

DESCRIPTION

TITLE OF INVENTION

SUBSTRATE-HOLDING DEVICE AND METHOD FOR MANUFACTURING
5 CONDUCTIVE-FILM-EQUIPPED SUBSTRATE

TECHNICAL FIELD

[0001] The present invention relates to a substrate-holding device that holds a substrate when
a film is formed on a surface of the substrate, and a method for manufacturing a substrate with
10 a conductive film using the substrate-holding device.

BACKGROUND ART

[0002] When a thin film is formed on a main surface of a substrate by an ion beam sputtering
method and a magnetron sputtering method, the substrate is held. A substrate holding unit
15 includes a mechanical unit, and exemplified thereof includes a device described in Patent
Literature 1.

[0003] The device described in Patent Literature 1 includes a substrate table on which a
substrate is placed, an end surface supporting unit that supports an end surface orthogonal to a
main surface of the substrate on the substrate table, and a substrate biasing unit that biases the
20 substrate toward the substrate table. The end surface supporting unit abuts against at least one
pair of opposing end surfaces of the substrate. According to this configuration, the substrate can
be held while preventing a movement of the substrate in a substrate surface direction during a
film forming step.

[0004] The device described in Patent Literature 1 includes an upper surface plate. The upper
25 surface plate functions as a mask member having an opening window smaller than the substrate
in plan view, and a sputter film is formed on a surface of the substrate exposed from the opening
window. Further, the upper surface plate is movable between an elevated position and a lowered
position in a direction perpendicular to a substrate surface. When the upper surface plate moves
toward the lowered position, the end surface supporting unit follows the movement and moves
30 to a position where the end surface supporting unit abuts against the end surfaces of the substrate.
When the upper surface plate reaches the lowered position, an interval is provided between the
upper surface plate and the main surface of the substrate.

CITATION LIST

PATENT LITERATURE

[0005] Patent Literature 1: JP2005-077845A

SUMMARY OF INVENTION

5 TECHNICAL PROBLEM

[0006] Regarding a mechanical substrate-holding device, there is a need for a device that has a simpler structure than a device in the related art including the device described in Patent Literature 1 and can position a substrate such that a film forming region on a main surface of the substrate is correctly exposed.

10 [0007] As in the device described in Patent Literature 1, an interval is usually provided between the substrate after positioning and the mask member disposed above the substrate. This interval needs to be maintained constant because the interval may affect film formation. However, in the device described in Patent Literature 1, the upper surface plate serving as the mask member is not fixed to the substrate in the direction perpendicular to the substrate surface,
15 and thus the above-mentioned interval may vary.

In particular, when a thickness of each substrate varies, an amount of variation thereof is directly added to an amount of variation in the interval between the mask member and the substrate.

[0008] The present invention has been made in view of the above problems, and an object
20 thereof is to provide a substrate-holding device capable of positioning a substrate such that a film forming region in a main surface of the substrate is correctly exposed, and maintaining a constant interval between the substrate and a mask member (specifically, an interval between the main surface of the substrate and the mask member).

Further, another object of the present invention is to provide a method for
25 manufacturing a substrate with a conductive film in which a conductive film is formed on the main surface of the substrate using the above-described substrate-holding device.

SOLUTION TO PROBLEM

[0009] As a result of intensive studies in view of the above problems, the present inventors have found that a desired effect can be obtained by using the substrate-holding device and the
30 method for manufacturing a substrate with a conductive film according to the present invention, and have completed the present invention.

[0010] That is, the inventors have found that the above problems can be solved by the following configurations.

[1] A substrate-holding device that positions and holds a substrate on which a thin film is to be formed on one main surface thereof, the substrate-holding device including:

a mask member having an opening that defines a film forming region in the main surface, and disposed at a position where the opening faces the main surface in a first direction;

5 one or more biasing devices configured to bias the substrate toward the mask member along the first direction; and

a contact member integrated with the mask member and configured to come into contact with an outer edge portion of the substrate, in which

the contact member includes

10 an inclined surface that is inclined toward an inner side of the mask member in a second direction intersecting with the first direction as the inclined surface approaches the mask member in the first direction,

an extension surface that is located closer to the mask member than the inclined surface in the first direction and extends along the first direction, and

15 an abutment surface that is located closer to the mask member than the extension surface in the first direction and abuts against the outer edge portion of the substrate in the first direction, and

the substrate in a state of being biased by the one or more biasing devices and the mask member are brought close to each other in the first direction, the outer edge portion of the
20 substrate is guided to an abutment surface side along the inclined surface, and the abutment surface abuts against the outer edge portion of the substrate to position the substrate.

[2] The substrate-holding device according to [1], in which

the contact member includes a plurality of contact members fixed to a surface of the mask member on a side facing the substrate, and

25 each of the plurality of contact members comprises the inclined surface, the extension surface, and the abutment surface, and is in contact with the outer edge portion of the substrate.

[3] The substrate-holding device according to [2], in which

in a case where the substrate has a polygonal shape when the substrate is viewed from the first direction, each of the plurality of contact members is in contact with a corner portion
30 of the outer edge portion of the substrate.

[4] The substrate-holding device according to [3], in which

the contact member has a bent shape when the contact member is viewed from the first direction,

an inner wall surface of the contact member is divided into two regions intersecting with each other at a bending point,

each of the two regions includes the inclined surface, the extension surface, and the abutment surface,

5 a recess formed toward an outside of the contact member is provided in a portion of the contact member where the two regions intersect with each other,

the extension surfaces of the two regions are arranged with the recess interposed therebetween, and

the abutment surfaces of the two regions are arranged with the recess interposed
10 therebetween.

[5] The substrate-holding device according to [4], in which

the recess is formed by curving the inner wall surface of the contact member toward the outside of the contact member, and

in a state where the substrate is held by the substrate-holding device, the corner
15 portion of the outer edge portion of the substrate enters the recess and is separated from the inner wall surface of the contact member.

[6] The substrate-holding device according to [2], in which

in a case where the substrate has a polygonal shape when the substrate is viewed from the first direction, at least one of the plurality of contact members comes into contact with the
20 outer edge portion of the substrate at a central portion of a side forming an outer edge of the substrate.

