

REMOVAL METHOD OF SUPPORT PLATE AND PROCESSING METHOD OF PLATE-SHAPED MEMBER

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a removal method of a support plate applied when the support plate that supports a plate-shaped member is separated and removed and a processing method of a plate-shaped member that uses this removal method of a support plate.

Description of the Related Art

There are increasing opportunities to thinly process a wafer in which such devices as integrated circuits are disposed on the front surface side in order to realize small-size, light-weight device chips. For example, the front surface side of the wafer is held by a chuck table, and a wheel for grinding to which abrasive stones for grinding processing containing abrasive grains are fixed and the chuck table are each rotated. Further, the abrasive stones are pressed against the back surface of the wafer while liquid such as purified water is supplied. As a result, this wafer is subjected to grinding processing and becomes thin.

Incidentally, when the whole of the wafer becomes

thin by the above-described method, the rigidity of the wafer also greatly lowers, and handling of the wafer in later steps becomes difficult. As such, before the wafer is subjected to the grinding processing, a support plate having predetermined rigidity suitable for reinforcement is stuck to the front surface side of the wafer with the interposition of an adhesion layer (for example, refer to Japanese Patent Laid-open No. 2004-153193 and Japanese Patent Laid-open No. 2014-53623). This support plate is separated and removed when processing of the wafer has ended.

SUMMARY OF THE INVENTION

Incidentally, if a large force is applied to the wafer when the support plate is removed from the wafer that has been subjected to the grinding processing and has become thin, the probability of breakage of the wafer also becomes high. Hence, a curable adhesive that cures by ultraviolet or the like is used for the adhesion layer, and the adhesion strength of the adhesion layer is lowered when the support plate is removed from the wafer.

However, the adhesion layer is in close contact with the support plate. Hence, even when the adhesion strength of the adhesion layer is lowered, a certain

degree of force is required when the support plate is to be separated from the adhesion layer. A method in which a special material that generates gas (gas generating agent) is added to the adhesion layer to lower the adhesiveness between the support plate and the adhesion layer is also being studied. However, with this method, the special material is required, and hence, the cost taken for the adhesion layer increases.

Therefore, an object of the present invention is to provide a removal method of a support plate by which the support plate can be removed by a small force without increasing the cost taken for an adhesion layer and a processing method of a plate-shaped member that uses this removal method of a support plate.

In accordance with an aspect of the present invention, there is provided a removal method of a support plate. The removal method of a support plate includes a curing step of irradiating with ultraviolet an adhesion layer that contains a curing material that cures when being irradiated with ultraviolet and is in an uncured state and bonds the support plate that allows the ultraviolet to be transmitted through the support plate to a plate-shaped member, from the side of the support plate to cure the curing material of the adhesion layer,

a void forming step of forming a plurality of voids in a surface in contact with the support plate in the adhesion layer through irradiating the adhesion layer with a laser beam with such a wavelength as to be transmitted through the support plate and be absorbed by the curing material from the side of the support plate, after the curing step, and a support plate removal step of separating the support plate from the adhesion layer with the surface being a border to remove the support plate from the adhesion layer bonding to the plate-shaped member, after the void forming step.

Preferably, irradiation with the laser beam in a pulsed form is executed in such a manner that adjacent irradiated regions do not overlap in the surface in the void forming step. Preferably, the plurality of voids are formed sequentially from an end part of the surface in the void forming step. Further preferably, the removal method of a support plate further includes an adhesion layer removal step of separating the adhesion layer from the plate-shaped member to remove the adhesion layer, after the support plate removal step.

In accordance with another aspect of the present invention, there is provided a processing method of a plate-shaped member that uses the above-described removal

method of a support plate. The processing method of a plate-shaped member includes a processing step of processing the plate-shaped member, before the void forming step.

In the removal method of a support plate according to the one aspect of the present invention, after the curing material that is contained in the adhesion layer and cures when being irradiated with the ultraviolet is cured, the adhesion layer is irradiated with the laser beam with such a wavelength as to be transmitted through the support plate and be absorbed by the curing material, from the support plate side, and the plurality of voids are formed in the surface in contact with the support plate in the adhesion layer. Hence, the adhesiveness between the support plate and the adhesion layer lowers due to the plurality of voids, and it becomes possible to separate the support plate from the adhesion layer by a small force.

Further, in the removal method of a support plate according to the one aspect of the present invention, without using a special material like a gas generating agent, the adhesiveness between the support plate and the adhesion layer can be lowered only by irradiating the curing material that has cured with the laser beam to

form the plurality of voids. Thus, increase in the cost taken for the adhesion layer due to the special material also does not occur. Hence, according to the one aspect and the other aspect of the present invention, the support plate can be removed by a small force without increasing the cost taken for the adhesion layer.

