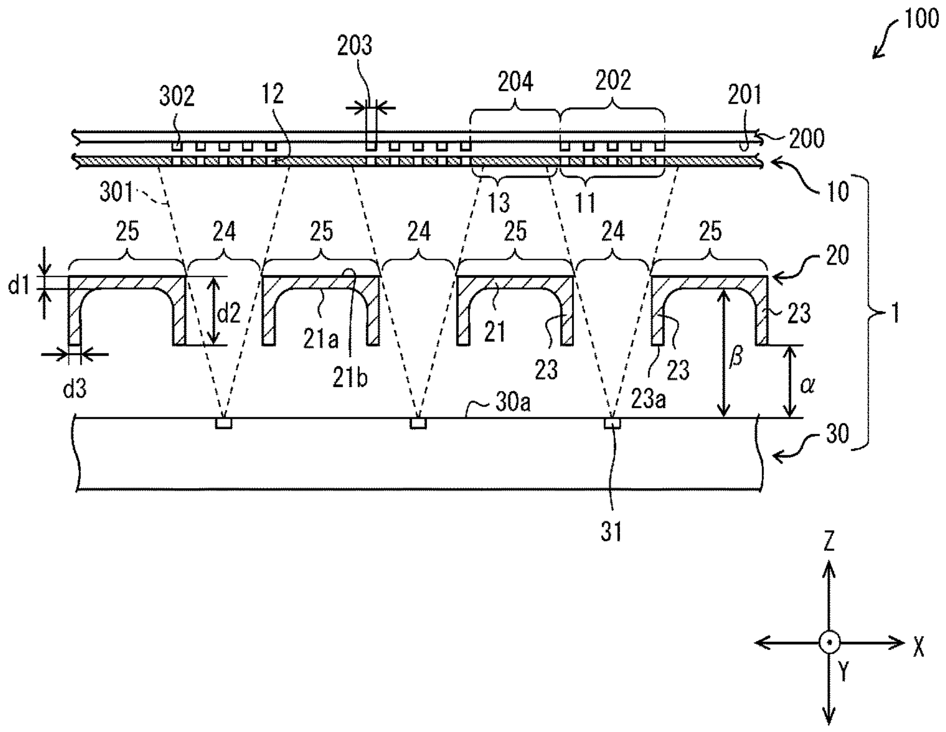
d3
Y
301
31
30


100
203
204
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302
12
201
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301
10
13
11
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d1
d2
21a
21b
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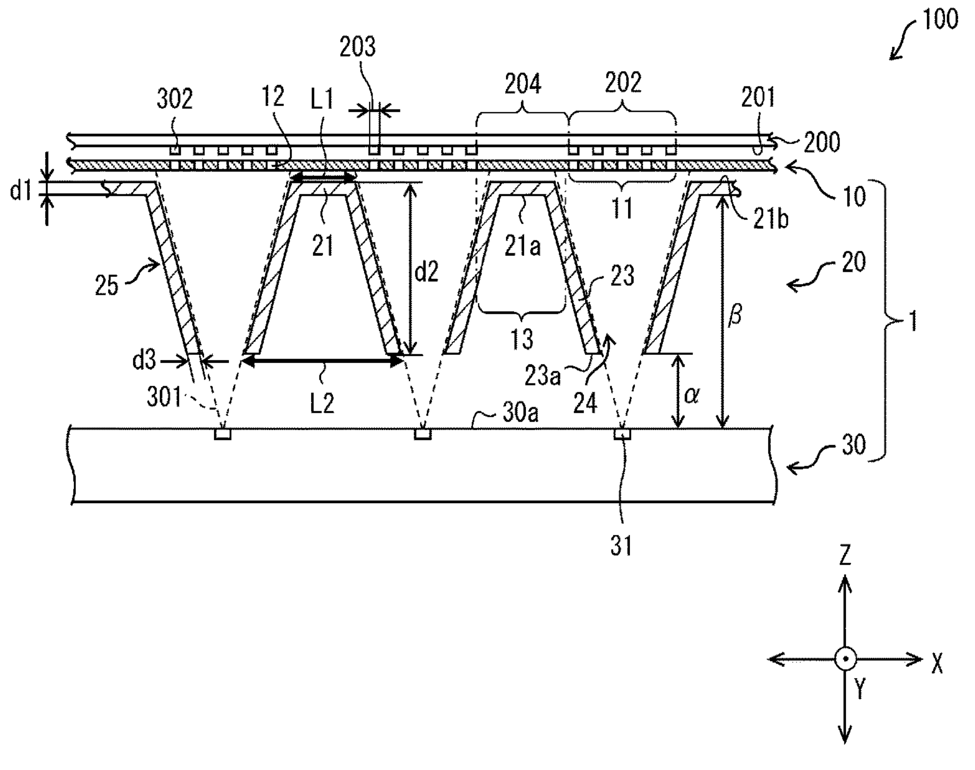
23
23
1
d3
β
α
23a
30a
30
31
Z
X
Y

FIG. 7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302
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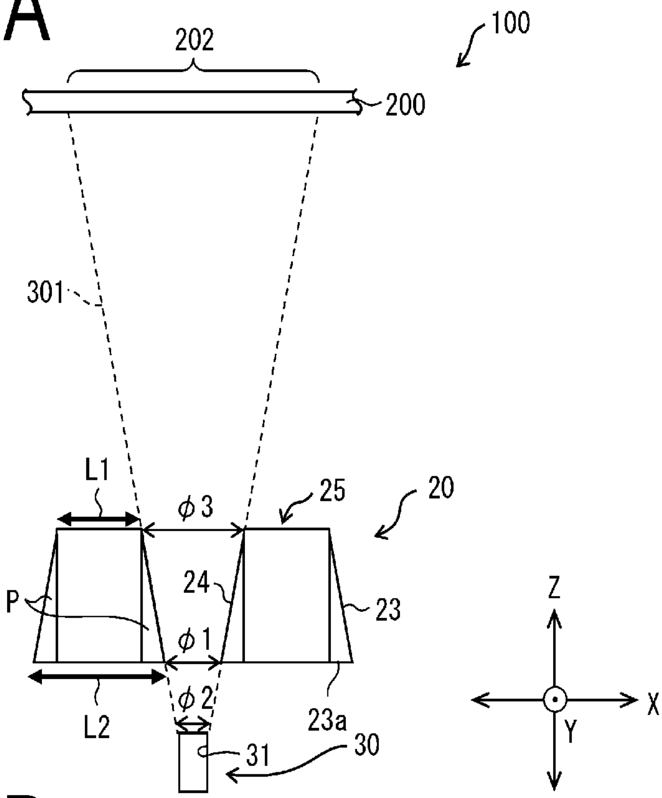
L1
201
200
10
d1
11
21b
21
21a
23
20
d2
25
β
1
13
d3
23a
α
L2
301
24
30a
30
31
Z
X
Y

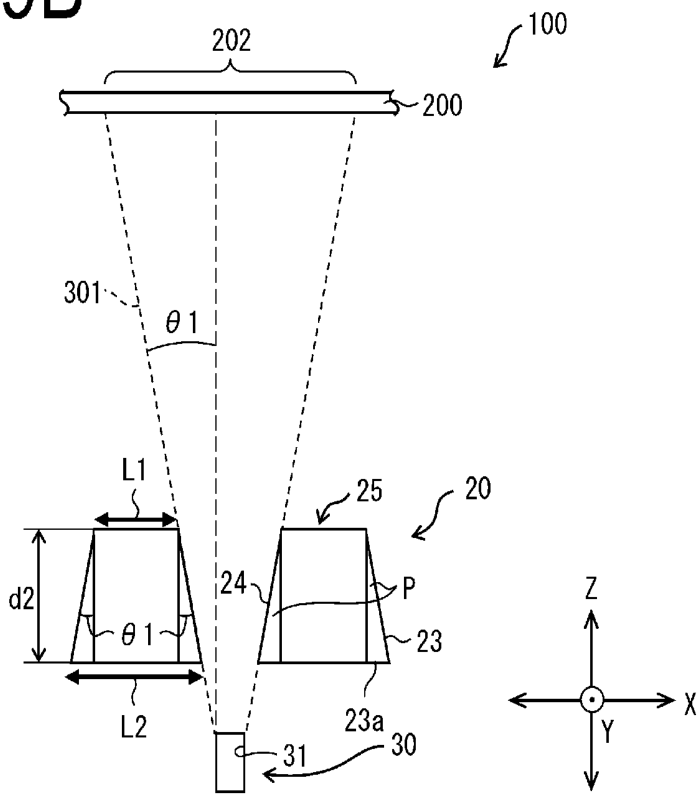
FIG. 8

FIG. 9A



202
100
200
301
L1
ϕ3
25
20
24
P
23
ϕ1
L2
ϕ2
23a
31
30
Z
X
Y

FIG. 9B



202
100
200
301
θ1
L1
25
20
d2
24
P
θ1
23
L2
23a
31
30
Z
X
Y

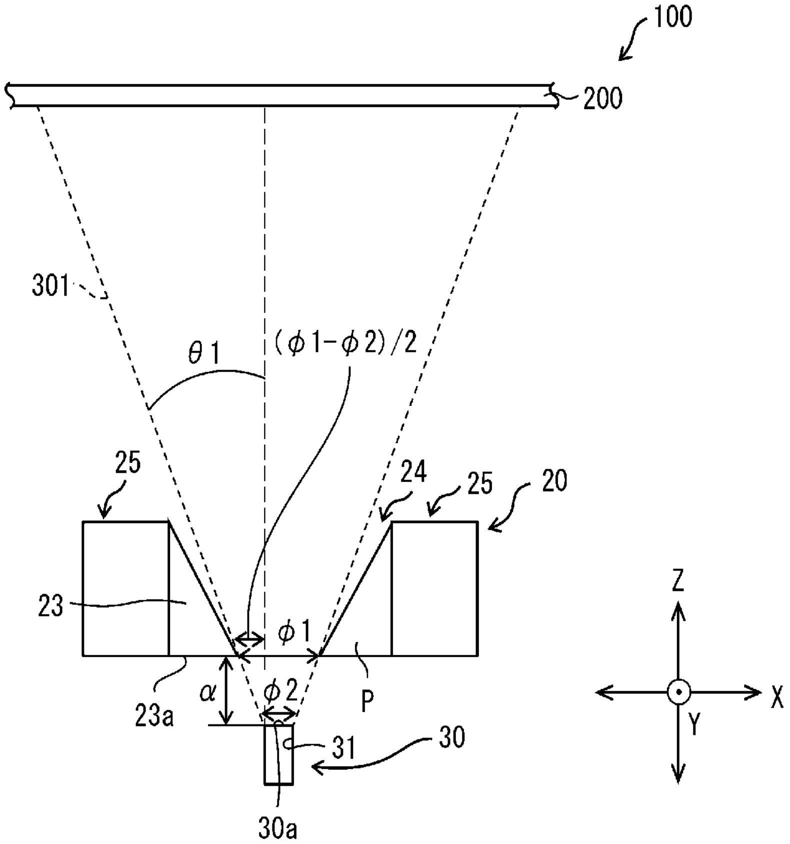


FIG. 10

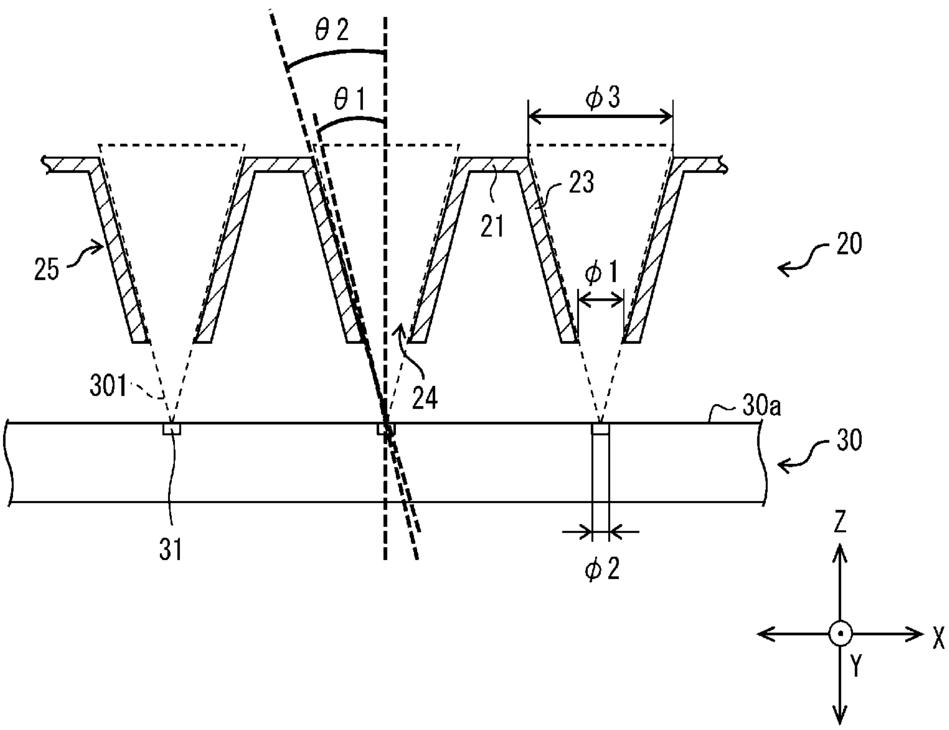


FIG. 11

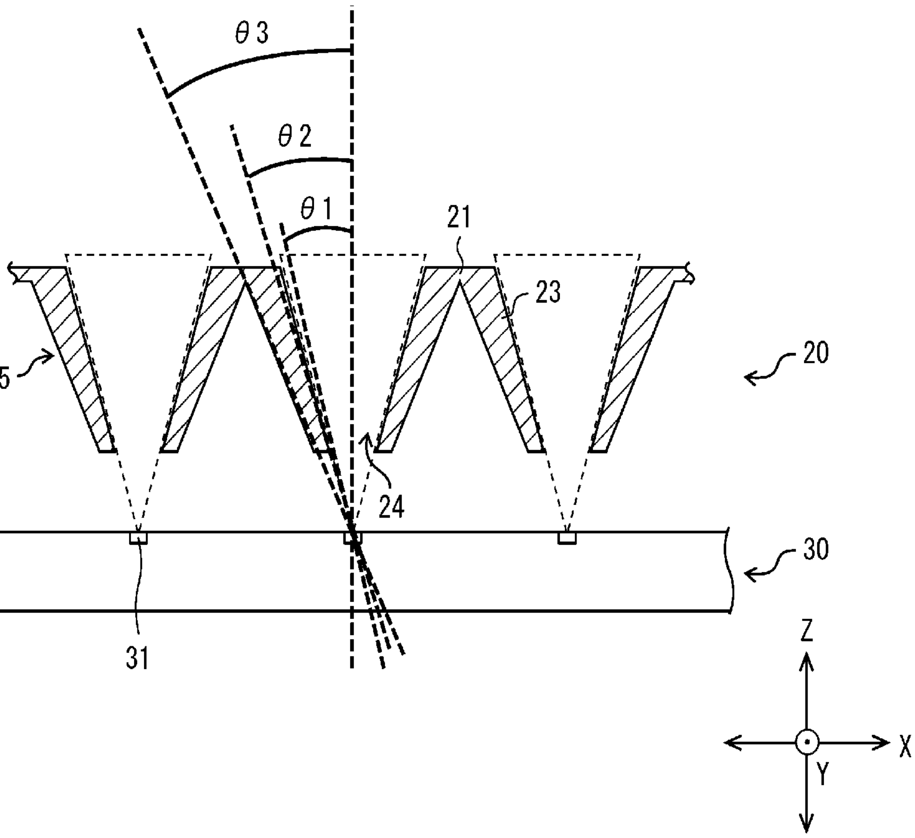
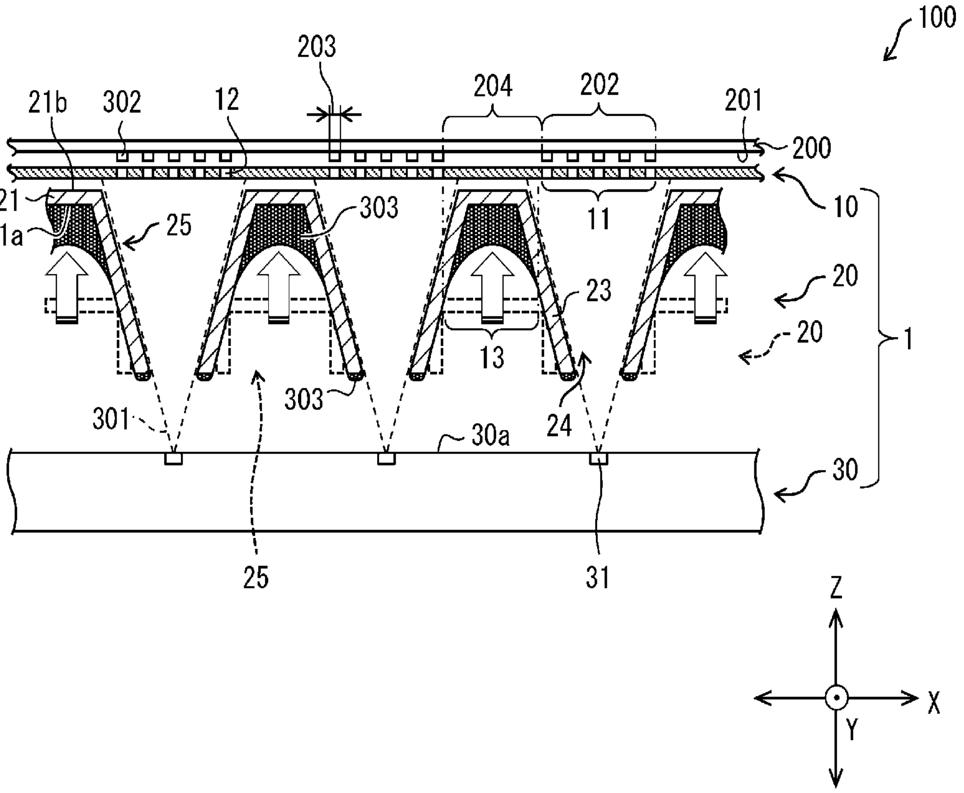