[7] The substrate-holding device according to any one of [1] to [6], in which

the outer edge portion of the substrate includes an outer edge surface continuous with the main surface which is a flat surface, and the outer edge surface is inclined with respect to
25 the main surface, and

the abutment surface is a surface inclined along the outer edge surface and abuts against the outer edge surface.

[8] The substrate-holding device according to any one of [1] to [7], in which

a plurality of the biasing devices are provided, and
30 in a case where the substrate has a polygonal shape when the substrate is viewed from the first direction, in a plurality of corner portions of the outer edge portion of the substrate, the biasing devices are in contact with the other main surface located on a side opposite to the main surface on which the thin film is to be formed, and bias the substrate toward the mask member.

[9] The substrate-holding device according to [8], in which each of the biasing devices includes a body portion in contact with the other main surface at a tip thereof, and an elastic body that applies, to the body portion, an elastic force for pressing the tip of the body portion against the other main surface, and

5 the elastic body is provided for each of the biasing devices.

[10] The substrate-holding device according to [9], in which the body portion and the elastic body are disposed at positions farther from the main surface than the other main surface of the substrate in the first direction.

[11] The substrate-holding device according to any one of [1] to [10], in which
10 a material constituting the contact member contains at least one of polyether ether ketone, a polyimide, a polybenzimidazole resin, a fluororesin, a fluororubber, and an elastomer material.

[12] A method for manufacturing a substrate with a conductive film in which a conductive film is formed on one main surface of a substrate, the method including:

15 positioning the substrate using the substrate-holding device according to any one of [1] to [11]; and

forming the conductive film on the one main surface by a dry film forming method after the substrate is positioned, in which

when the substrate is positioned, the substrate is biased toward the mask member in
20 the first direction by the one or more biasing devices, the substrate in a state of being biased by the one or more biasing devices and the mask member are brought close to each other in the first direction, the outer edge portion of the substrate is guided to the abutment surface side of the contact member along the inclined surface of the contact member, and the abutment surface abuts against the outer edge portion of the substrate.

25 ADVANTAGEOUS EFFECTS OF INVENTION

[0011] According to the present invention, there is provided a substrate-holding device capable of positioning a substrate such that a film forming region in a main surface of the substrate is correctly exposed and maintaining a constant interval between the substrate and a mask member. Further, a substrate with a conductive film can be appropriately manufactured
30 by forming a conductive film on the main surface of the substrate in a state where the substrate is appropriately positioned and held using the substrate-holding device according to the present invention.

BRIEF DESCRIPTION OF DRAWINGS

[0012] [FIG. 1] FIG. 1 is a perspective view of a substrate-holding device according to a first embodiment of the present invention.

5 [FIG. 2] FIG. 2 is a sectional view showing a configuration of the substrate-holding device according to the first embodiment of the present invention.

[FIG. 3] FIG. 3 is a perspective view of a contact member according to the first embodiment of the present invention, and is a view of the contact member viewed from below.

[FIG. 4] FIG. 4 is a plan view of the contact member according to the first embodiment of the present invention.

10 [FIG. 5] FIG. 5 is a side view of the contact member according to the first embodiment of the present invention.

[FIG. 6] FIG. 6 is a bottom view of the contact member according to the first embodiment of the present invention.

15 [FIG. 7] FIG. 7 is a view showing an arrangement position of contact members with respect to a mask member.

[FIG. 8] FIG. 8 is an enlarged view of the vicinity of the contact member in FIG. 7.

[FIG. 9] FIG. 9 is a partial cross-sectional view showing a configuration of a biasing device according to the first embodiment of the present invention.

20 [FIG. 10] FIG. 10 is a view showing a procedure of positioning a substrate by the contact member according to the first embodiment of the present invention (part 1).

[FIG. 11] FIG. 11 is a view showing the procedure of positioning the substrate by the contact member according to the first embodiment of the present invention (part 2).

[FIG. 12] FIG. 12 is a view showing the procedure of positioning the substrate by the contact member according to the first embodiment of the present invention (part 3).

25 [FIG. 13] FIG. 13 is a view showing the procedure of positioning the substrate by the contact member according to the first embodiment of the present invention (part 4).

[FIG. 14] FIG. 14 is a view showing an arrangement position of a contact member with respect to a mask member in a second embodiment of the present invention.

30 [FIG. 15] FIG. 15 is a bottom view of the contact member according to the second embodiment of the present invention.

[FIG. 16] FIG. 16 is a bottom view of a contact member according to a third embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0013] Hereinafter, specific embodiments of the present invention will be described. However, the following embodiments are merely examples given to facilitate understanding of the present invention, and are not intended to limit the present invention. That is, the present invention can be modified or improved from the following embodiments without departing from the gist thereof.

Further, a material, a shape, and the like of each device used for carrying out the present invention can be freely set according to an application of the present invention, a technical level at the time of carrying out the present invention, and the like. Further, the present invention includes equivalents thereof.

[0014] The meanings of the terms in the present invention are as follows.

In the present specification, "orthogonal," "perpendicular," "vertical," "parallel," and "horizontal" include a range of an error allowed in the technical field to which the present invention belongs.

The term "rectangular shape" in this specification includes an oblong shape and a square shape.

[0015] A substrate-holding device according to an embodiment of the present invention is a substrate-holding device that positions and holds a substrate on which a thin film is to be formed on one main surface thereof, the substrate-holding device including:

a mask member having an opening that defines a film forming region in the main surface, and disposed at a position where the opening faces the main surface in a first direction;
one or more biasing devices configured to bias the substrate toward the mask member along the first direction; and

a contact member integrated with the mask member and configured to come into contact with an outer edge portion of the substrate, in which
the contact member includes

an inclined surface that is inclined toward an inner side of the mask member in a second direction intersecting with the first direction as the inclined surface approaches the mask member in the first direction,

an extension surface that is located closer to the mask member than the inclined surface in the first direction and extends along the first direction, and

an abutment surface that is located closer to the mask member than the extension surface in the first direction and abuts against the outer edge portion of the substrate

in the first direction, and

the substrate in a state of being biased by the one or more biasing devices and the mask member are brought close to each other in the first direction, the outer edge portion of the substrate is guided to an abutment surface side along the inclined surface, and the abutment surface abuts against the outer edge portion of the substrate to position the substrate.

