

TITLE OF THE INVENTION:

SUBSTRATES ASSEMBLY APPARATUS AND METHOD FOR
ASSEMBLING SUBSTRATES

5 BACKGROUND OF THE INVENTION:

<Field of the Invention>

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

<Description of the related art including information>

One of the conventional manufacturing equipment for the liquid crystal display panel is described in Japanese Application Patent Laid-
15 Open Publication No. Hei 10-26763. This reference discloses a bonding process in which a liquid crystal is coated in one of the two glass substrates having transparent electrodes or thin film transistors thereon, spacers are dispersed, the other substrate is mounted over the one substrate using pins having lifting/lowering mechanisms, the other
20 substrate is positioned using positioning pins located in a direction from side to side of the apparatus, the chamber is evacuated to overlay the other substrate on the one substrate, the other substrate is positioned again, and the chamber pressure is released to the atmosphere pressure to bond the substrates.

25 Japanese Application Patent Laid-Open Publication No. 2001-

305563 discloses a unibody vacuum chamber, which contains a first table detachably holding one of the substrates on its upper or lower surface and a second table detachably holding the other one of the substrates on its lower or upper surface. The tables' upper and lower surfaces respectively holding each substrate are opposed. One of the tables is air tightly and movably connected to the vacuum chamber via an elastic body. The one table also includes a driving means on the atmosphere side of the vacuum chamber compartmented by the elastic body, for moving the table at least horizontally relative to the vacuum chamber.

Japanese Application Patent Laid-Open Publication No. 2001-5401 discloses substrates assembly apparatus that includes a chamber divided into top and bottom chambers, and the bottom chamber includes a substrate transfer device and a liquid crystal dropping device.

In the above described Japanese Application Patent Laid-Open Publication No. Hei 10-26763, the potential difference between the pressure between the substrates and the pressure outside the substrates only presses the substrates. Then the sealing materials between the substrates must reliably seal between upper and lower substrates. Thus, much use of the sealing materials is necessary and the materials may extend over the display portion. To hold the substrates in a vacuum, the lower substrate is mounted on a flat stage but the upper substrate is supported by pin shaped members at appropriate positions on the substrate's periphery. Thus, a large substrate over 1 m × 1 m may bend and it may be difficult to exactly position both of the upper and lower substrates.

The chamber is evacuated from atmospheric pressure to a vacuum after the upper and lower substrates are directly transferred into the vacuum chamber. Thus, it may take a long time to evacuate the chamber. This may make difficult to improve the productivity of the assembly apparatus.

In the Japanese Application Patent Laid-Open Publication No. Hei 2001-305563, the top and bottom tables are in the unibody vacuum chamber so that it is difficult to clean the tables in the vacuum chamber when the substrates are broken or any deposit on the substrates contaminates the tables. A substrate elevation mechanism to lift the bonded substrates before removing them, or a substrate temporarily fastening mechanism to prevent substrate displacement, a mark recognition mechanism or illumination mechanism to position the substrates are also fastened to the unibody vacuum chamber or on the structure side outside the vacuum chamber. As a vacuum chamber and bottom table move relatively to each other during positioning the substrates, a problem occurs that the bottom table needs to have larger grooves or holes for the substrate elevation mechanism, for temporarily fastening the substrate, and for the mark recognition or positioning. When pressurizing the substrates after positioning them, larger grooves and holes on the table may cause the variation of local pressure. This may make difficult to uniformly deform the adhesive.

In the conventional equipment with a chamber divided into top and bottom chambers, the bottom chamber and bottom table are not integrated with each other, the space between the bottom table and

bottom chamber is sealed, and the bottom table can do free movement such as rotation relative to the bottom chamber. Thus, the substrates are positioned by moving the entire chamber in XY direction and the mounting table for the substrate in θ direction. Therefore, two sealing
5 structures are necessary: one between the top and bottom chambers; and the other one between the bottom table and bottom chamber. This may lead to the problem of less air-tightly sealed equipment.

SUMMARY OF THE INVENTION:

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

To achieve the above object, the present invention provides substrates bonding equipment for bonding both substrates in a vacuum
15 chamber, wherein the chamber can be divided into top and bottom chambers, a first table for detachably holding one substrate in the top chamber and a second table for detachably holding the other substrate in the bottom chamber are provided such that the substrates are opposite each other, the first table includes a driving mechanism outside the top
20 chamber for lifting and lowering the top table in the top chamber, the second table is integrated with the bottom chamber, and a driving means for finely moving the bottom chamber at least horizontally relative to the top chamber is provided outside the bottom chamber.

