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TITLE OF THE INVENTION

SUBSTRATES ASSEMBLY APPARATUS



BACKGROUND OF THE INVENTION

(Field of the Invention)

5 The present invention relates to apparatus for
bonding substrates such as a liquid crystal substrate,
and more particularly, to substrates assembly apparatus
suitable for an assembly process of a liquid crystal
display panel and the like, including the steps of, in a
10 vacuum chamber, holding substrates to be bonded opposite
each other, reducing space between the substrates, and
bonding the substrates.

(Description of the related art including
information)

15 The production process of the liquid crystal display
panels includes a step of bonding two glass substrates
(bonded substrates are hereafter referred to as a cell),
which have transparent electrodes or thin film transistor
arrays thereon, at a very close distance of some μm using
20 an adhesive (hereafter also referred to as a sealing
agent) applied on the substrates' peripheries, and a step
of sealing a liquid crystal in the resultant space.

Japanese Application Patent Laid-open Publication No.
2000-284295 proposed that the liquid crystal is sealed in
25 by dropping the liquid crystal on one substrate in which
the sealing agent is drawn in a closed pattern not to
provide a filling opening, disposing the other substrate
over the one substrate in a vacuum chamber, and bringing

closer and bonding the upper and the lower substrate.

The conventional techniques disclosed in the above described Japanese Application Patent Laid-open

Publication No. 2000-284295 includes a configuration in

5 which the substrates are held in a vacuum by mounting the lower substrate on a flat stage, by sucking the upper substrate by negative pressure in atmospheric air, and by holding the upper substrate using an electrostatic

holding by electrostatic force under a predetermined

10 vacuum condition. Recent substrates tend to have a large size over 1mX1m and a small thickness reducing from 3 mm to 2 mm, 1 mm. Thus, when a pressurizing plate (top

table) sucks and holds the substrate, the middle of the substrate bends to be more apart from the plate, so that

15 the pressurizing plate may not hold the substrate thereon when the plate receives the substrate from the substrate transfer means. The pressurizing plate can only support the periphery of the substrate because the substrate

includes alignment layers or TFTs in the middle, so that

20 it is difficult to prevent the substrate from bending particularly when holding a substrate for a large display.

Even when the pressurizing plate holds the substrate, a residual stress may occur in the substrate or the mark position for positioning substrates may be out of

25 alignment. The robot hand has longer fingers for holding and transferring the large substrates so that the fingers may bend at the end during holding the substrates. As a result, the substrate at the end side of the robot hand

is also more apart from the pressurizing plate so that the plate cannot suck the substrate. The above described problems must be solved to correctly bond the large substrates.

5 BRIEF SUMMARY OF THE INVENTION

Therefore, the object of the present invention is to provide substrates bonding equipment of high productivity, which can hold large substrates with high accuracy and can bond them with high accuracy and at high speed.

10 To achieve the above object, the present invention provides substrates assembly apparatus including: a chamber for producing a reduced pressure atmosphere; a pressurizing plate (top table) configured to hold one substrate in said chamber and to be movable up and down; 15 and a substrate holding table (bottom table) for holding the other substrate opposite to said one substrate held on said pressurizing plate with a space therebetween, said substrate holding table being driven to position said one and the other substrates, said pressurizing 20 plate being lifted and lowered to reduce the space between the substrates, and said substrates being bonded in the reduced pressure atmosphere using adhesive provided on one of the substrates, wherein said pressurizing plate comprises more than one suction hole 25 to hold the substrate thereon by sucking the substrate by negative pressure, more than one electrostatic holding mechanism, and more than one up-and-down movable suction pad.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Figure 1 shows a schematic view of the configuration of the substrates assembly apparatus according to an embodiment of the present invention.

5 Figure 2 shows a schematic view of the robot hand used for transferring substrates.

 Figure 3 shows a schematic view of the general configuration of the suction pad on the pressurizing plate, and a diagram explaining how to hold the substrate
10 when it bends.

 Figure 4 shows a schematic view of the correction mechanism for correcting the substrate bending due to the robot hand fingers bending.

 Figure 5 shows a schematic view of another
15 configuration for holding the bent substrate according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

An embodiment of the present invention will be described below referring to the appended drawings.