[0016] <<First Embodiment of Present Invention>>

A first embodiment of the present invention will be described. Hereinafter, three directions orthogonal to one another are referred to as X, Y, and Z directions. The Z direction corresponds to a first direction of the present embodiment and coincides with a thickness direction of a mask member 10 to be described later. The X and Y directions correspond to second directions of the present embodiment, are directions intersecting (orthogonal to) the Z direction, and are horizontal directions when the Z direction is a vertical direction. In the following description, "when viewed in plan view" refers to when viewed from the Z direction.

[0017] [Substrate]

Before describing the substrate-holding device, the substrate (hereinafter, referred to as a substrate B) held by the substrate-holding device will be described. The substrate B is a glass plate having a polygonal shape, more specifically, a rectangular shape when viewed in plan view, and includes main surfaces at both end positions in a thickness direction of the substrate B. A thin film (conductive film) is formed on one main surface of the substrate B. Hereinafter, a main surface on which the thin film is formed is referred to as a "film forming surface Sa", and the other main surface located on a side opposite to the film forming surface Sa is referred to as a "back surface Sb".

[0018] In the first embodiment, the film forming surface Sa is a flat surface, and an outer edge portion on a film forming surface Sa side of the substrate B is chamfered. That is, the outer edge portion of the substrate B includes an outer edge surface Sc continuous with the film forming surface Sa and inclined with respect to the film forming surface Sa. Here, the outer edge portion of the substrate B means a side end surface (outer peripheral surface) of the substrate B and a peripheral portion thereof. Each of four corners of the outer edge portion of the substrate B may have an angular shape or a rounded shape.

[0019] [Basic Configuration of Substrate-holding Device according to First Embodiment]

A basic configuration of the substrate-holding device (hereinafter, referred to as a substrate-holding device 1) according to the first embodiment will be described with reference to FIGS. 1 and 2.

The substrate-holding device 1 is used for manufacturing a substrate with a conductive film, positions the substrate B in each of the X, Y, and Z directions at the time of forming the film, and holds the substrate B in a positioned state during the film formation.

[0020] As shown in FIG. 1, the substrate-holding device 1 includes one mask member 10, a plurality of contact members 20, a plurality of biasing devices 30, and a base unit 40. The mask member 10, the contact members 20, the biasing devices 30, and the base unit 40 are arranged in this order in the Z direction.

[0021] As shown in FIG. 2, the substrate-holding device 1 holds the substrate B by sandwiching the substrate B between the mask member 10 and the biasing device 30 in the Z direction, and more specifically, the substrate B is sandwiched between the contact member 20 and the biasing device 30.

[0022] The substrate-holding device 1 includes a posture changing mechanism (not shown) that changes a posture of the substrate-holding device 1 holding the substrate B. By an operation of the posture changing mechanism, a direction in which the members constituting the substrate-holding device 1 are arranged, that is, the Z direction is switched between a vertical direction and an intersecting direction. The intersecting direction is a direction intersecting with the vertical direction and is, for example, a horizontal direction or a direction inclined with respect to each of the vertical direction and the horizontal direction. Due to a posture change of the substrate-holding device 1, a film forming surface of the substrate B changes from a horizontal surface, specifically, stands up so as to face a target side (not shown).

[0023] The mask member 10 is made of a circular plate made of metal, and has a rectangular opening 12 at a central portion thereof. The opening 12 is a through hole that defines a film forming region in the film forming surface Sa. In the substrate-holding device 1, the mask member 10 is disposed at a position where the opening 12 faces the film forming surface Sa in the Z direction. Further, a size of the opening 12 when viewed in plan view is slightly smaller than a size of the substrate B.

[0024] The plurality of contact members 20 constitute the contact member according to the present embodiment, and in the first embodiment, the number of contact members 20 is the same as the number of corners of the outer edge portion of the substrate B, that is, four. In a state where the substrate-holding device 1 holds the substrate B, each of the plurality of contact members 20 is in contact with the outer edge portion of the substrate B. Further, the plurality of contact members 20 are integrated with the mask member 10, and specifically, are fixed to a surface (hereinafter, a bottom surface) of the mask member 10 on a side facing the substrate B.

A configuration of the contact member 20 will be described in detail later.

[0025] Each of the plurality of biasing devices 30 biases the substrate B in the Z direction, specifically, contacts the back surface Sb of the substrate B to bias the substrate B toward the mask member 10. In the first embodiment, the same number of biasing devices 30 as the corners of the outer edge portion of the substrate B, that is, four biasing devices 30 are provided. Each biasing device 30 is disposed at a position overlapping with the periphery of a corner portion in the Z direction in the edge portion of the opening 12 in the mask member 10.

A configuration of the biasing device 30 will be described in detail later.

[0026] The base unit 40 includes a fixed table 42 that forms a bottom portion of the substrate-holding device 1 and fixes base ends of the biasing devices 30, a housing 44 located closer to the mask member 10 than the fixed table 42, support arms 46 that support the mask member 10, and a movable table 48 that fixes base ends of the support arms 46. Further, an elevator 50 is provided between the fixed table 42 and the movable table 48 in the Z direction.

[0027] The elevator 50 is elevated and lowered by driving an air cylinder (not shown), and the movable table 48 moves in the Z direction relative to the fixed table 42 in accordance with an elevating and lowering operation of the elevator 50. Along with this, the support arms 46 and the mask member 10 supported by the support arms 46 move in the same direction as the movable table 48. As a result, the mask member 10 and the plurality of contact members 20 move relative to the substrate B placed on a tip of the biasing device 30, specifically, move close to or apart from the substrate B.

[0028] [Detailed Configuration of Contact Member]

The configuration of the contact member 20 will be described again with reference to FIGS. 3 to 8. Since each of the plurality of contact members 20 in the substrate-holding device 1 has the same configuration, the configuration of one contact member 20 will be described below.

[0029] A position, a posture, and the like of the contact member 20 to be described below are a position, a posture, and the like in which the contact member 20 is fixed to the mask member 10, unless otherwise specified. Hereinafter, for convenience of description, a side on which the mask member 10 is located when viewed from the contact member 20 is referred to as an "upper side", and an opposite side thereof is referred to as a "lower side".

[0030] The contact member 20 is a block-shaped resin molded article molded into a shape shown in FIGS. 3 to 6. The contact member 20 can be formed of various materials, but in view of moldability, a material for forming the contact member 20 may be, for example, a resin

material such as polyether ether ketone (PEEK), polyimides, a polybenzimidazole (PBI) resin, a fluororesin, and a fluororubber, or an elastomer material. Among them, polyether ether ketone (PEEK), polyimides, and a fluororubber are more preferable, and polyether ether ketone (PEEK) is particularly preferable.

