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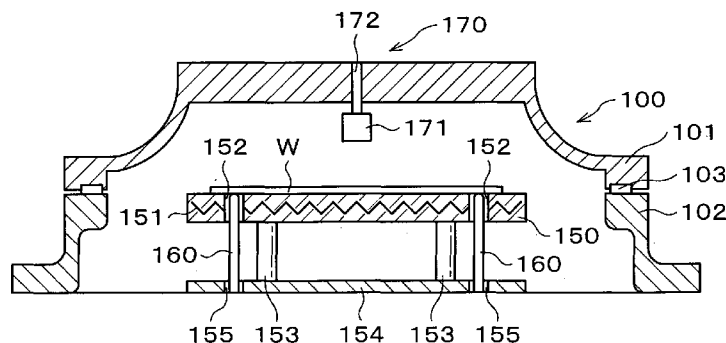
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(54) Title: JOINT APPARATUS, JOINT SYSTEM, AND JOINT METHOD

FIG.7



(57) Abstract: A joint apparatus configured to join a plurality of chips arranged on a substrate to the substrate includes: a processing chamber that houses the substrate; a mounting table that is provided inside the processing chamber and mounts the substrate thereon; a heating mechanism that is provided in the mounting table and heats the substrate; and a gas supply mechanism that supplies a pressurizing gas to an inside of the processing chamber.

[Name of Document] DESCRIPTION

[Title of the Invention] JOINT APPARATUS, JOINT SYSTEM, AND JOINT METHOD

[Technical Field]

5 [0001] (Cross-reference to related application)

This application is based upon and claims the benefit of priority of the prior Japanese Patent Application No. 2015-003446, filed in Japan on January 9, 2015, the entire contents of which are incorporated herein by reference.

10 [0002] The present invention relates to a joint apparatus configured to join a plurality of chips arranged on a substrate to the substrate, a joint system including the joint apparatus, and a joint method using the joint apparatus.

[Background Art]

15 [0003] In recent years, semiconductor chips (hereinafter, referred to as "chips") are increasingly highly integrated in a semiconductor device. When a plurality of highly integrated chips are arranged in a horizontal plane and the chips are connected by wiring into a product, there is a concern that the wiring length increases to lead to an increase in resistance of the wiring and an increase in wiring delay.

20 [0004] Hence, it is suggested to manufacture the semiconductor device using the three-dimensional integration technology of stacking chips in three dimensions. In this three-dimensional integration technology, bumps of the chips to be stacked are joined to each other, whereby the stacked chips are electrically connected.

25 [0005] As the three-dimensional integration method, a method of joining and stacking a plurality of chips on, for example, a semiconductor wafer (hereinafter, referred to as a "wafer") is used. In this method, a joint

apparatus described in Patent Document 1 is used to join the wafer and the chips by pressing them while heating them. More specifically, a plurality of chips are arranged on a wafer, and a plate-shape body is brought into contact with the top of the plurality of chips, and then the wafer and the plate-shape
5 body are pressed against each other while heating the wafer and the chips to join the wafer and the plurality of chips.

[Prior Art Document]

[Patent Document]

[0006] [Patent Document 1] Japanese Patent Application Laid-open
10 No. 2004-122216

[Disclosure of the Invention]

[Problems to Be Solved by the Invention]

[0007] However, when a plurality of chips are arranged on a wafer, the plurality of chips may sometimes vary in height. In this case, when using
15 the plate-shape body as in Patent Document 1, the wafer and the plurality of chips cannot be uniformly pressed. For example, when the pressure in pressing the wafer and the chips against each other is too small, the joining strength of the wafer and the chips becomes insufficient. On the other hand, when the pressure in pressing the wafer and the chips against each other is too
20 large, the bumps may be deformed, and the semiconductor device may be damaged. As described above, it is impossible to appropriately join the wafer and the plurality of chips.

[0008] The present invention has been made in consideration of the above points, and its object is to appropriately join a plurality of chips
25 arranged on a substrate to the substrate.

[Means for Solving the Problems]

[0009] To achieve the above object, the present invention is a joint apparatus configured to join a plurality of chips arranged on a substrate to the substrate, the joint apparatus including: a processing chamber that houses the substrate; a mounting table that is provided inside the processing chamber and
5 mounts the substrate thereon; a heating mechanism that is provided in the mounting table and heats the substrate; and a gas supply mechanism that supplies a pressurizing gas to an inside of the processing chamber.

[0010] According to the present invention, the substrate is transferred to the inside of the processing chamber and the inside of the processing chamber
10 is sealed, and the substrate is then mounted on the mounting table that has been heated to a predetermined temperature by the heating mechanism. This heats the substrate to a predetermined temperature. Thereafter, the pressurizing gas is supplied from the gas supply mechanism to the inside of the processing chamber to pressurize the inside of the processing chamber to a
15 predetermined pressure. Then, for example, even if the plurality of chips on the substrate vary in height, the pressurizing gas filled inside the processing chamber presses the plurality of chips, thereby making it possible to uniformly press the substrate and the plurality of chips with an appropriate pressure. Consequently, it is possible to appropriately press the substrate
20 and the plurality of chips while heating them to a predetermined temperature so as to appropriately join the substrate and the plurality of chips.

[0011] Further, it is only necessary to supply the pressurizing gas to the inside of the processing chamber to press the substrate and the plurality of chips, thus making it possible to simplify the apparatus configuration as
25 compared with the case of joining them using the plate-shape body as described in Patent Document 1.

[0012] The present invention according to another aspect is a joint system including the joint apparatus, the joint system including: a processing station that includes the joint apparatus, and a temperature adjustment apparatus that adjusts a temperature of the substrate to which the plurality of chips have
5 been joined in the joint apparatus; and a transfer-in/out station that holds a plurality of substrates and transfers in/out the substrates to/from the processing station.

[0013] The present invention according to still another aspect is a joint method for joining a plurality of chips arranged on a substrate to the substrate,
10 the joint method including: a first step of transferring the substrate to an inside of a processing chamber and sealing the inside of the processing chamber; a second step of mounting the substrate on a mounting table heated to a predetermined temperature by a heating mechanism; and a third step of supplying a pressurizing gas from a gas supply mechanism to the inside of the
15 processing chamber to pressurize the inside of the processing chamber to a predetermined pressure to thereby join the substrate and the plurality of chips.

[Effect of the Invention]

[0014] According to the present invention, it is possible to appropriately join a plurality of chips arranged on a substrate to the substrate.

20 [Brief Description of the Drawings]

[0015] [FIG. 1] A plan view illustrating the outline of a configuration of a joint system according to this embodiment;

[FIG. 2] A side view illustrating the outline of an internal configuration of the joint system according to this embodiment;

25 [FIG. 3] A perspective view of a wafer and a plurality of chips;

[FIG. 4] A side view of the wafer and the plurality of chips;

[FIG. 5] A longitudinal sectional view illustrating the outline of a configuration of a joint apparatus;

[FIG. 6] A plan view illustrating the outline of the configuration of the joint apparatus;

5 [FIG. 7] A longitudinal sectional view illustrating the outline of an internal configuration of a processing chamber;

[FIG. 8] A longitudinal sectional view illustrating the outline of a configuration of a lock mechanism;

10 [FIG. 9] A side view illustrating the outline of the configuration of the lock mechanism;

[FIG. 10] A flowchart illustrating main steps of joint processing;

[FIG. 11] An explanatory chart illustrating the temperature of a heating mechanism, the temperature of the wafer, and the internal pressure of the processing chamber in each step of the joint processing;

15 [FIG. 12] An explanatory view of a joint operation by the joint apparatus;

[FIG. 13] An explanatory view of a joint operation by the joint apparatus;

[FIG. 14] An explanatory view of a joint operation by the joint apparatus;

and

[FIG. 15] An explanatory view of a joint operation by the joint apparatus.

20 [Best Mode for Carrying out the Invention]

[0016] Hereinafter, embodiments of the present invention will be described referring to the accompanying drawings. Note that this invention is not limited by the embodiments described below.

[0017] <1. Configuration of Joint System>

25 First, a configuration of a joint system according to this embodiment will be described. FIG. 1 is a plan view illustrating the outline of the

configuration of a joint system 1. FIG. 2 is a side view illustrating the outline of an internal configuration of the joint system 1. Note that to clarify the positional relationship, an X-axis direction, a Y-axis direction, and a Z-axis direction perpendicular to one another are defined, and a Z-axis positive direction is assumed to be a vertical upward direction in the following.

[0018] In the joint system 1, a wafer W as a substrate and a plurality of chips C are joined as illustrated in FIG. 3 and FIG. 4. The wafer W is a semiconductor wafer (device wafer) made by forming devices, for example, on a silicon wafer or a compound semiconductor wafer. On the surface of the wafer W, a plurality of bumps are formed. Further, a plurality of bumps are formed also on surfaces of the chips C, and the chips C are arranged upside down so that the surfaces on which the plurality of bumps are formed are directed to the wafer W side. In other words, the surface of the wafer W where the plurality of bumps are formed and the surfaces of the chips C where the plurality of bumps are formed are arranged to face each other. The bumps of the wafer W and the bumps of the chips C are formed at positions corresponding to each other, and the bumps are joined together and thereby the wafer W and the plurality of chips C are joined together. Note that the bumps are made of, for example, copper, and in this case, the joint of the wafer W and the plurality of chips C is joint of copper to copper.