20 Figure 1 shows the substrates assembly apparatus according to the present invention, which includes a bottom chamber T1 and a top chamber T2. The top chamber T2 includes a top table 2 (hereafter may be referred to as a pressurizing plate) which is movable up and down by
25 a supporting leg 3 and more than one adjusting leg 4 through the top chamber T2. An O-rings 5 seals the supporting leg 3 and welded bellows 6 seal the adjusting legs 4 to isolate the top chamber T2 from the atmosphere.

The supporting leg 3 and adjusting legs 4 of the top chamber T2 fasten to a pressurizing base plate 7.

The central part of the pressurizing base plate 7 fastens to an intermediate base plate 8. A driving
5 mechanism, which has a driving motor 10 and reduction gear 11 on a ceiling frame 9 and a ball screw 12, allows the intermediate base plate 8 to move up and down guided by a ball spline bearing 13. Supporting posts other than the ball spline bearing 13 on the base frame 1 support
10 the sealing frame 9. Each of the adjusting legs 4, one end of which fastens to the pressurizing base plate 7, has the other end linked to a ball screw 15 driven by a motor 14 attached to the intermediate base plate 8. An up-and-down adjustment mechanism having the driving
15 motors 14 and ball screws 15 can apply force on the pressurizing base plate 7 to lift and lower the top table 2 with keeping its flatness.

The top chamber T2 also includes a fastening mechanism for connecting the top chamber T2 and the
20 pressurizing base plate 7. When the top chamber T2 separates from the bottom chamber T1, the fastening mechanism combines the pressurizing base plate 7 and the top chamber T2, and the driving motor 10 lifts the both together.

25 Outside the sidewall of the top chamber T2, a door valve 16 rests for transferring substrates to and from the chamber. On the opposite sidewall of the top chamber T2 at the position corresponding to the door valve 16, an

ionizer 17 rests for spraying an ionized ultrasonic air on the substrates to remove static electricity from them. Outside the top chamber T2 near the door valve 16, another ionizer 17a rests. With the door open, the
5 ionizer 17a sprays an ionized ultrasonic air on the substrates to help remove static electricity from the substrates.

Outside the ceiling of the top chamber T2, more than one push-structure sub-guide 18 rests with their center
10 shafts 19 extruded into the chamber. These center shafts 19 enter the holes on the protrusion around the top table 2 to make possible horizontal positioning of the top table 2. That is, the sub-guides 18 and center shafts 19 work as the horizontal positioning mechanism for the top
15 table 2.

The top chamber T2 has more than one observation window for observing the substrate marks. With a camera barrel 21 inserted into the observation window, the camera recognizes the substrate marks. The camera barrel
20 21 rests on a mobile stage including traveling axes in horizontal directions (X and Y directions) and a traveling axis in vertical direction (Z direction). The mobile stage fastens to the top chamber T2. The top table 2 also has a hole at the position corresponding to the
25 observation window for recognizing the substrate marks.

Although the present embodiment uses a configuration in which the camera is mounted outside the chamber, another configuration in which the camera is directly

mounted on the top table 2 may be used. This can bring the camera closer to the substrate so that the camera can recognize the marks with improved accuracy and the substrates can be positioned with improved accuracy.

5 A load cell intervenes between the intermediate base of the supporting leg 3 and the ball screw 12 to measure the pressure applied on the substrate. Each of the adjusting legs 4 on the pressurizing base plate 7 also has a load cell 23 to monitor the motor 14, which drives
10 the each of the adjusting legs 4, for overload when adjusting the flatness of the top table 2.

 A bottom table 24 fastens to the bottom chamber T1. If the entire surface of the bottom table 24 fastens to the bottom chamber T1, the bottom table 24 may reduce its
15 flatness by the deformation transferred from the bottom chamber T1 deformed under reduced pressure. The bottom table 24 is then fastens only at its periphery to the bottom chamber T1 to eliminate the effect from the deformed bottom chamber T1. The bottom chamber T1 has on
20 its entire circumference a seal ring 25 as described below. With the top chamber T2 in contact with the seal ring 25 and the door valve 16 closed, the chamber will be airtight to form a vacuum chamber.

 The bottom chamber T1 rests on a θ base table 28,
25 which is configured to be rotated by a motor 26, a ball screw (not shown), and a rotating bearing 27. The θ base table 28 fastens to the bottom chamber T1 with a box-shaped member between them to provide a predetermined

space. The space is provided to contain a UV irradiation mechanism 40, a substrate holding claws elevation mechanism 41, and a substrate lifting mechanism 42 under the bottom chamber T1. The θ base table 28 rests on a Y table 32 via the rotating bearing 27. A motor 29 moves
5 the Y table 32 along a linear rail on an X table 33. A motor 30 moves the X table 33 along a linear rail on the base frame 1.