5 Examples of the elastomer material include ester-based, amide-based, and olefin-based materials.

[0031] As shown in FIGS. 3 and 6, the contact member 20 has an L-shaped bent shape when viewed in plan view. The contact member 20 includes an inner wall surface and an outer wall surface, and is in contact with the substrate B at the inner wall surface. The inner wall surface
10 of the contact member 20 is divided into two regions intersecting with each other at a bending point. The two regions are planes substantially orthogonal to each other, one region extends along the X direction, and the other region extends along the Y direction.

[0032] As shown in FIGS. 3 and 5, each of the regions includes an inclined surface 21, an extension surface 22, an abutment surface 23, and a top surface 24 from the lower side of the
15 contact member 20. The inclined surface 21 is a surface inclined toward an inner side of the mask member 10 in the X or Y direction, which is the direction that intersects with the Z direction, as the inclined surface 21 approaches the mask member 10 in the Z direction (that is, as the inclined surface 21 goes upward). Here, the inner side of the mask member 10 is a side facing a center of the opening 12.

[0033] An inclination angle of the inclined surface 21 with respect to the Z direction is preferably 0° or more and 30° or less, and more preferably 10° or more and 20° or less in order
20 to position the substrate B according to a procedure to be described later. Here, the inclination angle is preferably 0° or more, more preferably 10° or more, and is preferably 30° or less, and more preferably 20° or less.

[0034] The extension surface 22 is continuous with the inclined surface 21 above the inclined surface 21 (that is, on a mask member 10 side) in the Z direction, and extends along the Z direction. A length of the extension surface 22 in the Z direction is not particularly limited, but is preferably set to a length suitable for positioning the substrate B based on a thickness of the
25 substrate B. Specifically, when the thickness of the substrate B is T (MM), the length of the extension surface 22 in the Z direction is preferably 0.2 T or more, and more preferably 0.5 T
30 or more.

[0035] The abutment surface 23 is continuous with the extension surface 22 above the extension surface 22 (that is, on the mask member 10 side) in the Z direction, and is a surface

that abuts against the outer edge portion of the substrate B in the Z direction, specifically, the outer edge surface Sc at the time of positioning the substrate B.

[0036] The abutment surface 23 is inclined toward the inner side of the mask member 10 in the X or Y direction as the abutment surface 23 approaches the mask member 10 in the Z direction, and more specifically, is a surface inclined along the outer edge surface Sc. That is, an inclination angle of the abutment surface 23 with respect to the Z direction is substantially the same as an inclination angle of the outer edge surface Sc with respect to the thickness direction (that is, the Z direction) of the substrate B. Here, the term "substantially the same" is not limited to a completely same value, but allows for design errors. Specifically, it means that a difference between the inclination angle of the abutment surface 23 and the inclination angle of the outer edge surface Sc is within $\pm 10\%$.

[0037] The top surface 24 forms an upper end portion of the inner wall surface of the contact member 20, is continuous with the abutment surface 23 above the abutment surface 23 (on the mask member 10 side) in the Z direction, and extends along the Z direction.

[0038] In the first embodiment, as shown in FIGS. 3 and 4, a recess 25 is provided in a bending portion of the contact member 20, that is, a portion where two regions intersect with each other in the inner wall surface. The recess 25 is formed toward an outside of the contact member 20 (a side away from the opening 12) in the X and Y directions, and is formed by the inner wall surface of the contact member 20 being curved in an arch shape toward the outside of the contact member 20. The recess 25 is formed in a substantially semicircular shape in plan view, and a curvature thereof is smaller than a curvature of a corner of the substrate B in a case where the recess 25 is rounded. Since the recess 25 is provided in the bending portion of the contact member 20, it is possible to prevent accumulation of foreign matter such as dust and dirt in the bending portion.

[0039] The extension surfaces 22 of the two regions on the inner wall surface of the contact member 20 are arranged with the recess 25 interposed therebetween. Similarly, the abutment surfaces 23 of the two regions are arranged with the recess 25 interposed therebetween, and the top surfaces 24 of the two regions are arranged with the recess 25 interposed therebetween.

[0040] As shown in FIGS. 3 to 6, a tongue-shaped portion 28 protrudes outward from the outer wall surface of the contact member 20. A hole is formed in the tongue-shaped portion 28, and the tongue-shaped portion 28 is positioned with respect to the mask member 10 by bolt fastening or the like and fixed to the bottom surface of the mask member 10. A fixing position of the contact member 20 is not particularly limited, and may be any fixing position as long as

the contact member 20 can be fixed such that the contact member 20 is preferably in contact with the substrate B.

[0041] In the first embodiment, the contact member 20 is fixed along the edge portion of the opening 12 in the mask member 10, and specifically, as shown in FIG. 7, the contact member 20 is fixed such that the inner wall surface of the contact member 20 extends along a corner portion of an edge of the opening 12. Accordingly, when the substrate B is positioned, the plurality of (specifically, four) contact members 20 fixed to the mask member 10 come into contact with the corner portions of the outer edge portion of the substrate B.

[0042] In a state where the contact member 20 is fixed to the mask member 10, as shown in FIG. 8, the abutment surface 23 and the top surface 24 are located inside the edge (indicated by a broken line in FIG. 8) of the opening 12. A dimension of the edge of the opening 12 is smaller than a dimension of an outer edge of the substrate B, and in a state where the substrate B is positioned with respect to the mask member 10, the extension surface 22 is located outside the outer edge of the substrate B.

[0043] [Detailed Configuration of Biasing Device]

The configuration of the biasing device 30 will be described again with reference to FIGS. 1 and 9. Since each of the plurality of biasing devices 30 in the substrate-holding device 1 has the same configuration, the configuration of one biasing device 30 will be described below.

[0044] As shown in FIG. 9, the biasing device 30 includes a body portion 31 extending in the Z direction and a spring body 32 attached to the body portion 31, contacts the back surface Sb of the substrate B at a tip of the body portion 31, and uses the spring body 32 to apply, to the body portion 31, elastic force for pressing the tip of the body portion 31 against the back surface Sb. The body portion 31 is formed by inserting a core rod portion 33 vertically standing from the fixed table 42 of the base unit 40 into a tube portion 34.