The above and other objects, features and advantages of the present invention and the manner of realizing them will become more apparent, and the invention itself will best be understood from a study of the following description and appended claims with reference to the attached drawings showing a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view illustrating a plate-shaped member;

FIG. 2 is a perspective view illustrating the state in which a support plate is bonded to the plate-shaped member;

FIG. 3 is a perspective view illustrating the plate-shaped member to which the support plate is bonded;

FIG. 4 is a sectional view illustrating part of an adhesion layer that bonds the plate-shaped member and

the support plate;

FIG. 5 is a perspective view illustrating the state in which the adhesion layer is irradiated with ultraviolet;

FIG. 6 is a sectional view illustrating part of an adhesion layer obtained after the irradiation with the ultraviolet;

FIG. 7 is a perspective view illustrating the state in which the adhesion layer is irradiated with a laser beam;

FIG. 8 is a sectional view illustrating part of the adhesion layer obtained after the irradiation with the laser beam;

FIG. 9 is a perspective view illustrating the state in which the support plate is separated from the adhesion layer;

FIG. 10 is a sectional view illustrating part of the adhesion layer from which the support plate has been separated;

FIG. 11 is a sectional view illustrating the state in which the adhesion layer is separated from the plate-shaped member; and

FIG. 12 is a perspective view illustrating the state in which grinding processing of the plate-shaped

member to which the support plate is bonded is executed.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the present invention will be described below with reference to the accompanying drawings. FIG. 1 is a perspective view illustrating a plate-shaped member 11 used in the present embodiment. The plate-shaped member 11 is a circular disc-shaped wafer composed of a semiconductor such as silicon, for example, and has a circular front surface 11a and a circular back surface 11b on the opposite side of the front surface 11a.

The side of the front surface 11a of this plate-shaped member 11 is segmented into plurality of small regions by plurality of streets (planned dividing lines) 13 that intersect each other, and a device 15 such as an integrated circuit (IC) is formed in each small region. Although the circular disc-shaped wafer composed of a semiconductor such as silicon is used as the plate-shaped member 11 in the present embodiment, the material, shape, structure, size, and so forth of the plate-shaped member 11 are not limited to the above-described form.

For example, a substrate composed of such a material as another semiconductor, ceramic, resin, or

metal can be used as the plate-shaped member 11.

Similarly, the kind, quantity, shape, structure, size, arrangement, and so forth of the devices 15 formed in the plate-shaped member 11 are also not limited to the above-described form. The devices 15 do not need to be formed in the plate-shaped member 11.

In the present embodiment, for example, a support plate having predetermined rigidity suitable for reinforcement is bonded to this plate-shaped member 11 in advance (bonding step). Owing to the bonding of the support plate to the plate-shaped member 11, handling of the post-processing plate-shaped member 11 becomes easy even when the rigidity of this plate-shaped member 11 is lowered due to the processing. FIG. 2 is a perspective view illustrating the state in which a support plate 21 is bonded to the plate-shaped member 11. FIG. 3 is a perspective view illustrating the plate-shaped member 11 to which the support plate 21 is bonded.

The support plate 21 is typically a circular disc-shaped member (substrate) composed of ceramic such as glass that allows light with a predetermined wavelength including ultraviolet to be transmitted through the member, and has a circular front surface 21a and a circular back surface 21b on the opposite side of

the front surface 21a. The diameter of the support plate 21 is equivalent to that of the plate-shaped member 11 or is larger than that of the plate-shaped member 11, for example.

However, the material, shape, structure, size, and so forth of the support plate 21 are not limited to the above-described form. For example, the shape, size, and so forth of the support plate 21 can be changed according to the kind and so forth of processing applied to the plate-shaped member 11. When there is no need to support the whole of the plate-shaped member 11 in processing, the support plate 21 with a small diameter compared with the plate-shaped member 11 may be used. Furthermore, a thick film or the like composed of resin or the like that allows ultraviolet to be transmitted through the film is used as the support plate 21 in some cases.

In the present embodiment, this support plate 21 is bonded to the side of the front surface 11a of the plate-shaped member 11 with the interposition of an adhesion layer containing a curing material that cures when being irradiated with ultraviolet as an adhesive. FIG. 4 is a sectional view illustrating part of an adhesion layer 23 that bonds the plate-shaped member 11

and the support plate 21. The adhesion layer 23 is, for example, a film with a circular disc shape (circular shape) for which an ultraviolet-curable resin that cures by ultraviolet is used as a curing material. The diameter of this adhesion layer 23 is equivalent to that of the plate-shaped member 11 or is slightly larger than that of the plate-shaped member 11.

Hence, for example, if the adhesion layer 23 is sandwiched between the front surface 11a of the plate-shaped member 11 and the front surface 21a of the support plate 21 and the adhesion layer 23 is brought into contact with the plate-shaped member 11 (front surface 11a) and the support plate 21 (front surface 21a), the support plate 21 is bonded to the plate-shaped member 11 through the adhesion layer 23. The adhesion layer 23 in this state contains the resin (curing material) in an uncured state and exhibits an adhesion strength (adhesive force) that derives from the resin (curing material) in the uncured state.