More than one ball bearings 34 for the top chamber T2
10 and swivel plates 35 with adjustment mechanisms are provided on the periphery of the θ base table 28 to constantly deform the seal ring 25 when the top chamber T2 contacts with the seal ring 25 of the bottom chamber T1 to form the vacuum chamber. These ball bearings 34 and
15 swivel plates 35 adjust the position to which the top chamber T2 moves down.

To prevent the θ base table 28 from becoming deformed, the periphery of the θ base table 28 is supported by more than one ball bearings 37 for the θ base plate 28 and
20 swivel plates 38 with adjustment mechanisms, which rest on members fastened to the equipment base frame 1. Thus, the ball bearings 37 and swivel plates 38 are configured to support the load of the θ base plate 28. Two types of the ball bears: the ball bearings 34 for the vacuum
25 chamber; and the ball bearings 37 for the θ base table, support the load of the periphery of the top and bottom chambers as described above, so that the chambers can become much less deformed.

The bottom chamber T1 has more than one transmitted illuminator 39 to recognize the substrate marks. The bottom table 24 has holes corresponding to the illuminators. The bottom chamber T1 has more than one pressurization/UV irradiation mechanism 40 therein to deform and cure the UV adhesive to prevent the displacement between the bonded substrates. The bottom chamber T1 also has the following: a substrate holding claws elevation mechanism 41 to prevent the substrate from bending in its width direction during substrate transfer, rotation and elevation pins to prevent the robot hands from bending and to prevent the substrate from bending in its back-and-forth direction, and a substrate lifting mechanism 43 to elevate the bonded substrates.

The bottom table 24 has holes such that the pressurization/UV irradiation mechanisms 40 can move up and down through the bottom table 24. The pressurization/UV irradiation mechanisms 40 also act as rotation and elevation pins. The bottom table 24 also has grooves (notches) on its substrate supporting side such that the substrate lifting mechanism 43 can move up and down. This substrate lifting mechanism 43 allows the robot hand to go into under the substrate during the substrate transfer. These holes or grooves may have the least margin, because the bottom table 24 fastens to the bottom chamber T1.

The pressurization/UV irradiation mechanism 40,

substrate holding claws elevation mechanism 41, and
substrate lifting mechanism 42 each have a
lifting/lowering mechanism passing through the bottom
chamber T1. O-rings between the bottom chamber T1 and
5 these lifting/lowering mechanisms seal the gap between
them.

The top table 2 can hold the upper substrate thereon
under reduced pressure using either of an electrically
holding mechanism with an electrostatic chuck or
10 physically holding mechanism with adhesive. For the
electrically holding mechanism with the electrostatic
chuck, the top table 2 can release the substrate by
turning off the applied voltage and lifting the top table
2 after predetermined time for removing static
15 electricity from the substrate. For the physically
holding mechanism with adhesive, the top table 2 can
release the upper substrate by mechanically pressing the
upper substrate on the lower substrate using more than
one pin and then lifting only the top table 2 leaving the
20 pins pressed on the lower substrate.

The bottom table 24 can also hold the lower substrate
thereon under reduced pressure using either of an
electrically holding mechanism with an electrostatic
chuck or physically holding mechanism with adhesive. The
25 top table 2 and bottom table 24 can hold the substrates
thereon with, for example, both using the electrostatic
chuck or adhesive, or one using the electrostatic chuck
and the other using the adhesive. Holding the substrates

on the tables under reduced pressure as described above is preferable in that it can have the standard flatness of the tables and can help assemble the substrates with the two tables parallel, thereby making possible the uniform bonding of the top and lower substrates. The present embodiment uses a configuration in which the suction holding mechanism by negative pressure and the electrostatic holding mechanism by electrostatic force can both be used.

The vacuum chamber can be evacuated by connecting the chamber to a vacuum valve and vacuum pump, such as dry pump or turbo molecular pump, through an exhaust port (not shown) on either top or bottom chamber. The vacuum chamber can be vented to the atmosphere by introducing an inert gas, such as nitrogen, or the atmospheric gas through a valve (not shown) on either top or bottom chamber. To reduce water adhesion to the chamber wall to reduce the evacuation time, the chamber is preferably vented to the atmosphere with an inert gas such as nitrogen, which includes less water molecules.