[0045] The tube portion 34 is supported by the core rod portion 33 in a manner of being movable in the Z direction with respect to the core rod portion 33. Further, a tip portion of the tube portion 34, that is, an end portion on the mask member 10 side is closed to form a closed end, and a hemispherical protrusion 35 is provided on the tip so as to project in the Z direction.

[0046] The spring body 32 is an elastic body, for example, a coil spring for details, is accommodated in the tube portion 34, and is disposed between the core rod portion 33 and the tube portion 34. That is, in the first embodiment, the spring bodies 32 are individually provided for the respective biasing devices 30, in other words, provided for the respective biasing devices 30.

The spring body 32 is preferably set to a spring force suitable for stably holding the substrate B while biasing the substrate B by the biasing device 30, for example, a spring constant and a pressing amount may be adjusted such that the spring force is approximately 5 times or more and 10 times or less a weight of the substrate B to be held.

5 [0047] In each biasing device 30, one end of the spring body 32 is fixed to an inner wall surface of the tube portion 34, and the other end of the spring body 32 is fixed to the core rod portion 33. Accordingly, when the tube portion 34 moves in the Z direction with respect to the core rod portion 33, the spring body 32 expands and contracts accordingly. Further, when the tube portion 34 moves to a fixed table 42 side (lower side) in the Z direction, the spring body
10 32 contracts to generate the elastic force, and the elastic force acts on the tube portion 34. At this time, when the substrate B is placed on the protrusion 35, an apex of the protrusion 35 receives the elastic force of the spring body 32 and is pressed against the back surface Sb of the substrate B.

[0048] In the first embodiment, the plurality of (specifically, four) biasing devices 30 is
15 disposed at the same positions as respective corner portions of the opening 12 of the mask member 10 in the X and Y directions. More specifically, each biasing device 30 is disposed in a manner of overlapping with at least a part of the inner wall surface of the contact member 20 in the Z direction. Accordingly, at each corner portion of the outer edge portion of the substrate B, each of the biasing devices 30 is in contact with the back surface Sb of the substrate B to
20 bias the substrate B toward the mask member 10.

[0049] In other words, the substrate B is in point contact with the protrusion 35 provided at a tip of the biasing device 30 at a peripheral position of the corner thereof, and is biased toward the mask member 10 by the biasing device 30. As a result, rattling of the substrate B can be prevented, and the substrate B can be held in a balanced manner. Further, since a contact
25 between the biasing device 30 and the substrate B is a point contact, a contact area with the substrate B can be minimized as much as possible. If the biasing device 30 comes into surface contact with the back surface Sb of the substrate B, when a contact surface of the biasing device 30 is inclined with respect to the back surface Sb, the rattling occurs in the substrate B, but in the first embodiment, because of the point contact, an occurrence of such rattling can be
30 prevented.

[0050] In the first embodiment, the body portion 31 and the spring body 32 constituting the biasing device 30 are disposed at positions farther away from the film forming surface Sa than the back surface Sb of the substrate B in the Z direction. Disposing the spring body 32 away

from the film forming surface Sa in this manner can effectively prevent contamination of the film forming surface Sa. That is, although dust may be generated due to the expansion and contraction of the spring body 32, by separating the spring body 32, which can be a source of dust generation, from the film forming surface Sa, a risk of contamination of the film forming surface Sa can be reduced.

[0051] [Method for Determining Position of Substrate according to First Embodiment]

Next, a method for positioning the substrate B by the substrate-holding device 1 will be described with reference to FIGS. 10 to 13.

[0052] When the substrate B is positioned, the Z direction is set to the vertical direction, and the substrate B is gripped by a robot arm (not shown). The robot arm transports the gripped substrate B to an upper position of the plurality of biasing devices 30, and places the four corner portions of the substrate B on the tips of the plurality of biasing devices 30. At this time, the mask member 10 is located at a position (hereinafter, referred to as an upper position) farthest from the fixed table 42 in the Z direction by an operation of the elevator 50.

[0053] After the substrate B is placed on the tips of the plurality of biasing devices 30, the elevator 50 is lowered and the movable table 48 is moved downward. Accordingly, the mask member 10 is lowered, and as a result, the substrate B that is biased by the plurality of biasing devices 30 and the mask member 10 are close to each other in the Z direction.

[0054] When the mask member 10 is lowered, each of the plurality of contact members 20 fixed to the bottom surface of the mask member 10 eventually becomes adjacent to the outer edge portion of the substrate B as shown in FIG. 10. At this time, when an arrangement position of the substrate B is deviated from a normal position (that is, a position after the positioning) in the X and Y directions, as shown in FIG. 10, the outer edge surface Sc of the substrate B abuts against the inclined surface 21 of the contact member 20.

[0055] Specifically, the outer edge surface Sc of the substrate B abuts against the inclined surface 21 of one of two contact members 20 (hereinafter, a pair of contact members 20) located on a diagonal line of the opening 12.

[0056] Although two inclined surfaces 21 that intersect with each other are present on the inner wall surface of the contact member 20 that abuts against the outer edge portion of the substrate B, one inclined surface 21 may abut against the outer edge surface Sc, or both inclined surfaces 21 may abut against the outer edge surface Sc.

[0057] When the mask member 10 continues to descend, as shown in FIG. 10, the outer edge surface Sc in contact with the inclined surface 21 slides on the inclined surface 21. Accordingly,

the outer edge portion of the substrate B is guided upward (that is, toward the abutment surface 23) along the inclined surface 21. At this time, if a portion of the outer edge portion of the substrate B on a side in contact with the inclined surface 21 is deviated outward from the normal position, the portion is pushed by the inclined surface 21 in the X or Y direction and moves
5 toward the inner side of the mask member 10.

[0058] Thereafter, when the mask member 10 is further lowered, as shown in FIGS. 11 and 12, the outer edge surface Sc in contact with the inclined surface 21 crosses over the inclined surface 21, and the side end surface (outer edge) of the substrate B comes into contact with the extension surface 22 of the contact member 20.

10 [0059] Specifically, in the pair of contact members 20, the extension surface 22 of the contact member 20 in which the inclined surface 21 abuts against the outer edge surface Sc of the substrate B abuts against the side end surface of the substrate B. At this time, the extension surface 22 of the other contact member 20 may or may not abut against the side end surface of the substrate B.