Although the film formed into the circular disc shape with the ultraviolet-curable resin is used as the adhesion layer 23 in the present embodiment, the material, shape, size, and so forth of the adhesion layer 23 are not limited to the above-described form. It

suffices for the adhesion layer 23 to be composed mainly of an ultraviolet-curable curing material. Further, it is desirable that the adhesion layer 23 do not contain a special material such as a gas generating agent.

For example, an ultraviolet-curable liquid resin may be used as the adhesion layer 23. In this case, for example, the liquid resin is supplied to one of the front surface 11a of the plate-shaped member 11 and the front surface 21a of the support plate 21 and the other of the front surface 11a of the plate-shaped member 11 and the front surface 21a of the support plate 21 is pressed against the liquid resin to push and spread this resin.

When the support plate 21 is bonded to the plate-shaped member 11 through the adhesion layer 23, the plate-shaped member 11 is reinforced by the support plate 21. Accordingly, even when the rigidity of the plate-shaped member 11 lowers due to processing, handling of the post-processing plate-shaped member 11 becomes easy. After the plate-shaped member 11 and the support plate 21 are bonded through the adhesion layer 23, the plate-shaped member 11 is processed according to need (processing step). An example of the processing will be described later.

A removal method of a support plate according to

the present embodiment is started in the state in which the support plate 21 is bonded to the plate-shaped member 11. Specifically, for example, in order to sufficiently cure the curing material of the adhesion layer 23 that bonds the support plate 21 to the plate-shaped member 11, this adhesion layer 23 is irradiated with ultraviolet from the side of the support plate 21 (curing step). FIG. 5 is a perspective view illustrating the state in which the adhesion layer 23 is irradiated with ultraviolet 25. In the present embodiment, for example, the adhesion layer 23 is irradiated with the ultraviolet 25 by an ultraviolet irradiating apparatus 2 illustrated in FIG. 5.

The ultraviolet irradiating apparatus 2 includes a base 4 with a circular disc shape, for example. A plurality of (in the present embodiment, five) ultraviolet light sources 6 are arranged on an upper surface 4a of the base 4. The ultraviolet light sources 6 are, for example, ultraviolet light emitting diodes (LEDs), mercury lamps, metal halide lamps, or the like and can radiate the ultraviolet 25 with such a wavelength as to be transmitted through the support plate 21 and be absorbed by the curing material of the adhesion layer 23. The structure of the ultraviolet irradiating apparatus 2

(the shape of the base 4, the number and kind of the ultraviolet light sources 6, and so forth) is not limited to the above-described form.

The adhesion layer 23 is irradiated with the ultraviolet 25 in the following procedure, for example. First, the support plate 21 bonded to the plate-shaped member 11 through the adhesion layer 23 is disposed above the ultraviolet irradiating apparatus 2. Specifically, as illustrated in FIG. 5, the support plate 21 is disposed above the ultraviolet light sources 6 in such a manner that the back surface 11b of the plate-shaped member 11 is oriented upward and the back surface 21b of the support plate 21 is oriented downward. The support plate 21 may be supported from the lower side, above the ultraviolet irradiating apparatus 2, by a table or the like that allows the ultraviolet 25 radiated from the ultraviolet light sources 6 to be transmitted through the table.

When power is supplied to the ultraviolet light sources 6 in this state, the ultraviolet light sources 6 emit light, and the ultraviolet 25 is radiated from the ultraviolet light sources 6. As described above, the support plate 21 is configured to allow the ultraviolet 25 to be transmitted through the support plate 21. Thus,

the ultraviolet 25 radiated from the ultraviolet light sources 6 is transmitted through the support plate 21 and is applied to the adhesion layer 23 and is absorbed by the curing material. As a result, the curing material cures.

Conditions of the irradiation with the ultraviolet 25 can be set within a range in which the curing material of the adhesion layer 23 can properly be cured. For example, with use of the ultraviolet light sources 6 that can implement illuminance of 50 mW/cm² to 90 mW/cm², typically 70 mW/cm², the adhesion layer 23 is irradiated with the ultraviolet 25 with light quantity of 100 mJ/cm² to 150 mJ/cm², typically 125 mJ/cm². FIG. 6 is a sectional view illustrating part of an adhesion layer 27 obtained after the irradiation with the ultraviolet 25.

When the curing material cures, the adhesion strength (adhesive force) that derives from the uncured curing material is lost, and it thus becomes easy for the support plate 21 to be peeled off from the adhesion layer 27 obtained after the irradiation with the ultraviolet 25. However, even after the curing material has completely cured, a first surface 27a and a second surface 27b of the adhesion layer 27 are in close contact

with the front surface 11a of the plate-shaped member 11 and the front surface 21a of the support plate 21, respectively, and the state in which the plate-shaped member 11 is supported by the support plate 21 is kept.