As an example of substrates assembly apparatus according to the present invention, a configuration in which the vacuum chamber is divided into two chambers has been explained. In addition to this configuration, the present invention can also apply to other assembly equipment configured to have a unibody vacuum chamber in which the top table having one substrate moves toward the bottom table having the other substrate (to reduce space

between the substrates) to bond the substrates.

Figure 2 shows a structure of a hand portion of a robot hand for transferring substrates into the vacuum chamber. Figure 3 shows a diagram explaining how the suction pad on the pressurizing plate sucks the substrate.

In Fig. 2, the hand portion of the robot hand has more than one finger 51 extending from the arm 52 to support substrates 60. The finger 51 has more than one suction pad 53. The suction pad 53 has a suction hole at its end, which can suck the substrate 60 by negative pressure. The suction pad 53 on the finger 51 can move up and down. Depending on the number of LCD panels per substrate 60 to be held, some of the suction pads 53, which may contact with the liquid crystal displays on the substrates 60, are configured to previously evacuate in a position where the pad 53 will not contact the substrate 60 surface. Thus, as shown in Fig. 2 (b), when one LCD panel is produced per substrate 60, the middle suction pads 53b of the suction pads 53 provided on the center finger evacuate not to contact with the substrate 60 surface, and the peripheral pads 53a support the substrate 60.

Consequently, the supported substrate 60 will be concave in the middle as shown in Fig. 2(b). When the suction holes on the pressuring plate (top table) 2 suck and hold such a concave substrate by negative pressure, the negative pressure cannot act on the middle of the substrate 60 so that the top table 2 may not hold the

substrate 60 thereon. Even when the top table 2 holds the substrate 60, the suction holes may not suck the substrate 60 uniformly and the substrate 60 may locally have a large tensile stress. This may contribute to
5 reduce the accuracy of bonding the substrates. In the present embodiment, the top table (pressurizing plate) 2 has more than one suction pad movable up and down in the middle of the table 2 to securely suck the middle of the substrate 60, as shown in Fig. 3 (a).

10 The suction pad consists of an air cylinder 55 for causing up-and-down motions, a rod 57 extending and contracting by the air cylinder 55, and a pad 56 at the end of the rod 57. Although not shown, it is configured to make the rod 57 hollow and supply an air under
15 negative pressure into the hollow portion of the rod 57. The pad 56 at the end of the rod 57 also has a hole communicating with the hollow portion of the rod 57.

Although not shown in Fig. 3 (a), the pressurizing plate 2 has, on its substrate suction surface, more than one
20 suction holding hole for suction by negative pressure. In such a configuration, the robot hand 50 can transfer the substrate 60 by operating the suction holding mechanism by negative pressure on the pressurizing plate 2, and by extending the up-and-down movable rod 57 of the suction
25 pad toward the substrate 60 by a given amount, as shown in Fig. 3. After the pad 56 holds the substrate 60, the rod 57 backs up to the substrate holding surface of the top table 2. Thus, the suction holding holes in the

middle of the top table 2 can securely suck the substrate
60. During bonding of the substrates 60 by applying
pressure to them, the pad 56 also receives negative
pressure to work as suction holding holes. The pad 56 is
5 made of elastic body such as rubber not to damage the
substrate 60 which is in contact with the pad 56.

In the present embodiment, the air cylinder 55 lifts
and lowers the rod 57. Although this actuator rests
outside the vacuum chamber T2 in the present embodiment,
10 it may be configured to rest on the pressurizing plate on
the surface opposite its pressurizing surface. The rod 57
of the suction pad can extend to a predetermined extent
by previously positioning appropriately, depending on the
previously measured bend amount of the substrate, the
15 stopper which controls the extension of the rod 57. It
may be configured to use other actuators such as motors.
A sensor to measure the bend amount of each of the
transferred substrates can be provided to control the
extension of the rod 57 according to the measured bend
20 amount.