FIG. 12


100
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303
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301
30a
30
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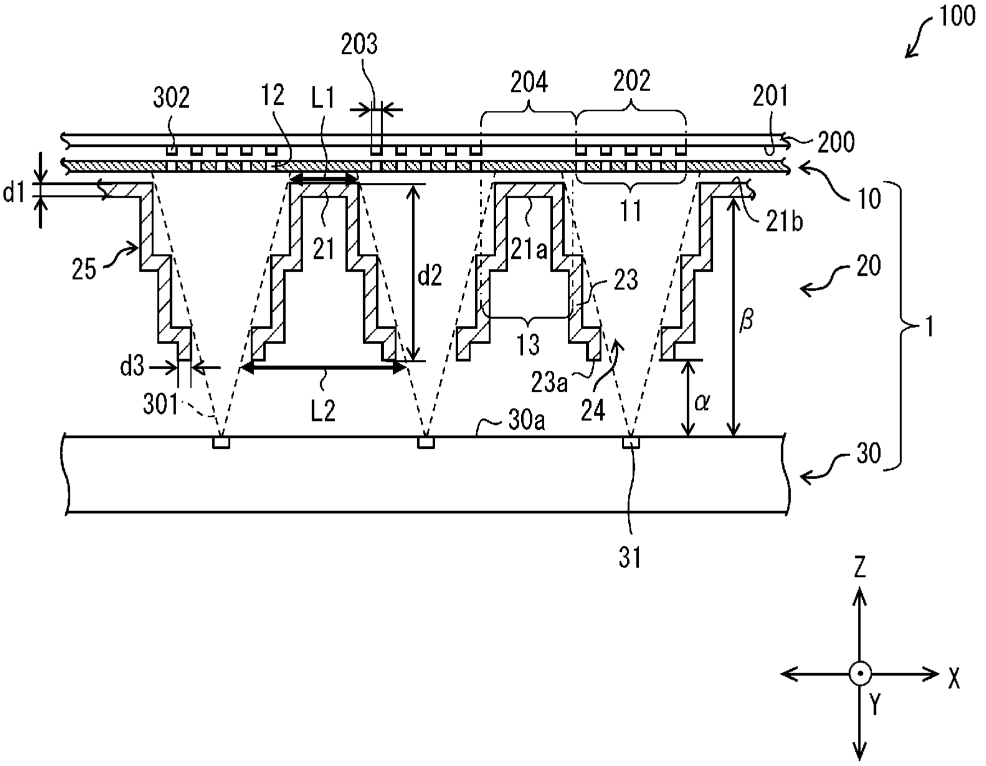
X
Y

FIG. 13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301
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30a
30
31
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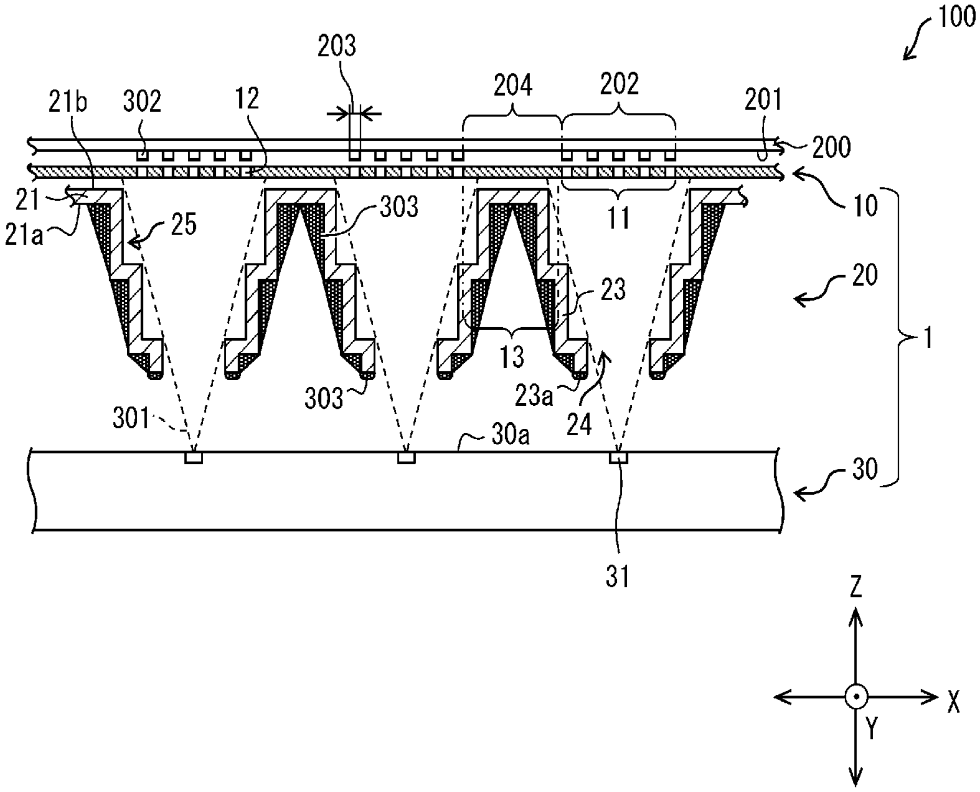
FIG. 14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21a
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23a
303
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301
30a
30
31
Z
X
Y

FIG. 15

FIG. 16A

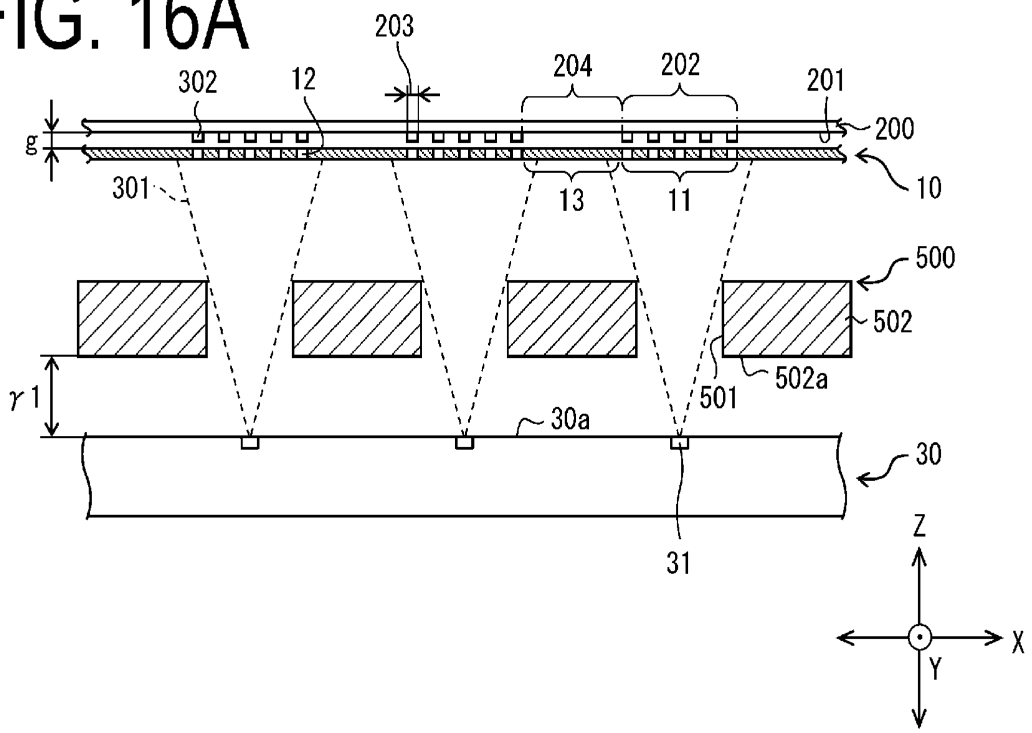
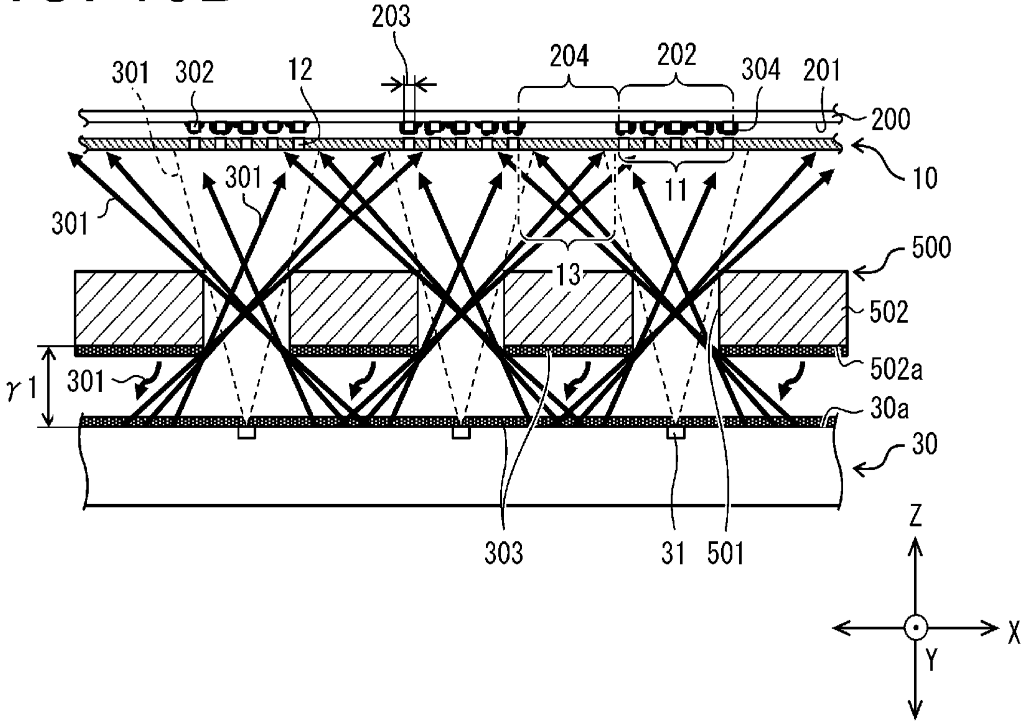


FIG. 16B



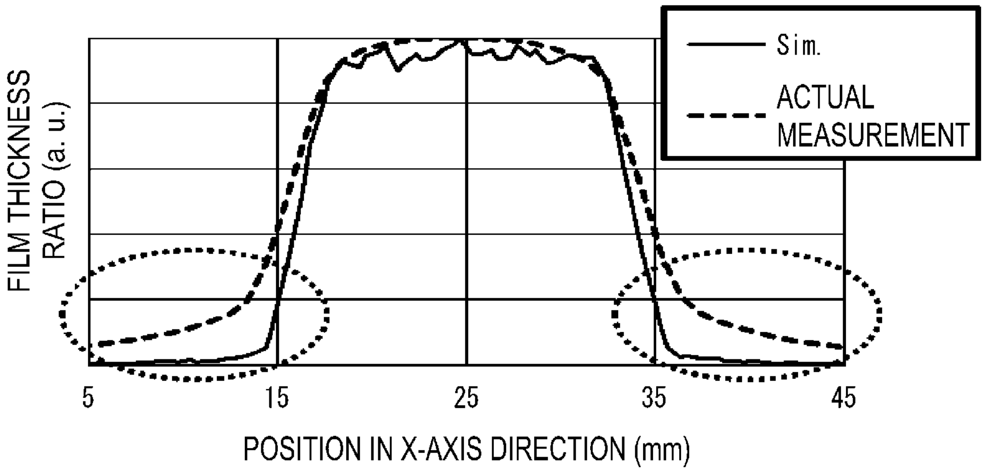
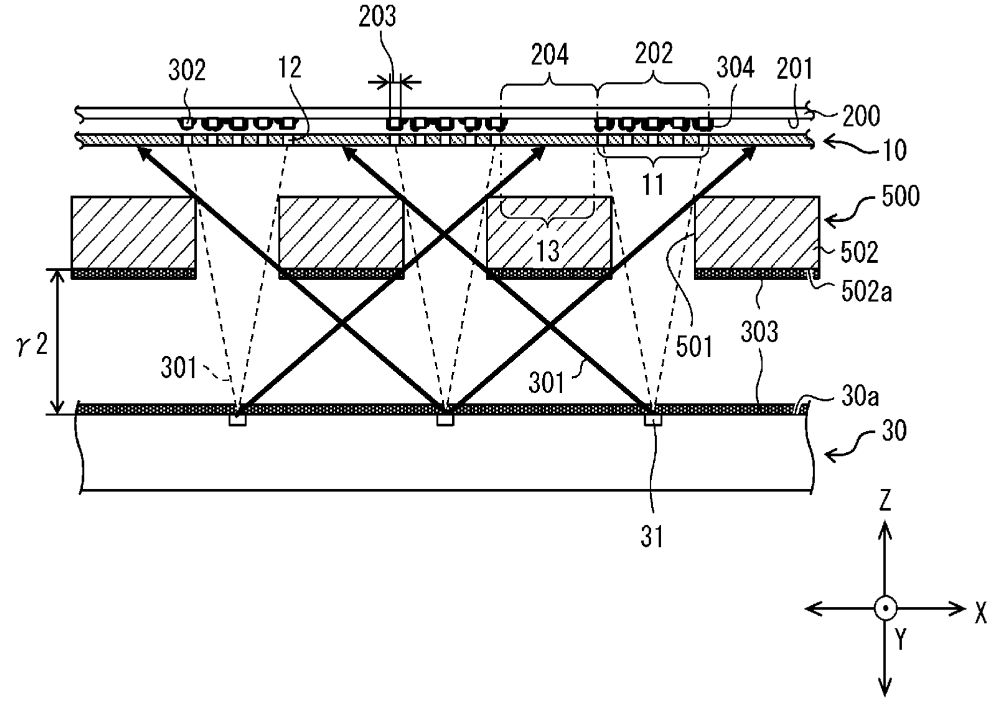

FILM THICKNESS RATIO (a. u.)
Sim.
ACTUAL MEASUREMENT
5
15
25
35
45
POSITION IN X-AXIS DIRECTION (mm)

FIG. 17



203
204
202
302
12
304
201
200
10
11
500
13
502
502a
γ2
303
501
301
301
30a
30
31
Z
X
Y

FIG. 18

RESTRICTION UNIT, VAPOR DEPOSITION DEVICE, PRODUCTION METHOD FOR VAPOR DEPOSITION FILM, PRODUCTION METHOD FOR ELECTROLUMINESCENCE DISPLAY DEVICE, AND ELECTROLUMINESCENCE DISPLAY DEVICE

TECHNICAL FIELD

[0001] The present disclosure relates to a restriction unit configured to restrict the passage of vapor deposition particles at a time of forming a vapor deposition film of a predetermined pattern on a target film forming substrate, a vapor deposition device including the restriction unit, a production method for a vapor deposition film for producing a vapor deposition film by using the vapor deposition device, a production method for an electroluminescence display device, and the electroluminescence display device.

BACKGROUND ART

[0002] An electro luminescence (hereinafter, "electro luminescence" is referred to as "EL") display device equipped with an EL element making use of EL of an organic or inorganic material is a complete solid-state device, has self-luminosity, and is excellent in terms of low voltage driving and high responsiveness; such EL display device has been developed as a candidate of a next-generation display technology.