Moreover, fluidity caused by the uncured curing material has been lost in the adhesion layer 27 in which the curing material has cured. Hence, the position of the plate-shaped member 11 relative to the support plate 21 is made more stable. That is, implementation of processing with high accuracy becomes easy owing to the curing of the curing material. Thus, the plate-shaped member 11 may be processed after the curing material has cured.

In particular, when a liquid resin with high fluidity is used as the adhesion layer 23, the position of the plate-shaped member 11 relative to the support plate 21 tends to become unstable, and it is hence desirable to cure the curing material before the plate-shaped member 11 is processed. In the case of curing the curing material before the plate-shaped member 11 is processed, the adhesion layer 23 may be irradiated with the ultraviolet 25 with conditions under which substantially the whole curing material cures (full curing) or the adhesion layer 23 may be irradiated with

the ultraviolet 25 with conditions under which the curing material partly cures (semi-curing).

After the curing material has cured, the adhesion layer 27 is irradiated with a laser beam from the side of the support plate 21 to cause a plurality of voids to be formed in the second surface 27b in contact with the support plate 21 in the adhesion layer 27 obtained after the curing (void forming step). FIG. 7 is a perspective view illustrating the state in which the adhesion layer 27 is irradiated with a laser beam 29. FIG. 8 is a sectional view illustrating part of the adhesion layer 27 that has been irradiated with the laser beam 29. In the present embodiment, for example, the adhesion layer 27 is irradiated with the laser beam 29 by a laser processing apparatus 12 illustrated in FIG. 7.

The laser processing apparatus 12 includes a chuck table 14 configured to be capable of holding the plate-shaped member 11. For example, the chuck table 14 includes a circular disc-shaped frame body formed of metal typified by stainless steel and a holding plate that is formed into a porous circular disc shape with a material such as ceramic and is fixed to a recessed part opened in the upper surface of the frame body.

The upper surface of the holding plate functions

as a holding surface that holds the side of the back surface 11b of the plate-shaped member 11. A suction source such as a vacuum pump is connected to the lower surface side of the holding plate through a flow path, a valve, and so forth. Hence, when the valve is opened in the state in which the suction source is operated, a suction force based on a negative pressure generated by this suction source acts on the holding surface (upper surface of the holding plate).

A rotational drive source (not illustrated) such as a motor is coupled to a lower part of the frame body of the chuck table 14, and the chuck table 14 can rotate around a rotation axis substantially perpendicular to the above-described holding surface by power of this rotation drive source. Moreover, the frame body of the chuck table 14 is supported by a movement mechanism (not illustrated) of a ball screw system, and the chuck table 14 can move, by power of this movement mechanism, in a processing feed direction substantially parallel to the above-described holding surface and an indexing feed direction that is substantially parallel to the holding surface and is substantially perpendicular to the processing feed direction.

A laser irradiation head 16 is disposed above the

chuck table 14. The laser irradiation head 16 focuses the laser beam 29 generated by a laser oscillator (not illustrated) on a predetermined position over the chuck table 14. The laser oscillator includes a laser medium such as neodymium-doped yttrium aluminum garnet (Nd:YAG), for example, and is configured to be capable of generating the pulsed laser beam 29 having such a wavelength as to be transmitted through the support plate 21 and be absorbed by the curing material of the adhesion layer 27.

The adhesion layer 27 is irradiated with the laser beam 29 in the following procedure, for example. First, the plate-shaped member 11 in the state of being supported by the support plate 21 with the interposition of the adhesion layer 27 is disposed on the holding surface of the chuck table 14. Specifically, as illustrated in FIG. 7, the plate-shaped member 11 is placed on the chuck table 14 in such a manner that the back surface 21b of the support plate 21 is oriented upward and the back surface 11b of the plate-shaped member 11 is oriented downward. A protective tape or the like may be stuck to the back surface 11b of the plate-shaped member 11.

Next, the valve is opened, and a suction force

based on a negative pressure of the suction source acts on the holding surface. As a result, the side of the back surface 11b of the plate-shaped member 11 is sucked by the holding surface, and the plate-shaped member 11 is held by the chuck table 14 in the state in which the back surface 21b of the support plate 21 is exposed upward. After the plate-shaped member 11 is held by the chuck table 14, the adhesion layer 27 is irradiated with the laser beam 29 with such a wavelength as to be transmitted through the support plate 21 and be absorbed by the curing material of the adhesion layer 27.

Specifically, the chuck table 14 moves or rotates in the state in which the pulsed laser beam 29 is repeatedly radiated from the laser irradiation head 16. That is, the adhesion layer 27 is irradiated with the laser beam 29 while the adhesion layer 27 and the irradiated region in the second surface 27b regarding the laser beam 29 with which the adhesion layer 27 is irradiated move relative to each other. Conditions of the movement, rotation, or the like of the chuck table 14 are adjusted according to the locus drawn by the irradiated regions in the second surface 27b, and so forth.