[0019] On the surface of the wafer W to be transferred into the joint system 1, the plurality of chips C have been arranged at predetermined positions in advance. Then, a film F is pasted from above the plurality of chips C to thereby fix the positions of the plurality of chips C to the wafer W. Note that means for fixing the plurality of chips C to the wafer W is not

limited to the film F, but arbitrary means such as coating can be used.

[0020] As illustrated in FIG. 1, the joint system 1 has a configuration in which, for example, a transfer-in/out station 2 to/from which cassette Cs each capable of housing a plurality of wafers W are transferred in/out from/to the outside, a processing station 3 which includes various kinds of processing apparatuses that perform predetermined processing on the wafer W on which the plurality of chips C are mounted, are integrally connected.

[0021] In the transfer-in/out station 2, a cassette mounting table 10 is provided. The cassette mounting table 10 is provided with, a plurality of, for example, two cassette mounting plates 11. The cassette mounting plates 11 are arranged side by side in a line in the Y-axis direction (a top-down direction in FIG. 1). On the cassette mounting plates 11, the cassettes Cs can be mounted when the cassettes Cs are transferred in/out from/to the outside of the joint system 1. As described above, the transfer-in/out station 2 is configured to be capable of holding the plurality of wafers W. Note that the number of cassette mounting plates 11 is not limited to this embodiment but can be arbitrarily decided.

[0022] In the transfer-in/out station 2, a wafer transfer section 20 is provided adjacent to the cassette mounting table 10. In the wafer transfer section 20, a wafer transfer apparatus 22 that is movable on a transfer path 21 extending in the Y-axis direction is provided. The wafer transfer apparatus 22 is movable also in the vertical direction and around the vertical axis (in a θ -direction) and thus can transfer the wafer W between the cassette Cs on each cassette mounting plate 11 and later-described position adjustment apparatus 32 and transition apparatus 33 in the processing station 3.

[0023] In the processing station 3, a joint apparatus 30, a temperature

adjustment apparatus 31, the position adjustment apparatus 32 and the transition apparatus 33 are provided. The joint apparatus 30 is provided, for example, on the front side in the processing station 3 (on a Y-axis direction negative direction side in FIG. 1), and the temperature adjustment apparatus 31 is provided on the back side in the processing station 3 (on a Y-axis direction positive direction side in FIG. 1). Further, the position adjustment apparatus 32 and the transition apparatus 33 are provided on the transfer-in/out station 2 side in the processing station 3 (on an X-axis direction positive direction side in FIG. 1). The position adjustment apparatus 32 and the transition apparatus 33 are provided at two tiers in this order as illustrated in FIG. 2. Note that the apparatus numbers and arrangement of the joint apparatus 30, the temperature adjustment apparatus 31, the position adjustment apparatus 32 and the transition apparatus 33 can be arbitrarily set.

[0024] The joint apparatus 30 is an apparatus that joins the wafer W to the plurality of chips C. The configuration of the joint apparatus 30 will be described later.

[0025] The temperature adjustment apparatus 31 is an apparatus that adjusts the temperature of the wafer W that has been heated in the joint apparatus 30. The temperature adjustment apparatus 31 has a built-in cooling member such as a Peltier element and includes a temperature adjustment plate (not illustrated) capable of adjusting temperature.

[0026] The position adjustment apparatus 32 is an apparatus that adjusts the orientation of the circumferential direction of the wafer W. The position adjustment apparatus 32 has a chuck (not illustrated) that rotates and holds the wafer W thereon and a detection unit (not illustrated) that detects the position

of a notch portion of the wafer W. The position adjustment apparatus 32 detects the position of the notch portion of the wafer W by the detection unit while rotating the wafer W held on the chuck to thereby adjust the position of the notch portion so as to adjust the orientation of the circumferential direction of the wafer W.

[0027] The transition apparatus 33 is an apparatus for temporarily mounting the wafer W thereon.

[0028] As illustrated in FIG. 1, a wafer transfer region 40 is formed in a region surrounded by the joint apparatus 30, the temperature adjustment apparatus 31, the position adjustment apparatus 32, and the transition apparatus 33. In the wafer transfer region 40, for example, a wafer transfer apparatus 41 is arranged.

[0029] The wafer transfer apparatus 41 has a transfer arm that is movable, for example, in the vertical direction, horizontal directions (the X-axis direction, the Y-axis direction), and around the vertical axis (in the θ -direction). The wafer transfer apparatus 41 can move in the wafer transfer region 40 to transfer the wafer W to the joint apparatus 30, the temperature adjustment apparatus 31, the position adjustment apparatus 32, and the transition apparatus 33 therearound.

[0030] In the above joint system 1, a control unit 50 is provided. The control unit 50 is, for example, a computer and has a program storage unit (not illustrated). In the program storage unit, a program that controls joint processing of the wafer W and the plurality of chips C in the joint system 1 is stored. The program storage unit further stores a program that controls the operations of the above-described various processing apparatuses and a driving system such as transfer apparatuses to realize later-described joint

processing in the joint system 1. Note that the programs may be the ones which are recorded, for example, in a computer-readable storage medium H such as a computer-readable hard disk (HD), flexible disk (FD), compact disk (CD), magneto-optical disk (MO), or memory card, and installed from the
5 storage medium H into the control unit 50.

[0031] <2. Configuration of Joint Apparatus>

Next, a configuration of the above-described joint apparatus 30 will be described. FIG. 5 is a longitudinal sectional view illustrating the outline of the configuration of the joint apparatus 30. FIG. 6 is a plan view illustrating
10 the outline of the configuration of the joint apparatus 30.

[0032] As illustrated in FIG. 5, the joint apparatus 30 has a processing chamber 100 whose inside can be sealed. The processing chamber 100 has an upper chamber 101 as a first chamber and a lower chamber 102 as a second chamber. The upper chamber 101 is provided above the lower
15 chamber 102.

[0033] As illustrated in FIG. 7, the upper chamber 101 has a hollow structure with the inner side of a lower surface opened. At the lower surface of the upper chamber 101, a sealing member 103 is annularly provided for keeping the air tightness inside the processing chamber 100. The sealing
20 member 103 is provided in a manner to project from the lower surface of the upper chamber 101. Further, the lower chamber 102 has a hollow structure with both the inner side of an upper surface and the inner side of a lower surface opened. The lower surface of the upper chamber 101 and the upper surface of the lower chamber 102 are arranged to face each other. Bringing
25 the sealing member 103 into contact with the upper surface of the lower chamber 102 forms the inside of the processing chamber 100 into a sealed

space.

[0034] As illustrated in FIG. 5, the upper chamber 101 is supported by an upper chamber base 110 provided at the upper surface of the upper chamber 101. The upper chamber base 110 has a diameter larger than that of the upper surface of the upper chamber 101.

[0035] Further, the upper chamber 101 has a tapered shape that concentrically increases in diameter from an upper part to a lower part, and has such a shape that a tapered part is convex inward in a side view. At an outer peripheral portion of the upper chamber 101, ribs 111 are provided, for example, at four places between the outer peripheral portion and the upper chamber base 110. In other words, the upper chamber 101 and the ribs 111 are fixed to and supported by the upper chamber base 110.

[0036] Here, the upper chamber 101 is supported at a central portion of the upper chamber base 110, so that, for example, when the inside of the processing chamber 100 is pressurized, the stress concentrates on the central portion of the upper chamber base 110 if there are no ribs 111. In this regard, the internal pressure of the processing chamber 100 is transmitted while dispersed to the central portion and the outer peripheral portion of the upper chamber base 110 via the upper chamber 101 and the ribs 111 in this embodiment. This makes it possible to suppress concentration of the stress to a specific place of the upper chamber base 110.

[0037] At a central portion of an upper surface of the upper chamber base 110, an upper cooling mechanism 112 that cools the upper chamber base 110 is provided. More specifically, at the central portion of the upper surface of the upper chamber base 110, a recessed part is formed to reduce the weight of the upper chamber base 110, and the upper cooling mechanism 112 is

provided in the recessed part. Inside the upper cooling mechanism 112, a refrigerant flow path (not illustrated) is formed through which a refrigerant such a cooling water circulates. Note that the upper cooling mechanism 112 is not limited to this embodiment, but can employ various configurations as long as it can cool the upper chamber base 110. For example, a cooling member such as a Peltier element may be built in the upper cooling mechanism 112.

[0038] The lower chamber 102 is supported by a lower chamber base 120 provided at a lower surface of the lower chamber 102. The lower chamber base 120 has a diameter larger than that of the lower surface of the lower chamber 102.

[0039] At a central portion of a lower surface of the lower chamber base 120, a lower cooling mechanism 121 that cools the lower chamber base 120 is provided. Inside the lower cooling mechanism 121, a refrigerant flow path (not illustrated) is formed through which a refrigerant such a cooling water circulates. Note that the lower cooling mechanism 121 is not limited to this embodiment, but can employ various configurations as long as it can cool the lower chamber base 120. For example, a cooling member such as a Peltier element may be built in the lower cooling mechanism 121.