A mechanism has been explained which operates when
the substrate 60 bends in the middle. When more than one
finger 51 of the robot hand 50 transfers the substrate 60,
a larger stiffness of the finger 51 would cause a bigger
25 finger 51, which may prevent the operation of the robot
hand 50. Thus, the finger 51 cannot have a large
stiffness. Therefore, as shown in Fig. 4, when large
substrates are transferred, the finger 51 may bend at the

end so that the pressurizing plate 2 cannot suck the substrates by negative pressure. To solve this problem, the chamber contains a wafer edge correction mechanism 70, which has a correction claw for lifting the wafer 60 edges before sucking and holding the wafer 60. The wafer edge correction mechanism 70 includes a wafer edge holding part 71 for holding the wafer edge, and a finger holding part 72 for lifting the finger 51 of the robot hand. The wafer edge holding part 71 intervenes between the adjacent fingers of the robot hand. The holding part 71 can correct the wafer bends between the fingers to help the pressurizing plate 2 to suck the substrate. To further help suck the substrate, the wafer edge holding parts 71 are provided both at the end side and at the arm side of the fingers

In Fig. 4, the wafer edge correction mechanisms 70 movable up and down by the cylinder rest on the bottom chamber T1. Thus, when the fingers 51 of the robot hand 50 bend, the correction mechanism 70 will correct the substrate bending to allow the pressurizing plate 2 to securely suck the substrate 60.

It may be configured to provide, instead of the wafer edge correction mechanism 70, the suction pad with the up-and-down actuator as described in the preceding embodiment on the pressurizing plate 2 at the position corresponding to the wafer holding part at the end side of the finger 51 of the robot hand 50 (at the position opposite the wafer-transfer-in entrance of the chamber,

i.e., at the very back of the chamber).

Figure 5 shows another embodiment of the present invention. In the present embodiment, the suction cramp holes on the pressurizing plate 2 divide into more than one group (R1, R2, and R3). Each group can separately receive a variable negative pressure either by separate negative pressure sources for each group, or by one negative pressure source with branched supply lines to each group. Each supply line has a pressure-regulating valve for regulating the pressure separately.

In the Fig. 5, the suction cramp holes divide into three groups R1, R2, and R3, and each group connects to either of two types of negative pressure sources applying two negative pressures A1 and A2. Because the middle of the substrate 60 includes alignment layers of the LCD panel, the pads 53 on both the sides of the robot hand support the substrate 60 and transfer it into the assembly equipment. Therefore, the middle of the substrate 60 bends and is more apart from the pressurizing plate 2, as shown in Fig. 5 (a). At first, the middle suction holding hole R2 receives a large negative pressure A1 and sucks the middle of the substrate (Fig. 5 (b)). Then, the suction holding holes R1 and R3 on both the sides receive a negative pressure A2 lower than the negative pressure A1 applied to the middle hole R2. Thus, the pressurizing plate 2 can suck the substrate 60 without any deformation left on the substrate (Fig. 5 (c)). In the present embodiment, the

suction holes dividing into three groups have been explained. The suction holes, however, may divide into more groups such that the holes can gradually suck the substrate from the middle to the edge of the substrate, thereby allowing more accurate suction. The above described suction can also be done by sequentially sucking and lifting the substrate from the periphery to the middle of the substrate or vice versa using more than one up-and-down movable suction pad 56 on the pressurizing plate 2 as described in Fig. 3, and correspondingly sucking the substrate on the pressurizing plate 2 using more than one suction holding hole on the plate 2. In addition to the suction holding mechanism as described above, the pressuring plate 2 also includes an adhesive holding mechanism or an electrostatic holding mechanism to prevent the substrates drop during evacuating the chamber of the substrates assembly apparatus, although not shown.

Now the method will be described below for bonding the liquid crystal panels using the substrates assembly apparatus according to the present invention.

First, the upper substrate in which an adhesive is applied in a frame pattern on or near the black matrix around the liquid crystal panel is inverted such that the adhesive-applied surface faces down and then the upper substrate is mounted on the lower finger of the robot hand. The lower substrate to which a liquid crystal is previously applied is provided such that the liquid-

crystal-dropped surface faces up and then is mounted on the upper finger of the robot hand. The robot hand with the two substrates on its upper and lower fingers moves to the front of the substrates bonding equipment. The
5 substrates assembly apparatus opens the door valve 16 of the top chamber T2. The robot hand inserts into the chamber the inverted upper substrate on its lower finger.