[0003] In general, an EL element is film-formed by a vacuum vapor deposition technique in which vapor deposition particles (target film formation components) are vapor-deposited on a target film forming substrate under reduced pressure (under high vacuum) through a vapor deposition mask (also called a shadow mask) where openings are formed in a predetermined pattern. At this time, a scan vapor deposition technique has promise as a large-size substrate film formation technique using a large-size substrate such as a mother substrate as the target film forming substrate. In this technique, a vapor deposition mask, a vapor deposition source, or the like whose size is equivalent to that of the large-size target film forming substrate is unnecessary.

[0004] In the scan vapor deposition technique, vapor deposition particles are vapor-deposited in all target film forming regions of the target film forming substrate while scanning the target film forming substrate by relatively moving at least one of the target film forming substrate and a set of the vapor deposition mask and the vapor deposition source by, for example, integrating the vapor deposition mask and the vapor deposition source, or the like. For the vapor deposition source, such a vapor deposition source is used that a plurality of vapor deposition source openings (nozzle section) used as emission openings through which vapor deposition particles are emitted are provided corresponding to each of the target film forming regions arranged in a direction orthogonal to a scanning direction in the target film forming substrate, at a constant pitch in the direction orthogonal to the scanning direction, for example.

[0005] As such, a restriction unit configured to restrict the passage of vapor deposition particles is provided in an emission path of the vapor deposition particles traveling from the vapor deposition source toward the target film forming substrate, in such a manner as to prevent the vapor deposition particles emitted from each of the vapor deposition source openings from being deposited in a region other than the target film forming region corresponding to each vapor deposition source opening.

[0006] For example, PTL 1 discloses a deposition preventing plate, as a restriction unit, including openings (restriction openings) each corresponding to a panel pattern section of a target film forming substrate. The deposition preventing plate disclosed in PTL 1 has a structure in which a plurality of openings are provided in a plate-like member, and a non-opening functions as a deposition preventing section (restriction section) configured to block or suppress a vapor deposition material supplied to a region other than a formation region of the panel pattern section in the target film forming substrate (in other words, a region other than the target film forming region).

[0007] PTL 1 states that, with the above-discussed scheme, useless usage of the vapor deposition material is prevented, and a recovery rate of the vapor deposition material having been not effectively used is raised.

CITATION LIST

Patent Literature

[0008] PTL 1: JP 2004-199919 A (published on Jul. 15, 2004)

SUMMARY

Technical Problem

[0009] However, in the scan vapor deposition technique, since a gap is formed between the vapor deposition mask and the target film forming substrate, there is a case in which a tiny film is generated in a region other than a desired region in the target film forming substrate even in a case where the restriction unit is used. Such tiny film brings about a decrease in display quality such as display failure. As such, with the scan vapor deposition technique, the resolution of an obtainable film formation pattern is limited, thereby reducing versatility thereof.

[0010] FIGS. **16**A and **16**B are diagrams each illustrating a film formation state when film-forming a vapor deposition film **302** on a target film forming substrate **200** with the scan vapor deposition technique using a known restriction unit **500**. Specifically, FIG. **16**A illustrates an ideal film formation state, while FIG. **16**B illustrates an actual film formation state.

[0011] A Y-axis in each of FIGS. **16**A and **16**B indicates a horizontal direction axis along a scanning direction on the target film forming substrate **200**; an X-axis in each thereof indicates another horizontal direction axis along a direction orthogonal to the scanning direction on the target film forming substrate **200**; and a Z-axis indicates a vertical direction axis (up-down direction axis), which is orthogonal to the X-axis and the Y-axis, is a normal direction of a target deposition surface **201** of the target film forming substrate **200**, and is also a direction in which a vapor deposition axis line perpendicular to the target deposition surface **201** extends.

[0012] As illustrated in FIGS. **16**A and **16**B, on the target deposition surface **201** of the target film forming substrate **200**, a plurality of target film forming regions **202** and non-film forming regions **204** are provided being partitioned. A plurality of target film forming pattern regions **203** where a vapor deposition film **302** is film-formed are provided inside the target film forming region **202**. The target film forming region **202** corresponds to the formation region of the panel pattern section in PTL 1.

[0013] As illustrated in FIG. **16**A, vapor deposition particles **301** emitted from a vapor deposition source opening **31** as an emission opening are restricted in such a manner that the plate-like restriction unit **500** restricts the target film forming region **202** where the vapor deposition particles **301** emitted from each of the vapor deposition source openings **31** are deposited.

[0014] The vapor deposition particles **301** emitted from the vapor deposition source opening **31** reaches a vapor deposition mask **10** with an incident angle thereof on a mask opening **12** of the vapor deposition mask **10** being restricted by the particles passing through a restriction plate opening **501** of the restriction unit **500**. The vapor deposition particles **301** having passed through the mask opening **12** are deposited on the target film forming substrate **200**, whereby a film formation pattern made of the vapor deposition film **302** is formed on the target film forming substrate **200**.

[0015] Ideally speaking, a film thickness profile to be formed is determined by a nozzle diameter of the vapor deposition source opening **31** and a distance from the vapor deposition mask **10** to the target film forming substrate **200** (size of a gap "g" in the Z-axis direction), and takes a shape illustrated with a solid line in FIG. **17**.

[0016] FIG. **17** is a graph that shows, taking, as a reference value, the maximum value of the film thickness of the vapor deposition film **302** having been film-formed on the target film forming substrate **200** obtained by simulation as indicated by "Sim" in FIG. **17**, the film thickness of the vapor deposition film **302** obtained by the simulation and actual measurement at respective positions in the X-axis direction, where the film thickness is normalized with the above-mentioned reference value.

[0017] However, in reality, as illustrated in FIG. **16**B, of the vapor deposition particles **301** emitted from the vapor deposition source opening **31**, the vapor deposition particles **301** having unfavorable directivity (in other words, the vapor deposition particles **301** spreading in the X-axis direction) are blocked and captured by a plate-like restriction section **502**, which is a non-opening. Due to this, a large amount of vapor deposition particles **301** adhere, as vapor deposition objects **303**, to a lower face **502***a* of the restriction section **502**, which is also a lower face of the restriction unit **500** (a bottom face thereof, that is, a face opposing the vapor deposition source **30**).

[0018] Because the vapor deposition particles **301** having adhered to the lower face **502***a* are close in distance to the vapor deposition source **30** as a heat source, the stated particles re-evaporate by being heated and adhere again as the vapor deposition objects **303** to an upper face **30***a* (surface) of the vapor deposition source **30**.

[0019] The vapor deposition objects **303** having adhered again to the upper face **30***a* of the vapor deposition source **30** re-evaporate again because the vapor deposition source **30** is in a high temperature state. This brings about an effect in which the nozzle diameter is substantially expanded. Due to the vapor deposition objects **303** re-evaporating again, in addition to the vapor deposition particles **301** emitted from the vapor deposition source opening **31** as indicated by a dotted line in FIG. **16**B, the vapor deposition particles **301** scattering from a portion other than the vapor deposition source opening **31** enter the mask opening **12** as indicated by an arrow in FIG. **16**B. As a result, in addition to the vapor deposition film **302** of a normal pattern (a normal-pattern film), a tiny film **304**, which is an abnormal-pattern vapor deposition film, is formed. Consequently, as indicated by a dotted line in FIG. **17**, a vapor deposition blur (pattern blur) becomes large to lower the display quality.

[0020] As illustrated in FIG. **16**B, the tiny film **304** is formed not only on an outer side of the target film forming pattern region **203** but also formed on the whole region including a center portion of the target film forming pattern region **203**.

[0021] Accordingly, in the case of using the restriction unit **500**, it is important to suppress the vapor deposition objects **303** adhering again to the vapor deposition source due to the re-evaporation of the vapor deposition objects **303** having adhered to the lower face **502***a*.

[0022] However, PTL 1 touches upon only the control of the flow of vapor deposition particles (vapor deposition flow), and touches upon neither the spread of vapor deposition particles between the vapor deposition source and the deposition preventing plate as a control unit nor the re-evaporation of the vapor deposition objects adhering to the lower face of the deposition preventing plate in any way.

[0023] The present disclosure has been conceived in view of the above problems, and an object thereof is to provide a restriction unit capable of suppressing re-evaporation of vapor deposition objects adhering to a face of the restriction unit opposing a vapor deposition source, a vapor deposition device, a production method for a vapor deposition film, a production method for an electroluminescence display device including a vapor deposition film of a highly precise pattern without adhesion of a tiny film due to the re-evaporation of the above vapor deposition objects, and the electroluminescence display device.

Solution to Problem

[0024] To address the above issues, a restriction unit according to an aspect of the present disclosure is a restriction unit that is configured to restrict the passage of vapor deposition particles emitted from a vapor deposition source and includes at least one opening configured to allow the vapor deposition particles to pass through and a plurality of non-openings prepared at both sides of the above opening. In the stated restriction unit, the non-opening has a cross-sectional shape of an inverse concave formed of a top wall and opening walls.

[0025] To address the above issues, a vapor deposition device according to an aspect of the present disclosure includes the restriction unit and the vapor deposition source that is disposed opposing the restriction unit and emits the vapor deposition particles.

[0026] To address the above issues, a production method for a vapor deposition film according to an aspect of the present disclosure includes forming a vapor deposition film of a predetermined pattern on a target film forming substrate using the above vapor deposition device.

[0027] To address the above issues, a production method for an electroluminescence display device according to an aspect of the present disclosure includes the production method for the vapor deposition film according to the above-mentioned aspect of the present disclosure.

[0028] To address the above issues, an electroluminescence display device according to an aspect of the present disclosure is an electroluminescence display device in which a first electrode, an electroluminescence layer formed of an organic or inorganic layer, and a second electrode are provided in that order on a substrate. In the stated electroluminescence display device, the electroluminescence layer includes a light emitting layer formed of a pattern of a vapor deposition film that is formed by vapor deposition particles having passed through an opening of a restriction unit including at least one opening configured to allow the vapor deposition particles emitted from a vapor deposition source to pass through and a plurality of non-openings prepared at both sides of the above opening where the non-opening has a cross-sectional shape of an inverse concave formed of a top wall and opening walls.

Advantageous Effects of Disclosure

[0029] According to the aspects of the present disclosure, the following can be provided: a restriction unit capable of suppressing the re-evaporation of vapor deposition objects adhering to a face of the restriction unit opposing a vapor deposition source, a vapor deposition device, a production method for a vapor deposition film, a production method for an electroluminescence display device including a vapor deposition film of a highly precise pattern without the adhesion of a tiny film due to the re-evaporation of the above vapor deposition objects, and the electroluminescence display device.

BRIEF DESCRIPTION OF DRAWINGS

[0030] FIG. **1** is a cross-sectional view illustrating a schematic configuration of a main portion of a vapor deposition device according to a first embodiment of the present invention.

[0031] FIG. **2** is a perspective view illustrating a basic configuration of the vapor deposition device according to the first embodiment of the present invention.

[0032] FIG. **3**A is a cross-sectional view illustrating an example of a schematic configuration of an organic EL display device produced in the first embodiment of the present invention, and FIG. **3**B is a plan view illustrating a schematic configuration of a sub pixel of the organic EL display device illustrated in FIG. **3**A.

[0033] FIG. **4** is a flowchart illustrating production processes of the organic EL display device illustrated in FIGS. **3**A and **3**B in the order of the processes to be carried out.

[0034] FIG. **5** is a cross-sectional view illustrating an example of an effect by a restriction unit according to the first embodiment of the present invention.

[0035] FIGS. **6**A and **6**B are cross-sectional views illustrating an example of an effect by the restriction unit according to the first embodiment of the present invention compared to a case in which a cross-section of a restriction section is formed in a T shape.

[0036] FIG. **7** is a cross-sectional view illustrating a schematic configuration of a main portion of a vapor deposition device according to a first modification on the first embodiment of the present invention.

[0037] FIG. **8** is a cross-sectional view illustrating a schematic configuration of a main portion of a vapor deposition device according to a second embodiment of the present invention.

[0038] FIGS. **9**A and **9**B are cross-sectional views each schematically illustrating the configuration of a main portion of the vapor deposition device according to the second embodiment of the present invention.

[0039] FIG. **10** is a cross-sectional view explaining a vapor deposition angle of the vapor deposition device according to the second embodiment of the present invention.

[0040] FIG. **11** is a cross-sectional view explaining a taper angle of an opening wall of a restriction unit according to the second embodiment of the present invention.

[0041] FIG. **12** is another cross-sectional view explaining a taper angle of an opening wall of the restriction unit according to the second embodiment of the present invention.

[0042] FIG. **13** is a cross-sectional view illustrating an effect by the restriction unit according to the second embodiment of the present invention.

[0043] FIG. **14** is a cross-sectional view illustrating a schematic configuration of a main portion of a vapor deposition device according to a third embodiment of the present invention.

[0044] FIG. **15** is a cross-sectional view illustrating an effect by the restriction unit according to the third embodiment of the present invention.

[0045] FIGS. **16**A and **16**B are diagrams each illustrating a film formation state when film-forming a vapor deposition film on a target film forming substrate with the scan vapor deposition technique using a known restriction unit. Specifically, FIG. **16**A illustrates an ideal film formation state, while FIG. **16**B illustrates an actual film formation state.

[0046] FIG. **17** is a graph that shows, taking the maximum value of a film thickness of a vapor deposition film having been film-formed on a target film forming substrate as a reference value, the film thickness of the vapor deposition film obtained by the simulation and actual measurement at respective positions in a direction orthogonal to a scanning direction, where the film thickness is normalized with the above-mentioned reference value.

[0047] FIG. **18** is a cross-sectional view indicating a problematic point in a case where a distance from a lower face of a restriction section of the restriction unit to an upper face of a vapor deposition source is made larger than that illustrated in FIGS. **16**A and **16**B.

DESCRIPTION OF EMBODIMENTS

[0048] A detailed description follows regarding embodiments of the present invention.

First Embodiment

[0049] With reference to FIGS. **1** to **7**, FIGS. **16**A and **16**B, and FIG. **18**, embodiments of the present invention will be described as follows.

[0050] In FIG. **1**, FIG. **2**, and FIGS. **5** to **7**, for the sake of convenience in illustration, the numbers of mask openings and restriction openings, the numbers of target film forming regions and target film forming pattern regions, the number of pixels, and the like are reduced in the drawings.

[0051] FIG. **1** is a cross-sectional view illustrating a schematic configuration of a main portion of a vapor deposition device **100** according to the present embodiment. FIG. **2** is a perspective view illustrating a basic configuration of the vapor deposition device **100** according to the present embodiment.

[0052] The vapor deposition device **100** and a vapor deposition technique according to the present embodiment are particularly useful for vapor deposition of an EL layer such as a light emitting layer configuring an EL element in an EL display device such as an organic EL display device.

[0053] Hereinafter, exemplified is a case in which the vapor deposition device **100** and the vapor deposition technique according to the present embodiment are applied to a production of an RGB full color-display organic EL display device where organic EL elements of red (R), green (G), and blue (B) colors are arranged as sub pixels on a substrate thereof, and a light emitting layer of the organic EL element is film-formed by an RGB selective patterning method, for example.

[0054] In other words, hereinafter, a case in which a vapor deposition film **302** film-formed by the vapor deposition device **100** according to the present embodiment is a light emitting layer for each color of R, G, and B in the organic EL display device is exemplified and described. Note that, however, the present embodiment is not limited thereto, and the vapor deposition device **100** and the vapor deposition technique according to the present embodiment can be generally applied to the productions of devices using a vapor-phase growth technique including, as representative examples, the productions of organic EL display devices and inorganic EL display devices.

[0055] In the following description as well, a horizontal direction axis along a scanning direction on a target film forming substrate **200** is taken as a Y-axis; another horizontal direction axis along a direction orthogonal to the scanning direction on the target film forming substrate **200** is taken as an X-axis; and a vertical direction axis (up-down direction axis) that is orthogonal to the X-axis and the Y-axis, and is a normal direction of a target deposition surface **201** of the target film forming substrate **200** is taken as a Z-axis. For the sake of convenience in description, unless otherwise specifically mentioned, a side of an upward arrow in the Z-axis direction is taken as an upper side in the following description. In addition, unless otherwise specifically mentioned, "cross section" refers to a cross section parallel to the X-axis direction.

Schematic Configuration of Vapor Deposition Device **100**

[0056] As illustrated in FIGS. **1** and **2**, the vapor deposition device **100** is a device configured to film-form the vapor deposition film **302** in a target film forming region **202** on the target deposition surface **201** of the target film forming substrate **200** by a scan vapor deposition technique using a restriction unit **20**.

[0057] The vapor deposition device **100** according to the present embodiment includes, as absolutely necessary constituent elements, a vapor deposition mask **10**, the restriction unit **20**, and a vapor deposition source **30**.