[0040] The upper chamber base 110 is provided with a moving mechanism 130 that moves the upper chamber base 110, namely, the upper chamber 101 in the vertical direction. The moving mechanism 130 has shafts 131, a support plate 132, and a vertical moving unit 133. The shafts 131 are provided, for example, at four places at the outer peripheral portion of the upper chamber base 110. Further, each of the shafts 131 extends in the vertical direction, penetrates the lower chamber base 120, and is supported by

the support plate 132 that is provided below the lower chamber base 120. The support plate 132 is provided with the vertical moving unit 133 such as an air cylinder. By means of the vertical moving unit 133, the support plate 132 and the shafts 131 move in the vertical direction, and the upper chamber base 110 and the upper chamber 101 are movable in the vertical direction.

[0041] The shafts 131 are provided with lock mechanisms 140 that restrict the movement of the shafts 131. As illustrated in FIG. 6, the lock mechanisms 140 are provided, for example, at four places corresponding to the shafts 131. Further, the lock mechanisms 140 are provided on the lower chamber base 120.

[0042] As illustrated in FIG. 8 and FIG. 9, the lock mechanism 140 has a lock pin 141, a horizontal moving unit 142, and a casing 143. The lock pin 141 is inserted into a through hole 131a formed in the shaft 131. The through hole 131a penetrates in a diameter direction of the shaft 131. Further, the length in an axial direction (vertical direction) of the shaft 131 in the through hole 131a is larger than the diameter of the lock pin 141.

[0043] At a base end portion of the lock pin 141, the horizontal moving unit 142 such as an air cylinder is provided. By means of the horizontal moving unit 142, the lock pin 141 is movable in the horizontal direction with respect to the through hole 131a.

[0044] At an outer peripheral surface of the shaft 131, the casing 143 is provided. The casing 143 is formed with a pair of insertion holes 144, 144 into which the lock pin 141 is inserted. The pair of insertion holes 144, 144 are formed at positions corresponding to the through hole 131a, namely, in the penetration direction of the through hole 131a. The lock pin 141, in a state of being inserted in the through hole 131a, is supported in the insertion holes

144, 144.

[0045] As illustrated in FIG. 7, a mounting table 150 for mounting the wafer W thereon is provided inside the processing chamber 100. On the mounting table 150, a plurality of gap pins (not illustrated) are provided and support the wafer W. Further, on the mounting table 150, a plurality of guide pins (not illustrated) are provided and fix the position in the horizontal direction of the wafer W. Inside the mounting table 150, a heating mechanism 151 that heats the wafer W is provided. As the heating mechanism 151, for example, a heater is used. Note that the mounting table 150 is divided into a plurality of regions, and the heating mechanism 151 may be divided into a plurality of portions to correspond to the divided regions. In this case, the plurality of regions made by dividing the mounting table 150 become capable of adjusting temperature for each region.

[0046] The mounting table 150 has through holes 152 penetrating in the thickness direction formed, for example, at three places. Through the through holes 152, later-described raising and lowering pins 160 pass.

[0047] Note that a heat insulating plate (not illustrated) may be provided below the mounting table 150. This heat insulating plate can inhibit the heat when the heating mechanism 151 heats the wafer W from being transferred to a later-described mounting table base 154 and the lower chamber base 120.

[0048] The mounting table 150 is supported by the mounting table base 154 provided below the mounting table 150 via a plurality of rods 153. The mounting table base 154 is mounted on the lower chamber base 120. Providing an air layer between the mounting table 150 and the mounting table base 154 makes it possible to inhibit the heat when the heating mechanism 151 heats the wafer W from being transferred to the mounting table base 154

and the lower chamber base 120.

[0049] The mounting table base 154 has through holes 155 penetrating in the thickness direction formed, for example, at three places. Through the through holes 155, the later-described raising and lowering pins 160 pass.

5 [0050] The mounting table base 154 is not fixed to the lower chamber base 120. In this case, for example, even when the inside of the processing chamber 100 is heated during the joint processing, the mounting table base 154 can freely thermally expand, resulting in suppression of the thermal stress and flexure which can occur due to fixing it.

10 [0051] As illustrated in FIG. 5, below the mounting table 150, the raising and lowering pins 160 for supporting the wafer W from below and raising and lowering the wafer W are provided, for example, at three places. The raising and lowering pins 160 pass through the mounting table 150, the mounting table base 154, the lower chamber base 120, and the lower cooling mechanism 121, and are supported by a support plate 161 provided below the lower cooling mechanism 121. The support plate 161 is provided with a raising and lowering drive unit 162 having a built-in motor and the like. The raising and lowering drive unit 162 raise and lower the support plate 161 and the raising and lowering pins 160, and makes the raising and lowering pins
15 160 capable of projecting from the upper surface of the mounting table 150.

[0052] The processing chamber 100 is provided with a gas supply mechanism 170 that supplies a pressurizing gas to the inside of the processing chamber 100. The gas supply mechanism 170 has a gas supply unit 171, a gas supply line 172, and a gas supply apparatus 173. The gas supply unit
20 171 is provided above the mounting table 150 and supplies the pressurizing gas to the inside of the processing chamber 100. The gas supply unit 171

communicates with the gas supply apparatus 173 via the gas supply line 172. The gas supply line 172 is provided penetrating the upper chamber 101, the upper chamber base 110, and the upper cooling mechanism 112. The gas supply apparatus 173 stores the pressurizing gas therein and supplies the
5 pressurizing gas to the gas supply unit 171.

[0053] The processing chamber 100 is provided with an exhaust mechanism 180 that exhausts the processing chamber. The exhaust mechanism 180 has an exhaust line 181 and an exhaust apparatus 182. The exhaust line 181 is connected to exhaust ports formed, for example, at two
10 places at the upper surface of the lower chamber base 120, and provided penetrating the lower chamber base 120 and the lower cooling mechanism 121. Further, the exhaust line 181 is connected to the exhaust apparatus 182 such as a vacuum pump.

[0054] Note that the operations of the units in the joint apparatus 30 are
15 controlled by the above-described control unit 50.

[0055] <3. Operation of Joint System>

Next, the joint processing method of the wafer W and the plurality of chips C performed using the joint system 1 configured as described above will be described. FIG. 10 is a flowchart illustrating an example of main
20 steps of the joint processing. FIG. 11 is an explanatory chart illustrating the temperature of the heating mechanism 151 (mounting table 150), the temperature of the wafer W, and the pressure inside the processing chamber 100 in each step of the joint processing.

[0056] Note that in this embodiment, on the surface of the wafer W to be
25 transferred into the joint system 1, the plurality of chips C have been arranged at predetermined positions and the positions of the plurality of chips C have

been fixed by the film F as illustrated in FIG. 3 and FIG. 4.

[0057] First, a cassette Cs housing a plurality of wafers W is mounted on a predetermined cassette mounting plate 11 in the transfer-in/out station 2. Thereafter, a wafer W in the cassette Cs is taken out by the wafer transfer apparatus 22 and transferred to the position adjustment apparatus 32 in the processing station 3. In the position adjustment apparatus 32, the position of the notch portion of the wafer W is adjusted so that the orientation of the circumferential direction of the wafer W is adjusted (Step S1 in FIG. 10).

[0058] At Step S1, the temperature of the heating mechanism 151 is maintained at a predetermined temperature, for example 250°C in the joint apparatus 30 as illustrated in FIG 11. The temperature of the heating mechanism 151 is maintained at the predetermined temperature through the joint processing (later-described Steps S2 to S8). Note that the temperature of the upper cooling mechanism 112 and the temperature of the lower cooling mechanism 121 are also maintained at room temperature, for example, 25°C through the joint processing to cool the upper chamber base 110 and the lower chamber base 120 respectively. Further, the temperature of the wafer W is at room temperature, for example, 25°C. Further, the processing chamber 100 is closed, and the pressure inside thereof is, for example, 0.1 MPa (atmospheric pressure).

[0059] Thereafter, in the joint apparatus 30, the upper chamber 101 is moved upward by the moving mechanism 130 to open the processing chamber 100 as illustrated in FIG. 12. Then, the wafer W is transferred to the inside of the processing chamber 100 by the wafer transfer apparatus 41 and delivered to the raising and lowering pins 160 which have been raised and waiting in advance.

[0060] Subsequently, the upper chamber 101 is moved downward by the moving mechanism 130 to close the processing chamber 100 as illustrated in FIG. 13. In this event, the sealing member 103 and the upper surface of the lower chamber 102 are brought into contact to seal the inside of the processing chamber 100 (Step S2 in FIG. 10).

[0061] Thereafter, while the raising and lowering pins 160 are being lowered by the raising and lowering drive unit 162 as illustrated in FIG. 13, the temperature of the wafer W is adjusted, whereby so-called temperature leveling of the wafer W is performed (Step S3 in FIG. 10). At Step S3, the atmosphere inside the processing chamber 100 is heated by the heating mechanism 151, and the wafer W is also heated. Then, just before the wafer W is mounted on the mounting table 150, the wafer W is adjusted to about 250°C. Note that the temperature adjustment of the wafer W may be controlled by adjusting the lowering speed of the raising and lowering pins 160 or adjusted by lowering the raising and lowering pins 160 stepwise.