15 [0060] When the mask member 10 is further lowered from the above state, the extension surface 22 in contact with the side end surface of the substrate B is lowered along the side end surface, in other words, the substrate B moves substantially perpendicularly to the mask member 10 side along the extension surface 22. Further, as the mask member 10 is further lowered, as shown in FIG. 13, the outer edge portion of the substrate B abuts against the
20 abutment surface 23 of the contact member 20 in the Z direction.

[0061] More specifically, in the pair of contact members 20, the abutment surface 23 of the contact member 20 in which the inclined surface 21 abuts against the outer edge surface Sc of the substrate B abuts against the outer edge surface Sc. At this time, the abutment surface 23 of the other contact member 20 may or may not abut against the outer edge surface Sc.

25 [0062] Although two abutment surfaces 23 that intersect with each other are present via the recess 25 on the inner wall surface of the contact member 20, one of the abutment surfaces 23 may abut against the outer edge surface Sc, or both of the abutment surfaces 23 may abut against the outer edge surface Sc.

[0063] According to the above procedure, the substrate B is positioned in the X and Y
30 directions. That is, in the first embodiment, while the substrate B is biased toward the mask member 10 side by the biasing device 30, the biased substrate B and the mask member 10 are brought close to each other in the Z direction.

[0064] In this process, when the outer edge portion of the substrate B abuts against the

inclined surface 21 of the contact member 20, the outer edge portion of the substrate B is guided to an abutment surface 23 side of the contact member 20 along the inclined surface 21. At this time, when the substrate B is deviated from the normal arrangement position in the X and Y directions, the substrate B is pushed to the inner side of the mask member 10 by the inclined surface 21 and the position of the substrate B is adjusted. As a result, the substrate B is positioned such that the film forming region in the film forming surface Sa is properly exposed through the opening 12.

[0065] In the first embodiment, the four contact members 20 are provided, but from the viewpoint of stably holding the substrate B, preferably at least two or more contact members 20 are in contact with the outer edge portion of the substrate B, more preferably three or more contact members 20 are in contact with the outer edge portion of the substrate B, and particularly preferably all four contact members 20 are in contact with the outer edge portion of the substrate B.

[0066] When the mask member 10 is lowered to a position (hereinafter referred to as a lowered position) closest to the fixed table 42 in a state where the abutment surface 23 abuts against the outer edge portion of the substrate B, specifically, the outer edge surface Sc, gravity (own weight) of the substrate B acts on the plurality of biasing devices 30. Accordingly, the tube portion 34 of each biasing device 30 moves toward the fixed table 42 (lower side) in the Z direction, and the spring body 32 in the tube portion 34 contracts to generate the elastic force. This elastic force acts on the substrate B via the tube portion 34.

[0067] That is, the substrate B is sandwiched between the contact member 20 and the biasing device 30 in the Z direction, and is pressed toward the mask member 10 by biasing force (elastic force) of the biasing device 30. As a result, an interval between the mask member 10 and the substrate B in the Z direction, specifically, an interval between the mask member 10 and the main surface of the substrate B is an interval according to a length from the abutment surface 23 to the mask member 10, that is, an interval of a constant size. Accordingly, even if there is a variation in the thickness of the substrate B, the interval is not affected.

[0068] As described above, the substrate B can be positioned in the Z direction such that the interval between the substrate B and the mask member 10 is set to a predetermined value. Specifically, since the contact member 20 and the mask member 10 are integrated with each other, the outer edge portion of the substrate B comes into contact with the abutment surface 23 biased toward the mask member 10 by the biasing device 30, and thus the position of the substrate B with respect to the mask member 10 in the Z direction is determined. Accordingly,

thereafter, an interval between the film forming surface Sa of the substrate B and the mask member 10 is maintained constant.

The interval between the substrate B and the mask member 10 can be adjusted by interposing a shim spacer (not shown) between the mask member 10 and the contact member 20.

[0069] The substrate B sandwiched between the contact member 20 and the biasing device 30 is stably held at the position after the positioning by the biasing force of the biasing device 30. Further, even when the posture of the substrate-holding device 1 is changed due to the film formation and the substrate B stands up from a horizontal posture, a holding state of the substrate B is favorably maintained by the biasing force of the biasing device 30.

[0070] In the state where the substrate B is held at the position after the positioning, the corner portion of the outer edge portion of the substrate B enters the recess 25 of the contact member 20 and is separated from the inner wall surface of the contact member 20 (see FIG. 8). According to such a configuration, it is possible to prevent the corner portion of the outer edge portion of the substrate B from contacting and rubbing the contact member 20.

[0071] [Method for Manufacturing Substrate with Conductive film according to First Embodiment]

Next, a method for manufacturing a substrate with a conductive film according to the first embodiment will be described.

First, the substrate B is positioned and held in each of the X, Y, and Z directions by using the substrate-holding device 1 according to the present embodiment. Specifically, when the Z direction is set to the vertical direction and the mask member 10 is in the upper position, the substrate B is picked up by the robot arm (not shown). Thereafter, the substrate B is inserted into a space between the mask member 10 and the plurality of biasing devices 30 from a side of the substrate-holding device 1, and is placed on the tips of the biasing devices 30. Accordingly, the substrate B is biased toward the mask member 10 by the plurality of biasing devices 30 in the Z direction.

[0072] Thereafter, the mask member 10 is lowered by the elevator 50, and the substrate B biased by the biasing device 30 and the mask member 10 are brought close to each other in the Z direction. In this process, the outer edge portion of the substrate B abuts against the inclined surface 21 of the contact member 20 and is guided to the abutment surface 23 side of the contact member 20 along the inclined surface 21. Further, by further lowering the mask member 10, the abutment surface 23 abuts against the outer edge portion of the substrate B, specifically, the

outer edge surface Sc. Accordingly, the substrate B is positioned in the X and Y directions such that the film forming region in the film forming surface Sa of the substrate B is correctly exposed through the opening 12 of the mask member 10.

[0073] Finally, when the mask member 10 is lowered to a lower position, the spring body 32 of each biasing device 30 contracts to generate the elastic force. Due to the elastic force, the substrate B is sandwiched between the contact member 20 and the biasing device 30 and pressed toward the mask member 10. According to the above steps, the substrate B is positioned in the X, Y, and Z directions, and thereafter, the substrate B is held at the position after the positioning.

