

## DESCRIPTION

SUBSTRATE HOLDING DEVICE, FILM DEPOSITION DEVICE, AND  
SUBSTRATE HOLDING METHOD

## 5      Technical Field

[0001]      The present invention relates to a substrate holding device that holds a mask for film deposition and a substrate by using a magnet, to a film deposition device including the substrate holding device, and to a  
10      substrate holding method.

## Background Art

[0002]      As the technology of forming a thin film in a predetermined region of a substrate, there is known a method of using a mask for film deposition. For  
15      example, Patent Document 1 describes an in-line type film deposition device that deposits vapor of a vapor deposition material, which is generated from a vapor deposition source, on a film deposition surface of a substrate, a plate-like mask being disposed on the film  
20      deposition surface, while conveying the substrate within a film deposition chamber.

[0003]      In this type of film deposition device, in order to inhibit the vapor of the vapor deposition material from moving around from a clearance between  
25      the mask and the substrate, it is necessary to ensure adhesion between the mask and the substrate. In this

regard, there is known a method of sandwiching a substrate and a substrate holding body that holds the substrate to be flat together between a mask and a magnetic plate that magnetically attracts the mask (see, for example, Patent Document 2).

[0004] Meanwhile, along with increase in size of the substrate in recent years, the thickness of the substrate holding body has needed to be larger so as to obtain the flatness. As a result, there have been concerns about reduction in magnetic force acting on the mask of the magnetic plate and reduction in adhesion between the substrate and the mask. In order to eliminate those problems, Patent Document 2 describes that a mask pressing mechanism that presses a mask against a substrate is provided on an evaporation source side with respect to the mask, and the mask is brought into close contact with the substrate.

[0005] Patent Document 1: Japanese Patent Application Laid-open No. 2010-118157

Patent Document 2: Japanese Patent Application Laid-open No. 2013-247040

Summary of Invention

Problem to be solved by the Invention

[0006] However, in the configuration described in Patent Document 2, a mechanism portion that constitutes the mask pressing mechanism is installed on the mask

evaporation source side, and thus there are concerns that the mechanism portion is vapor-deposited and this causes operation failures. Further, in a case where the mask has a large aperture ratio or where the intervals of apertures are narrow, it is difficult to dispose the mechanism portion without blocking the apertures.

[0007] In view of the circumstances as described above, it is an object of the present invention to provide a substrate holding device, a film deposition device, and a substrate holding method that are capable of ensuring adhesion between a mask and a substrate without providing a mechanism portion on an evaporation source side with respect to the mask.

#### Means for solving the Problem

[0008] In order to achieve the object described above, according to an embodiment of the present invention, there is provided a substrate holding device including a mask plate, an intermediate plate, a holding plate, and a pressing mechanism.

The mask plate is made of a magnetic material.

The intermediate plate has a first surface facing the mask plate and a second surface being on the opposite side of the first surface and is configured such that the first surface can come into contact with a substrate disposed on the mask plate.

The holding plate supports the intermediate plate

such that the intermediate plate is relatively movable in an axis direction orthogonal to the mask plate. The holding plate includes a magnet configured to be capable of magnetically attracting the mask plate with the intermediate plate and the substrate being interposed therebetween.

The pressing mechanism is disposed to face the second surface. The pressing mechanism is configured to be capable of pressing at least a part of the second surface along the axis direction.

[0009] In the substrate holding device, the intermediate plate has a function of maintaining a flat state of the substrate by coming into contact with a non-film deposition surface of the substrate that faces the mask plate. Meanwhile, as the intermediate plate is larger or as the thickness of the intermediate plate is smaller, the flatness of the intermediate plate itself may be reduced because of insufficient strength of the intermediate plate or deformation due to heat input during film deposition. In this regard, the substrate holding device includes the pressing mechanism that presses at least a part of the intermediate plate toward the mask plate side. With this configuration, as a result of increase in flatness of the intermediate plate, the flatness of the substrate being in contact with the intermediate plate is also maintained, and

good adhesion with the mask plate is ensured. Further, since the intermediate plate can be made thin, a stable adhesion force between the mask plate and the substrate can be ensured irrespective of the size of the substrate.

5 [0010] In the substrate holding device, since the pressing mechanism is disposed to face the second surface of the intermediate plate, adhesion between the mask plate and the substrate can be achieved without installing some kind of mechanism portion on an evaporation source side with respect to the mask plate. Thus, an effect of adhesion between the mask plate and the substrate can be stably maintained without depending on an aperture ratio of the mask plate or an arrangement form of apertures of the mask.

10 [0011] The axis direction is typically an axis direction parallel to a gravity direction. In this case, the pressing mechanism can inhibit reduction in flatness due to deformation by deflection of the substrate or the intermediate plate. Thus, desired film deposition accuracy can be stably obtained.