[0062] Here, if the wafer W is mounted on the mounting table 150 without the temperature leveling of the wafer W at Step S3, the temperature of the wafer W rapidly increases to result in a warped wafer W. In this regard, performing the temperature leveling of the wafer W makes it possible to suppress warpage of the wafer W. From the viewpoint of suppression of the warpage of the wafer W, the wafer W only needs to be heated to close to 250°C but does not need to be strictly adjusted to 250°C.

[0063] Thereafter, the wafer W is mounted on the mounting table 150 as illustrated in FIG. 14. Then, the wafer W is heated to 250°C.

[0064] After the wafer W is heated to 250°C, the lock pins 141 are inserted into the through holes 131a in the shafts 131 by the horizontal

moving units 142 of the lock mechanisms 140. This fixes the shafts 131 in the vertical direction (Step S4 in FIG. 10).

[0065] Note that the fixing of the shafts 131 by the lock mechanisms 140 is performed just before the pressurizing gas is supplied from the gas supply unit 171 to the inside of the processing chamber 100 at later-described Step S5. The upper chamber 101 thermally expands due to the heat from the heating mechanism 151. Hence, fixing the shafts 131 in a state that the thermal expansion of the upper chamber 101 is stable makes it possible to appropriately fix the position of the upper chamber 101.

[0066] Thereafter, the pressurizing gas is supplied from the gas supply unit 171 to the inside of the processing chamber 100 as illustrated in FIG. 15 to pressurize the inside of the processing chamber 100 to a predetermined pressure, for example, 0.9 MPa (Step S5 in FIG. 10). The pressurization may be performed at a fixed pressurizing speed, or may be performed stepwise by repeatedly performing pressure retention for a predetermined time and pressure increase. Further, the control of pressurization may be performed by adjusting the opening degree of a valve (not illustrated) provided, for example, at the gas supply line 172, or may be performed by controlling an electropneumatic regulator (not illustrated) provided at the gas supply line 172.

[0067] Note that at Step S5, pressure is applied vertically upward to the upper chamber 101, and force acts vertically upward also on the upper chamber base 110. In this regard, since the lock pins 141 are inserted into the through holes 131a as described above, the lower surfaces of the lock pins 141 are in contact with the lower surfaces of the through holes 131a so that the shafts 131 never move vertically upward. Therefore, also the upper

chamber base 110 and the upper chamber 101 never move vertically upward to be able to appropriately seal the inside of the processing chamber 100 and maintain the internal pressure at a predetermined pressure.

[0068] Then, the inside of the processing chamber 100 is maintained at 0.9 MPa, for example, for 30 minutes. This causes the pressurizing gas filled inside the processing chamber 100 to press the plurality of chips C, so that even if the plurality of chips C on the wafer W vary in height, the wafer W and the plurality of chips C can be uniformly pressed with an appropriate pressure. Therefore, it is possible to appropriately press the wafer W and the plurality of chips C while heating them to a predetermined temperature so as to appropriately join the wafer W and the plurality of chips C (Step S6 in FIG. 10).

[0069] Thereafter, the supply of the pressurizing gas from the gas supply mechanism 170 is stopped, and the processing chamber 100 is exhausted by the exhaust mechanism 180 (Step S7 in FIG. 10). Then, the inside of the processing chamber 100 is reduced in pressure down to 0.1 MPa. Note that this pressure reduction may be performed, for example, at a fixed pressure reduction rate, or may be performed stepwise by repeatedly performing pressure retention for a predetermined time and pressure increase. Further, the control of the pressure reduction may be performed by adjusting the opening degree of the valve (not illustrated) provided, for example, at the gas supply line 172, or may be performed by controlling the electropneumatic regulator (not illustrated) provided at the gas supply line 172.

[0070] Note that the wafer W is raised by the raising and lowering pins 160 at Step S7. In this event, the wafer W is cooled.

[0071] Then, after the inside of the processing chamber 100 is reduced in

pressure down to 0.1 MPa, the fixing of the shafts 131 by the lock mechanisms 140 is released, and the moving mechanism 130 moves upward the upper chamber 101 to open the processing chamber 100. Thereafter, the wafer W is transferred out of the processing chamber 100 by the wafer transfer apparatus 41. Note that after the wafer W is transferred out of the processing chamber 100, the processing chamber 100 is closed again.

[0072] Thereafter, the wafer W is transferred by the wafer transfer apparatus 41 to the temperature adjustment apparatus 31. In the temperature adjustment apparatus 31, the wafer W is temperature-adjusted to room temperature, for example, 25°C (Step S8 in FIG. 10).

[0073] Thereafter, the wafer W is transferred by the wafer transfer apparatus 41 to the transition apparatus 33, and further transferred by the wafer transfer apparatus 22 in the transfer-in/out station 2 to the cassette Cs on the predetermined cassette mounting plate 11. Thus, a series of joint processing of the wafer W and the plurality of chips C ends.

[0074] According to the above embodiment, the pressurizing gas supplied to the inside of the processing chamber 100 pressurizes the inside of the processing chamber 100 to a predetermined pressure at Step S5, so that, for example, even if the plurality of chips C on the wafer W vary in height, the wafer W and the plurality of chips C can be uniformly pressed with an appropriate pressure. Accordingly, it is possible to appropriately press the wafer W and the plurality of chips C with a predetermined pressure while heating them to a predetermined temperature so as to appropriately join the wafer W and the plurality of chips C.

[0075] In addition, it is only necessary to supply the pressurizing gas to the inside of the processing chamber 100 for pressing the wafer W and the

plurality of chips C, thus making it possible to simplify the apparatus configuration as compared with the conventional case of joining them using the plate-shape body as described in Patent Document 1.

[0076] Further, temperature leveling of the wafer W is performed while
5 the raising and lowering pins 160 are being lowered at Step S3 before the wafer W is mounted on the mounting table 150, thereby making it possible to suppress the warpage of the wafer W.

[0077] Further, just before the pressurizing gas is supplied from the gas supply unit 171 to the inside of the processing chamber 100 at Step S5, the
10 shafts 131 are fixed by the lock mechanisms 140 at Step S4. Fixing the shafts 131 in a state that the thermal expansion of the upper chamber 101 are stable as described above makes it possible to appropriately fix the position of the upper chamber 101.

[0078] Further, the transfer-in/out station 2 can hold a plurality of wafers
15 W, and the wafers W can be successively transferred from the transfer-in/out station 2 to the processing station 3 in the joint system 1. In addition, the joint system 1 has the joint apparatus 30 and the temperature adjustment apparatus 31 and thus can continuously join the wafers W and the plurality of chips C by sequentially performing the above-described Steps S1 to S8.
20 Further, it is possible that while the joint apparatus 30 is performing predetermined processing on the one hand, the temperature adjustment apparatus 31 can perform other processing on the other hand. In short, a plurality of wafers W can be processed in parallel in the joint system 1. Accordingly, it is possible to efficiently perform joint of the wafer W and the
25 plurality of chips C to improve the throughput of the joint processing.

[0079] Further, the joint system 1 has the position adjustment apparatus

32 which adjusts the orientation of the circumferential direction of the wafer W at Step S1 before the joint processing at Steps S2 to S8 is performed. Here, the plurality of chips C have been fixed in advance at predetermined positions on the wafer W which is to be subjected to the joint processing, so
5 that the adjustment of the orientation of the circumferential direction of the wafer W is unnecessary from the viewpoint of joining the wafer W and the plurality of chips C in the joint apparatus 30. However, adjusting the orientation of the circumferential direction of the wafer W as in this embodiment makes it easy, if a failure occurs, for example, in the joint
10 processing at Steps S2 to S8, to specify the cause of the failure by following a wafer history. In other words, positional information on the wafer W is acquired at Step S1 and its history is left, thereby making it possible to search for the place where the failure occurs on the wafer in the joint processing. This makes it easy to specify the cause of the failure in the joint processing.
15 Therefore, it is possible to improve the conditions of the joint processing and to further appropriately join the wafer W and the plurality of chips C.

[0080] <4. Other Embodiments>

Though the moving mechanism 130 moves the upper chamber 101 in the joint apparatus 30 in the above embodiment, the upper chamber 101 and
20 the lower chamber 102 only need to be relatively moved. For example, the moving mechanism 130 may move the lower chamber 102 or may move both the upper chamber 101 and the lower chamber 102.

[0081] Further, the processing chamber 100 is divided into the upper chamber 101 and the lower chamber 102 in the vertical direction but may be
25 divided in the horizontal direction.

[0082] Further, the mounting table 150 simply mounts the wafer W

thereon, but may vacuum-suck the wafer W thereon or may electrostatically attract the wafer W thereon for instance.

[0083] Note that the predetermined temperature (250°C) for heating the wafer W, the pressure (0.9 MPa) for pressurizing the inside the processing chamber 100, and the time (30 minutes) for pressurizing the inside the processing chamber 100 are examples only in the joint processing in the above embodiments, and are arbitrarily set under various conditions.

[0084] Preferred embodiments of the present invention have been described above with reference to the accompanying drawings, but the present invention is not limited to the embodiments. It should be understood that various changes and modifications are readily apparent to those skilled in the art within the scope of the spirit as set forth in What Is Claimed, and those should also be covered by the technical scope of the present invention.