[0058] A positional relationship among the vapor deposition mask **10**, the restriction unit **20**, and the vapor deposition source **30** is fixed. The restriction unit **20** and the vapor deposition source **30** may be respectively fixed within a film formation space (e.g., an inner wall of a film formation chamber **2**), or may be unitized as a vapor deposition unit **1** whereby the positional relationship between them may be fixed. The vapor deposition mask **10**, the restriction unit **20**, and the vapor deposition source **30** may be fixed to each other with, for example, a rigid member (not illustrated) such as a holder (holding member), or may have independent configurations and operate as the vapor deposition unit **1** with a single control operation. At least one of the target film forming substrate **200** and a set of the vapor deposition mask **10**, the restriction unit **20** and the vapor deposition source **30** relatively moves with respect to the other along the Y-axis direction which is the scanning direction as illustrated in FIG. **2**, whereby the vapor deposition film **302** is consequently formed in all the target film forming regions **202** of the target film forming substrate **200**.

[0059] The vapor deposition device **100** according to the present embodiment includes, for example, the film formation chamber **2**, a substrate carrying device **3** (substrate movement device), the vapor deposition mask **10**, the restriction unit **20**, the vapor deposition source **30**, and further includes a mask holder, a substrate holder, a restriction unit holder, a deposition preventing member, a shutter, a control device, and the like (not illustrated).

[0060] Next, more detailed description follows regarding each of the configurations.

Target Film Forming Substrate **200**

[0061] The target film forming substrate **200** used in the present embodiment will be described first.

[0062] As illustrated in FIGS. **1** and **2**, on the target deposition surface **201** of the target film forming substrate **200**, the plurality of target film forming regions **202** are provided being partitioned.

[0063] The target film forming substrate **200** is a mother substrate. In a mass-production process, a plurality of organic EL display devices **400** are formed on the mother substrate, and thereafter are divided into each individual organic EL display device **400**.

[0064] The target film forming regions **202** are formed in a stripe pattern from one end to the other end of the target film forming substrate **200**. In the periphery of each target film forming region **202**, a non-film forming region **204** is provided to surround each target film forming region **202**.

[0065] In each of the target film forming regions **202**, provided are a plurality of pixel areas where a plurality of pixels **401** of the organic EL display devices **400** are arranged. With this, on the target film forming substrate **200**, the pixel areas of the organic EL display devices **400** are formed in a two-dimensional (matrix) pattern.

[0066] Each of the pixels **401** in the pixel areas includes sub pixels **402** of colors of R, G, and B. As such, in each of the target film forming regions **202**, a plurality of sub pixels **402** of respective colors made of organic EL elements of R, G, and B colors are provided, and a fine vapor deposition film pattern that is made of the vapor deposition films **302** of R, G, and B colors and is used as a light emitting layer of the organic EL element is formed as the vapor deposition film **302** in each sub pixel **402**.

[0067] Although not illustrated, in the present embodiment, a drive circuit of the organic EL display device **400** and one of a pair of electrodes prepared at both sides of the light emitting layer in the organic EL element are formed in advance in each of the target film forming regions **202**.

[0068] As illustrated in FIG. **1**, in each target film forming region **202**, the plurality of target film forming pattern regions **203** forming the vapor deposition films **302** of the above-mentioned colors are provided corresponding to the respective sub pixels **402**.

[0069] The target film forming substrate **200** is held by a substrate holder (not illustrated). In a case where the vapor deposition mask **10**, the restriction unit **20**, and the vapor deposition source **30** are relatively moved with respect to the target film forming substrate **200** (in other words, in the case where, of the target film forming substrate **200** and the vapor deposition unit **1**, only the vapor deposition unit **1** is moved), the substrate holder may be fixed to an inner wall of the film formation chamber **2**.

Vapor Deposition Mask **10**

[0070] As illustrated in FIG. **2**, the vapor deposition mask **10** is a plate-like member in which a mask face as its principal face is in parallel to an X-Y plane. When performing the scan vapor deposition, a vapor deposition mask smaller in size at least in the Y-axis direction than the target film forming substrate **200** in plan view is used for the vapor deposition mask **10**. Here, the "in plan view" refers to "as seen from a direction orthogonal to the principal face of the vapor deposition mask **10** (that is, a direction parallel to the Z-axis)".

[0071] The vapor deposition mask **10** is held by a mask holder (not illustrated). In a case where only the target film forming substrate **200** is relatively moved with respect to the vapor deposition mask **10**, the restriction unit **20**, and the vapor deposition source **30**, the mask holder may be fixed to the inner wall of the film formation chamber **2**.

[0072] The vapor deposition mask **10** may be used as is, or may be fixed to a mask frame (not illustrated) in a state of tensile force being applied thereto in order to suppress self-weight bending. The mask frame is formed in a rectangular shape whose outer shape is the same as, or is a size slightly larger than that of the vapor deposition mask **10** in plan view.

[0073] As illustrated in FIGS. **1** and **2**, the vapor deposition mask **10** includes a plurality of mask opening regions **11** opposing the target film forming regions **202** of the target film forming substrate **200** when the mask opposes the target film forming substrate **200**. In the mask opening region **11**, there are provided a plurality of openings (through-holes), as mask openings **12**, that function as passage ports to allow vapor deposition particles **301** (vapor deposition material) to pass through. The mask openings **12** correspond to part of the patterns of the vapor deposition films **302**. The mask opening region **11** is configured of a group of the mask openings **12**. A region other than the mask opening **12** in the vapor deposition mask **10** is a non-opening **13** (non-opening region) and functions as a blocking section configured to block a flow of the vapor deposition particles **301** (vapor deposition flow).

[0074] The mask openings **12** are provided corresponding to part of the patterns of the vapor deposition films **302** film-formed by the vapor deposition mask **10** in use so that the vapor deposition particles **301** do not adhere to a region other than the target film forming pattern region **203** as a film formation target on the target film forming substrate **200**.

[0075] As illustrated in FIG. **1**, only the vapor deposition particles **301** having passed through the mask openings **12** reach the target film forming substrate **200**, whereby the vapor deposition films **302** in the patterns corresponding to the mask openings **12** are formed on the target film forming substrate **200**.

[0076] In an example illustrated in FIG. **2**, in each of the mask opening regions **11**, the plurality of mask openings **12** each formed in an elongated slit shape extending in a column direction are provided being aligned in the X-axis direction. However, the mask opening **12** may be formed in a slot shape, for example. The shape in plan view and the number of the mask opening **12** and the mask opening region **11** are not specifically limited.

[0077] In addition, the material of the vapor deposition mask **10** is not limited to any specific one. The material of the vapor deposition mask **10** may be metal such as Invar (iron-nickel alloy), or may be resin or ceramics, or may be a material in which the cited materials are combined.

Vapor Deposition Source **30**

[0078] The vapor deposition source **30** is, for example, a container configured to store a vapor deposition material therein. The vapor deposition source **30** may be a container configured to directly store the vapor deposition material in the interior of the container, or may be formed in such a manner as to include load-lock type piping and be supplied with the vapor deposition material from exterior.

[0079] The vapor deposition source **30** is formed in a rectangular shape as illustrated in FIG. **2**, for example. A plurality of vapor deposition source openings **31** (emission openings, or a nozzle section) are provided, as emission openings for emitting the vapor deposition particles **301**, in an upper face **30*a*** of the vapor deposition source **30** (in other words, a face opposing the restriction unit **20**). The vapor deposition source openings **31** are arranged at a constant pitch in the X-axis direction.

[0080] The vapor deposition source **30** generates the vapor deposition particles **301** in a gaseous state by heating the vapor deposition material to evaporate it (in the case of the vapor deposition material being a liquid one) or sublimate it (in the case of the vapor deposition material being a solid one). The vapor deposition source **30** emits the vapor deposition material, having been gasified in the above manner, as the vapor deposition particles **301** toward the restriction unit **20** from the vapor deposition source openings **31**.

[0081] In the present embodiment, as discussed above, a line vapor deposition source (line source) including the plurality of vapor deposition source openings **31** can be used as the vapor deposition source **30**, and moreover it is possible to perform uniform film formation on the target film forming substrate **200** having a large area by moving the vapor deposition source **30** in the Y-axis direction. In this case, a decrease in throughput is not generated at the time of mass production, which is a large advantage of the present embodiment.

[0082] The vapor deposition source **30** may be held by a vapor deposition source holder (not illustrated), or may be fixed to the inner wall of the film formation chamber **2** in the case where only the target film forming substrate **200** is relatively moved with respect to the vapor deposition mask **10**, the restriction unit **20**, and the vapor deposition source **30**.

Restriction Unit **20**

[0083] The restriction unit **20** is provided between the vapor deposition mask **10** and the vapor deposition source **30**, as illustrated in FIGS. **1** and **2**.

[0084] The restriction unit **20** is held by a restriction unit holder (not illustrated). In the case where only the target film forming substrate **200** is relatively moved with respect to the vapor deposition mask **10**, the restriction unit **20**, and the vapor deposition source **30**, the restriction unit holder may be fixed to the inner wall of the film formation chamber **2**.

[0085] The restriction unit **20** is provided being distanced from the vapor deposition mask **10** and the vapor deposition source **30**, and controls an isotropic flow of the vapor deposition particles **301** (vapor deposition flow) emitted from the vapor deposition source opening **31** to enhance the directivity.

[0086] In the present embodiment, since the scan vapor deposition is carried out as discussed above, any of the vapor deposition mask **10**, the restriction unit **20**, and the vapor deposition source **30** is formed to be smaller in size in the Y-axis direction than the target film forming substrate **200** in plan view. The size of the restriction unit **20** is equal to or larger than that of the vapor deposition mask **10** in plan view.

[0087] The restriction unit **20** is a hollow block-shaped unit without a base (in other words, a reverse tray-shaped unit) that is configured by a plate-like top wall **21** as a transverse plate disposed in the horizontal direction, a plurality of plate-like side walls **22** as longitudinal plates (vertical walls) each disposed in a direction intersecting with the horizontal direction, and a plurality of plate-like opening walls **23** (nozzle walls). The restriction unit **20** includes a plurality of restriction openings **24** as nozzle-like openings (through-holes) surrounded by the opening walls **23**, and a restriction section **25** as a non-opening configured by the top wall **21**, the side walls **22**, and the opening walls **23**.

[0088] The side walls **22** are formed projecting downward on the periphery of the top wall **21** while surrounding the top wall **21**. The opening walls **23** are formed projecting downward on the periphery of each of the restriction openings **24** while surrounding the restriction opening **24**.

[0089] In the present embodiment, the side walls **22** are vertically provided downward (vertically hung) from the top wall **21** in parallel to a normal direction of the top wall **21** in such a manner as to surround the top wall **21**. The opening walls **23** are vertically provided downward (vertically hung) from the top wall **21** in parallel to the normal direction of the top wall **21** in such a manner as to surround the restriction opening **24**.

[0090] The restriction openings **24** are arranged in the top wall **21** at a constant pitch along the X-axis direction in plan view. The restriction openings **24** each function as a passage port to allow the vapor deposition particles **301** (vapor deposition material) to pass through.

[0091] A portion other than the restriction opening **24** in the restriction unit **20** is the restriction section **25** as the non-opening. The restriction section **25** is a blocking section configured to block the flow of the vapor deposition particles **301**, and takes a role of restricting an incident angle of the vapor deposition particles **301** entering the mask openings **12** of the vapor deposition mask **10**.

[0092] The restriction unit **20** prevents, with the restriction section **25**, the passage of the vapor deposition particles **301** supplied to a region other than the target film forming pattern region **203** in the target film forming substrate **200**, and enhances the directivity of the vapor deposition particles **301** passing through the restriction openings **24**.

[0093] As illustrated in FIG. **1**, the vapor deposition particles **301** emitted from the vapor deposition source opening **31** arrive at the vapor deposition mask **10** while the incident angle of the vapor deposition particles **301** on the mask opening **12** being restricted by the particles passing through the restriction opening **24**. The vapor deposition particles **301** having passed through the mask opening **12** are deposited on the target film forming substrate **200**, whereby a film formation pattern made of the vapor deposition film **302** is formed on the target film forming substrate **200**.

[0094] The restriction unit **20** partitions a space between the vapor deposition mask **10** and the vapor deposition source **30** into a plurality of vapor deposition spaces configured of the restriction openings **24** by the restriction sections **25**.

[0095] The restriction opening **24** and the target film forming region **202** have a one-on-one relationship. Accordingly, the restriction opening **24** and the mask opening region **11** have a one-on-one relationship.

[0096] The pitch of the restriction openings **24** is formed to be larger than the pitch of the mask openings **12**, and the plurality of mask openings **12** are arranged between the restriction sections **25** adjacent to each other at both sides of the restriction opening **24** in the X-axis direction in plan view.

[0097] The restriction openings **24** and the vapor deposition source openings **31** are formed at the same pitch in the X-axis direction. Due to this, the restriction openings **24** and the vapor deposition source openings **31** have a one-on-one relationship in the X-axis direction. Each of the vapor deposition source openings **31** is disposed corresponding to each of the restriction openings **24** in such a manner as to be positioned at the center position in the X-axis direction of each restriction opening **24** in plan view (in other words, at the center position in the X-axis direction between the restriction sections **25** adjacent to each other at both sides of each of the vapor deposition source openings **31** in the X-axis direction).

[0098] In the present embodiment, as illustrated in FIG. **2**, a line vapor deposition source is used for the vapor deposition source **30** in which the vapor deposition source openings **31** are arranged in a one-dimensional form (that is, in a line form) in the X-axis direction. As such, in order to have a one-on-one relationship with each of the restriction openings **24**, for example, the vapor deposition source opening **31** is disposed at the center of each restriction opening **24** in plan view (the center in both the X-axis direction and Y-axis direction).

[0099] Note that, however, the present embodiment is not limited thereto, and the vapor deposition source openings **31** may be arranged in a two-dimensional form (tiling form) in the X-axis and Y-axis directions. Also, in the case where the vapor deposition source openings **31** are two-dimensionally disposed, it is preferable for each vapor deposition source opening **31** to be so disposed as to be positioned at the center position in the X-axis direction of each restriction opening **24**.

[0100] As discussed above, the restriction unit **20** according to the present embodiment is constituted of the top wall **21** in which the restriction openings **24** are provided, the side walls **22** that are so provided as to project downward from part of the top wall **21**, and the opening walls **23**.

[0101] Accordingly, a height d2 of the side wall **22** and the opening wall **23** is larger than a thickness d1 of the top wall **21**, and each of the restriction sections **25** constituted of the top wall **21** and the side walls **22** or the opening walls **23** has a cross-sectional shape with the base open, that is, a cross-sectional shape of an inverse concave, as illustrated in FIG. **1**.

[0102] To be more specific, in the present embodiment, each restriction section **25** has a cross-sectional shape of a square with one side on the bottom side being open where the side walls **22** and the opening walls **23** are vertically hung (vertically provided downward) in the vertical direction from the top wall **21**.

[0103] The thickness d**1** of the top wall **21** indicates a length of the top wall **21** in the Z-axis direction (a normal direction of the top wall **21**) which is a plate thickness of the top wall **21**, that is, a distance from an upper face **21***b* to a lower face **21***a* of the top wall **21**. The height d**2** of the side wall **22** and the opening wall **23** indicates a height in the Z-axis direction of the side wall **22** and the opening wall **23**, in other words, a distance in the Z-axis direction from the upper face **21***b* of the top wall **21** to a lower face **23***a* of the opening wall **23**, and a distance in the Z-axis direction from the upper face **21***b* of the top wall **21** to a lower face of the side wall **22**.

[0104] In the known scheme, as illustrated in FIGS. **16**A and **16**B, in general, the restriction section **502** of the restriction unit **500** is called, for example, a restriction plate, and each of the restriction sections **502** is formed in a plate-like shape with a uniform thickness. For example, the restriction unit **20** described in PTL 1 is a deposition preventing plate, and the whole thereof is formed in a plate-like shape.

[0105] As illustrated in FIG. **16**B, a large amount of vapor deposition particles **301** adhere, as the vapor deposition objects **303**, to a plate bottom, which is the lower face **502***a* of the restriction section **502**, at the time of vapor deposition.

[0106] As a method for reducing the re-evaporation of the vapor deposition objects **303** having adhered to the lower face **502***a* of the restriction section **502** as described above, a method to reduce the area of the lower face **502***a* of the restriction section **502** (Method 1), for example, can be conceived.

[0107] A project area of the restriction section **502** needs to be reduced in order to reduce the amount of vapor deposition objects **303** adhering to the lower face **502***a* of the restriction section **502** by reducing the area of the lower face **502***a* of the restriction section **502**. However, because the restriction plate opening **501** and the target film forming region **202** correspond to each other on a one-on-one basis, the pitch of the restriction sections **502** adjacent to each other at both sides of the restriction plate opening **501** is changed when the project area of the restriction section **502** is changed. The pitch of the restriction sections **502** cannot be largely changed in consideration of the relationship with the target film forming region **202**. Therefore, it is difficult to actually employ Method 1 discussed above.