For example, the adhesion layer 27 is irradiated

with the laser beam 29 in such a manner that the irradiated regions in the second surface 27b by the pulsed laser beam 29 draw a linear locus. In this case, typically, movement of the chuck table 14 in the processing feed direction and movement thereof in the indexing feed direction are alternately repeated, and a plurality of voids 31 arranged along linear loci are formed in the second surface 27b of the adhesion layer 27.

Further, the adhesion layer 27 may be irradiated with the laser beam 29 in such a manner that the irradiated regions in the second surface 27b by the pulsed laser beam 29 draw a spiral locus. In this case, movement of the chuck table 14 in the processing feed direction and movement thereof in the indexing feed direction are simultaneously executed, and a plurality of voids 31 arranged along the spiral locus are formed in the second surface 27b of the adhesion layer 27. In this case, movement of the chuck table 14 in the processing feed direction (or movement in the indexing feed direction) and rotation may simultaneously be executed.

Conditions of the irradiation with the pulsed laser beam 29 are set within a range in which a plurality of voids 31 suitable for separation of the support plate

21 can be formed in the second surface 27b of the adhesion layer 27. Specifically, for example, the adhesion layer 27 is repeatedly irradiated with the pulsed laser beam 29 having a wavelength of 300 nm to 600 nm, typically 355 nm, output power of 1.0 W to 5.0 W, typically 3.0 W, and a pulse width of 100 ps to 300 ns, typically 100 ns.

Further, it is desirable that the repetition frequency be set to 10 kHz to 100 kHz, the speed of the relative movement of the adhesion layer 27 and the irradiated region be set to 500 mm/s to 1500 mm/s, and the diameter of the irradiated region in the second surface 27b be set to 10 μm to 30 μm in order to keep adjacent irradiated regions from overlapping with each other in the second surface 27b. Through the irradiation with the laser beam 29 with conditions under which the irradiated regions do not overlap as above, the plurality of voids 31 suitable for separation of the support plate 21 can efficiently be formed.

In FIG. 7, the state in which the adhesion layer 27 is irradiated with the laser beam 29 in such a manner that the irradiated regions in the second surface 27b draw linear loci is illustrated. In this case, for example, when the repetition frequency is set to 40 kHz,

the speed of movement in the processing feed direction (speed of relative movement of the adhesion layer 27 and the irradiated region) is set to 1000 mm/s, and the diameter of the irradiated region in the second surface 27b is set to 20 μm , the distance between the centers of the irradiated regions is 25 μm , and adjacent irradiated regions do not overlap with each other.

For example, after irradiation with the laser beam 29 is executed along the processing feed direction from one end to the other end of the adhesion layer 27, the movement in the processing feed direction ends, and movement in the indexing feed direction is started. Conditions of the movement in the indexing feed direction are also set within a range in which the plurality of voids 31 suitable for separation of the support plate 21 can be formed in the second surface 27b of the adhesion layer 27.

Specifically, for example, it is preferable that conditions of the movement in the indexing feed direction be set in such a manner that the interval between two adjacent linear loci drawn by relative movement of the adhesion layer 27 and the irradiated region in the processing feed direction becomes 100 μm to 1000 μm , typically 600 μm . The movement in the processing feed

direction and the movement in the indexing feed direction as the above-described ones are repeated until a plurality of voids 31 are formed at predetermined intervals in the whole of the adhesion layer 27, for example.

It is desirable that irradiation with this pulsed laser beam 29 be executed sequentially from an end part of the second surface 27b of the adhesion layer 27. That is, it is desirable that the plurality of voids 31 be formed sequentially from an end part of the second surface 27b of the adhesion layer 27. In this case, because the voids 31 are formed sequentially from the end part of the second surface 27b, gas generated in association with the formation of the voids 31 escapes from the end part of the second surface 27b to the external and does not remain in the vicinity of the interface between the support plate 21 and the adhesion layer 27. Thus, a high stress is not applied to the vicinity of the interface between the support plate 21 and the adhesion layer 27.

On the other hand, irradiation with the pulsed laser beam 29 may be executed sequentially from a region (central part or the like) excluding the end part of the second surface 27b of the adhesion layer 27. That is,

the plurality of voids 31 may be formed sequentially from a region (central part or the like) excluding the end part of the second surface 27b of the adhesion layer 27. In this case, gas generated in association with the formation of the voids 31 remains in the vicinity of the interface between the support plate 21 and the adhesion layer 27 and can prevent close contact between the support plate 21 and the adhesion layer 27.

The laser beam 29 with which the adhesion layer 27 is irradiated from the side of the support plate 21 in the above-described manner is sufficiently absorbed by the curing material of the adhesion layer 27 and only rarely reaches the front surface 11a of the plate-shaped member 11. Owing to this phenomenon, damage by the laser beam 29 received by the devices 15 and so forth of the plate-shaped member 11 can be made substantially zero.