[Explanation of Codes]

- 15 [0085]
- 1 joint system
 - 2 transfer-in/out station
 - 3 processing station
 - 30 joint apparatus
 - 20 31 temperature adjustment apparatus
 - 32 position adjustment apparatus
 - 33 transition apparatus
 - 41 wafer transfer apparatus
 - 50 control unit
 - 25 100 processing chamber
 - 101 upper chamber

	102	lower chamber
	110	upper chamber base
	120	lower chamber base
	130	moving mechanism
5	131	shaft
	131a	through hole
	133	vertical moving unit
	140	lock mechanism
	141	lock pin
10	142	horizontal moving unit
	150	mounting table
	151	heating mechanism
	170	gas supply mechanism
	C	chip
15	F	film
	W	wafer

[Name of Document] **C L A I M S**

[Claim 1] A joint apparatus configured to join a plurality of chips arranged on a substrate to the substrate, the joint apparatus comprising:

a processing chamber that houses the substrate;

5 a mounting table that is provided inside the processing chamber and mounts the substrate thereon;

a heating mechanism that is provided in the mounting table and heats the substrate; and

10 a gas supply mechanism that supplies a pressurizing gas to an inside of the processing chamber.

[Claim 2] The joint apparatus according to claim 1,

wherein the processing chamber is divided into a first chamber and a second chamber, and

15 wherein the joint apparatus further comprises a moving mechanism that relatively moves the first chamber and the second chamber.

[Claim 3] The joint apparatus according to claim 2,

wherein the first chamber is provided above the second chamber,

20 wherein the moving mechanism comprises a shaft that supports the first chamber and extends in a vertical direction, and a vertical moving unit that moves the shaft in the vertical direction,

wherein the shaft is provided with a lock mechanism that restricts movement of the shaft, and

25 wherein the lock mechanism comprises a lock pin that is to be inserted into a through hole formed in the shaft, and a horizontal moving unit that moves the lock pin in a horizontal direction with respect to the through hole.

[Claim 4] A joint system comprising a joint apparatus configured to join a

plurality of chips arranged on a substrate to the substrate,

the joint apparatus comprising:

a processing chamber that houses the substrate;

a mounting table that is provided inside the processing
5 chamber and mounts the substrate thereon;

a heating mechanism that is provided in the mounting table
and heats the substrate; and

a gas supply mechanism that supplies a pressurizing gas to an
inside of the processing chamber,

10 the joint system comprising:

a processing station that comprises the joint apparatus, and a
temperature adjustment apparatus that adjusts a temperature of the substrate
to which the plurality of chips have been joined in the joint apparatus; and

a transfer-in/out station that holds a plurality of substrates and
15 transfers in/out the substrates to/from the processing station.

[Claim 5] The joint system according to claim 4,

wherein the processing station further comprises a position adjustment
apparatus that adjusts an orientation of a circumferential direction of the
substrate.

20 [Claim 6] A joint method for joining a plurality of chips arranged on a
substrate to the substrate, the joint method comprising:

a first step of transferring the substrate to an inside of a processing
chamber and sealing the inside of the processing chamber;

a second step of mounting the substrate on a mounting table heated to
25 a predetermined temperature by a heating mechanism; and

a third step of supplying a pressurizing gas from a gas supply

mechanism to the inside of the processing chamber to pressurize the inside of the processing chamber to a predetermined pressure to thereby join the substrate and the plurality of chips.

[Claim 7] The joint method according to claim 6,

5 wherein at the second step, before the substrate is mounted on the mounting table, the substrate is held inside the processing chamber and a temperature of the substrate is adjusted.

[Claim 8] The joint method according to claim 6,

10 wherein the processing chamber is divided into a first chamber and a second chamber, and

wherein at the first step, the inside of the processing chamber is sealed by a moving mechanism relatively moving the first chamber and the second chamber.

[Claim 9] The joint method according to claim 8,

15 wherein the first chamber is provided above the second chamber,

wherein the moving mechanism comprises a shaft that supports the first chamber and extends in a vertical direction, and a vertical moving unit that moves the shaft in the vertical direction,

20 wherein the shaft is provided with a lock mechanism that restricts movement of the shaft,

wherein the lock mechanism comprises a lock pin that is to be inserted into a through hole formed in the shaft, and a horizontal moving unit that moves the lock pin in a horizontal direction with respect to the through hole, and

25 wherein after the second step and just before the pressurizing gas is supplied from the gas supply mechanism to the inside of the processing

chamber at the third step, the horizontal moving unit inserts the lock pin into the through hole.