[0108] As another method for reducing the re-evaporation of the vapor deposition objects **303** having adhered to the lower face **502***a* of the restriction section **502**, a method to distance the lower face **502***a* of the restriction section **502** from the vapor deposition source **30** (Method 2), for example, can be conceived.

[0109] According to Method 2 mentioned above, the re-evaporation of the vapor deposition objects **303** can be reduced by reducing the radiation heat from the vapor deposition source **30** toward the vapor deposition objects **303** adhering to the lower face **502***a*. However, Method 2 mentioned above also has a problem.

[0110] FIG. **18** is a cross-sectional view indicating a problematic point in a case where a distance γ2 from the lower face **502***a* of the restriction section **502** of the restriction unit **20** to the upper face **30***a* of the vapor deposition source **30** is made larger than a distance y**1** from the lower face **502***a* of the restriction section **502** of the restriction unit **500** illustrated in FIGS. **16**A and **16**B to the upper face **30***a* of the vapor deposition source **30**.

[0111] As illustrated in FIG. **18**, in the case where, for example, the restriction section **502** is further distanced from the vapor deposition source **30** compared to the case illustrated in FIGS. **16**A and **16**B (that is, γ2>γ1) so as to reduce the radiation heat from the vapor deposition source **30**, it is difficult to block the vapor deposition particles **301** being scattered from the vapor deposition source opening **31** (called an "adjacent nozzle" below) adjacent to the vapor deposition source opening **31** ejecting the vapor deposition particles **301** that are originally expected to enter each restriction plate opening **501**.

[0112] In the case where the vapor deposition particles **301** scattered from the adjacent nozzle and not expected to enter any openings pass through a certain restriction plate opening **501**, the vapor deposition particles **301** from the adjacent nozzle are mixed in the vapor deposition film **302** to be film-formed, the scattering of the vapor deposition particles **301** is caused, or the like. The above phenomena cause the tiny film **304** as illustrated in FIG. **16**B to be film-formed, thereby raising a possibility that the display quality is significantly degraded.

[0113] As another method to distance the lower face **502***a* of the restriction section **502** from the vapor deposition source **30** as described in Method 2 mentioned above, such a scheme can be conceived that the thickness of the restriction section **502** (in other words, the plate thickness of the restriction plate) is reduced while keeping the position of the upper face of the restriction section **502**.

[0114] However, in the case where the overall thickness of the restriction section **502** is simply reduced by using, for example, a restriction plate with a thinned plate thickness or the like for the restriction section **502**, a physical nozzle length of each of the restriction plate openings **501** is shortened, whereby an effect of improvement in collimator properties of the vapor deposition particles **301** is lowered and it is difficult to block the vapor deposition particles **301** scattering from the adjacent nozzle like in the case illustrated in FIG. **18**.

[0115] In contrast, by forming the cross section of the restriction section **25** in an inverse concave shape as discussed above, the height d2 of the opening wall **23** that determines the nozzle length of the restriction opening **24** makes it possible to distance most part of the face of the restriction section **25** opposing the vapor deposition source **30** from the vapor deposition source **30** while the height d2 maintaining a range defined by design.

[0116] In the present embodiment, as the thickness d**1** of the top wall **21** is smaller, the influence of the radiation heat from the vapor deposition source **30** can be preferably reduced. Note that, however, when d**1** is excessively small, the strength is lowered and the top wall **21** cannot be kept as a structural member. Accordingly, it is preferable for d**1** to be not less than 1 mm, and more preferable to be not less than 5 mm.

[0117] The height d2 of the side wall **22** and the opening wall **23**, particularly the height d2 of the opening wall **23** is not limited to any specific value as long as the relation of d1<d2 is satisfied as discussed above. As d2 is longer, a

difference between d1 and d2 becomes larger and the radiation heat of the vapor deposition source **30** toward the top wall **21** is further reduced, whereby an effect of the reduction in re-evaporation of the vapor deposition objects **303** is further enhanced.

[0118] Further, as a thickness d3 of the open wall **23** and the side wall **22**, particularly the thickness d3 of the opening wall **23** facing the restriction opening **24** is smaller, an absolute value of the adhesion amount of the vapor deposition objects **303** adhering to the lower face of the restriction section **25**, that is, a face of the restriction section **25** opposing the vapor deposition source **30** (in other words, the lower face **23***a* of the opening wall **23** and the lower face of the side wall **22**) can be preferably decreased.

[0119] Here, the thickness d3 of the opening wall **23** and the side wall **22** indicates a length in the X-axis direction of each of the opening wall **23** and the side wall **22**, which is a plate thickness of the opening wall **23** and the side wall **22**. To be more specific, the thickness d3 indicates the length of the lower face **23***a* of the opening wall **23** and the lower face of the side wall **22** in the X-axis direction of each thereof.

[0120] However, when d3 is excessively small, the strength is lowered like in the case of d1 and the wall having such d3 cannot be kept as a structural member. Accordingly, it is preferable for d3 to be not less than 1 mm, and more preferable to be not less than 5 mm.

[0121] The values of d1 and d3 may be the same or may be different. However, processing is more easily carried out when the values of d1 and d3 are the same. In other words, the restriction unit **20** can be produced with ease.

[0122] In the present embodiment, the following case is exemplified and explained: the height of the opening wall **23** illustrated in FIG. **1** (length in the Z-axis direction) and the height of the side wall **22** illustrated in FIG. **2** (length in the Z-axis direction) are the same (in other words, the height of the opening wall **23**=the height of the side wall **22**=d2), and the thickness of the opening wall **23** illustrated in FIG. **1** (d3, the length in the X-axis direction) and the thickness of the side wall **22** (length in the X-axis direction, not illustrated) are the same (in other words, the thickness of the opening wall **23**=the thickness of the side wall **22**=d3), as described above.

[0123] However, also in the present embodiment, as long as the height of the opening wall **23** (d2) is larger than the thickness d1 of the top wall **21**, it may be acceptable that the height of the opening wall **23** and the height of the side wall **22** are the same or are different.

[0124] In the case where, of the vapor deposition particles **301** emitted from the vapor deposition source **30**, unnecessary vapor deposition particles **301** not used for the film formation of the vapor deposition film **302** in the target film forming region **202** can be prevented from entering the mask opening **12**, it is not absolutely necessary to provide the side walls **22** in the restriction unit **20**.

[0125] Furthermore, according to the present embodiment, by forming the cross section of the restriction section **25** in an inverse concave shape as described above, a distance β from the lower face **21***a* of the top wall **21** to the upper face **30***a* of the vapor deposition source **30** can be set to the same height as the distance γ**2** from the lower face **502***a* of the restriction section **502** of the restriction unit **20** illustrated in FIG. **18** to the upper face **30***a* of the vapor deposition source **30** while maintaining a distance α from the lower face **23***a* of the opening wall **23** as well as the lower face of the side wall **22** to the upper face **30***a* of the vapor deposition source **30** at the same height as the distance γ**1** from the lower face **502***a* of the restriction section **502** of the restriction unit **20** illustrated in FIGS. **16**A and **16**B to the upper face **30***a* of the vapor deposition source **30**.

[0126] The distance α from the lower face **23***a* of the opening wall **23** as well as the lower face of the side wall **22** to the upper face **30***a* of the vapor deposition source **30**, particularly the distance α from the lower face **23***a* of the opening wall **23** to the upper face **30***a* of the vapor deposition source **30** is not limited to any specific length. However, in the case where the distance α is excessively long like the case of the distance γ**2** illustrated in FIG. **18**, there arises a possibility that the vapor deposition flow from the adjacent nozzle enters into the restriction opening **24** as illustrated in FIG. **18**. Accordingly, it is preferable for the distance α to be not greater than 100 mm, and more preferable to be not greater than 50 mm.

[0127] On the other hand, in the case where the distance α is excessively short, the influence of the radiation heat from the vapor deposition source **30**, particularly the influence of the radiation heat from the vapor deposition source **30** toward the lower face **23***a* of the opening wall **23** and the lower face of the side wall **22** becomes large. Accordingly, it is preferable for the distance α to be not less than 1 mm, and more preferable to be not less than 10 mm.

[0128] In a case where a shutter (not illustrated) is inserted between the lower face **23***a* of the opening wall **23** as well as the lower face of the side wall **22** and the upper face **30***a* of the vapor deposition source **30**, specifically between the lower face **23***a* of the opening wall **23** as well as the lower face of the side wall **22** and the upper face **30***a* of the vapor deposition source **30** in a range between the vapor deposition source openings **31** adjacent to each other, it is preferable to satisfy a relation of α≥20 mm.

[0129] It is sufficient that the lengths in the X-axis and Y-axis directions of the top wall **21** surrounding the respective restriction openings **24** and the length in the Y-axis direction of the opening wall **23** and the side wall **22** are appropriately set in accordance with the sizes of the target film forming region **202** and the non-film forming region **204** in the target film forming substrate **200**, the size of the restriction opening **24** corresponding to the size of the target film forming region **202**, and the like. Accordingly, these lengths are not limited to any specific values.

Film Formation Chamber **2**

[0130] In the film formation chamber **2**, in order to keep the inside of the film formation chamber **2** in a vacuum state at the time of vapor deposition, there is provided a vacuum pump (not illustrated) configured to perform vacuum exhaust operation to form a vacuum inside the film formation chamber **2** through an exhaust port (not illustrated) provided in the film formation chamber **2**. The control device configured to control actions of the vacuum pump and the vapor deposition device **100** is provided outside the film formation chamber **2**. The substrate carrying device **3**, the vapor deposition mask **10**, the restriction unit **20** and the vapor deposition source **30**; and a mask holder, a substrate holder, a deposition preventing member and a shutter (these are not illustrated) are provided inside the film formation chamber **2**.

Substrate Carrying Device 3

[0131] The vapor deposition device **100** according to the present embodiment includes at least one of the substrate carrying device **3** and a not illustrated vapor deposition unit carrying device (vapor deposition unit movement device), for example. With this configuration, in the present embodiment, scan vapor deposition is carried out by relatively moving the target film forming substrate **200** and the vapor deposition unit **1** including the vapor deposition mask **10**, the restriction unit **20**, and the vapor deposition source **30** in such a manner as to make the Y-axis direction be the scanning direction.

[0132] FIG. **2** illustrates a case in which the vapor deposition mask **10**, the restriction unit **20**, and the vapor deposition source **30** are moved as one unit along the scanning direction as discussed above as an example.

[0133] The substrate carrying device **3** and the vapor deposition unit carrying device are not limited to any specific devices, and various types of known movement devices such as a roller type movement device and a hydraulic movement device, for example, can be used.

[0134] Note that, however, it is sufficient that at least one of the target film forming substrate **200** and the vapor deposition unit **1** is provided in a relatively movable manner. Accordingly, it is also sufficient that at least one of the substrate carrying device **3** and the vapor deposition unit carrying device is provided, and one of the target film forming substrate **200** and the vapor deposition unit **1** may be fixed to the inner wall of the film formation chamber **2** as discussed above.

Production Method for Vapor Deposition Film

[0135] In the present embodiment, the vapor deposition is carried out while at least one of the target film forming substrate **200** and the vapor deposition unit **1** being relatively moved in the Y-axis direction, as discussed above.

[0136] A production method for a vapor deposition film according to the present embodiment includes: a disposing process in which the vapor deposition unit **1** and the target film forming substrate **200** are disposed opposing each other and being distanced from each other by a constant distance; an alignment process in which alignment of relative positions of the vapor deposition mask **10** and the target film forming substrate **200** is carried out using alignment markers (not illustrated) provided on the vapor deposition mask **10** and the target film forming substrate **200** respectively, and adjustment of a gap between the vapor deposition mask **10** and the target film forming substrate **200** (gap control) is carried out; and a deposition process in which the vapor deposition particles **301** emitted from the vapor deposition source **30** are deposited on the target film forming substrate **200** through the restriction unit **20** and the vapor deposition mask **10** while relatively moving, in plan view, at least one of the vapor deposition unit **1** and the target film forming substrate **200** in the scanning direction (in other words, the Y-axis direction, which is a direction orthogonal to the X-axis direction in which the restriction openings **24** are arranged).

[0137] As the vapor deposition film **302**, selective patterning layers (e.g., light emitting layers of respective colors) in an organic EL display device can be cited, for example.

[0138] The restriction unit **20** according to the present embodiment, the vapor deposition device **100** using the restriction unit **20**, and the production method for the vapor deposition film using the vapor deposition device **100** can be appropriately applied to a production method for an EL element and an EL display device including the stated EL element.

[0139] Examples of an EL display device produced by the vapor deposition device **100** and a production method for the stated display device will be described below. Hereinafter, the organic EL display device **400** is cited and described as an example of the above-mentioned EL display device. In the following description, "organic EL display device" can be rephrased as "inorganic EL display device" or "EL display device". Likewise, "organic EL layer" can be rephrased as "inorganic EL layer" or "EL layer".

Schematic Configuration of EL Display Device

[0140] FIG. **3**A is a cross-sectional view illustrating an example of a schematic configuration of the organic EL display device **400** produced in the present embodiment, and FIG. **3**B is a plan view illustrating a schematic configuration of the sub pixel **402** of the organic EL display device **400** illustrated in FIG. **3**A.

[0141] As illustrated in FIG. **3**A, the organic EL display device **400** has a structure in which an organic EL element **420** and a sealing layer **430** are provided in that order on a Thin Film Transistor (TFT) substrate **410**.

[0142] The TFT substrate **410** is provided with an insulating substrate **411**, as a support substrate, made of a glass substrate, a plastic substrate, or the like. A TFT **412**, signal lines **413**, an interlayer insulating film **414**, and the like are provided on the insulating substrate **411**.

[0143] The signal lines **413** are configured of a plurality of gate lines, a plurality of source lines, a plurality of power source lines, and the like. In each of regions surrounded by these signal lines **413** in a lattice form, the sub pixels **402** of respective colors are disposed. For example, a set of sub pixels **402** of red (R), green (G), and blue (B) forms one pixel **401** (see FIG. **2**).

[0144] The sub pixels **402** respectively include the TFTs **412**. The TFTs **412** are each connected to the signal lines **413**, where the sub pixel **402** to which a signal is inputted is selected by the gate line, an amount of charge to be inputted to the selected sub pixel **402** is determined by the source line, and a current is made to flow into the organic EL element **420** from the power source line.

[0145] The TFTs **412** and the signal lines **413** are covered with the interlayer insulating film **414**. As a material of the interlayer insulating film **414**, an insulative material such as an acrylic resin or a polyimide resin, for example, can be used. It is sufficient for the thickness of the interlayer insulating film **414** to be such that a step on an upper face of the TFT **412** and the signal line **413** can be removed, and thus the thickness thereof is not limited to any specific value.

[0146] The organic EL element **420** is configured of a first electrode **421** (positive electrode), an organic EL layer **422**, a second electrode **423** (negative electrode), and the like.

[0147] The first electrode **421** is formed on the interlayer insulating film **414**. The first electrode **421** injects (supplies) holes into the organic EL layer **422**, while the second electrode **423** injects electrons into the organic EL layer **422**. The first electrode **421** is electrically connected with the TFT **412** via a contact hole **414***a* formed in the interlayer insulating film **414**.

[0148] An end portion of the first electrode **421** is covered with an edge cover **415**. The edge cover **415** is an insulating layer, and is constituted with a photosensitive resin, for example. The edge cover **415** prevents a short circuit with the second electrode **423** at the end portion of the first electrode **421** due to electrode concentration, the organic EL layer **422** being thinned, or the like. Further, the edge cover **415** also functions as a pixel separation film to prevent the current from being leaked to adjacent sub pixels **402**.

[0149] An opening **415***a* is provided in the edge cover **415** for each of the sub pixels **402**. An exposed portion of the first electrode **421** by the above opening **415***a* becomes a light emitting region of each sub pixel **402**.

[0150] The organic EL layer **422** is provided between the first electrode **421** and the second electrode **423**. The organic EL layer **422** has a structure in which, as organic layers, a hole injection and transport layer **422***a*, a light emitting layer **422***b*, an electron transport and injection layer **422***c*, and the like are layered in that order from the first electrode **421** side, for example.

[0151] The organic layers other than the light emitting layer **422***b* are not absolutely necessary layers, and may be appropriately formed in accordance with required characteristics of the organic EL element **420**. As such, it is sufficient that the organic EL layer **422** includes the light emitting layer **422***b*; that is, the organic EL layer **422** may be the light emitting layer **422***b* itself, or may include the light emitting layer **422***b* and a layer other than the light emitting layer **422***b*.

[0152] The light emitting layer **422***b* is a layer having a function to recombine the holes injected from the first electrode **421** side and the electrons injected from the second electrode **423** side so as to emit light. The light emitting layer **422***b* is formed with a material of high light emitting efficiency such as low molecular weight fluorescent colorant or a metal complex.