[0074] Thereafter, the posture changing mechanism changes the posture of the substrate-holding device 1 such that the Z direction is inclined with respect to the vertical direction. Accordingly, in the film forming surface Sa of the substrate B, the film forming region exposed through the opening 12 faces a target (not shown).

[0075] Thereafter, the conductive film is formed in the film forming region by a dry film forming method. As the dry film forming method, known film forming methods, for example, sputtering methods such as a magnetron sputtering method and an ion beam sputtering method, a chemical vapor deposition (CVD) method, and a vacuum deposition method can be used.

[0076] When the film forming method described above is used, it is preferable to use a material that does not emit a gas component under a vacuum atmosphere in a film forming container as the material constituting the contact member 20 of the substrate-holding device 1.

Further, since the substrate B may have heat in a film forming device, the contact member 20 preferably has a chemical and physical heat resistance up to at least about 150°C.

[0077] During the film formation, the substrate-holding device 1 may be rotated. According to the present embodiment, the extension surface 22 of the contact member 20 can also cope with centrifugal force generated by the rotation of the substrate-holding device 1.

[0078] The method for manufacturing a substrate with a conductive film described above is effective for manufacturing a reflective mask blank for extreme ultraviolet (EUV) lithography (hereinafter, referred to as an EUV mask blank), or for manufacturing a functional-film-equipped substrate for an EUV mask blank used in semiconductor manufacturing or the like.

[0079] <<Other Embodiments>>

Although the substrate-holding device and the method for manufacturing a substrate with a conductive film according to the present invention have been described above with reference to one specific example, the above-described embodiment is merely an example, and other embodiments may be considered as described below.

[0080] [Second Embodiment]

In the first embodiment, each of the plurality of contact members 20 has an L-shaped bent shape when viewed in plan view, and is fixed in the vicinity of the corner of the edge of the opening 12 in the mask member 10. Further, in the first embodiment, when the substrate-holding device 1 holds the substrate B, each contact member 20 comes into contact with the corner portion of the outer edge portion of the substrate B. However, a second embodiment different from this configuration is conceivable. Hereinafter, points of the second embodiment that are different from the first embodiment will be mainly described with reference to FIGS. 14 and 15.

[0081] FIGS. 14 and 15 are explanatory views of the second embodiment, in which FIG. 14 is a view corresponding to FIG. 7, and FIG. 15 is a view corresponding to FIG. 6. Among members shown in FIGS. 14 and 15, the same members as those in the first embodiment are denoted by the same reference numerals as those in the first embodiment.

[0082] In the second embodiment, as shown in FIG. 14, each of four contact members 20X has a linearly extending shape in plan view and is fixed to a central portion of each side forming an edge of the opening 12. Further, as illustrated in FIG. 15, an inner wall surface of each of the contact members 20X includes the inclined surface 21, the extension surface 22, the abutment surface 23, and the top surface 24. A shape of each surface is the same as that of the first embodiment.

[0083] Further, in the second embodiment, when the substrate-holding device 1 holds the substrate B, at least one of the four contact members 20X comes into contact with the outer edge portion of the substrate B at a central portion of a side forming an outer edge of the substrate B. Even with such a configuration, the same effects as those of the first embodiment can be obtained. That is, even in the case of using the contact member 20X according to the second embodiment, the substrate B can also be positioned such that a film forming region in the film forming surface Sa is correctly exposed, and an interval between the substrate B and the mask member 10 can be maintained constant.

[0084] In the second embodiment, it is preferable that two or more of the four contact members 20X contact the substrate B, and particularly contact central portions of opposite sides at the outer edge of the substrate B. Further, from the viewpoint of more stably holding the substrate B, it is more preferable that three or more contact members 20X come into contact with the substrate B, and it is particularly preferable that all of the four contact members 20X come into contact with the substrate B.

[0085] [Third Embodiment]

In the first embodiment, the recess 25 is provided at the bending point on the inner wall surface of each contact member 20, and the recess 25 is formed by curving the inner wall surface toward the outside of the contact member 20. However, a third embodiment in which a shape of the recess is different from the above-described shape is conceivable. Hereinafter, points of the third embodiment that are different from the first embodiment will be mainly described with reference to FIG. 16.

[0086] FIG. 16 is an explanatory view of the third embodiment and corresponds to FIG. 6, and portions of a contact member shown in FIG. 16 that are the same as those of the first embodiment are denoted by the same reference numerals as those of the first embodiment.

[0087] A contact member 20Y according to the third embodiment has an L-shape when viewed in plan view, as shown in FIG. 16. Further, the contact member 20Y has a slit-shaped recess 26 formed in a bending portion. That is, the contact member 20Y is divided into two fragments (hereinafter referred to as contact member fragments 27) by the recess 26 which is a slit. In an example shown in FIG. 16, the two contact member fragments 27 are separated from each other, but some thereof may be connected. The two contact member fragments 27 are disposed at positions intersecting (specifically, orthogonal to) each other via the recess 26, and an inner wall surface of each contact member fragment 27 includes the inclined surface 21, the extension surface 22, the abutment surface 23, and the top surface 24. A shape of each surface is the same as that of the first embodiment.

[0088] The contact member 20Y according to the third embodiment is provided with the recess 26, and foreign matters such as dust and dirt can be discharged from the recess 26 at a corner of the contact member 20Y. Further, in a state where the substrate B is held by the substrate-holding device 1, a corner portion of an outer edge portion of the substrate B enters the recess 26. Since the recess 26 is the slit as described above, it is possible to prevent the corner portion of the outer edge portion of the substrate B from contacting and rubbing the contact member 20Y.

[0089] [Other Embodiments]

Configurations other than the embodiments described above may be considered, for example, the outer edge portion of the substrate B on the film forming surface Sa side may not be chamfered, and the outer edge surface Sc may be an extension of the film forming surface Sa, that is, a horizontal surface. In this case, the abutment surface 23 of the inner wall surface of each of the contact members 20, 20X, and 20Y may be a surface perpendicular to the

extension surface 22, that is, a horizontal surface, from the viewpoint of a good contact with the outer edge surface Sc of the substrate B.