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FIG.1

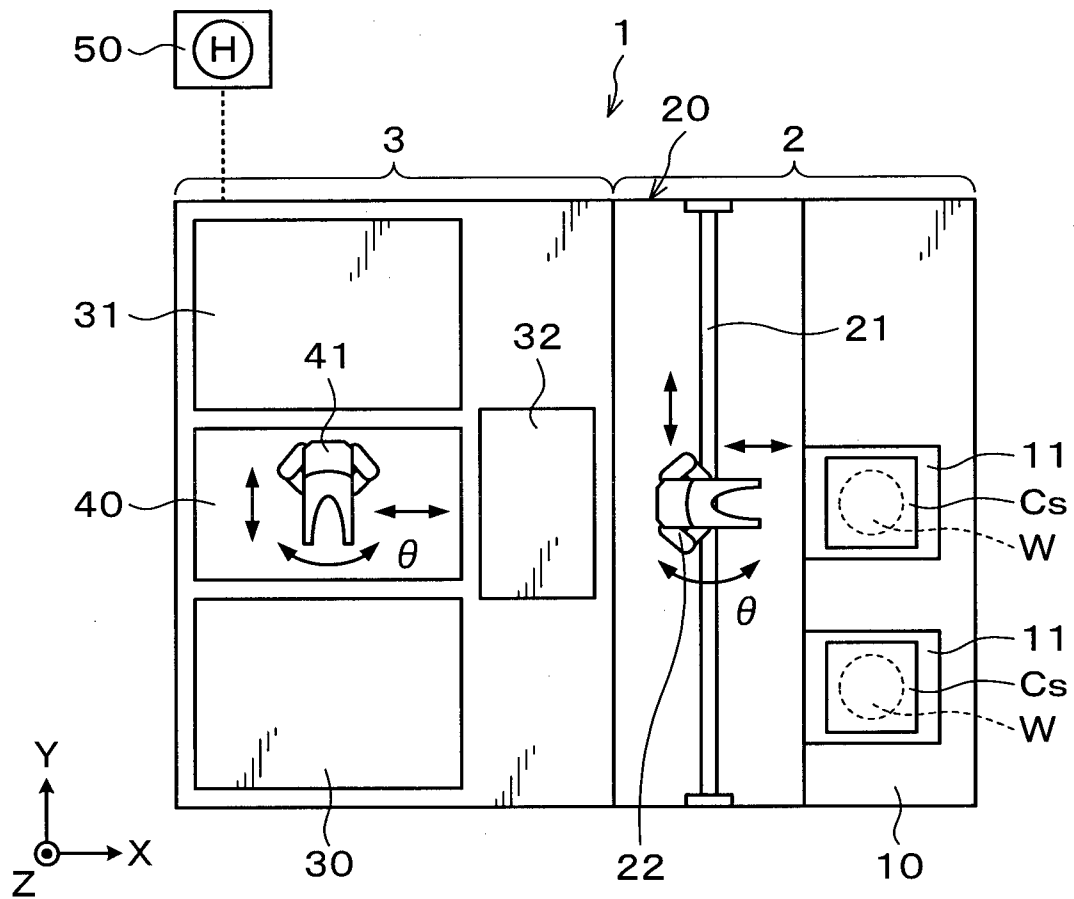


FIG.2

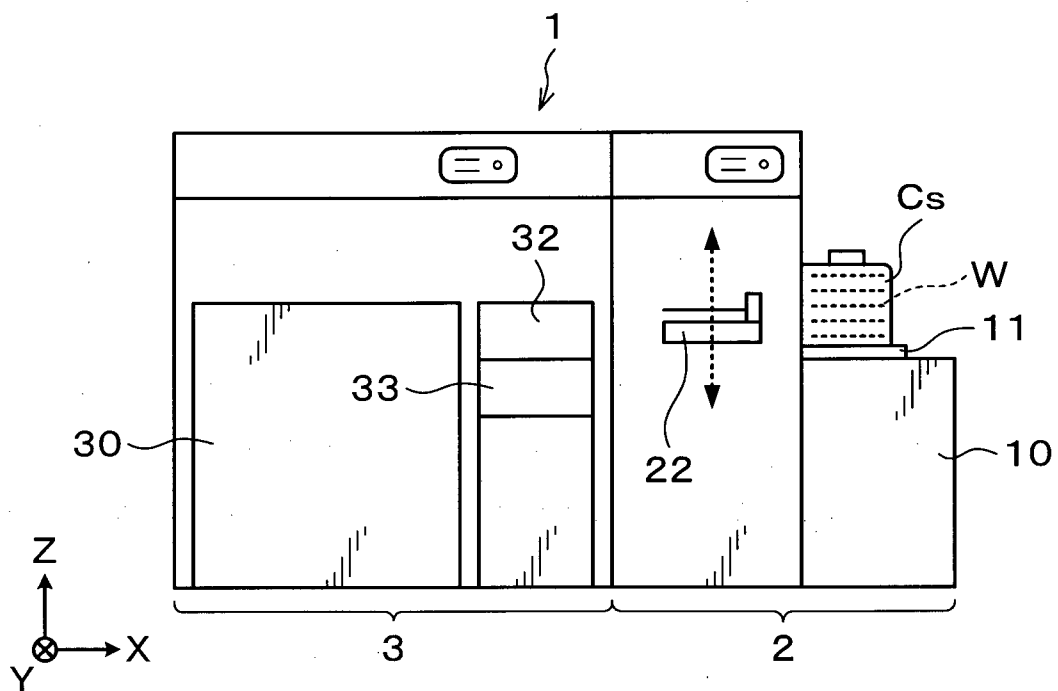


FIG.3

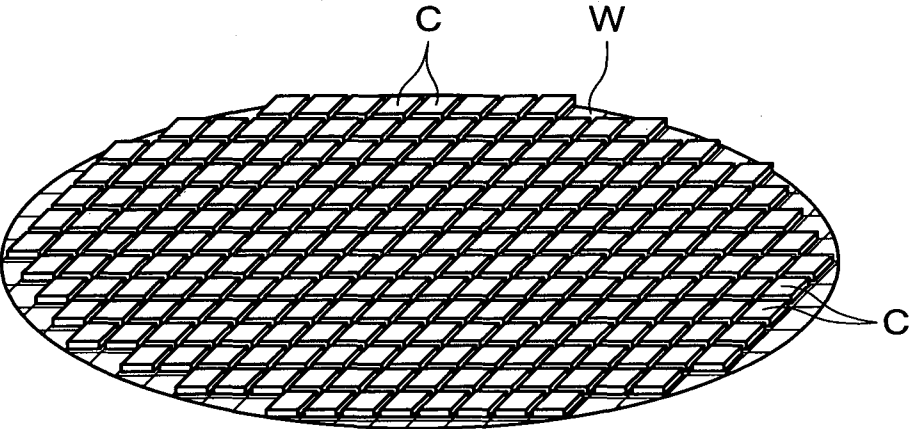
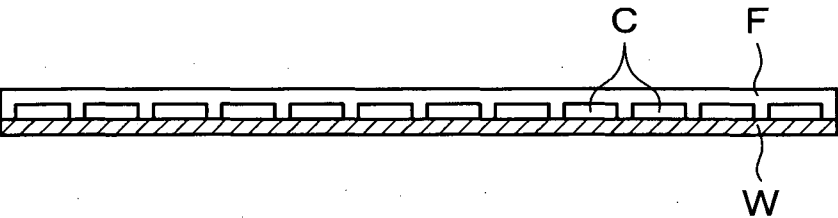


FIG.4



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FIG.6

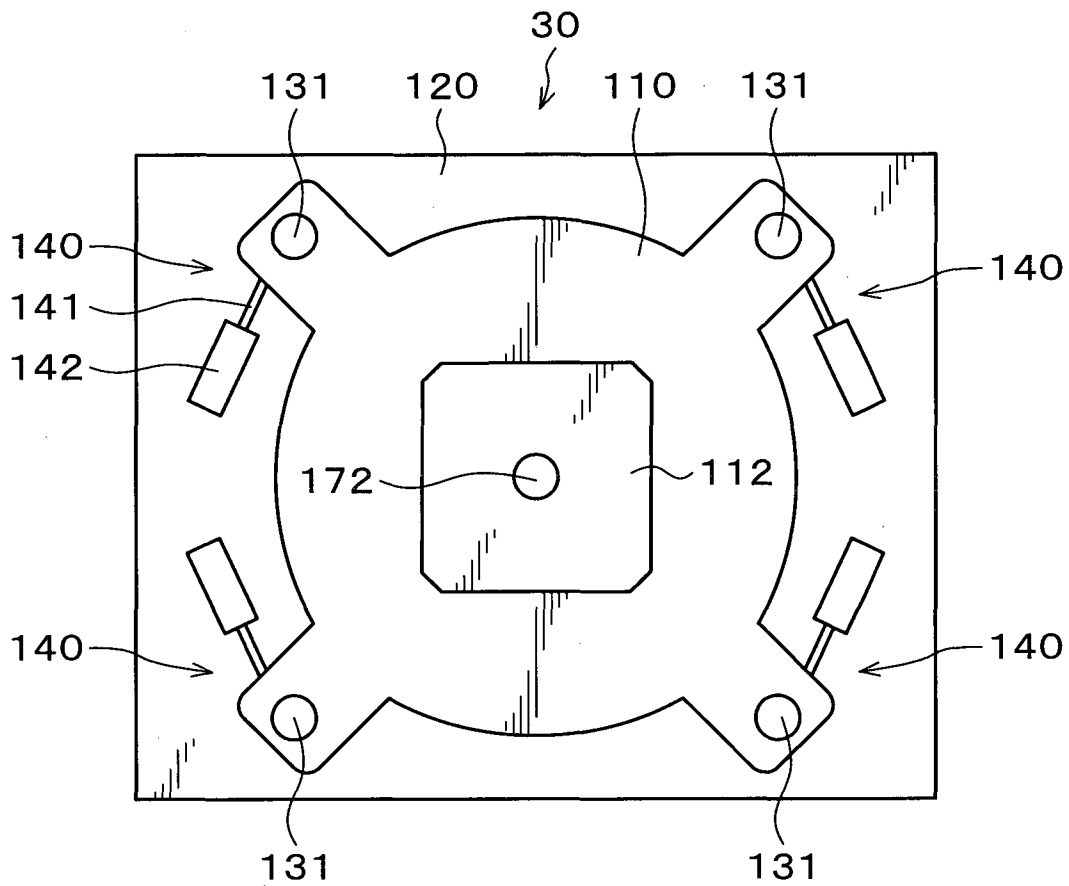
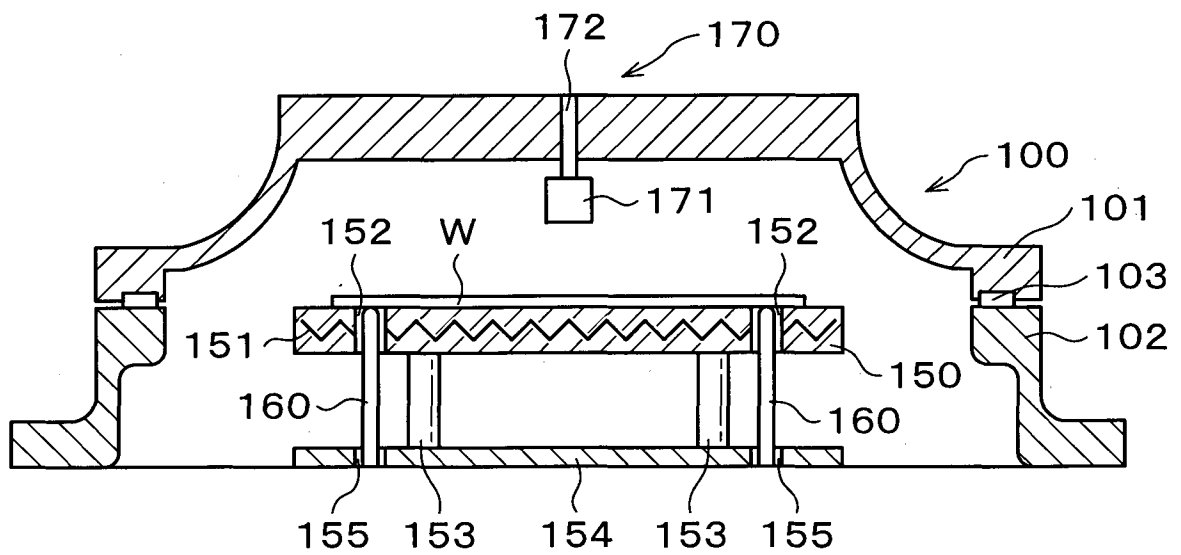