25 BRIEF DESCRIPTION OF THE DRAWINGS:

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

Fig. 2 shows a schematic view of a fastening mechanism for connecting and moving the top chamber and pressurizing base plate.

5 Fig. 3 shows an example of a cross section of the seal ring between the top chamber and bottom chamber.

DETAILED DESCRIPTION OF THE INVENTION:

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

Fig. 1 shows substrates assemble equipment 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 which is movable up and down by a supporting leg 3 and more than one adjusting legs 4 through the top chamber T2. The supporting leg 3 and adjusting legs 4 are sealed with O-rings 5 and welded bellows 6, respectively, to isolate the top chamber T2 from the atmosphere. The supporting leg 3 and adjusting legs 4 of the top chamber T2 are fastened to a pressurizing base plate 7.

20 The central part of the pressurizing base plate 7 is fastened to an intermediate base plate 8. A driving mechanism having 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
25 on the base frame 1 support the sealing frame 9. Each of the adjusting

legs 4, one end of which is fastened to the pressurizing base plate 7, has the other end linked to a ball screw 15 driven by a motor 14 on the intermediate base plate 8. An up-and-down adjustment mechanism having the driving 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.

Fig. 2 shows an example of a mechanism for driving the top chamber T2. The top chamber T2 has a fastening mechanism for fastening the top chamber T2 to the top table 2. The mechanism has a lever 51 driven by a cylinder 50 and a T-shaped fastening member 52. The pressurizing base plate 7 has a through hole through which the fastening member 52 can move up and down. With the pressurizing base plate 7 down, the lever 51 will be inserted between the T-shaped fastening member 52 and pressurizing base plate 7. Thus, the lifting of the pressurizing base plate 7 can also lift the top chamber T2. The top chamber T2 can also move up and down guided by the ball spline bearing 13 but is almost rigid in the direction back and forth and from side to side (horizontal direction). One end of the ball spline bearing 13 is fastened to the base frame 1. Thus, the fastening mechanism can lift and lower the top table 2 and top chamber T2 together to move the top chamber T2.

Outside the sidewall of the top chamber T2, a door valve 16 is provided for transferring the 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 is provided 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 is provided. With the door open, the ionizer 17a sprays an ionized ultrasonic air on the substrates to help remove static electricity from the substrates. Although the ionizer 17 in the chamber is provided on the top chamber T2 in Fig. 1, the ionizer can be provided on anywhere for spraying the ionized wind on the substrate surfaces. For example the ionizer can be provided on the bottom chamber T1. Through the door valve 16, the substrates are transferred to the chamber and bonded liquid crystal panels are transferred from the chamber.

Outside the ceiling of the top chamber T2, more than one push structure sub-guide 18 are provided with their center shafts 19 extruded into the chamber. These center shafts 19 match 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 table 2. Thus, the horizontal position of the top table 2 can be finely adjusted to help position the substrate and apply uniform pressure on the substrate.

The top chamber T2 has more than one observation window at the bottom of the window frames convex into the chamber for observing the substrate marks. With a camera barrel 21 inserted into the observation window, the camera recognizes the substrate marks. The camera barrel 21 is mounted 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 is fastened to the top chamber T2. The top table 2 also has a hole at the position corresponding to the

observation window for recognizing the substrate marks.

Although the present embodiment mounts the camera outside the chamber, the camera may be directly mounted on the top table 2. This can eliminate the observation windows to improve the airtightness of the chamber. It can also bring the camera closer to the substrate so that the camera can recognize the marks at improved accuracy and the substrates can also be positioned at improved accuracy.

A load cell 22 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, when adjusting the flatness of the top table 2, the overload of the motor 14, which drives the each adjusting leg 4.

A bottom table 24 is fastened to the bottom chamber T1. If the entire surface of the bottom table 24 is fastened to the bottom chamber T1, the bottom table 24 may reduce its flatness by the deformation transferred from the deformed bottom chamber T1 under reduced pressure. The bottom table 24 is then fastened 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 its circumference a seal ring 25 as described below. The top chamber T2 in contact with the seal ring 25 and the door valve 16 closed will make the chamber airtight to form a vacuum chamber.

The bottom chamber T1 is mounted on a θ base table 28, which is rotated by a motor 26, a ball screw (not shown), and a rotating bearing 27.