15 [0012] The pressing mechanism is typically installed on the holding plate. When the pressing mechanism is installed on the holding plate, the device configuration can be simplified, and a desired position of the intermediate plate can be stably pressed.

[0013] The pressing mechanism may include a plurality of pressing units configured to be capable of respectively pressing a plurality of positions of the second surface. In such a manner, when the plurality of positions on the intermediate plate can be pressed, the flatness of the intermediate plate is easy to improve. A pressed position of the intermediate plate is not particularly limited and is typically the center portion and/or the circumferential portion of the intermediate plate (second surface).

[0014] The intermediate plate may be configured to be movable between a contact position and a holding position along the axis direction. The contact position is assumed as a position at which at least a part of the first surface comes into contact with the substrate and a relative distance with respect to the holding plate is a first distance. The holding position is assumed as a position at which a relative distance with respect to the holding plate is a second distance smaller than the first distance. In this case, the pressing mechanism presses the second surface along the axis direction in a process in which the intermediate plate moves from the contact position to the holding position.

According to the configuration described above, the magnet is approaching the second surface of the intermediate plate with the first surface of the

intermediate plate being in contact with the substrate,  
and the second surface is pressed with the pressing  
mechanism. Therefore, the substrate can be brought into  
close contact with the mask plate with high flatness  
5 without causing the displacement of the substrate with  
respect to the mask plate.

[0015] The pressing unit includes, for example, a  
pressing element and an elastic member. The pressing  
element is disposed to face the second surface. The  
10 elastic member is disposed between the pressing element  
and the second surface and is configured to be  
elastically deformable in the axis direction.

With this configuration, a desired pressing force  
can be stably imparted to the plurality of positions on  
15 the intermediate plate. Thus, the intermediate plate  
and the substrate can be maintained with target  
flatness.

[0016] A constituent material of the intermediate  
plate is not particularly limited and may be a magnetic  
20 material or a non-magnetic material. In a case where  
the intermediate plate is made of a magnetic material,  
a magnetic path through which a magnetic field from the  
magnet passes is formed. Thus, a magnetic attraction  
force with respect to the mask plate can be enhanced.  
25 Meanwhile, in a case where the intermediate plate is  
made of a non-magnetic material, when the holding of

the substrate by the magnet is released after film deposition, the holding plate can be separated from the mask plate with the intermediate plate being in contact with the substrate.

5 [0017] According to an embodiment of the present invention, there is provided a film deposition device including a film deposition chamber, a film deposition source, a mask plate, an intermediate plate, a holding plate, and a pressing mechanism.

10 The film deposition source is disposed in the film deposition chamber.

The mask plate is disposed to face the film deposition source and is made of a magnetic material.

15 The intermediate plate has a first surface facing the mask plate and a second surface being on the opposite side of the first surface and is configured such that the first surface can come into contact with a substrate disposed on the mask plate.

20 The holding plate supports the intermediate plate such that the intermediate plate is relatively movable in an axis direction orthogonal to the mask plate. The holding plate includes a magnet configured to be capable of magnetically attracting the mask plate with the intermediate plate and the substrate being  
25 interposed therebetween.

The pressing mechanism is disposed to face the

second surface. The pressing mechanism is configured to be capable of pressing at least a part of the second surface along the axis direction.

[0018] According to an embodiment of the present invention, there is provided a substrate holding method including: disposing a substrate on a mask plate made of a magnetic material; bringing an intermediate plate into contact with the substrate; pressing at least a part of the intermediate plate toward the mask plate with use of a pressing mechanism; and disposing a holding plate on the intermediate plate, the holding plate including a magnet magnetically attracting the mask plate, and thus integrally holding the intermediate plate, the substrate, and the mask plate.

#### Effects of the Invention

[0019] According to the present invention, it is possible to ensure adhesion between a mask and a substrate.

#### Brief Description of Drawings

[0020] [Fig. 1] Fig. 1 is a schematic cross-sectional view of a film deposition device according to an embodiment of the present invention.

[Fig. 2] Fig. 2 is a schematically enlarged view of a substrate holding device in the film deposition device and shows a state before a substrate is held.

[Fig. 3] Fig. 3 is a schematically enlarged view of

the substrate holding device in the film deposition device and shows a state where the substrate is held.

[Fig. 4] Fig. 4 is a side view schematically showing a positional relationship between a mask plate, a

5 substrate, an intermediate plate, and a magnet (holding plate) in the substrate holding device.

[Fig. 5] Fig. 5 is a schematic side view for describing a state where the substrate is held when the intermediate plate is deformed.

10 [Fig. 6] Fig. 6 is a schematic side view for describing an action of the substrate holding device.

[Fig. 7] Fig. 7 is a schematic cross-sectional side view showing one configuration example of a pressing mechanism of the substrate holding device and showing a state where the substrate is not held.

15 [Fig. 8] Fig. 8 is a schematic cross-sectional side view showing one configuration example of the pressing mechanism of the substrate holding device and showing a state immediately before the substrate is held.