The substrates assembly apparatus lowers the top table 2 and the suction holding mechanism by negative
10 pressure sucks and holds the inverted upper substrate on the top table 2. When the substrate bends, the wafer edge correction mechanism 70 or the suction pad operates together to hold the substrate evenly on the top table 2. That is to say, when the substrate bends, the suction pad
15 projects from the top table 2 surface to the position where the pad can suck the substrate. After the suction pad sucks the substrate, the suction pad surface backs up to the position of the top table surface so that the top table 2 can hold the substrate evenly thereon.

20 If the suction holes of the top table divide into more than one group, the negative pressure sequentially acts on from the middle suction hole to the edge side suction hole. Thus, the pressurizing plate 2 can hold the substrate evenly without any deformation left on the
25 substrate.

Next, the lower robot hand once exits from the substrates assembly apparatus. After the robot hand exits, the substrates assembly apparatus 1 lifts the bonded

liquid crystal panels on the bottom table 24 using the substrate lifting mechanism 43 and substrate holding claws elevation mechanism 41. With the bonded panels lifted, the substrates assembly apparatus 1 inserts the lower robot hand again into the substrates assembly apparatus 1 under the liquid crystal panels, then lifts the hand, and backs up the hand to remove the liquid crystal panels from the substrates assembly apparatus 1. Then the substrates assembly apparatus 1 lowers the substrate lifting mechanism 43 and substrate holding claws elevation mechanism 41.

Next, the substrates assembly apparatus 1 inserts into the apparatus 1 the lower substrate with a liquid crystal previously applied thereto on the upper robot hand. The apparatus 1 lifts the substrate holding claws elevation mechanism 41 to lift the lower substrate. After the robot hand exits from the apparatus 1, the mechanism 41 mounts the lower substrate on the bottom table 24, which sucks the substrate.

The camera barrel 21 is then lowered using the traveling axis in vertical direction to measure the substrate mark positions of the upper substrate. Using the traveling axes in horizontal directions, the camera barrel 21 is moved to the point where the center of the camera barrel 21 matches the mark center position of the upper substrate. The top table 2 is then lowered and the camera barrel 21 measures the displacement of the mark positions between the upper and lower substrates. An

elevation mechanism (not shown) then lifts the ball bearings 34. Thus, through the swivel plates with adjustment mechanisms, the top chamber T2 is also lifted up such that the seal ring 25 barely touches or does not touch the top chamber T2 (to prevent the load of the top chamber from acting on the seal ring). Then the driving motor 26, the driving motor 29, and the driving motor 30 horizontally move the bottom chamber T1 and the bottom table 24 together in XYθ directions to roughly position the alignment marks of the upper and lower substrates. After roughly positioning, the ball bearings 34 lower. If the top and bottom tables hold the substrate using the electrostatic chucks, voltages are applied on the electrostatic chucks to hold the substrate. With the substrate held, the door valve 16 is closed and the vacuum pump exhausts the vacuum chamber. During the exhaust, the top table 2 is lifted to help exhaust gas between the upper and lower substrates.

After the pressure reaches a constant reduced pressure in the chamber, the top table 2 is again lowered and the displacement of the mark positions is measured between the upper and lower substrates. Then the motor 26, the motor 29, and the motor 30 horizontally move the bottom chamber T1 in XYθ directions to finely position the alignment marks of the upper and lower substrates. After finely positioning, the top table 2 is further lowered with reading load cell 22 to pressurize and bond the substrates. After a predetermined pressure for deforming

the adhesive is reached, the pressurization is stopped.
To temporarily fasten the substrates to prevent them from
being displaced, the pressurization/UV irradiation
mechanism 40 pressurizes and gives UV light over the UV
5 adhesive previously applied to the substrate at the
position for temporarily fastening the substrates.

After temporarily fastening, the pressurization/UV
irradiation mechanism 40 is lifted. If the top table 2
uses the electrostatic chuck to hold the substrates under
10 reduced pressure, the voltage applied to the
electrostatic chuck is turned off. The top table 2 is
lifted after the period for removing static electricity.
If the top table 2 uses adhesive to hold the substrates,
the upper substrate is mechanically pressed on the lower
15 substrate using more than one pin, and only the top table
2 is lifted leaving the pins pressed downward to release
the upper substrate.