The θ base table 28 is fastened to the bottom chamber T1 using a box-shaped member therebetween to provide a predetermined space. The space contains a UV irradiation mechanism 40, substrate holding claws elevation mechanism 41, and substrate lifting mechanism 43 under the bottom chamber T1. The θ base table 28 is mounted on a Y table via the rotating bearing 27. A motor 29 moves 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. Thus, a driving mechanism outside the bottom chamber T1 drives the bottom chamber T1 to which the bottom table 24 is fastened. The movement of the bottom chamber T1 can position the substrates on the bottom table 24. Because the chamber is tightly sealed and the driving mechanism is outside the chamber, the substrates will not encounter any dust from the driving mechanism operated and can be bonded accurately.

More than one ball bearing 34 for the top chamber T2 and swivel plates 35 with adjustment mechanisms are provided around 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 bears 34 and swivel plates 35 adjust the position to which the top chamber T2 moves down. In the present embodiment, the top chamber T2's own weight connects the top chamber T2 and bottom chamber T1. The top chamber T2's own weight can apply enough force on the chambers to connect them with a large connecting force, because the pressure reduction in the chambers can apply additional force on the chambers from the atmosphere.

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 bearing 37 for the θ base plate 28 and swivel plates 38 with adjustment mechanisms 38 which are mounted on members fastened to the equipment base frame 1. The ball bearings 37 and swivel plates 38 support the load of the θ base plate 28. Two types of the ball bearings: the ball bearings 34 for the 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 bend in its width direction during substrate transfer, rotation and elevation pins to prevent the robot hands bend and to prevent the substrate bend 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 be provided with the least margin, because the bottom table 24 is fastened to the bottom chamber T1.

The pressurization/UV irradiation mechanism 40, substrate holding claws elevation mechanism 41, and substrate lifting mechanism 43 each have a lifting/lowering mechanism passing through the bottom chamber T1. O-rings between the bottom chamber T1 and 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 physically holding mechanism with adhesive. For the holding mechanism using 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 electricity from the substrate. For the physically holding mechanism using the sheet adhesive on the top table 2, the top table 2 can release the upper substrate by mechanically pressing the upper substrate on the lower substrate with more than one pin and then lifting only the top table 2 leaving the 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 top table 2 and bottom table 24 can clamp the substrates thereon under reduced pressure 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 table under reduced
5 pressure can keep the standard flatness of the table and keep the two tables parallel to help assemble the substrates. Thus, the top and lower substrates can be bonded uniformly. In the present embodiment, the suction clamp by a negative pressure and the electrostatic clamp by an electrostatic force can both be used.

10 The vacuum chamber can be evacuated by connecting 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 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
15 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.

Now the method for bonding the liquid crystal panels using the
20 substrates assembly apparatus according to the present invention will be described below. First, the upper substrate with an adhesive 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 is mounted on the lower robot arm of the robot. The lower substrate with a
25 liquid crystal previously applied thereto is provided such that the liquid-

crystal-dropped surface faces up and then is mounted on the upper arm of the robot. The robot with the two substrates on its upper and lower arms moves to the front of the substrates assembly apparatus. The controller of the substrates assembly apparatus commands that the door
5 valve 16 of the top chamber T2 open. The robot inserts into the chamber the inverted upper substrate on its lower arm.

After the upper substrate is inserted, the controller commands that top table 2 lower and the suction clamp by a negative pressure hold the inverted upper substrate on the top table 2. If the tip of the extended
10 robot arm bends too much so that the suction clamp cannot hold the substrate, the rotation and elevation pins in the chamber will lift and support the robot arm's tip. After the lower robot arm exits from the chamber, the controller of the substrates assembly apparatus commands the substrate lifting mechanism 43 and substrate holding claws elevation
15 mechanism 41 to lift the bonded liquid crystal panels on the bottom table 24. The robot then inserts the lower robot arm again into under the liquid crystal panel in the chamber, lifts the hand, and backs up the hand to remove the liquid crystal panel from the chamber. Then the controller commands the substrate lifting mechanism 43 and substrate holding
20 claws elevation mechanism 41 to lower.

The robot then inserts into the chamber the lower substrate with a liquid crystal previously applied thereto on the upper robot arm. After the lower substrate inserted into the chamber, the substrate holding claws elevation mechanism 41 rises to lift the lower substrate. After the robot
25 arm exits from the chamber, the mechanism 41 mounts the lower

substrate on the bottom table 24. The suction clamp by a negative pressure then holds the substrate.

The camera barrel 21 is lowered using the traveling axis in vertical direction CZ to measure the substrate mark positions of the upper
5 substrate. Using the traveling axes in horizontal directions CX, CY, the camera barrel 21 is then 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
10 substrates. The fine height elevation mechanism (not shown) then lifts the ball bearings 34. Thus, the swivel plates with adjustment mechanisms on the top chamber T2 and the top chamber T2 are also lifted, up to the point where the seal ring 25 barely touches the top chamber T2. Then the θ axis driving motor 26, Y axis driving motor 29,
15 and X axis driving motor 30 horizontally move the bottom chamber T1 in XY θ directions to roughly position the alignment marks of the upper and lower substrates.