20 [Fig. 9] Fig. 9 is a schematic cross-sectional side view showing one configuration example of the pressing mechanism of the substrate holding device and showing a state where the substrate is held.

[Fig. 10] Fig. 10 is a schematic plan view showing an example of positions of the intermediate plate, which are pressed with the pressing mechanism.

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[Fig. 11] Fig. 11 is a schematic plan view of the intermediate plate, showing a modified example of the pressing mechanism.

Mode(s) for Carrying Out the Invention

5 [0021] Hereinafter, an embodiment of the present invention will be described with reference to the drawings.

[0022] Fig. 1 is a schematic cross-sectional view of a film deposition device 100 according to an embodiment  
10 of the present invention. In the figure, X, Y, and Z axes represent three axis directions orthogonal to one another, in which the X and Y axes represent the horizontal direction, and the Z axis represents the height direction (the same applies to the figures  
15 mentioned below).

[0023] [Overall Configuration of Film Deposition Device]

The film deposition device 100 of this embodiment is configured as a vacuum vapor deposition device and  
20 includes a film deposition chamber 10, an evaporation source 20 (film deposition source), and a substrate holding device 30.

[0024] The film deposition chamber 10 is constituted of a vacuum chamber. In other words, the film  
25 deposition chamber 10 is connected with a vacuum pump (not shown in the figure) and is configured such that

the inside of the film deposition chamber 10 can be evacuated to a predetermined reduced-pressure atmosphere and maintained.

[0025] The film deposition device 100 is constituted of, for example, a cluster-type vacuum film deposition device in which a plurality of processing chambers including the film deposition chamber 10 are disposed around a conveyor chamber via gate valves. In this case, as shown in Fig. 1, a substrate W is conveyed from the conveyor chamber to the film deposition chamber 10 or from the film deposition chamber 10 to the conveyor chamber via a substrate conveying robot (not shown in the figure) installed in the conveyor chamber.

[0026] The evaporation source 20 is for generating vapor of a vapor deposition material (or evaporation material), and evaporation sources of various methods such as a resistance heating method, an induction heating method, and an electron beam heating method are applicable. For the vapor deposition material, metal materials, metal compound materials such as a metal oxide and a metal sulfide, synthetic resin materials, materials for organic EL, and the like are used.

[0027] It should be noted that the evaporation source 20 may include a shutter capable of inhibiting the vapor of the vapor deposition material from reaching the substrate W held by the substrate holding

device 30. Further, the evaporation source 20 may be fixed to the bottom portion of the film deposition chamber 10 or may be configured to be relatively movable in the horizontal direction with respect to the bottom portion of the film deposition chamber 10 and the substrate holding device 30.

[0028] [Substrate Holding Device]

The substrate holding device 30 is disposed at a position immediately above the evaporation source 20 and is configured to be capable of holding the substrate W, which is to be subjected to film deposition, at a position facing the evaporation source 20. The substrate holding device 30 includes a mask member 31, an intermediate plate 32, a holding plate 33, and a pressing mechanism 34.

[0029] Figs. 2 and 3 are schematically enlarged views of the substrate holding device 30. Fig. 2 shows a state before the substrate W is held. Fig. 3 shows a state where the substrate W is held.

[0030] The mask member 31 is disposed to face the evaporation source 20. The mask member 31 is fixed to the inside of the film deposition chamber 10 via a fixed portion (not shown in the figure).

[0031] The mask member 31 includes a mask plate 311 that faces a film deposition surface of the substrate W, and a frame portion 312 that supports the circumference

of the mask plate 311.

[0032] The mask plate 311 is constituted of a thin plate that is made of a magnetic material having a predetermined aperture pattern. A constituent material of the mask plate 311 is not particularly limited. Typically, a ferromagnetic material having high magnetic permeability characteristics (soft magnetic characteristics), such as Fe, Co, Ni, or an alloy of them, is used. Further, in order to suppress thermal deformation of the mask plate 311 that results from heat input from a film deposition source (evaporation source 20) at the time of film deposition, an alloy such as invar having a small thermal expansion coefficient may be used as the constituent material of the mask plate 311. The mask plate 311 is formed in a size capable of covering the film deposition surface of the substrate W. The size of the substrate W is not particularly limited. In this embodiment, the fourth and fifth generation (G4 to G5) rectangular glass substrates (for example, 680 mm to 1200 mm in longitudinal length by 730 mm to 1300 mm in lateral length) are used.

[0033] The frame portion 312 is fixed to the fixed portion and holds the mask plate 311 such that the mask plate 311 is in a horizontal posture. The frame portion 312 may be made of a magnetic material similarly to the

mask plate 311, but the frame portion 312 is not limited thereto and may be made of a non-magnetic material.