FIG.7



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FIG.8

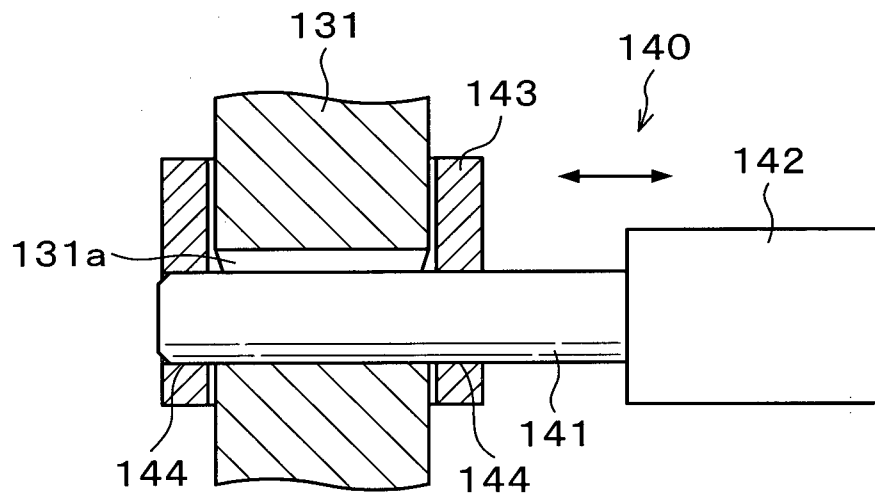
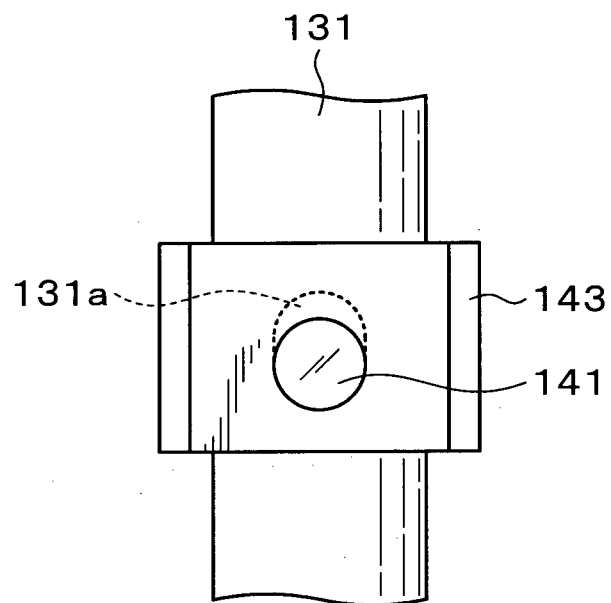


FIG.9



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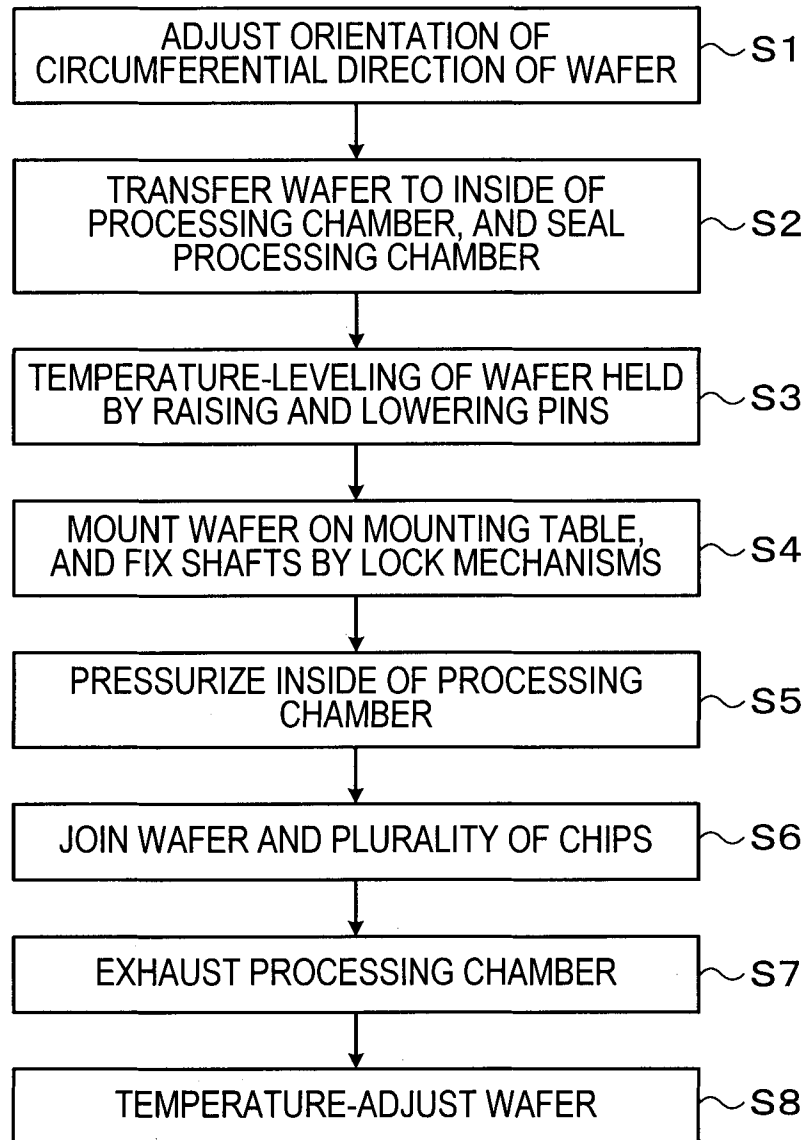
FIG.10