That is, it is desirable that irradiation with the laser beam 29 be executed with conditions under which damage is not given to the devices 15 and so forth of the plate-shaped member 11. For example, it can be said that damage by the laser beam 29 received by the devices 15 and so forth becomes substantially zero in the case of using such conditions under which the voids 31 whose depth from the second surface 27b is equal to or smaller

than 70%, preferably equal to or smaller than 55%, of the thickness of the adhesion layer 27. Specific conditions can optionally be set within a range in which the voids 31 with the above-described depth are formed.

After the plurality of voids 31 are formed in the second surface 27b, the support plate 21 is separated from the adhesion layer 27 with this second surface 27b being the border, and the support plate 21 is removed from the adhesion layer 27 (support plate removal step). FIG. 9 is a perspective view illustrating the state in which the support plate 21 is separated from the adhesion layer 27. FIG. 10 is a sectional view illustrating part of the adhesion layer 27 from which the support plate 21 has been separated.

In the present embodiment, for example, as illustrated in FIG. 9, a tape 41 with a larger diameter than the plate-shaped member 11 is stuck to the back surface 11b of the plate-shaped member 11. Moreover, an annular frame 43 that surrounds the plate-shaped member 11 is fixed to an outer edge part of the tape 41. Further, the plate-shaped member 11 is fixed to a table (not illustrated) with the interposition of the tape 41 and the frame 43, and the side of the back surface 21b of the support plate 21 is held by a holding pad (not

illustrated) of a vacuum suction adhesion type.

Thereafter, when the holding pad moves in such a direction as to get farther away from the table, the support plate 21 held by the holding pad is separated from the adhesion layer 27 with the second surface 27b being the border. In the present embodiment, the plurality of voids 31 are formed in the second surface 27b of the adhesion layer 27 in advance, and the adhesiveness between the support plate 21 and the adhesion layer 27 has lowered. Thus, the support plate 21 is separated from the adhesion layer 27 by a small force.

In the present embodiment, the support plate 21 is separated with use of the table that fixes the plate-shaped member 11 and the holding pad of the vacuum suction adhesion type that holds the support plate 21. However, another instrument or apparatus may be used for the separation of the support plate 21. Moreover, although the tape 41 is stuck to the plate-shaped member 11 and the annular frame 43 is fixed to the outer edge part of the tape 41 in the present embodiment, the tape 41 and the frame 43 do not necessarily need to be used.

As described above, in the removal method of a support plate according to the present embodiment, after

the curing material that is contained in the adhesion layer 23 and cures when being irradiated with the ultraviolet 25 is cured, the adhesion layer 27 (adhesion layer 23 that has been cured) is irradiated with the laser beam 29 with such a wavelength as to be transmitted through the support plate 21 and be absorbed by the curing material, from the side of the support plate 21, and the plurality of voids 31 are formed in the second surface 27b in contact with the support plate 21 in the adhesion layer 27. Accordingly, the adhesiveness between the support plate 21 and the adhesion layer 27 lowers due to the plurality of voids 31, and it becomes possible to separate the support plate 21 from the adhesion layer 27 by a small force.

Moreover, in the removal method of a support plate according to the present embodiment, without a special material such as a gas generating agent being used, the adhesiveness between the support plate 21 and the adhesion layer 27 can be lowered only by irradiating the curing material that has cured with the laser beam 29 to form the plurality of voids 31. Thus, increase in the cost taken for the adhesion layer 23 (adhesion layer 27) due to the special material also does not occur. Hence, according to the removal method of a support plate in

accordance with the present embodiment, the support plate 21 can be removed by a small force without increasing the cost taken for the adhesion layer 23 (adhesion layer 27).

After the support plate 21 is removed from the adhesion layer 27, the adhesion layer 27 is removed from the plate-shaped member 11 according to need (adhesion layer removal step). FIG. 11 is a sectional view illustrating the state in which the adhesion layer 27 is separated from the plate-shaped member 11. Specifically, for example, as illustrated in FIG. 11, a tape 51 with a larger diameter than the adhesion layer 27 is stuck to the exposed second surface 27b of the adhesion layer 27. Next, an end part of the adhesion layer 27 is pulled through this tape 51, and the adhesion layer 27 is thereby separated from the plate-shaped member 11.

The tape 51 is composed of a soft material with flexibility and hence easily gets deformed unlike the support plate 21. Accordingly, by this tape 51 being pulled in such a manner as to be bent, the adhesion layer 27 is easily separated from the plate-shaped member 11 by a small force. That is, the adhesion layer 27 is easily separated from the plate-shaped member 11 although such voids as those formed in the second surface 27b for lowering the adhesiveness between the plate-shaped member

11 and the adhesion layer 27 are not formed in the first surface 27a. However, the specific method relating to the removal of the adhesion layer 27 is not limited to the above-described form.