[0034] The intermediate plate 32 is disposed above the mask member 31. The intermediate plate 32 is made of a rectangular plate material having a predetermined thickness larger than that of the substrate W. In this embodiment, the intermediate plate 32 is made of a non-magnetic material such as austenite stainless steel, aluminum, or copper. The intermediate plate 32 has a lower surface 32a (first surface) that faces the mask plate 311, and an upper surface 32b (second surface) on the opposite side. The lower surface 32a of the intermediate plate 32 is configured to be capable of coming into contact with the back surface (non-vapor deposition surface) of the substrate W, the substrate W facing the mask plate 311, at the time when the substrate is held (Fig. 3).

[0035] A circulation flow passage for cooling water may be formed into the intermediate plate 32. With this configuration, an excessive temperature rise of the substrate W during film deposition can be suppressed, and the substrate W can be cooled to a predetermined temperature or lower.

[0036] The holding plate 33 is disposed above the intermediate plate 32 and supports the intermediate

plate 32 such that the intermediate plate 32 is relatively movable in the axis direction (Z-axis direction) orthogonal to the mask plate 31. The holding plate 33 includes a magnet 331 configured to be capable of magnetically attracting the mask plate 311 with the intermediate plate 32 and the substrate W being interposed therebetween. The magnet 331 is made of a plate-like permanent magnet, which is larger than the substrate W and disposed on the lower surface of the holding plate 33.

[0037] The holding plate 33 is configured to be relatively movable in the Z-axis direction with respect to the mask member 31 through a raising and lowering mechanism (not shown in the figure). In a state before the substrate W is held, the holding plate 33 is at a position separate from the mask plate 311 (raised position) as shown in Fig. 2. When the substrate W is held, the holding plate 33 is at a position close to the mask plate 311 (lowered position) as shown in Fig. 3. As will be described later, the intermediate plate 32 is configured such that the lower surface 32a is separate from the mask plate 311 by a predetermined distance at the raised position, and that the lower surface 32a comes into contact with the mask plate 311 (or the substrate W) at the lowered position.

[0038] The pressing mechanism 34 includes a

plurality of pressing units 35, which are configured to be capable of pressing at least a part of the upper surface 32b of the intermediate plate 32 along the Z-axis direction. As will be described later, the  
5 plurality of pressing units 35 are installed on the holding plate 33 so as to face the upper surface 32b of the intermediate plate 32.

[0039] The pressing mechanism 34 is for preventing generation of a clearance between the substrate W and the intermediate plate 32 due to deflection or  
10 deformation of the intermediate plate 32. The pressing mechanism 34 has a function of pressing, when the holding plate 33 reaches the lowered position, the upper surface of the intermediate plate 32 at a  
15 predetermined pressure, the intermediate plate 32 being in contact with the non-vapor deposition surface of the substrate W, and correcting the shape of the intermediate plate 32 to be flat.

[0040] Fig. 4 is a side view schematically showing a positional relationship between the mask plate 311, the  
20 substrate W, the intermediate plate 32, and the magnet 331 (holding plate 33). When the substrate W is held, the holding plate 33 is moved to the lowered position, and thus the intermediate plate 32 comes into contact  
25 with the non-vapor deposition surface of the substrate W. Further, the magnet 331 magnetically attracts the

mask plate 311 and sandwiches the substrate W between the intermediate plate 32 and the mask plate 311.

[0041] At that time, as shown in Fig. 5, when a clearance is generated between the substrate W and the intermediate plate 32 due to the deformation of the intermediate plate 32, also in a state where the holding plate 33 is moved to the lowered position, i.e., a state where the substrate is held, a distance between the mask plate 311 and the magnet 331 becomes large. This leads to a situation where a magnetic force of the magnet 331, which is necessary to bring the mask plate 311 into close contact with the substrate W, becomes insufficient. In this regard, in this embodiment, as shown in Fig. 6, with the holding plate 33 being moved to the lowered position, at least a part of the upper surface 32b of the intermediate plate 32 is pressed toward the substrate W (mask plate 311), and the amount of deformation of the intermediate plate 32 is reduced. This provides a configuration to maintain the flatness of the intermediate plate 32.

[0042] The plurality of pressing units 35 are each configured to be capable of partially pressing the upper surface of the intermediate plate 32. The pressing mechanism 34 includes the plurality of pressing units 35, and thus the flatness of the intermediate plate 32 is easy to improve. A pressed

position of the intermediate plate 32 (a position at which the pressing unit 35 is disposed) is not particularly limited and is typically the center portion or the circumferential portion of the intermediate plate 32 or are both of them.

[0043] The plurality of pressing units 35 typically have an identical configuration. Figs. 7 to 9 are cross-sectional side views each schematically showing a configuration of the pressing unit 35. Fig. 7 shows a state before the substrate W is held. Fig. 8 shows a state immediately before the substrate is held. Fig. 9 shows a state where the substrate W is held.