FIG.11

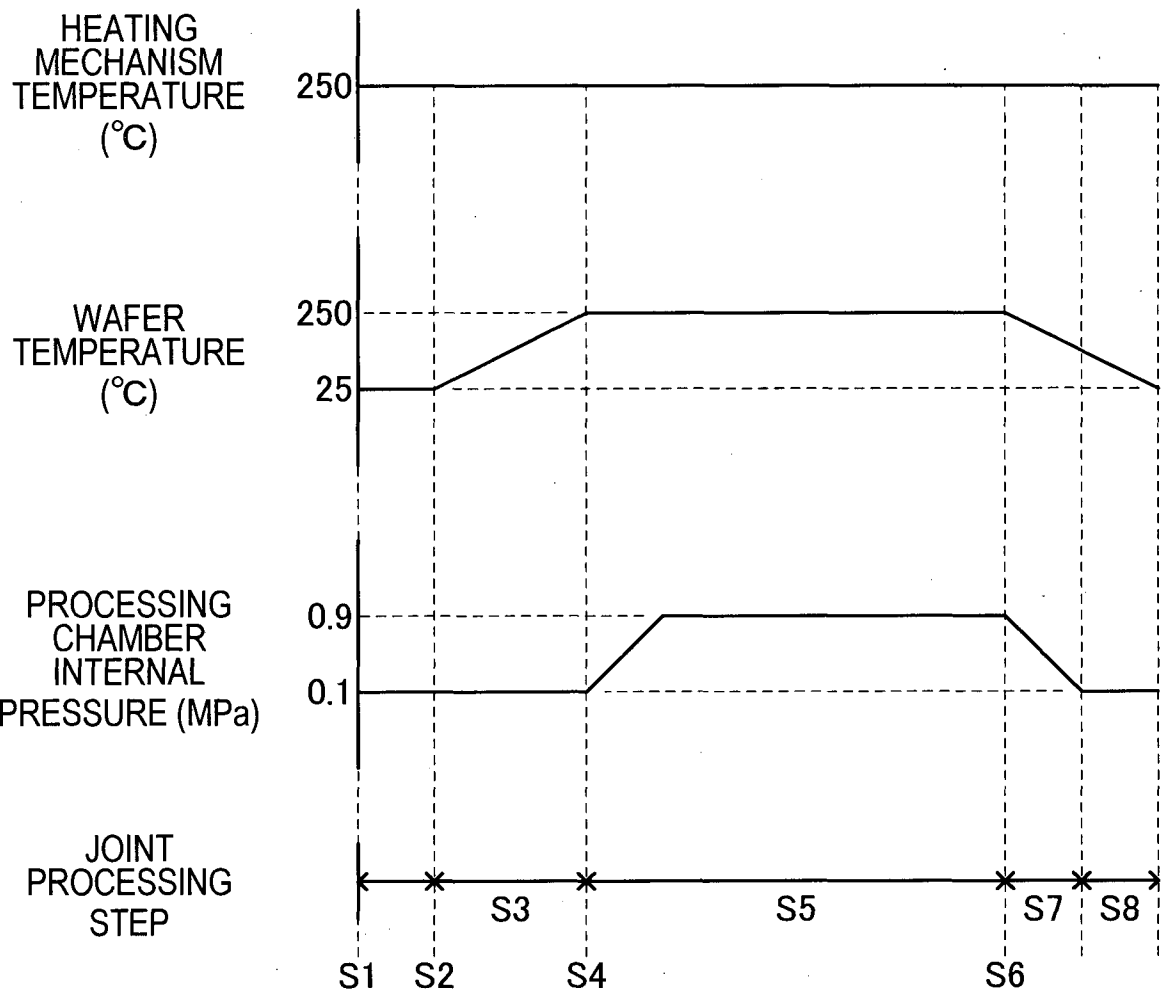


FIG.12

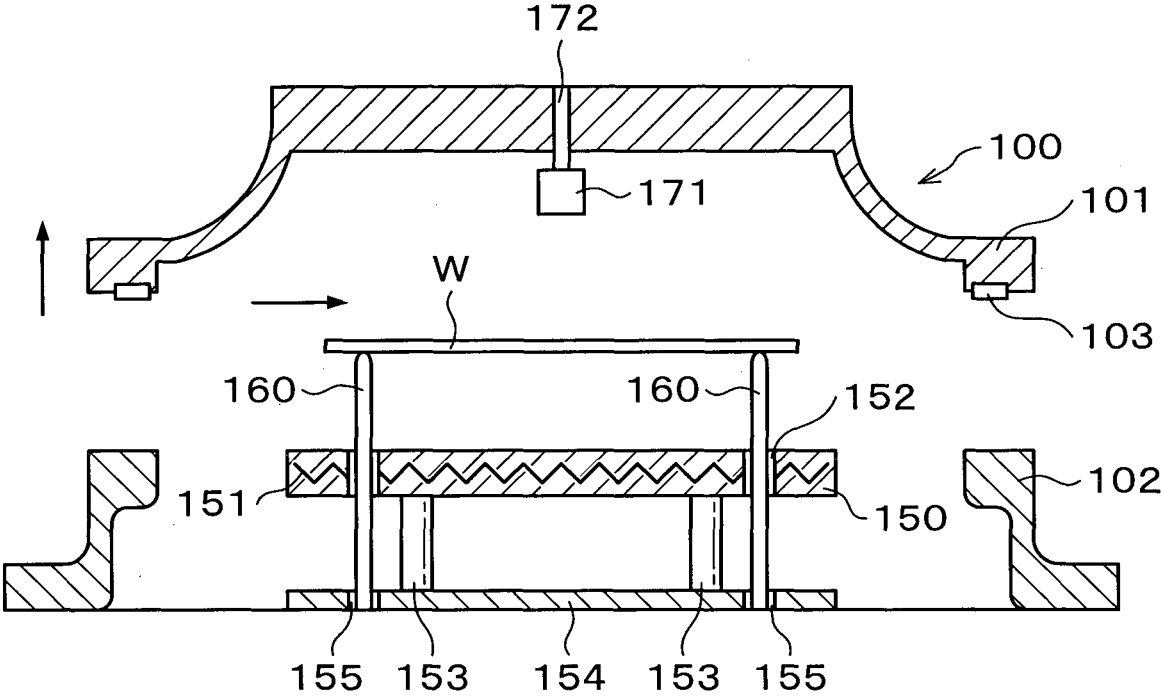


FIG.13

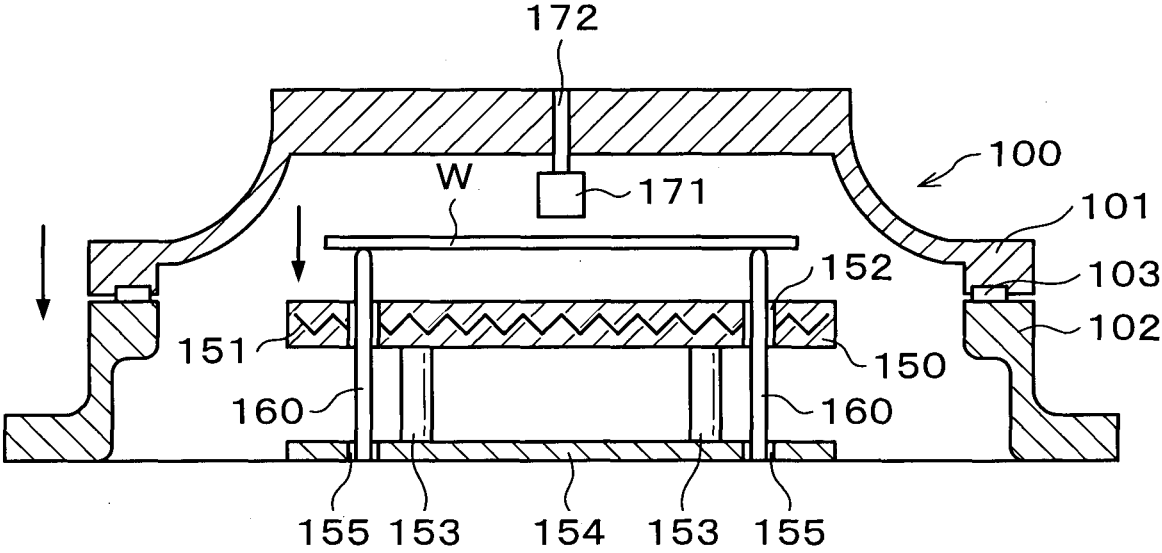


FIG.14

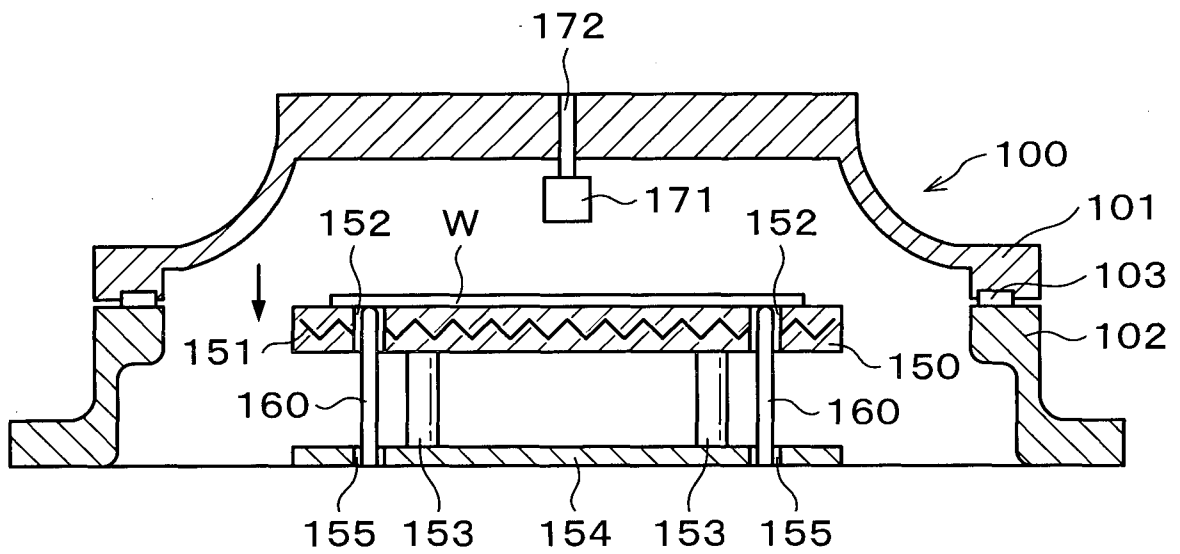
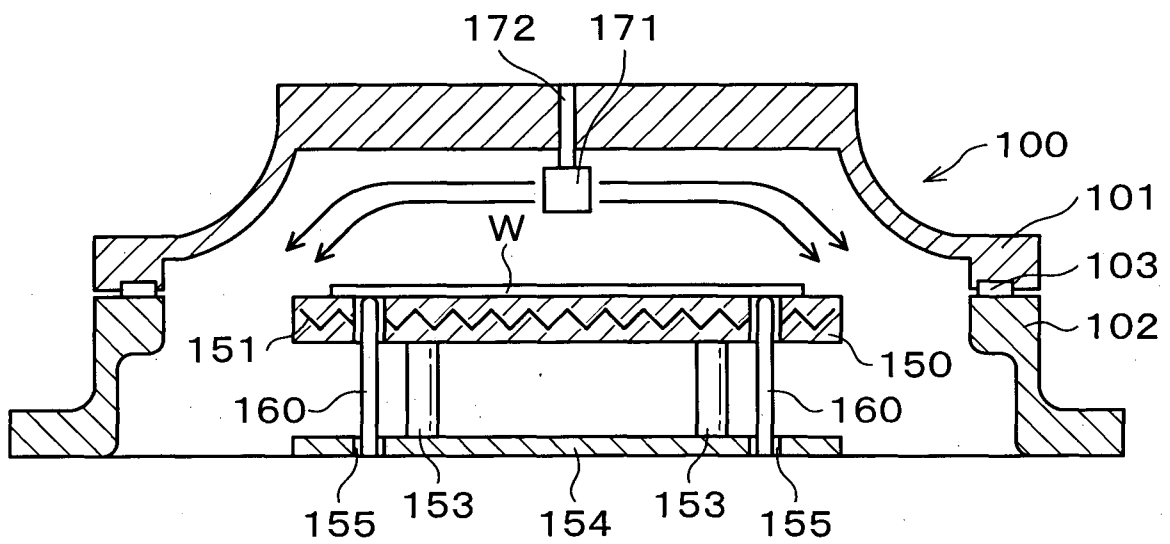


FIG.15



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/050594

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. H01L21/60 (2006.01) i, B23K20/00 (2006.01) i, H01L21/02 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. H01L21/60, B23K20/00, H01L21/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
 Published unexamined utility model applications of Japan 1971-2016
 Registered utility model specifications of Japan 1996-2016
 Published registered utility model applications of Japan 1994-2016

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 2003-115510 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 2003.04.18, paragraphs [0047] to [0072], [0086] to [0103] & US 2003/0027371 A1, paragraphs [0089] to [0116], [0132] to [0150] & EP 1282162 A2 & TW 536768 B & KR 10-2003-0012808 A	1, 2, 6, 8 4, 5, 7 3, 9
Y	WO 2013/035599 A1 (TOKYO ELECTRON LIMITED) 2013.03.14, paragraphs [0014] to [0040], [0093] to [0094] & JP 2013-58572 A & TW 201332037 A	4, 5, 7



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

16.03.2016

Date of mailing of the international search report

29.03.2016

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