[0090] The biasing device 30 may be formed by, for example, a plate spring, and may be in surface contact with the back surface Sb of the substrate B. However, as described above, from the viewpoint of performing biasing in a well-balanced manner, it is more preferable that the biasing device 30 contact the back surface Sb through point contact.

[0091] Further, the contact members 20, 20X, and 20Y may not be separate members from the mask member 10, and may be formed of the same member as the mask member 10. That is, the contact members 20, 20X, and 20Y and the mask member 10 may be integrally formed as a part.

[0092] The present invention can also be applied to an aspect in which the mask member 10 is fixed and the substrate B is movable, that is, a configuration in which the substrate B is moved with respect to the mask member 10.

[0093] Although the present invention has been described in detail with reference to specific embodiments, it is apparent to those skilled in the art that various changes and modifications can be made without departing from the spirit and scope of the present invention. The present application is based on Japanese Patent Application No. 2021-139521 filed on August 30, 2021, the contents of which are incorporated herein by reference.

REFERENCE SIGNS LIST

[0094] 1: substrate-holding device
 10: mask member
 12: opening
 20, 20X, 20Y: contact member
 21: inclined surface
 22: extension surface
 23: abutment surface
 24: top surface
 25, 26: recess
 27: contact member fragment
 28: tongue-shaped portion
 30: biasing device
 31: body portion

	32: spring body (elastic body)
	33: core rod portion
	34: tube portion
	35: protrusion
5	40: base unit
	42: fixed table
	44: housing
	46: support arm
	48: movable table
10	50: elevator
	B: substrate
	Sa: film forming surface (one main surface)
	Sb: back surface (the other main surface)
	Sc: outer edge surface
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CLAIMS

1. A substrate-holding device that positions and holds a substrate on which a thin film is to be formed on one main surface, the substrate-holding device comprising:

5 a mask member having an opening that defines a film forming region in the main surface, and disposed at a position where the opening faces the main surface in a first direction;

one or more biasing devices configured to bias the substrate toward the mask member along the first direction; and

10 a contact member integrated with the mask member and configured to come into contact with an outer edge portion of the substrate, wherein

the contact member comprises

an inclined surface that is inclined toward an inner side of the mask member in a second direction intersecting with the first direction as the inclined surface approaches the mask member in the first direction,

15 an extension surface that is located closer to the mask member than the inclined surface in the first direction and extends along the first direction, and

an abutment surface that is located closer to the mask member than the extension surface in the first direction and abuts against the outer edge portion of the substrate in the first direction, and

20 the substrate in a state of being biased by the one or more biasing devices and the mask member are brought close to each other in the first direction, the outer edge portion of the substrate is guided to an abutment surface side along the inclined surface, and the abutment surface abuts against the outer edge portion of the substrate to position the substrate.

25 2. The substrate-holding device according to claim 1, wherein the contact member includes a plurality of contact members fixed to a surface of the mask member on a side facing the substrate, and

each of the plurality of contact members comprises the inclined surface, the extension surface, and the abutment surface, and is in contact with the outer edge portion of the substrate.

30 3. The substrate-holding device according to claim 2, wherein in a case where the substrate has a polygonal shape when the substrate is viewed from the first direction, each of the plurality of contact members is in contact with a corner portion of the outer edge portion of

the substrate.

4. The substrate-holding device according to claim 3, wherein the contact member has a bent shape when the contact member is viewed from the first direction,

5 an inner wall surface of the contact member is divided into two regions intersecting with each other at a bending point,

each of the two regions comprises the inclined surface, the extension surface, and the abutment surface,

10 a recess formed toward an outside of the contact member is provided in a portion of the contact member where the two regions intersect with each other,

the extension surfaces of the two regions are arranged with the recess interposed therebetween, and

the abutment surfaces of the two regions are arranged with the recess interposed therebetween.

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5. The substrate-holding device according to claim 4, wherein the recess is formed by curving the inner wall surface of the contact member toward the outside of the contact member, and

20 in a state where the substrate is held by the substrate-holding device, the corner portion of the outer edge portion of the substrate enters the recess and is separated from the inner wall surface of the contact member.

6. The substrate-holding device according to claim 2, wherein in a case where the substrate has a polygonal shape when the substrate is viewed from the first direction, at least
25 one of the plurality of contact members comes into contact with the outer edge portion of the substrate at a central portion of a side forming an outer edge of the substrate.

7. The substrate-holding device according to any one of claims 1 to 6, wherein the outer edge portion of the substrate comprises an outer edge surface continuous with the main surface
30 which is a flat surface, and the outer edge surface is inclined with respect to the main surface, and

the abutment surface is a surface inclined along the outer edge surface and abuts against the outer edge surface.

8. The substrate-holding device according to any one of claims 1 to 6, wherein a plurality of the biasing devices are provided, and

in a case where the substrate has a polygonal shape when the substrate is viewed from the first direction, in a plurality of corner portions of the outer edge portion of the substrate, the biasing devices are in contact with the other main surface located on a side opposite to the main surface on which the thin film is to be formed, and bias the substrate toward the mask member.

9. The substrate-holding device according to claim 8, wherein each of the biasing devices comprises a body portion in contact with the other main surface at a tip thereof, and an elastic body that applies, to the body portion, an elastic force for pressing the tip of the body portion against the other main surface, and

the elastic body is provided for each of the biasing devices.

10. The substrate-holding device according to claim 9, wherein the body portion and the elastic body are disposed at positions farther from the main surface than the other main surface of the substrate in the first direction.

11. The substrate-holding device according to any one of claims 1 to 6, wherein a material constituting the contact member comprises at least one of polyether ether ketone, a polyimide, a polybenzimidazole resin, a fluororesin, a fluororubber, and an elastomer material.

12. A method for manufacturing a substrate with a conductive film in which a conductive film is formed on one main surface of a substrate, the method comprising:

positioning the substrate using the substrate-holding device according to any one of claims 1 to 6; and

forming the conductive film on the one main surface by a dry film forming method after the substrate is positioned, wherein

when the substrate is positioned, the substrate is biased toward the mask member in the first direction by the one or more biasing devices, the substrate in a state of being biased by the one or more biasing devices and the mask member are brought close to each other in the first direction, the outer edge portion of the substrate is guided to the abutment surface side of the contact member along the inclined surface of the contact member, and the abutment surface

abuts against the outer edge portion of the substrate.