Here, Fig. 7 shows a state where the substrate W and the holding plate 33 are lowered from the raised position of the holding plate 33 shown in Fig. 2, and the substrate W is placed on the upper surface of the mask plate 311, and also shows a state where the intermediate plate is not in contact with the substrate W.

Further, in order to easily understand an action of the pressing units 35, the intermediate plate 32 is drawn in a slightly deformed state (deflected state) in Figs. 7 and 8. In a state shown in Fig. 9 where the substrate W is held, the intermediate plate 32 is drawn in a state where the deflection thereof is corrected (flat state).

[0044] The upper surface 32b of the intermediate plate 32 is provided with a plurality of shaft portions 321 extending in the Z-axis direction. The holding plate 33 and the magnet 331 are provided with a  
5 plurality of through-holes 332 so as to correspond to the positions of the shaft portions 321. The plurality of shaft portions 321 penetrate through the plurality of through-holes 332. Each shaft portion 321 has a head 321h at the upper end thereof, the head 321h being  
10 capable of abutting from above on the circumference of the aperture of the through-hole 332 on the holding plate 33 side.

[0045] Each shaft portion 321 is configured to have an identical length. Each shaft portion 321 is set to  
15 have a length with which a distance G1 is formed between the upper surface 32b of the intermediate plate 32 and the lower surface of the magnet 331 when the shaft portion 321 is hung by the weight of the intermediate plate 32 (for example, when the holding  
20 plate 33 is located at the raised position). With this configuration, the intermediate plate 32 is supported so as to be relatively movable with respect to the holding plate 33 in the Z-axis direction by the distance G1 at a maximum.

25 [0046] In this embodiment, the head 321h of the shaft portion 321 is formed into an inverted truncated

cone shape. With this configuration, in the hung state of the intermediate plate 32 shown in Fig. 7, the axial center of each shaft portion 321 can coincide with the axial center of each through-hole 332. Thus, a hung posture of the intermediate plate 32 with respect to the holding plate 33 can be stably maintained. It should be noted that, in order to further enhance the effect described above, as shown in the figure, the aperture of each through-hole 332 on the holding plate 33 side may be formed into a tapered shape (mortar shape) having an inverted cone shape, which corresponds to the shape of the head 321h.

[0047] Meanwhile, the plurality of pressing units 35 are installed on the holding plate 33 and respectively disposed at positions where the plurality of shaft portions 321 penetrate. Each pressing unit 35 includes a pressing element 351 disposed at a position immediately above the head 321h of the shaft portion 321, and an elastic member 355 disposed between the pressing element 351 and the upper surface 32b of the intermediate plate 32.

[0048] The pressing element 351 is disposed to face the head 321h of the shaft portion 321 in the Z-axis direction. The pressing element 351 is made of, for example, a circular plate material, and a bolt member 352 extending in the Z-axis direction is fixed to the

center of the pressing element 351. The bolt member 352 penetrates through the top of a support portion 353, which is installed on the upper surface of the holding plate 33 so as to surround the head 321h of the shaft portion 321, and is screwed into a nut member 354 fixed to the upper surface of the support portion 353.

Therefore, when the bolt member 352 is rotated about the shaft with respect to the nut member 354, a relative distance of the pressing element 351 with respect to the head 321h of the shaft portion 321 can be adjusted.

[0049] The elastic member 355 is elastically deformable in the Z-axis direction and is installed on the upper surface of the head 321h of the shaft portion 321. The elastic member 355 is typically constituted of a coil spring, but the elastic member 355 is not limited thereto and may be constituted of an elastic material such as rubber or elastomer. In this embodiment, in a case where the holding plate 33 is at a first position, a distance G2 is formed between the upper surface of the elastic member 355 and the lower surface of the pressing element 351. The distance G2 is set to a value smaller than the distance G1. The value of the distance G2 may be zero. It should be noted that the elastic member 355 may be installed not on the upper surface of the head 321h of the shaft portion 321

but on the lower surface of the pressing element 351.

[0050] In this embodiment, the intermediate plate 32 has a first position shown in Fig. 7, a second position (contact position) shown in Fig. 8, and a third position (holding position) shown in Fig. 9 with respect to the holding plate 33 (magnet 331). The intermediate plate 32 is configured to be movable along the Z-axis direction between the first position and the third position via the second position.

[0051] At the first position, the intermediate plate 32 is hung from the holding plate 33, the lower surface 32a of the intermediate plate 32 is not in contact with the substrate W, and the upper surface 32b of the intermediate plate 32 faces the holding plate 33 (magnet 331) at a relative distance of a gap G1.

At the second position, the lower surface 32a of the intermediate plate 32 comes into contact with the substrate W, the holding plate 33 is lowered until the pressing element 351 comes into contact with the upper surface of the elastic member 355, and the upper surface 32b of the intermediate plate 32 faces the holding plate 33 (magnet 331) at a relative distance (first distance) of a gap (G1-G2).