The plate-shaped member 11 can properly be processed by using the above-described removal method of a support plate according to the present embodiment. In a processing method of a plate-shaped member that uses the above-described removal method of a support plate, for example, the plate-shaped member 11 is processed after the support plate 21 is bonded to the plate-shaped member 11 but before the plurality of voids 31 are formed in the second surface 27b of the adhesion layer 27 (processing step).

As forms of the processing, for example, processing in any forms, such as grinding processing in which a grinding wheel is used, polishing processing in which a polishing pad is used, cutting processing in which a cutting blade is used, and laser processing in which a laser beam is used, can be applied without limitation. FIG. 12 is a perspective view illustrating the state in which grinding processing of the plate-shaped member 11 to which the support plate 21 is bonded is executed. When the grinding processing of the plate-

shaped member 11 is executed, a grinding apparatus 22 illustrated in FIG. 12 is used, for example.

The grinding apparatus 22 includes a chuck table 24 configured to be capable of holding the support plate 21 that supports the plate-shaped member 11. The structure of the chuck table 24 is similar to that of the chuck table 14 included in the above-described laser processing apparatus 12. Specifically, this chuck table 24 includes a circular disc-shaped frame body formed with use of ceramic or the like and a holding plate that is formed into a porous circular disc shape with a material such as ceramic and is fixed to a recessed part opened in the upper surface of the frame body.

For example, the upper surface of the holding plate is configured into a shape equivalent to the side surface of a circular cone and functions as a holding surface that holds the side of the back surface 21b of the support plate 21. However, the difference in the height (height difference) between the center and the outer circumferential edge of the holding surface (upper surface of the holding plate) is only approximately 10 μm to 30 μm . A suction source such as a vacuum pump is connected to the lower surface side of the holding plate through a flow path, a valve, and so forth. Hence, when

the valve is opened in the state in which the suction source is operated, a suction force based on a negative pressure generated by this suction source acts on the holding surface (upper surface of the holding plate).

A rotational drive source (not illustrated) such as a motor is coupled to a lower part of the frame body of the chuck table 24, and the chuck table 24 can rotate around a rotation axis that is parallel to or slightly inclined from the vertical direction by power of this rotation drive source. Further, the frame body of the chuck table 24 is supported by a chuck table movement mechanism (not illustrated) of a ball screw system, and the chuck table 24 can move in a direction substantially parallel to the horizontal direction by power of this chuck table movement mechanism.

A grinding unit 26 is disposed above the chuck table 24. The grinding unit 26 includes a cylindrical spindle housing (not illustrated), for example. Part of a columnar spindle 28 is housed in a space inside the spindle housing. The axial center (rotation axis) of the spindle 28 is parallel to or slightly inclined from the vertical direction, for example, and intersects the holding surface of the chuck table 24.

For example, a mount 30 with a circular disc

shape is disposed at a lower end part of the spindle 28. A plurality of holes (not illustrated) that penetrate this mount 30 in the thickness direction are formed at an outer circumferential part of the mount 30, and a bolt 32 or the like is inserted in each hole. A circular disc-shaped grinding wheel 34 whose diameter is substantially equal to that of this mount 30 is fixed to the lower surface of the mount 30 by the bolts 32 or the like.

The grinding wheel 34 includes a circular disc-shaped wheel base 36 formed with use of such metal as stainless steel or aluminum. A plurality of grinding abrasive stones 38 are fixed to the lower surface of the wheel base 36 along the circumferential direction of this wheel base 36. A rotational drive source (not illustrated) such as a motor is coupled to the upper end side of the spindle 28. The grinding wheel 34 rotates around the axial center of the spindle 28 by a force generated by this rotational drive source.

A nozzle for grinding (not illustrated) configured to be capable of supplying liquid (grinding liquid) such as water to the grinding abrasive stones 38 and the plate-shaped member 11 is disposed beside the grinding wheel 34 or inside the grinding wheel 34. The spindle housing of the grinding unit 26 is supported by a

grinding unit movement mechanism (not illustrated), for example. The grinding unit 26 moves in a direction substantially parallel to the vertical direction by this grinding unit movement mechanism.

Grinding processing of the plate-shaped member 11 is executed in the following procedure, for example. First, the support plate 21 that supports the plate-shaped member 11 is disposed on the holding surface of the chuck table 24. Specifically, as illustrated in FIG. 12, the support plate 21 is placed on the chuck table 24 in such a manner that the back surface 11b of the plate-shaped member 11 is oriented upward and the back surface 21b of the support plate 21 is oriented downward.

Next, the valve is opened, and a suction force based on a negative pressure of the suction source acts on the holding surface. As a result, the back surface 21b of the support plate 21 is sucked by the holding surface, and the plate-shaped member 11 is held by the chuck table 24 with the interposition of the support plate 21 in the state in which the back surface 11b is exposed upward. After the plate-shaped member 11 is held by the chuck table 24, grinding processing of the side of the back surface 11b of the plate-shaped member 11 is executed by the grinding wheel 34.