[0153] Note that, a single layer may have a plurality of functions. For example, the hole injection and transport layer **422***a* may have a structure in which a hole injecting layer and a hole transport layer are provided as separate layers, or may be a hole injection-cum-transport layer including functions of both the stated layers. Likewise, the electron transport and injection layer **422***c* may have a structure in which an electron injecting layer and an electron transport layer are provided as separate layers, or may be an electron injection-cum-transport layer including functions of both the stated layers. A carrier blocking layer may be appropriately provided between the respective layers.

[0154] Although, in FIG. **3**A, the first electrode **421** is taken as a positive electrode (a pattern electrode, a pixel electrode) and the second electrode **423** is taken as a negative electrode (a common electrode), the first electrode **421** may be taken as the negative electrode and the second electrode **423** may be taken as the positive electrode. Note that, however, in this case, the order of the layers constituting the organic EL layer **422** is reversed.

[0155] In a case where the organic EL display device **400** is a bottom-emitting type device configured to radiate light from a rear face side of the insulating substrate **411**, it is preferable that the second electrode **423** be formed with a reflective electrode material, and that the first electrode **421** be formed with a transparent electrode material being transparent or semi-transparent.

[0156] On the other hand, in a case where the organic EL display device **400** is a top-emitting type device configured to radiate light from the sealing layer **430** side, it is preferable that the first electrode **421** be formed with a reflective electrode material, and that the second electrode **423** be formed with a transparent electrode material being transparent or semi-transparent.

[0157] The sealing layer **430** is formed on the second electrode **423** to cover the second electrode **423**, the organic EL layer **422**, the edge cover **415**, the interlayer insulating film **414**, and the like. An organic layer (not illustrated) may be provided between the second electrode **423** and the sealing layer **430** in order to adjust optical characteristics.

[0158] The sealing layer **430** prevents the organic EL element **420** from being degraded by moisture, oxygen, or the like entering from exterior. The sealing layer **430** is constituted of, for example, an inorganic film, a layered film of an inorganic film and an organic film, or the like. As an example, silicon nitride, silicon oxide, or the like can be cited.

[0159] The organic EL display device **400** controls a voltage applied across the second electrode **423** and the first electrode **421** through the TFT **412** by a drive circuit (not illustrated), thereby making the light emitting layer **422***b* emit light so as to perform display.

Production Method for Organic EL Display Device **400**

[0160] FIG. **4** is a flowchart illustrating production processes of the organic EL display device **400** in the order of the processes to be carried out.

[0161] As illustrated in FIG. **4**, a production method for the organic EL display device **400** according to the present embodiment includes, roughly speaking, four steps (Ss), namely, a preparation process of a TFT substrate and a first electrode (S**1**), a vapor deposition process of an organic EL layer (S**2**), a vapor deposition process of a second electrode (S**3**), and a sealing process (S**4**), for example.

[0162] Hereinafter, with reference to FIGS. **3**A and **3**B, an example of each of the above-mentioned processes will be described following the flowchart illustrated in FIG. **4**.

[0163] First, the TFT **412**, the signal line **413**, and the like are formed on the insulating substrate **411** by a known method. Next, a photosensitive resin is applied on the insulating substrate **411** to cover the TFT **412** and the signal line **413**, and patterning is performed by a photolithographic technique. With this, the interlayer insulating film **414** is formed on the insulating substrate **411**.

[0164] Next, the contact hole **414***a* used for electrically connecting the first electrode **421** to the TFT **412** is formed in the interlayer insulating film **414**.

[0165] Subsequently, the first electrode **421** is formed on the interlayer insulating film **414**. The first electrode **421** can be formed as follows: a conductive film (electrode film) is film-formed on the interlayer insulating film **414**, photoresist is applied onto the conductive film, and patterning is performed using the photolithographic technique; and thereafter etching is performed on the conductive film and the photoresist is separated.

[0166] The sputtering, vacuum vapor deposition technique, CVD, plasma CVD, printing method, or the like can be used for layering the above conductive film.

[0167] Hereinafter, a case in which the restriction unit **20** and the vapor deposition device **100** including the restriction unit **20** according to the present embodiment are used at least for the film formation of the light emitting layer **422***b* of the organic EL layer **422** is cited as an example and explained. However, it goes without saying that the restriction unit **20** and the vapor deposition device **100** according to the present embodiment can be used for the film formation of the above-mentioned conductive film.

[0168] Next, the edge cover **415** is formed in a predetermined pattern. Through the above-discussed steps, the TFT substrate **410** and the first electrode **421** are produced (S1).

[0169] Next, pressure reduction baking processing for dehydration is performed on the TFT substrate **410** on which the first electrode **421** is formed, and further oxygen plasma processing is performed for surface washing of the first electrode **421**.

[0170] Thereafter, the organic EL layer **422** including the light emitting layer **422***b* is film-formed on the TFT substrate **410** (S2).

[0171] The ink-jet method, printing method, vacuum vapor deposition technique, CVD, plasma CVD, or the like can be used for the film formation of the organic EL layer **422**. In the present embodiment, as described above, the production method for the vapor deposition film using the restriction unit **20** and the vapor deposition device **100** is applied at least to the film formation of the light emitting layer **422***b* of the organic EL layer **422**. The production method for the vapor deposition film using the restriction unit **20** and the vapor deposition device **100** may be applied to the film formation of the hole injection and transport layer **422***a*, the electron transport and injection layer **422***c*, and the like, by changing the mask pattern shape of the vapor deposition mask **10**.

[0172] In the present embodiment, a vapor deposition process of the hole injection and transport layer (S**11**), a vapor deposition process of the light emitting layer (S**12**), and a vapor deposition process of the electron transport and injection layer (S**13**) are carried out in that order as the vapor deposition process of the organic EL layer (S2). In other words, the vapor deposition process of the organic EL layer (S2) according to the present embodiment may include the vapor deposition process of the hole injection and transport layer (S**11**), the vapor deposition process of the light emitting layer (S**12**), and the vapor deposition process of the electron transport and injection layer (S**13**). Note that the order of the steps (processes) indicated by S**11** to S**13** mentioned above is reversed in a case where the first electrode **421** is taken as a negative electrode and the second electrode **423** is taken as a positive electrode. In a case of the organic EL layer **422** being formed of the light emitting layer **422***b*, the vapor deposition process of the organic EL layer (S2) refers to the vapor deposition process of the light emitting layer (S**12**).

[0173] In the vapor deposition process of the organic EL layer (S2), the above-described production method for the vapor deposition film according to the present embodiment is applied at least in the vapor deposition process of the light emitting layer (S**12**). In other words, in the present embodiment, at least the light emitting layer **422***b* of each of the sub pixels **402** is produced (film-formed) by the production method for the vapor deposition film according to the present embodiment.

[0174] Because of this, at least the vapor deposition process of the light emitting layer (S**12**) includes, for example, the aforementioned alignment process and deposition process. Also, in the processes other than the vapor deposition process of the light emitting layer (S**12**), it goes without saying that the process to which the production method for the vapor deposition film according to the present embodiment is applied includes the aforementioned alignment process and deposition process.

[0175] In the vapor deposition process of the organic EL layer (S2), the TFT substrate **410** on which the first electrode **421** and the edge cover **415** prepared in the preparation process of the TFT substrate and the first electrode (S1) are formed, is used as the target film forming substrate **200**. In other words, in the vapor deposition process of the organic EL layer (S2), used is the target film forming substrate **200** where, as one of the pair of electrodes prepared at both sides of the light emitting layer **422***b*, the first electrode **421** is provided beforehand in the target film forming region **202**. At this time, by using a mother substrate, as the target film forming substrate **200**, in which a plurality of target film forming regions **202** to become formation regions of the organic EL display devices **400** are provided and from which the plurality of organic EL display devices **400** can be cut out, a production method supporting the mass production process can be realized. In the case of using a mother substrate for the target film forming substrate **200**, after the sealing process (S**4**), a partitioning process (S**5**, an organic EL display device cutout process, not illustrated) is additionally carried out in which the plurality of organic EL display devices **400** are cut out from the mother substrate by partitioning the stated mother substrate.

[0176] In FIGS. **3**A and **3**B, a case in which the light emitting layer **422***b* is vapor-deposited selectively patterned for each light emission color so as to perform full color display is cited and illustrated as an example. However, a scheme in which the organic EL element **420** configured to emit white (W) color light using the light emitting layer **422***b* emitting white color light and a color filter (CF) layer (not illustrated) are combined so as to select light emission color in each sub pixel **402**, a scheme in which the light emitting layer **422***b* emitting W color light is used and a micro cavity structure is introduced to each of the sub pixels **402** so as to realize image display of full color, or the like may be employed. In the case where light emission color of each of the sub pixels **402** is changed by a method such as the CF layer or the micro cavity structure, the light emitting layer **422***b* need not be selectively patterned for each sub pixel **402**.

[0177] Next, the second electrode **423** is formed across the whole display region of the TFT substrate **410** in such a manner as to cover the organic EL layer **422** (S**3**).

[0178] The second electrode **423** can be formed by the same method as that of the hole injection and transport layer **422***a*, the electron transport and injection layer **422***c*, or the like, for example. Accordingly, the restriction unit **20** and the vapor deposition device **100** can also be used for the film formation of the second electrode **423**.

[0179] By the method discussed above, the organic EL element **420** formed of the first electrode **421**, the organic EL layer **422**, and the second electrode **423** can be formed on the TFT substrate **410**.

[0180] Thereafter, the sealing layer **430** is formed on the second electrode **423** to cover the second electrode **423**. The sputtering, vacuum vapor deposition technique, CVD, plasma CVD, printing method, or the like can be used for forming the sealing layer **430** in a case of the sealing layer **430** being a sealing film. In the case of the sealing layer **430**

being a sealing film, the restriction unit **20** and the vapor deposition device **100** according to the present embodiment may be used for the film formation of the sealing layer **430**.

[0181] The sealing layer **430** may be a sealing substrate made of an insulating substrate such as a glass substrate or a plastic substrate. In this case, an insulating substrate having substantially the same size as the insulating substrate **411** may be used for the sealing layer **430**, and the partitioning may be performed, after having sealed the organic EL element **420**, in accordance with the size of the target organic EL display device **400**. Indented glass may be used as a sealing substrate, and the sealing layer **430** may be formed by performing sealing in a frame shape using a sealing resin, frit glass, or the like. Alternatively, the sealing layer **430** made of a sealing substrate and a resin may be formed by filling the resin between the TFT substrate **410** and the sealing substrate.

[0182] As discussed thus far, in the production processes of the organic EL display device **400** according to the present embodiment, it is sufficient that at least any one of the vapor deposition process of the organic EL layer (S**2**), the vapor deposition process of the second electrode (S**3**), and the sealing process (S**4**) includes the aforementioned alignment process and deposition process. Further, it is sufficient for the organic EL display device **400** according to the present embodiment to include a pattern of the vapor deposition film **302** formed with the vapor deposition particles **301** having passed through the restriction opening **24** of the restriction unit **20**.

[0183] However, because the vapor deposition process of the light-emitting layer (S**12**) includes the alignment process and the deposition process, the light emitting layer **422***b* having a high resolution pattern without a pattern blur, a color mix, or the like due to the adhesion of the tiny film **304** (see FIG. **18**) can be formed. Because of this, it is preferable that at least the vapor deposition process of the light emitting layer (S**12**) include the alignment process and the deposition process. With this, an EL display device, such as the organic EL display device **400**, having higher display quality than the existing display device can be provided.

Advantageous Effects

[0184] FIG. **5** is a cross-sectional view illustrating an example of an effect by the restriction unit **20** according to the present embodiment.

[0185] According to the present embodiment, as illustrated in FIG. **5**, by forming a cross section of the restriction section **25** in an inverse concave shape, of a face of the restriction section **25** opposing the vapor deposition source **30** (that is, the lower face of the restriction section **25**), a portion other than the face of the opening wall **23** and the side wall **22** opposing the vapor deposition source **30** (that is, the lower face **21***a* of the top wall **21**) can be distanced from the vapor deposition source **30**. According to the present embodiment, it is possible to substantially distance the restriction section **25** from the vapor deposition source **30** without degrading an original function of the restriction unit **20** to control the isotropic vapor deposition flow and enhance the directivity.

[0186] As such, according to the present embodiment, because the radiation heat from the vapor deposition source **30** toward the restriction section **25** can be reduced and the temperature of the lower face of the restriction section **25** can be lowered, the re-evaporation of the vapor deposition objects **303** adhering to the restriction section **25** can be reduced. As a result, abnormal film formation like the tiny film **304** can be prevented because re-adhesion of the vapor deposition objects **303** to the vapor deposition source **30** caused by the re-evaporation of the vapor deposition objects **303** having adhered to the restriction section **25** can be suppressed or prevented.

[0187] A side surface of each of the opening wall **23** and the side wall **22**, in other words, a Z-Y plane of the restriction section **25** is not heated to a high temperature in comparison with the lower face of restriction section **25**, so that the amount of re-evaporation is physically small. In reality, significant amounts of re-evaporation from the side surfaces of the opening wall **23** and the side wall **22** were not observed in experiment using an actual device, and as illustrated in FIG. **5**, the re-adhesion of the vapor deposition objects **303** as illustrated in FIG. **16**B and FIG. **18** was not observed on the upper face **30***a* of the vapor deposition source **30**.

[0188] According to the present embodiment, it is possible to provide an EL display device, such as the organic EL display device **400**, that includes a high resolution pattern without the adhesion of the tiny film **304**, and exhibits higher display quality than the existing display device.

[0189] FIGS. **6**A and **6**B are cross-sectional views illustrating an example of an effect by the restriction unit **20** according to the present embodiment compared to a case in which a cross-sectional shape of a cross section parallel to the X-axis direction of the restriction section **25** has a T shape. FIG. **6**A schematically illustrates a main portion of the vapor deposition device **100** according to the present embodiment. Meanwhile, FIG. **6**B is a comparative example in which the configuration of a main portion of the vapor deposition device **100** is schematically illustrated when the cross section of the restriction section **25** of the restriction unit **20** of the vapor deposition device **100** illustrated in FIG. **6**A is formed in a T shape.

[0190] An equation of $d1=d3$ holds in each restriction unit **20** illustrated in FIGS. **6**A and **6**B, and a relation of $d1<d2$ is satisfied therein.

[0191] In the restriction unit **20** of FIG. **6**A, an opening width $\phi 1$ in the X-axis direction at a lower portion of the restriction opening **24** (that is, on the vapor deposition source **30** side) is equal to an opening width $\phi 3$ in the X-axis direction at an upper portion of the restriction opening **24** (that is, on the vapor deposition mask **10** side). As such, in the restriction unit **20** illustrated in FIG. **6**A, a film formation range in the X-axis direction on the target film forming substrate **200** (in other words, size of the target film forming region **202** in the X-axis direction) brought by the vapor deposition flow is determined by the opening width $\phi 3$ in the X-axis direction at the upper portion of the restriction opening **24**. On the other hand, an unnecessary vapor deposition flow is cut (captured) in the lower face of the restriction section **25**.

[0192] As illustrated in FIG. **6**A, in the case where the cross section of the restriction section **25** is formed in an inverse concave shape, the lower face **23***a* of the opening wall **23** is present near the vapor deposition source opening **31**. Due to this, as indicated by arrow marks in FIG. **6**A, even in a case where the vapor deposition particles **301** emitted from the vapor deposition source opening **31** pass under the restriction section **25** surrounding the restriction opening **24** corresponding to the above vapor deposition source opening **31** and scatter toward the target film forming region **202** adjacent to the target film forming region **202** corresponding to the above restriction opening **24**, in other words, toward the target film forming region **202** other than the target film forming region **202** corresponding to the above restriction opening **24** (called an "adjacent target film forming region" below), such vapor deposition particles are cut (captured) by the restriction section **25** adjacent to the restriction section **25** surrounding the above-mentioned restriction opening **24** (called an "adjacent restriction section" below). As such, in this case, the vapor deposition particles **301** can be prevented from flying to the adjacent target film forming region on the target film forming substrate **200**.

[0193] Meanwhile, as illustrated in FIG. **6**B, in the case where the cross section of the restriction section **25** is formed in a T shape, the opening width ϕ**3** in the X-axis direction at the upper portion of the restriction opening **24** is smaller than the opening width ϕ**1** in the X-axis direction at the lower portion of the restriction opening **24**. Due to this, in the case where the cross section of the restriction section **25** is formed in a T shape, the size in the X-axis direction of the target film forming region **202** is determined by the opening width ϕ**3** in the X-axis direction at the upper portion of the restriction opening **24** and the unnecessary vapor deposition flow is cut (captured) in the lower face of the restriction section **25**. However, the lower face **23***a* of the opening wall **23** is not present near the vapor deposition source opening **31**. As such, in this case, as indicated by arrows in FIG. **6**B, there is a possibility that the vapor deposition particles **301** emitted from the vapor deposition source opening **31** are not cut by the adjacent restriction section and travel toward the adjacent target film forming region.