The vacuum chamber is then vented to the atmosphere
by introducing an inert gas such as nitrogen or the
20 atmospheric gas through a valve on the vacuum chamber.
The door 16 is then opened to transfer the substrates.
Maintenance such as cleaning can be done inside the
chamber of the substrates assembly apparatus as follows.
The pressurizing base plate 7 and the top chamber T2 are
25 connected using the fastening mechanism on the top
chamber T2. Then the top table 2 and top chamber T2 are
lifted together in the Z-axis direction using the driving
motor 10. Thus, the maintenance on the top and bottom

tables is possible with the chamber open. As described above, the present embodiment solves the problem that the top table cannot securely hold the large substrate because the substrate bends during the wafer transfer, thereby improving the accuracy of bonding the substrates.

As described above, according to the substrates bonding apparatus of the present invention, the top table can securely hold the substrate in a predetermined position without the effect of the substrate bending which occurs when the substrates are transferred into the apparatus, and particularly when the top table holds the large upper substrate. Thus, the substrates can be bonded with improved accuracy and in reduced time.

CLAIMS

1. Substrates assembly apparatus including: a chamber for producing a reduced pressure atmosphere; a pressurizing plate configured to hold one substrate in said chamber and to be movable up and down; and a substrate holding table for holding the other substrate opposite to said one substrate held on said pressurizing plate with a space therebetween, said substrate holding table being driven to position said one and the other substrates, said pressurizing plate being lifted and lowered to reduce the space between the substrates, and said substrates being bonded in the reduced pressure atmosphere using adhesive provided on one of the substrates, wherein

said pressurizing plate comprises more than one suction hole to hold the substrate thereon by sucking the substrate by negative pressure,

the suction holes near and around the middle of the pressurizing plate of said more than one suction hole are provided on more than one suction pad including a up-and-down motion mechanism.

2. The substrates assembly apparatus of claim 1, wherein said more than one suction pad is provided near the middle of the pressurizing plate.

3. The substrates assembly apparatus of claim 1 or 2, wherein more than one suction pad is provided at the end side of said pressurizing plate opposite the wafer-transfer-in entrance.

4. Substrates assembly apparatus including: a chamber for producing a reduced pressure atmosphere; a pressurizing plate configured to hold one substrate in said chamber and to be movable up and down; and a
5 substrate holding table for holding the other substrate opposite to said one substrate held on said pressurizing plate with a space therebetween, said substrate holding table being driven to position said one and the other substrates, said pressurizing plate being lifted and
10 lowered to reduce the space between the substrates, and said substrates being bonded in the reduced pressure atmosphere using adhesive provided on one of the substrates, wherein

the chamber contains a wafer edge correction
15 mechanism for lifting the substrate toward the pressurizing plate depending on the bending amount of the end of the finger of the robot hand which transfers the substrate to said pressurizing plate.

5. Substrates assembly apparatus including: a chamber
20 for producing a reduced pressure atmosphere; a pressurizing plate configured to hold one substrate in said chamber and to be movable up and down; and a substrate holding table for holding the other substrate opposite to said one substrate held on said pressurizing
25 plate with a space therebetween, said substrate holding table being driven to position said one and the other substrates, said pressurizing plate being lifted and lowered to reduce the space between the substrates, and

said substrates being bonded in the reduced pressure atmosphere using adhesive provided on one of the substrates, wherein

in order to suck the substrate on said pressurizing plate, more than one suction holding hole divides into three or more groups, each group of which includes a negative pressure source or a pressure regulating valve to separately apply variable suction force.

6. The substrates assembly apparatus of claims 1 to 5, further comprising or an electrostatic holding mechanism or an adhesive holding mechanism to hold the substrate during evacuation of the chamber.

7. A method for assembling substrates including, in a vacuum chamber, opposing two substrates at top and bottom with a space therebetween, holding by suction holding mechanism each of the substrates on a top and a bottom, respectively, positioning the substrates, reducing the space between the substrates, and bonding the substrates using adhesive provided on one of the substrates, wherein the substrate is held on said top table by applying a suction holding force on the middle of said substrate.

8. A method for assembling substrates including, in a vacuum chamber, opposing two substrates at top and bottom with a space therebetween, holding by suction each of the substrates on a top and a bottom, respectively, positioning the substrates, reducing the space between the substrates, and bonding the substrates using adhesive provided on one of the substrates, wherein

the substrate is held on said top table by
sequentially sucking and lifting the substrate from the
middle to the periphery of the substrate using a suction
pad including a up-and-down motion mechanism, and by
5 sucking the substrate on the top table.