At the third position, at least a part of the lower surface 32a of the intermediate plate 32 comes into contact with the substrate W, the holding plate 33

is further lowered by a predetermined amount while compressing and deforming the elastic member 355, and the upper surface 32b of the intermediate plate 32 faces the holding plate 33 (magnet 331) at a relative distance (second distance) of a gap G3 that is smaller than the gap (G1-G2).

[0052] Since the pressing unit 35 is configured as described above, the pressing mechanism 34 can press the upper surface 32b of the intermediate plate 32 along the Z-axis direction in the process in which the intermediate plate 32 moves from the second position (contact position) to the third position (holding position).

[0053] The lowered position of the holding plate 33 is set to a predetermined height position from the mask plate 311. In this case, a force of the pressing mechanism 34 (pressing unit 35) to press the intermediate plate 32 is set in accordance with the value of the distance G2. Therefore, the pressing force can be easily adjusted by changing the distance G2.

[0054] As shown in Figs. 2 and 3, the substrate holding device 30 further includes a support unit 36 that supports the substrate W, which is conveyed into the film deposition chamber 10, between the mask plate 311 and the intermediate plate 32. The support unit 36 includes, for example, a plurality of hooks that

support the circumferential portion of the lower surface of the substrate W. The support unit 36 is configured to be movable up and down between a substrate delivering position (Fig. 2) at which the substrate is delivered with a substrate conveying device (not shown in the figure) and a substrate placing position (Fig. 3) at which the substrate is placed on the mask plate 311. Further, in order to enable the substrate W to be aligned with the mask plate 311, the support unit 36 is configured to be movable in the horizontal direction.

[0055] The film deposition device 100 further includes a control unit 40 that controls operations of the evaporation source 20, the substrate holding device 30, the support unit 36, and the like. The control unit 40 is typically constituted of a computer and executes a predetermined program to thus control operations of the respective components.

[0056] [Operation of Film Deposition Device]

Next, a typical operation of the film deposition device 100 of this embodiment configured as described above will be described.

[0057] The substrate W, which is conveyed into the film deposition chamber 10 via a gate valve (not shown in the figure), is supported by the support unit 36 with a film deposition surface facing down, the support

unit 36 being on standby at the substrate delivering position. At that time, the holding plate 33 is moved to the raised position as shown in Fig. 2, and the intermediate plate 32 is hung from the holding plate 33 by the weight of the intermediate plate 32. The substrate W is disposed between the intermediate plate 32 and the mask plate 311 by the support unit 36. Subsequently, alignment of the substrate W with the mask plate 311 in the horizontal direction is executed.

[0058] After the alignment of the substrate W, the support unit 36 is lowered to the substrate placing position, and the substrate W is placed on the upper surface of the mask plate 311. It should be noted that the upper surface of the frame portion 312 of the mask member 31 is provided with a plurality of runout portions (recessed portions) 312a for avoiding collision with the support unit 36 lowered to the substrate placing position.

[0059] Subsequently, the holding plate 33 is moved from the raised position shown in Fig. 2 to the lowered position shown in Fig. 3. With this configuration, the lower surface 32a of the intermediate plate 32 comes into contact with a non-vapor deposition surface (non-film deposition surface) of the substrate W, and at the same time, the holding plate 33 is relatively moved with respect to the intermediate plate 32, and thus the

magnet 331 comes close to the upper surface 32b of the intermediate plate 32. At that time, the magnet 331 stops while leaving a small clearance (G3) with respect to the upper surface 32b of the intermediate plate.

5 [0060] Meanwhile, the upper surface 32b of the intermediate plate 32 is partially pressed at a plurality of portions from the respective pressing units 35 toward the substrate W and the mask plate 311 in the Z-axis direction until the intermediate plate 32 is moved from the first position shown in Fig. 7 to the  
10 third position (holding position) shown in Fig. 9 via the second position (contact position) shown in Fig. 8. In this embodiment, the intermediate plate 32 is pressed toward the mask plate 311 with use of each  
15 pressing unit 35 by a pressing amount corresponding to the distance of (G1-G2-G3). At that time, in a case where the intermediate plate 32 is deflected or deformed, this deflection or deformation is corrected to be flat, and thus the flatness of the intermediate  
20 plate 32 is enhanced (Fig. 9). With this configuration, a contact area of the lower surface 32a of the intermediate plate 32 to the substrate W is increased, a relative distance between the magnet 331 and the mask plate 311 is shortened, and a magnetic attraction force  
25 of the magnet 331 with respect to the mask plate 311 is increased. As a result, adhesion between the substrate

W and the mask plate 311 is improved.