[0194] Further, in the case where the cross section of the restriction section **25** is formed in a T shape, since the lower face **23***a* of the opening wall **23** is not present near the vapor deposition source opening **31**, a physical nozzle length of each of the restriction openings **24** is substantially equal to the thickness d**1** of the top wall **21**. As such, in the case where the cross section of the restriction section **25** is formed in an inverse concave shape, the physical nozzle length of each of the restriction openings **24** is longer than that in the case where the cross section of the restriction section **25** is formed in a T shape. Because of this, in the case where the cross section of the restriction section **25** is formed in an inverse concave shape, an effect of improvement in collimator properties of the vapor deposition particles **301** is enhanced in comparison with the case where the cross section of the restriction section **25** is formed in a T shape.

First Modification

[0195] FIG. **7** is a cross-sectional view illustrating a schematic configuration of a main portion of the vapor deposition device **100** according to a first modification on the first embodiment.

[0196] In the present embodiment, as illustrated in FIG. **1**, for example, the case in which, in each of the restriction sections **25** of the restriction unit **20**, the thicknesses of the top wall **21** and the opening wall **23** are uniform and are the same in size and the opening wall **23** has a shape vertically hung in the vertical direction (vertically provided downward) from the top wall **21** is cited as an example and explained. However, the present embodiment is not limited thereto.

[0197] It is not absolutely necessary for the top wall **21** and the opening wall **23** to have uniform thicknesses, and they may have different thicknesses from each other. Accordingly, as illustrated in FIG. **7**, each of the restriction sections **25** of the restriction unit **20** may have a shape in which the lower face **21***a* of the top wall **21** is round (curved shape), for example. In this case, when a thickness of a center portion of the top wall **21** is taken as d**1** and a length in the X-axis direction of the lower face **23***a* of the opening wall **23** is taken as d**3** in each restriction section **25**, the thickness d**1** and the length d**3** can be designed in the same manner as in the case of the restriction unit **20** illustrated in FIG. **1**.

[0198] As discussed above, it is sufficient that each restriction section **25** of the restriction unit **20** according to the present embodiment has a cross-sectional shape of an inverse concave with the base open, in other words, a shape in which the base surface is recessed toward the inner side.

Second Modification

[0199] Further, in the present embodiment, although the case in which the restriction unit **20** includes the plurality of restriction openings **24** arranged in the X-axis direction is cited as an example and explained, the present embodiment is not limited thereto. It is sufficient that the restriction unit **20** includes at least one restriction opening **24** and is provided with the plurality of restriction sections **25**, prepared at both sides of the restriction opening **24**, each having the top wall **21** and vertical walls including the opening walls **23**, and that these restriction sections **25** have a cross-sectional shape of an inverse concave as discussed above. Even in a case where only one target film forming region **202** is provided on the target film forming substrate **200** and only one restriction opening **24** is provided, the above-described effect can be obtained.

Third Modification

[0200] Furthermore, in the present embodiment, the case in which a line vapor deposition source including the plurality of vapor deposition source openings **31** (nozzle section) in the X-axis direction is used for the vapor deposition source **30**, is cited as an example and explained. However, as discussed above, in the case where there is provided only one restriction opening **24**, it is sufficient for the vapor deposition source **30** to include one vapor deposition source opening **31**.

Fourth Modification

[0201] For example, as illustrated in FIG. **6**A, it is also possible to arrange a plurality of vapor deposition sources each including one vapor deposition source opening **31** in the X-axis direction and use them in place of the line vapor deposition source.

Fifth Modification

[0202] Moreover, the restriction unit **20**, the vapor deposition unit **1**, and the vapor deposition device **100** according to the present embodiment can be appropriately used for the scan vapor deposition as discussed above. However, the present embodiment is not limited thereto. The restriction unit **20**, the vapor deposition unit **1**, and the vapor deposition device **100** can be appropriately used in the following: (1) a method in which vapor deposition is performed while fixing each of positional relationships among the target film forming substrate **200**, the vapor deposition mask **10**, the restriction unit **20**, and the vapor deposition source **30**, (2) vapor deposition in which film formation is performed by sequentially moving the vapor deposition mask **10** relative to the target film forming substrate **200** and causing the mask to adhere (contact) for each movement, or the like. Even in the case of using the restriction unit **20** in this type of vapor deposition scheme, the use of the restriction unit **20** makes it possible to improve at least film thickness distribution in the X-axis direction and achieve the above-mentioned effect.

Second Embodiment

[0203] A description follows regarding a second embodiment, with reference to FIGS. **8** to **13**. The present embodiment will be stated by the differences between the present embodiment and the first embodiment, and components having the same functions as the components used in the first embodiment are appended with the same reference signs, and the description thereof is omitted.

[0204] In FIG. **8** to FIG. **13**, for the sake of convenience in illustration in the present embodiment as well, the numbers of mask openings **12** and restriction openings **24**, the numbers of target film forming regions **202** and target film forming pattern regions **203**, and the like are reduced in the drawings.

Schematic Configuration of Vapor Deposition Device 100

[0205] FIG. **8** is a cross-sectional view illustrating a schematic configuration of a main portion of the vapor deposition device **100** according to the present embodiment.

[0206] As illustrated in FIG. **8**, the vapor deposition device **100** according to the present embodiment is the same as the vapor deposition device **100** according to the first embodiment except for a point that the opening wall **23** of the restriction unit **20** is slanted relative to a normal direction of the top wall **21**.

[0207] As illustrated in FIG. **8**, the opening wall **23** of the restriction unit **20** according to the present embodiment is vertically provided downward (vertically hung) from the top wall **21** to spread toward an outer side relative to the normal direction of the top wall **21**, in other words, toward the vapor deposition source opening **31**.

[0208] As such, in the present embodiment, each of the restriction sections **25** has a cross-sectional shape of an inverse concave in which the opening walls **23** prepared at both sides of the top wall **21** are slanted to spread toward the outer side relative to the normal direction of the top wall **21** (in other words, a reversely tapered cross-sectional shape in which the top wall **21** side is narrower than the vapor deposition source **30** side). That is to say, in the present embodiment, the cross-sectional shape of each restriction section **25** is changed from a general rectangular parallelepiped shape illustrated in FIGS. **16**A and **16**B to a trapezoidal shape with a vacant interior without the base (that is, with the base open) as illustrated in FIG. **8**.

[0209] Hereinafter, design of the restriction unit **20** according to the present embodiment will be described additionally referring to FIGS. **9**A and **9**B to FIG. **12**.

[0210] FIGS. **9**A and **9**B are cross-sectional views each schematically illustrating the configuration of a main portion of the vapor deposition device **100** according to the present embodiment, in order to explain the design of the restriction unit **20** according to the present embodiment. Note that the vapor deposition mask **10** is not illustrated in FIGS. **9**A and **9**B. FIG. **10** is a cross-sectional view explaining a vapor deposition angle $\theta 1$ of the vapor deposition device according to the present embodiment. FIG. **11** is a cross-sectional view explaining a taper angle of the opening wall **23** of the restriction unit **20** according to the present embodiment. FIG. **12** is another cross-sectional view explaining the taper angle of the opening wall **23** of the restriction unit **20** according to the present embodiment.

[0211] As discussed above, each of the restriction sections **25** of the restriction unit **20** according to the present embodiment has a cross section formed in a trapezoidal shape with a vacant interior. Because of this, as illustrated in FIG. **8** and FIGS. **9**A and **9**B, a length L**1** in the X-axis direction of the top wall **21** in each restriction section **25**, to be more specific, a length L**1** in the X-axis direction of the top wall **21** interposed between the restriction openings **24** adjacent to each other is shorter than a length L**2** in the X-axis direction of an outer shape of each of the restriction sections **25** in plan view.

[0212] Accordingly, in the restriction unit **20**, as illustrated in FIGS. **9**A and **9**B, an opening width $\phi 1$ in the X-axis direction at the lower portion of the restriction opening **24** is smaller than an opening width $\phi 3$ in the X-axis direction at the upper portion of the restriction opening **24**. Because of this, in the present embodiment, the size in the X-axis direction of the target film forming region **202** is determined by the opening width $\phi 1$ in the X-axis direction at the lower portion of the restriction opening **24**. In the present embodiment, the size in the X-axis direction of the restriction opening **24** on the vapor deposition source **30** side (the above opening width $\phi 1$) is smaller than the size in the X-axis direction of the restriction plate opening **501** of the restriction unit **500** with the cross section of the restriction section **502** being a cross-sectional shape of a general rectangular parallelepiped as illustrated in FIGS. **16**A and **16**B, and is also smaller than the size in the X-axis direction of the restriction opening **24** of the restriction unit **20** (opening width $\phi 1$) in the first embodiment.

[0213] Here, in the present embodiment, the length L1 can be rephrased as a distance between opening ends on the top wall **21** side of the opening walls **23** adjacent to each other in the X-axis direction in each of the restriction sections **25**, that is, a distance between the opening ends of the opening walls **23** adjacent to each other in the X-axis direction on a face of each restriction section **25** opposing the vapor deposition mask **10**. Further, the length L**2** can be rephrased as a distance between the opening ends of the opening walls **23** adjacent to each other in the X-axis direction on a surface of each restriction section **25** opposing the vapor deposition source **30**. To be more specific, in a case where an outer shape of a cross section of each of the restriction sections **25** parallel to the X-axis direction is taken as a trapezoid, the length L**1** indicates the length of the upper base of the trapezoid, and the length L**2** indicates the length of the lower base of the trapezoid.

[0214] Neither L**1** nor L**2** is limited to any specific value as long as a relation of $L1<L2$ is satisfied. Note that the opening width $\phi 1$ and the length L**2** in the X-axis direction

of the outer shape of each restriction section 25 in plan view are determined by the vapor deposition angle $\theta 1$ with respect to the target film forming region 202 in such a manner as for the vapor deposition film 302 to be formed across the whole of each target film forming region 202 in the X-axis direction. Preferable design of the restriction unit 20 will be described below.

[0215] A range in the X-axis direction of the vapor deposition flow in the case where the outer shape of the cross section of each of the restriction sections 25 has a cross-sectional shape of a rectangular parallelepiped, in other words, the size in the X-axis direction of the target film forming region 202 brought by the above vapor deposition flow is determined by the opening width $\phi 3$ in the X-axis direction at the upper portion of restriction opening 24.

[0216] Here, the case where the outer shape of the cross section of each of the restriction sections 25 has a cross-sectional shape of a rectangular parallelepiped refers to a case where the restriction sections 25 have a cross-sectional shape of a square with one side open in which the opening walls 23 are vertically hung in the vertical direction (vertically provided downward) from the top wall 21 like in the first embodiment, or a case where each restriction section is made of a plate called a restriction plate like in the known technique. In other words, in the present embodiment, the outer shape of the cross section of each restriction section 25 refers to a shape connecting the base in the case where the base of each restriction section 25 is open (that is, a shape connecting the lower faces 23*a* of the opening walls 23 of the restriction section 25, for example).

[0217] As illustrated in FIGS. 9A and 9B, in the case where the cross section of each of the restriction sections 25 is formed in a trapezoidal shape with a vacant interior without the base (in other words, in the case where the outer shape of the cross section of each restriction section 25 takes a trapezoidal shape), in order to maintain substantially the same size in the X-axis direction of the vapor deposition flow as in the case of the outer shape of the cross section of each restriction section 25 taking a cross-sectional shape of a rectangular parallelepiped, the length L2 needs to fall within a range of $L2 \leq L1+\phi 3-\phi 1$, where L1 represents the length in the X-axis direction of the top wall 21 of each restriction sections 25, in other words, an outer edge in the X-axis direction of the lower face 23*a* of the opening wall 23 needs to fall within a range indicated by a triangular hatched portion P on the periphery of the restriction section 25 whose outer shape of the cross section takes a cross-sectional shape of a rectangular parallelepiped as illustrated in FIGS. 9A and 9B.

[0218] When the length L2 exceeds the above-mentioned range (in other words, when the outer edge in the X-axis direction of the lower face 23*a* of the opening wall 23 exceeds the above hatched portion P), an available vapor deposition range becomes smaller than a vapor deposition range in the case of the outer shape of the cross section of each restriction section 25 taking a cross-sectional shape of a rectangular parallelepiped. Therefore, it is advisable for the length L2 to be set within the above-mentioned range. Further, in order to enhance, to the maximum, the effect of cutting an unnecessary vapor deposition flow under the restriction section 25, it is more preferable that the length L2 be given by an equation of $L2=L1+\phi 3-\phi 1$ (in other words, the outer edge in the X-axis direction of the lower face 23*a* of the opening wall 23 be positioned at an end portion on the restriction opening 24 side in the hatched portion P).

[0219] Like in the first embodiment, in the case where the height of the opening wall 23 (that is, the height in the Z-axis direction of the opening wall 23 and a distance in the Z-axis direction from the upper face 21*b* of the top wall 21 to the lower face 23*a* of the opening wall 23) is taken as d2, a preferable value of L2 is indicated by an equation of $L2=L1+2*d2*\tan\theta 1$.

[0220] Further, as illustrated in FIG. 8, in the case where a distance from the lower face 21*a* of the top wall 21 to the upper face 30*a* of the vapor deposition source 30 is taken as (3, and a distance from the lower face 23*a* of the opening wall 23 as well as the lower face of the side wall 22 to the upper face 30*a* of the vapor deposition source 30 is taken as α, the height d2 of the opening wall 23 is represented by an equation of $d2=\beta+d1-\alpha$.

[0221] The vapor deposition angle $\theta 1$ is determined from the opening width $\phi 1$ of the restriction opening 24, the size in the X-axis direction of the vapor deposition source opening 31 (nozzle diameter $\phi 2$), and the distance α from the lower face 23*a* of the opening wall 23 to the upper face 30*a* of the vapor deposition source 30.

[0222] As can be understood from FIG. 10, an equation of $\tan\theta 1=(\phi 1-\phi 2)/2\alpha$ holds. Accordingly, the vapor deposition angle $\theta 1$ can be indicated by an equation of $\theta 1=\arctan((\phi 1-\phi 2)/2\alpha)$.

[0223] Further, as illustrated in FIG. 11, it is preferable that the lengths L1 and L2 be set so that, for example, a taper angle of the opening wall 23 as a longitudinal plate of the restriction section 25, particularly a taper angle $\theta 2$ of a face (upper face) of the opening wall 23 facing the restriction opening 24 (that is, a taper angle of an outer side of a trapezoid forming the restriction section 25) becomes larger than the vapor deposition angle $\theta 1$.

[0224] In the case where the taper angle $\theta 2$ is smaller than the vapor deposition angle $\theta 1$, there is a possibility that the vapor deposition flow restricted at the entrance of the restriction opening 24 on the vapor deposition source 30 side (in other words, at the opening on the lower face side of the restriction unit 20) is cut (blocked, captured) at the upper face of the opening wall 23 of the restriction section 25.

[0225] Further, it is ideal that a taper angle $\theta 3$ (see FIG. 12) of a face of the opening wall 23 on the opposite side to the face thereof facing the restriction opening 24 (in other words, a taper angle of a face on an inner side of the trapezoid forming the restriction section 25) is equal to the taper angle $\theta 2$.

[0226] That is to say, it is preferable that, as illustrated in FIGS. 8 and 11, the opening wall 23 have a uniform thickness, and that a face of the opening wall 23 on the opposite side to the face thereof facing the restriction opening 24 (in other words, a face on the inner side of the trapezoid forming the restriction section 25) be parallel to the face facing the restriction opening 24.

[0227] However, the present embodiment is not limited thereto, and the taper angle $\theta 3$ may be larger than the taper angle $\theta 2$ as illustrated in FIG. 12. In other words, the thickness of the opening wall 23 may be formed to be larger toward the top wall 21 side.

[0228] Also, in the present embodiment, the thickness d1 of the top wall 21, the height d2 of the side wall 22 and the opening wall 23, the thickness d3 of the opening wall 23 and the side wall **22**, the distance α, and the distance β(β=α+d**2**) can be set in the same manner as in the first embodiment.

Advantageous Effects

[0229] FIG. **13** is a cross-sectional view illustrating an effect by the restriction unit **20** according to the present embodiment.

[0230] According to the present embodiment, by the restriction section **25** having a reversely tapered cross-sectional shape as described above, the lower face **21***a* of the top wall **21**, to which the vapor deposition objects **303** adhere most, can be distanced from the vapor deposition source **30**, as indicated by a dotted line in FIG. **13**, in comparison with a case in which each of the restriction sections **25** has a cross-sectional shape of a square with one side on the base side being open where the opening wall **23** is vertically hung (vertically provided downward) in the vertical direction from the top wall **21** like in the first embodiment. This makes it possible to further decrease the temperature of an adhesion portion of the vapor deposition objects **303** in the restriction unit **20** compared to the first embodiment. Accordingly, the present embodiment makes it possible to further enhance the effect of reduction in the re-adhesion of the vapor deposition objects **303** to the upper face **30***a* of the vapor deposition source **30** compared to the first embodiment.