After roughly positioning, the ball bearings 34 are lowered. If the top and bottom tables have the electrostatic chucks, voltages are applied
20 on the electrostatic chucks to electrostatically clamp the substrate onto the table. Then the door valve 16 is closed and the vacuum pump exhausts air from the chamber. The top table 2 is lifted before the exhaust to help exhaust gas between the upper and lower substrates. After a constant reduced pressure is reached, again the top table 2 is
25 lowered and the camera barrel 21 measures the displacement of the mark

positions between the upper and lower substrates. Then the motor 26, motor 29, and motor 30 horizontally move the bottom chamber T1 in XY θ directions to finely position the alignment marks of the upper and lower substrates. As described above, the seal ring 25 on the bottom chamber T1 is designed such that when the top chamber T2 engages with the bottom chamber T1, the fine movement of the bottom chamber T1 in XY θ directions will not move the top chamber T2.

As described above, the substrates are held in the atmosphere with the suction clamp by a negative pressure followed by the electrostatic clamp by an electrostatic force. In this case low voltage needs to be applied to the electrostatic chuck to prevent a discharge between the substrate and electrostatic chuck. The applied voltage needs to be increased with reducing chamber pressure. Thus, a predetermined voltage may be applied to the electrostatic chuck after a predetermined reduced pressure is reached in the vacuum chamber.

Fig. 3 shows an example of a cross section of the seal ring 25 used in the present embodiment. The seal ring 25 in the present embodiment has a shape such that the elastic force is lower in the direction back and forth and from side to side than in the up and down direction (Fig. 3(a) or (b)). As described above, the top chamber T2 is provided on the ball spline bearing 13, which can move up and down but can hardly move back and forth from side to side (horizontally). Thus, the horizontal fine movement of the bottom chamber T1 will not move the top chamber T2 so that the bottom table 24 can be positioned relative to the top table 2.

The seal ring shape in the present embodiment is not limited to the shape

shown in Fig. 3 and may be any shape that realizes the elastic properties as described above.

After finely positioning as described above, the top table 2 is further lowered with reading load cell 22 to pressurize and bond the substrates.

5 After a predetermined pressure for deforming the adhesive is reached, the pressurization is stopped. The pressurization/UV irradiation mechanism 40 then pressurizes and gives UV light over the UV adhesive for temporarily fastening, which is previously applied to the position for temporarily fastening, to temporarily fasten the substrates such that they
10 will not be displaced.

After temporarily fastening, the pressurization/UV irradiation mechanism 40 rises. The voltage applied to the electrostatic chuck is then turned off, if the top table 2 uses the electrostatic chuck to clamp the substrates under reduced pressure. The ionizer then removes static
15 electricity from the substrates. After the period for removing static electricity, the top table 2 rises. To save time for removing static electricity, the substrates may be connected to the power line to be grounded. If the top table 2 uses adhesive to clamp the substrates, more than one pin can mechanically press the upper substrate on the lower
20 substrate. Lifting only the top table 2 leaving pins pressed on the lower substrate can stop the holding of the upper substrate.

The chamber is then vented to the atmosphere by introducing an inert gas such as nitrogen or the atmospheric gas through a valve on the chamber. The door 16 is then opened to transfer the substrates.

25 Maintenance such as cleaning can be done inside the chamber of

the substrates assembly apparatus as follows. With the pressurizing base plate 7 down, the cylinder-driven lever 51 on the top chamber T2 is inserted between the pressurizing base plate 7 and the fastening member 52 on the top chamber T2. Then the driving motor 10 lifts the top table 2 and top chamber T2 in the Z-axis direction. Thus, the fastening mechanism can fasten the top chamber T2 and top table 2, and the driving motor 10 used for pressurizing the top table 2 can lift the top chamber T2. Therefore, no need for additional driving mechanism for lifting the top chamber T2 can provide simpler assembly apparatus. Also, maintenance on the top and bottom tables is possible with the chamber open.

Thus, according to the present invention, a series of operations can be done in the substrates assembly process with the top and bottom chambers combined, but the maintenance on the equipment after bonding a predetermined number of substrates can be done with the top and bottom chambers separated, thereby making possible to save time for bonding substrates and for maintenance.