[0061] As described above, the intermediate plate 32, the substrate W, and the mask plate 311 are integrally held. Subsequently, processing of film deposition on the substrate W is performed. According to this embodiment, since the adhesion between the substrate W and the mask plate 311 is ensured by the substrate holding device 30, a clearance between the substrate W and the mask plate 311 is made as small as possible. This can inhibit the vapor deposition material from moving around from the clearance.

[0062] Further, the flatness of the intermediate plate 32 is increased by the pressing unit 35, and thus the flatness of the substrate W that follows the shape of the lower surface 32a of the intermediate plate 32 is also ensured. With this configuration, the mask film deposition processing with high accuracy can be implemented on the film deposition surface of the substrate W. Furthermore, the film deposition processing is performed while causing the evaporation source 20 to reciprocate in the horizontal direction, and thus in-plane uniformity of the film deposition processing can be enhanced over the entire film deposition surface of the substrate W.

[0063] After the film deposition processing is terminated, the substrate holding device 30 moves the

holding plate 33 from the lowered position shown in Fig. 3 to the raised position shown in Fig. 2. At that time, until the holding plate 33 is moved by a predetermined distance (distance corresponding to G1-G3), the

5 substrate W is being pressed against the mask plate 311 by the pressing force of the pressing unit 35 and the weight of the intermediate unit. With this configuration, the substrate W is prevented from being displaced with respect to the mask plate 311, and a

10 vapor deposition pattern formed on the film deposition surface is inhibited from being damaged in the aperture of the mask. Further, since the intermediate plate 32 is made of a non-magnetic material, the magnet 331 can be easily detached from the mask plate 311.

15 [0064] After the holding plate 33 is moved to the raised position, the support unit 36 is raised to the substrate delivering position (Fig. 2). The film-deposited substrate W is then conveyed to the outside of the film deposition chamber 10 through the substrate

20 conveying device (not shown in the figure). Furthermore, a new substrate W to be film-deposited is conveyed to the support unit 36 and is held and subjected to the film deposition processing through the operation similar to that described above.

25 [0065] As described above, the intermediate plate 32 has a function of maintaining the flat state of the

substrate W by coming into contact with the non-film deposition surface of the substrate W that faces the mask plate 311. Meanwhile, as the intermediate plate 32 is larger or as the thickness of the intermediate plate 32 is smaller, the flatness of the intermediate plate 32 itself may be reduced. In this regard, the substrate holding device 30 of this embodiment includes the pressing mechanism 34 that presses at least a part of the intermediate plate 32 toward the mask plate 311 side. With this configuration, as a result of increase in flatness of the intermediate plate 32, the flatness of the substrate that comes into contact with the intermediate plate 32 is also maintained, and good adhesion with the mask plate 311 is ensured. Further, since the intermediate plate 32 can be made thin, a stable adhesion force between the mask plate 311 and the substrate W can be ensured irrespective of the size of the substrate.

[0066] Further, in the substrate holding device 30 of this embodiment, since the pressing mechanism 34 (pressing unit 35) is disposed to face the upper surface 32b of the intermediate plate 32, adhesion between the mask plate 311 and the substrate W can be achieved without installing some kind of mechanism portion on the evaporation source 20 side with respect to the mask plate 311. Thus, an effect of adhesion

between the mask plate 311 and the substrate W can be stably maintained without depending on the aperture ratio of the mask plate 311 or the arrangement form of the apertures of the mask.

5 [0067] Further, since the pressing mechanism 34 is installed on the holding plate 33, the device configuration can be simplified, and a desired position of the intermediate plate 32 can be stably pressed.

[0068] Furthermore, the substrate holding device 30  
10 of this embodiment is configured such that the intermediate plate 32 can be pressed with the pressing mechanism 34 in a gravity direction. With this configuration, reduction in flatness due to deformation by deflection of the substrate W or the intermediate  
15 plate 32 can be inhibited using the weight of the intermediate plate 32 as well. Thus, desired film deposition accuracy can be stably obtained.

[0069] Hereinabove, the embodiment of the present invention has been described. However, the present  
20 invention is not limited to the embodiment described above and can be variously modified as a matter of course.

[0070] For example, in the embodiment described above, the vacuum vapor deposition device has been  
25 exemplified as a film deposition device, but the present invention is not limited thereto. The present

invention is also applicable to another film deposition device such as a sputtering device. In this case, a sputtering cathode that holds a sputtering target is configured as a film deposition source.

5 [0071] Further, the plurality of pressing units 35 that constitute the pressing mechanism 34 are not limited to be disposed at the center portion and/or the circumferential portion of the intermediate plate 32. As schematically shown in Fig. 10, the pressing units  
10 35 may be disposed at the center portion, the circumferential portion, and four corner portions of the intermediate plate 32, and also intermediate positions of the above portions and the like, in accordance with the shape, the size, the thickness, and  
15 the like of the intermediate plate 32. The number of pressing units 35 to be disposed is also not particularly limited. In a case where an arbitrary part of the intermediate plate is pressed, at least one pressing unit 35 suffices. In a case where the almost  
20 entire region of the intermediate plate is pressed, much more pressing units may be disposed in narrow pitches. Furthermore, as shown in Fig. 11, a frame-shaped pressing unit 37 that can press the circumferential portion of the intermediate plate 32 at  
25 a time may be used.