Third Embodiment

[0231] A description follows regarding a third embodiment, with reference to FIGS. **14** and **15**. The present embodiment will be stated by the differences between the present embodiment and the first and second embodiments. Components having the same functions as the components used in the first and second embodiments are appended with the same reference signs, and the description thereof is omitted.

[0232] Also, in the present embodiment, for the sake of convenience in illustration in FIGS. **14** and **15**, the numbers of mask openings **12** and restriction openings **24**, the numbers of target film forming regions **202** and target film forming pattern regions **203**, and the like are reduced in the drawings.

Schematic Configuration of Vapor Deposition Device 100

[0233] FIG. **14** is a cross-sectional view illustrating a schematic configuration of a main portion of the vapor deposition device **100** according to the present embodiment.

[0234] As illustrated in FIG. **14**, the vapor deposition device **100** according to the present embodiment is the same as the vapor deposition device **100** according to the second embodiment except for a point that the opening wall **23** of the restriction unit **20** is formed stepwise.

[0235] Neither the height of each step of the opening wall **23** nor the number of steps thereof is limited to any specific value in the present embodiment. In FIG. **14**, a case in which the number of steps of the opening wall **23** is three is cited as an example and illustrated. However, it is sufficient for the number of steps to be not less than two, and the number thereof may be two or may be not less than four.

[0236] Also in the present embodiment, the thickness d**1** of the top wall **21**, the height d**2** of the side wall **22** and the opening wall **23**, the thickness d**3** of the opening wall **23** and the side wall **22**, the distance α, and the distance β (β=α+d**2**) can be set in the same manner as in the first and second embodiments.

Advantageous Effects

[0237] FIG. **15** is a diagram illustrating an effect by the restriction unit **20** according to the present embodiment.

[0238] Also, in the present embodiment, by the restriction section **25** having a reversely tapered cross-sectional shape like in the second embodiment, the lower face **21***a* of the top wall **21**, to which the vapor deposition objects **303** adhere most, can be distanced from the vapor deposition source **30** in comparison with the first embodiment, as illustrated in FIG. **15**. Accordingly, the present embodiment can also obtain similar advantageous effects to those of the second embodiment.

[0239] Further, according to the present embodiment, since the opening wall **23** is formed stepwise, in other words, formed in a multi-step rectangular shape, the restriction section **25** can be processed with ease. Furthermore, since the height, width, or the like of each step can be appropriately changed, versatility is further enhanced compared to the second embodiment.

Supplement

[0240] The restriction unit **20** according to a first aspect of the present invention is a restriction unit that is configured to restrict the passage of the vapor deposition particles **301** emitted from the vapor deposition source **30** and includes at least one opening (restriction opening **24**) configured to allow the vapor deposition particles **301** to pass through and a plurality of non-openings (restriction sections **25**) prepared at both sides of the above opening, wherein the non-opening has a cross-sectional shape of an inverse concave formed of the top wall **21** and the opening walls **23**.

[0241] Because of this, the non-opening has a cross-sectional shape in which the thickness d**1** of the top wall **21** is smaller than the height d**2** of the opening wall **23** in the non-opening, no base wall is provided, and the base of the non-opening is open.

[0242] As such, according to the above configuration, the height d**2** of the opening wall **23** that determines a nozzle length of the restriction opening **24** makes it possible to distance most part of a face of the non-opening opposing the vapor deposition source **30**, particularly the lower face **21***a* of the top wall **21**, to which the vapor deposition objects **303** adhere most, from the vapor deposition source **30** while the height d**2** maintaining a range defined by design.

[0243] Accordingly, the above configuration makes it possible to substantially distance the non-opening from the vapor deposition source **30** without degrading an original function of the restriction unit **20** to control the isotropic vapor deposition flow and enhance the directivity.

[0244] As such, with the above configuration, because the radiation heat from the vapor deposition source **30** toward the non-opening can be reduced and the temperature of the adhesion portion of the vapor deposition objects **303** in the non-opening can be lowered, the re-evaporation of the vapor deposition objects **303** adhering to the non-opening can be reduced. As a result, according to the above configuration, abnormal film formation like the tiny film **304** can be prevented because the re-adhesion of the vapor deposition objects **303** to the vapor deposition source **30** caused by the re-evaporation of the vapor deposition objects **303** having adhered to the non-opening can be suppressed or prevented. Accordingly, the vapor deposition film **302** of a high resolution pattern without the adhesion of the tiny film **304** due to the re-evaporation of the vapor deposition objects **303**, can be produced (film-formed).

[0245] The restriction unit **20** according to a second aspect of the present invention is such that, in the first aspect, the opening wall **23** may be provided in parallel to a normal direction of the top wall **21**.

[0246] According to the above configuration, an effect described in the first aspect can be obtained with a simple configuration.

[0247] The restriction unit **20** according to a third aspect of the present invention is such that, in the first aspect, the opening wall **23** may be provided being slanted relative to the normal direction of the top wall **21**, and the non-opening may have a reversely tapered cross-sectional shape smaller in size on the top wall **21** side than on the vapor deposition source **30** side.

[0248] The above configuration makes it possible to distance the lower face **21***a* of the top wall **21**, to which the vapor deposition objects **303** adhere most, from the vapor deposition source **30** in comparison with a case in which the opening wall **23** is provided in parallel to the normal direction of the top wall **21**. With this, the temperature of the adhesion portion of the vapor deposition objects **303** in the restriction unit **20** can be further decreased in comparison with the case in which the opening wall **23** is provided in parallel to the normal direction of the top wall **21**, thereby making it possible to further enhance the effect of reduction in the re-adhesion of the vapor deposition objects **303** to the upper face **30***a* of the vapor deposition source **30**.

[0249] The restriction unit **20** according to a fourth aspect of the present invention is such that, in the third aspect, the opening wall **23** may be provided stepwise.

[0250] With the above configuration, since the opening wall **23** is formed stepwise, processing thereof (formation of the opening wall **23**) is carried out with ease. In addition, since the height, width, or the like of each step can be appropriately changed, the versatility can be further enhanced.

[0251] The restriction unit **20** according to a fifth aspect of the present invention is such that, in any one of the first through fourth aspects, a thickness of the opening wall **23** may be equal to a thickness of the top wall **21**.

[0252] In this case, the processing is carried out with ease so that the restriction unit **20** can be produced with ease.

[0253] A vapor deposition device **100** according to a sixth aspect of the present invention includes the restriction unit **20** according to any one of the first through fifth aspects, and the vapor deposition source **30** that is disposed opposing the restriction unit **20** and emits the vapor deposition particles **301**.

[0254] According to the above configuration, an effect similar to that of the first aspect can be obtained.

[0255] The vapor deposition device **100** according to a seventh aspect of the present invention is such that, in the sixth aspect, a distance α from a face (the lower face **23***a*) of the opening wall **23** opposing the vapor deposition source **30** to the upper face **30***a* of the vapor deposition source **30**, may be not less than 1 mm and not greater than 100 mm.

[0256] In the case where the distance α is excessively short, the influence of the radiation heat from the vapor deposition source **30**, particularly the influence of the radiation heat from the vapor deposition source **30** toward the lower face **23***a* of the opening wall **23** and the lower face of the side wall **22** becomes large. In the case where the plurality of openings mentioned above are provided and a plurality of emission openings (vapor deposition source openings **31**) through which the vapor deposition particles **301** from the vapor deposition source **30** are emitted are provided corresponding to the respective openings, there is a possibility that the vapor deposition particles **301** emitted from the emission openings other than the emission openings corresponding to the respective openings flow into the respective openings if the distance α is excessively long. However, by making the distance α fall within the above-mentioned range, the influence of the radiation heat from the vapor deposition source **30** can be suppressed, and such a possibility does not arise, in the above-mentioned case, that the vapor deposition particles **301** emitted from the emission openings other than the emission openings corresponding to the respective openings flow into the respective openings.

[0257] A production method for a vapor deposition film according to an eighth aspect of the present invention is a method for forming the vapor deposition film **302** of a predetermined pattern on the target film forming substrate **200** using the vapor deposition device **100** according to the sixth or seventh aspect.

[0258] According to the above method, an effect similar to that of the first aspect can be obtained.

[0259] The production method for the vapor deposition film according to a ninth aspect of the present invention is such that, in the eighth aspect, the plurality of openings are provided in the restriction unit **20** being arranged in a first direction (X-axis direction) in plan view, and vapor deposition may be performed while relatively moving at least one of the target film forming substrate **200** and a set of the restriction unit **20** and the vapor deposition source **30** in a second direction (Y-axis direction) orthogonal to the first direction in plan view.

[0260] With the above method, the vapor deposition film **302** can be efficiently film-formed on the target film forming substrate **200** of large size using the restriction unit **20** smaller in size than the target film forming substrate **200**.

[0261] A production method for an electroluminescence display device according to a tenth aspect of the present invention includes the production method for the vapor deposition film according to the eighth or ninth aspect.

[0262] With the above method, an effect similar to that of the eighth or ninth aspect can be obtained.

[0263] The production method for the electroluminescence display device according to an eleventh aspect of the present invention is such that, in the tenth aspect, the method includes a first electrode formation process (a preparation process of a TFT substrate and a first electrode (S1)) in which the first electrode **421** is formed on a substrate (TFT substrate **410**), an electroluminescence layer formation process (a vapor deposition process of an organic EL layer (S2)) in which an electroluminescence layer (organic EL layer **422**) that is formed of an organic or inorganic layer and includes at least the light emitting layer **422***b* is formed on the first electrode **421**, and a second electrode formation process (a vapor deposition process of a second electrode (S3)) in which the second electrode **423** is formed on the electroluminescence layer, and at least the light emitting layer **422***b* is formed by the production method for the vapor deposition film according to the eighth or ninth aspect.

[0264] With the above method, abnormal film formation like the tiny film **304** can be prevented because the re-adhesion of the vapor deposition objects **303** to the vapor deposition source **30** caused by the re-evaporation of the vapor deposition objects **303** having adhered to the non-opening can be suppressed or prevented. Accordingly, the above-discussed production method makes it possible to form the light emitting layer **422***b* including a high resolution pattern without the adhesion of the tiny film **304** due to the re-evaporation of the vapor deposition objects **303**. With this, according to the above-discussed production method, an EL display device, such as the organic EL display device **400**, having higher display quality than the existing display device can be provided.

[0265] An electroluminescence display device according to a twelfth aspect of the present invention is an electroluminescence display device (organic EL display device **400**) in which the first electrode **421**, an electroluminescence layer (organic EL layer **422**) formed of an organic or inorganic layer, and a second electrode **423** are provided in that order on a substrate (TFT substrate **410**), wherein the electroluminescence layer includes the light emitting layer **422***b* formed of a pattern of the vapor deposition film **302** that is formed by the vapor deposition particles **301** having passed through an opening (restriction opening **24**) of the restriction unit **20** including at least one opening configured to allow the vapor deposition particles **301** emitted from the vapor deposition source **30** to pass through and a plurality of non-openings (restriction sections **25**) prepared at both sides of the above opening where the non-opening has a cross-sectional shape of an inverse concave formed of the top wall **21** and the opening walls **23**.

[0266] The above configuration makes it possible to obtain an effect similar to that of the eleventh aspect.

[0267] The present invention is not limited to each of the embodiments stated above, and various modifications may be implemented within a range not departing from the scope of the claims. Embodiments obtained by appropriately combining technical approaches stated in each of the different embodiments also fall within the scope of the technology of the present invention. Moreover, novel technical features may be formed by combining the technical approaches stated in each of the embodiments.

REFERENCE SIGNS LIST

[0268] **1** Vapor deposition unit
[0269] **2** Film formation chamber
[0270] **3** Substrate carrying device
[0271] **10** Vapor deposition mask
[0272] **11** Mask opening region
[0273] **12** Mask opening
[0274] **13** Non-opening
[0275] **20** Restriction unit
[0276] **21** Top wall
[0277] **21***a*, **23***a*, **502***a* Lower face
[0278] **21***b*, **30***a* Upper face
[0279] **22** Side wall
[0280] **23** Opening wall
[0281] **24** Restriction opening (opening)
[0282] **25**, **502** restriction section (non-opening)
[0283] **30** Vapor deposition source
[0284] **31** Vapor deposition source opening
[0285] **100** Vapor deposition device
[0286] **200** Target film forming substrate
[0287] **201** Target deposition surface
[0288] **202** Target film forming region
[0289] **203** Target film forming pattern region
[0290] **204** Non-film forming region
[0291] **301** Vapor deposition particle
[0292] **302** Vapor deposition film
[0293] **303** Vapor deposition object
[0294] **304** Tiny film
[0295] **400** Organic EL display device
[0296] **401** Pixel
[0297] **402** Sub pixel
[0298] **410** TFT substrate (substrate)
[0299] **411** Insulating substrate
[0300] **412** TFT
[0301] **413** Signal line
[0302] **414** Interlayer insulating film
[0303] **414***a* Contact hole
[0304] **415** Edge cover
[0305] **415***a* Opening
[0306] **420** Organic EL element
[0307] **421** First electrode
[0308] **422** Organic EL layer (electroluminescence layer)
[0309] **422***a* Hole injection and transport layer (organic layer, inorganic layer)
[0310] **422***b* Light emitting layer (organic layer, inorganic layer)
[0311] **422***c* Electron transport and injection layer (organic layer, inorganic layer)
[0312] **423** Second electrode
[0313] **430** Sealing layer
[0314] **500** Restriction unit
[0315] **501** Restriction plate opening

1. A restriction unit configured to restrict a passage of vapor deposition particles emitted from a vapor deposition source, the unit comprising:
at least one opening configured to allow the vapor deposition particles to pass through; and
a plurality of non-openings prepared at both sides of the above opening,
wherein the non-opening has a cross-sectional shape of an inverse concave formed of a top wall and opening walls.

2. The restriction unit according to claim **1**,
wherein the opening wall is provided in parallel to a normal direction of the top wall.

3. The restriction unit according to claim **1**,
wherein the opening wall is provided being slanted relative to the normal direction of the top wall, and
the non-opening has a reversely tapered cross-sectional shape smaller in size on the top wall side than on the vapor deposition source side.

4. The restriction unit according to claim **3**,
wherein the opening wall is formed stepwise.

5. The restriction unit according to claim **1**,
wherein a thickness of the opening wall is equal to a thickness of the top wall.

6. A vapor deposition device comprising:
the restriction unit according to claim **1**; and
the vapor deposition source disposed opposing the restriction unit and configured to emit the vapor deposition particles.

7. The vapor deposition device according to claim **6**,
wherein a distance from a face of the opening wall opposing the vapor deposition source to an upper face of the vapor deposition source is not less than 1 mm and not greater than 100 mm.

8. A production method for a vapor deposition film, the method comprising:
forming a vapor deposition film of a predetermined pattern on a target film forming substrate by using the vapor deposition device according to claim **6**.

9. The production method for the vapor deposition film according to claim **8**,
wherein the at least one opening includes a plurality of openings, the plurality of openings are provided in the restriction unit being arranged in a first direction in plan view, and
vapor deposition is performed while relatively moving at least one of the target film forming substrate and a set of the restriction unit and the vapor deposition source in a second direction orthogonal to the first direction in plan view.

10. A production method for an electroluminescence display device, the method comprising:
the production method for the vapor deposition film according to claim **8**.

11. The production method for the electroluminescence display device according to claim **10**, the method further comprising:
forming a first electrode, the first electrode being formed on a substrate;
forming an electroluminescence layer, the electroluminescence layer formed of an organic or inorganic layer and including at least a light emitting layer being formed on the first electrode; and
forming a second electrode, the second electrode being formed on the electroluminescence layer,
wherein at least the light emitting layer is formed by the production method for the vapor deposition film.

12. An electroluminescence display device comprising:
a first electrode;
an electroluminescence layer formed of an organic or inorganic layer; and
a second electrode, the first electrode, the electroluminescence layer, and the second electrode being provided in that order on a substrate,
wherein the electroluminescence layer includes a light emitting layer formed of a pattern of a vapor deposition film formed by vapor deposition particles having passed through an opening of a restriction unit including at least one opening configured to allow the vapor deposition particles emitted from a vapor deposition source to pass through and a plurality of non-openings prepared at both sides of the above opening where the non-opening has a cross-sectional shape of an inverse concave formed of a top wall and opening walls.

* * * * *

专利名称(译)	限制单元，蒸镀装置，蒸镀膜的制造方法，电致发光显示装置的制造方法以及电致发光显示装置		
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摘要(译)

限制单元包括至少一个限制开口和多个限制部分，所述限制开口构造成允许蒸汽沉积颗粒通过，所述限制部分设置在限制开口的两侧。限制部分具有由顶壁和开口壁形成的倒凹形的横截面形状。