As described above, in the substrate bonding apparatus according to the present invention, the bottom and top chambers are combined to make the whole chamber and the chambers are positioned using the driving mechanism outside the chambers, so that the fewest holes can be made on the chambers and the substrates can be bonded with high accuracy under constant reduced pressure, and the top chamber movable up and down can facilitate the maintenance inside the vacuum chamber.

WHAT IS CLAIMED IS:

1. Substrates assembly apparatus for holding substrates to be bonded opposite each other at top and bottom, respectively, and for positioning
5 the substrates, reducing spacing between the substrates, and bonding the substrates in a vacuum chamber using adhesive provided on at least one of the substrates, wherein
said chamber consists of a top chamber and a bottom chamber,
a top table for detachably holding one substrate in the top chamber
10 and a bottom table for detachably holding the other substrate in the bottom chamber are provided such that the substrates are opposite each other,
said top table includes a driving mechanism outside the top chamber for increasing and lowering the top table in the top chamber,
15 said bottom table is integrated with the bottom chamber, and
a driving mechanism for moving said bottom chamber at least horizontally relative to the top chamber is provided outside the bottom chamber; and wherein
the top chamber is moved upwardly and downwardly using the driving mechanism for moving the top table upwardly and downwardly.
- 20 2. The substrates assembly apparatus of claim 1, further comprising an elevation mechanism including a guide and driving means for lifting said top chamber.
3. The substrates assembly apparatus of claim 1 or 2, further comprising
25 a door valve on the top chamber for transferring the substrates.

4. The substrates assembly apparatus of claims 1 to 3, further comprising a seal ring and more than one ball bearing around said bottom chamber for connecting the bottom chamber air tightly and horizontally movably to the top chamber.

5. The substrates assembly apparatus of claims 1 to 4, further comprising a substrate elevation mechanism for lifting the bonded substrates before removing them, or a substrate temporarily fastening mechanism for prevent substrate displacement, a mark recognition mechanism or illumination mechanism for positioning the substrates in the bottom chamber, said mechanisms of which are integrated with and movable with the bottom chamber and bottom table.

6. The substrates assembly apparatus of claims 1 to 5, further comprising a fine height elevation mechanism for lifting the top chamber up to the height where the top chamber does not touch the bottom chamber.

7. The substrates assembly apparatus of claims 1 to 6, further comprising an ionizer on said top chamber for removing static electricity from the bonded substrates.

8. The substrates assembly apparatus of claims 1 to 7, further comprising a table movable in XYZ directions outside said top chamber, and a camera on said table for recognizing the substrate position.

9. The substrates assembly apparatus of claims 1 to 7, further comprising a camera on said top table for observing the alignment marks of the substrates.

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10. The substrates assembly apparatus of claims 1 to 8, further comprising an adjustment mechanism on said top chamber for finely adjusting the horizontal position of the said top table.

10 11. Substrates assembly apparatus comprising: a XYθ table on a base frame; a chamber for forming a vacuum chamber; a top table and a bottom table for holding two spaced opposite upper and lower substrates in said chamber; and a driving mechanism outside said chamber for lifting and lowering said top table, said driving mechanism lowering the top table
15 to reduce spacing between the tables to bond the substrates,

wherein,

said chamber consists of a top chamber and a bottom chamber, said top chamber is attached to a guide such that the top chamber moves up and down along said guide, said top table and said top chamber are
20 connected by a fastening mechanism, said top chamber is moved by a driving motor for moving said top table.

12. Substrates assembly apparatus comprising: a XYθ table on a base frame; a chamber for forming a vacuum chamber; a top table and a
25 bottom table for holding two spaced opposite upper and lower substrates

in said chamber; and a driving mechanism outside said chamber for lifting and lowering said top table, said driving mechanism lowering the top table to reduce spacing between the tables to bond the substrates,

wherein,

5 said chamber consists of a top chamber and a bottom chamber, a seal ring between said top chamber and bottom chamber has stiffness lower in the horizontal direction than in the vertical direction.

13. A method for assembling substrates in a vacuum chamber consisting
10 of a top chamber including a top table and a bottom chamber including a bottom table, including: applying sealing materials circularly on one substrate; holding on the bottom table said one substrate on which a liquid crystal is dropped in an area surround by the sealing materials; holding on the top table the other substrate opposite to said one
15 substrate; and reducing spacing between said one and the other substrates to bond the substrates, said method comprising:

 when bonding the substrates, lifting and lowering only the top table;
and when doing maintenance inside the chamber, connecting the top table and top chamber with a fastening member and lifting both the top
20 table and top chamber off the bottom chamber.