[0072] In the embodiment described above, the

example in which the pressing mechanism 34 is installed  
on the holding plate 33 has been described, but the  
present invention is not limited thereto. The pressing  
mechanism 34 may be configured independently of the  
5 holding plate 33.

Description of Reference Numerals

[0073] 10 film deposition chamber  
20 evaporation source  
30 substrate holding device  
10 31 mask member  
32 intermediate plate  
33 holding plate  
34 pressing mechanism  
35 pressing unit  
15 100 film deposition device  
311 mask plate  
331 magnet  
351 pressing element  
355 elastic member  
20 W substrate

## Claims

[1] A substrate holding device, comprising:

a mask plate that is made of a magnetic material;

an intermediate plate that has a first surface

5 facing the mask plate and a second surface being on the opposite side of the first surface and is configured such that the first surface can come into contact with a substrate disposed on the mask plate;

a holding plate that supports the intermediate

10 plate such that the intermediate plate is relatively movable in an axis direction orthogonal to the mask plate, and includes a magnet configured to be capable of magnetically attracting the mask plate with the intermediate plate and the substrate being interposed  
15 therebetween; and

a pressing mechanism that is disposed to face the second surface, is configured to be capable of pressing at least a part of the second surface along the axis direction, and is installed on the holding plate,

20 wherein

the intermediate plate is configured to be movable between a contact position at which at least a part of the first surface comes into contact with the substrate and a relative distance with respect to the holding  
25 plate is a first distance, and a holding position at which a relative distance with respect to the holding

plate is a second distance smaller than the first distance, and

the pressing mechanism

includes a pressing unit including

5 a pressing element that is disposed to face the second surface, and

an elastic member that is disposed between the pressing element and the second surface and is elastically deformable in the axis direction, and

10 presses the second surface along the axis direction in a process in which the intermediate plate moves from the contact position to the holding position.

[2] A substrate holding device, comprising:

15 a mask plate that is made of a magnetic material;  
an intermediate plate that has a first surface facing the mask plate and a second surface being on the opposite side of the first surface and is configured such that the first surface can come into contact with  
20 a substrate disposed on the mask plate;

a holding plate that supports the intermediate plate such that the intermediate plate is relatively movable in an axis direction orthogonal to the mask plate, and includes a magnet configured to be capable  
25 of magnetically attracting the mask plate with the intermediate plate and the substrate being interposed

therebetween; and

a pressing mechanism that is disposed to face the second surface, is configured to be capable of pressing at least a part of the second surface along the axis direction, and includes a pressing unit including

5

a pressing element that is disposed to face the second surface, and

an elastic member that is disposed between the pressing element and the second surface and is elastically deformable in the axis direction.

10

[3] The substrate holding device according to claim 1 or 2, wherein

the pressing mechanism includes a plurality of pressing units configured to be capable of respectively pressing a plurality of positions of the second surface.

15

[4] The substrate holding device according to any one of claims 1 to 3, wherein

the pressing unit is configured to be capable of pressing the center portion and/or a circumferential portion of the second surface.

20

[5] The substrate holding device according to any one of claims 1 to 4, wherein

the intermediate plate is made of a non-magnetic material.

25

[6] A film deposition device, comprising:

a film deposition chamber;

a film deposition source that is disposed in the film deposition chamber;

a mask plate that is disposed to face the film  
5 deposition source and is made of a magnetic material;

an intermediate plate that has a first surface facing the mask plate and a second surface being on the opposite side of the first surface and is configured such that the first surface can come into contact with  
10 a substrate disposed on the mask plate;

a holding plate that supports the intermediate plate such that the intermediate plate is relatively movable in an axis direction orthogonal to the mask plate, and includes a magnet configured to be capable  
15 of magnetically attracting the mask plate with the intermediate plate and the substrate being interposed therebetween; and

a pressing mechanism that is disposed to face the second surface, is configured to be capable of pressing  
20 at least a part of the second surface along the axis direction, and is installed on the holding plate, wherein

the intermediate plate is configured to be movable between a contact position at which at least a part of  
25 the first surface comes into contact with the substrate and a relative distance with respect to the holding

plate is a first distance, and a holding position at which a relative distance with respect to the holding plate is a second distance smaller than the first distance, and

5           the pressing mechanism

          includes a pressing unit including

                  a pressing element that is disposed to face the second surface, and

                  an elastic member that is disposed  
10       between the pressing element and the second surface and is elastically deformable in the axis direction, and  
              presses the second surface along the axis direction in a process in which the intermediate plate moves from the contact position to the holding  
15       position.