Specifically, as illustrated in FIG. 12, in the state in which the chuck table 24 and the grinding wheel 34 rotate and the liquid is supplied from the nozzle for grinding, the grinding unit movement mechanism gradually lowers the grinding unit 26. As a result, the plate-shaped member 11 is subjected to the grinding processing from the side of the back surface 11b and becomes thin to a desired thickness.

The present invention is not limited to the description of the above-described embodiment and can be carried out with various changes. For example, in the above-described embodiment, the support plate 21 is bonded to the side of the front surface 11a of the plate-shaped member 11. However, the support plate 21 may be bonded to the side of the back surface 11b of the plate-shaped member 11 in the case where the plate-shaped member 11 needs to be processed from the side of the front surface 11a, or the like, for example.

Moreover, in the above-described embodiment, the adhesion layer 27 and the irradiated region in the second surface 27b by the laser beam 29 relatively move through movement or rotation of the chuck table 14. However, this relative movement may be implemented by another method. For example, a scanning apparatus such as a

galvano scanner may be incorporated in the laser processing apparatus 12, and this scanning apparatus may move the irradiated region in the second surface 27b by the laser beam 29 in the processing feed direction or the indexing feed direction.

When a galvano scanner is used as the scanning apparatus, the speed of the relative movement of the adhesion layer 27 and the irradiated region can be set to 1500 mm/s to 3000 mm/s. Also in this case, it is desirable that such conditions as the repetition frequency of the laser beam 29 and the diameter of the irradiated region in the second surface 27b be set to keep adjacent irradiated regions from overlapping with each other in the second surface 27b.

Besides, structures, methods, and so forth according to the above-described embodiment and modification examples can be carried out with appropriate changes without departing from the range of the object of the present invention.

The present invention is not limited to the details of the above described preferred embodiment. The scope of the invention is defined by the appended claims and all changes and modifications as fall within the equivalence of the scope of the claims are therefore to

be embraced by the invention.

WHAT IS CLAIMED IS:

1. A removal method of a support plate,
comprising:

a curing step of irradiating with ultraviolet an
adhesion layer that contains a curing material that cures
when being irradiated with ultraviolet and is in an
uncured state and bonds the support plate that allows the
ultraviolet to be transmitted through the support plate
to a plate-shaped member, from a side of the support
plate to cure the curing material of the adhesion layer;

a void forming step of forming a plurality of
voids in a surface in contact with the support plate in
the adhesion layer through irradiating the adhesion layer
with a laser beam with such a wavelength as to be
transmitted through the support plate and be absorbed by
the curing material from the side of the support plate,
after the curing step; and

a support plate removal step of separating the
support plate from the adhesion layer with the surface
being a border to remove the support plate from the
adhesion layer bonding to the plate-shaped member, after
the void forming step.

2. The removal method of a support plate
according to claim 1, wherein

irradiation with the laser beam in a pulsed form is executed in such a manner that adjacent irradiated regions do not overlap in the surface in the void forming step.

3. The removal method of a support plate according to claim 1 or claim 2, wherein

the plurality of voids are formed sequentially from an end part of the surface in the void forming step.

4. The removal method of a support plate according to any one of claim 1 to claim 3, further comprising:

an adhesion layer removal step of separating the adhesion layer from the plate-shaped member to remove the adhesion layer, after the support plate removal step.

5. A processing method of a plate-shaped member, comprising:

a curing step of irradiating with ultraviolet an adhesion layer that contains a curing material that cures when being irradiated with ultraviolet and is in an uncured state and bonds a support plate that allows the ultraviolet to be transmitted through the support plate to the plate-shaped member, from a side of the support plate to cure the curing material of the adhesion layer;

a void forming step of forming a plurality of

voids in a surface in contact with the support plate in the adhesion layer through irradiating the adhesion layer with a laser beam with such a wavelength as to be transmitted through the support plate and be absorbed by the curing material from the side of the support plate after the curing step;

a support plate removal step of separating the support plate from the adhesion layer with the surface being a border to remove the support plate from the adhesion layer bonding to the plate-shaped member, after the void forming step; and

a processing step of processing the plate-shaped member before the void forming step.

6. The processing method of a plate-shaped member according to claim 5, wherein

irradiation with the laser beam in a pulsed form is executed in such a manner that adjacent irradiated regions do not overlap in the surface in the void forming step.

7. The processing method of a plate-shaped member according to claim 5 or claim 6, wherein

the plurality of voids are formed sequentially from an end part of the surface in the void forming step.

8. The processing method of a plate-shaped

member according to any one of claim 5 to claim 7,
further comprising:

an adhesion layer removal step of separating the
adhesion layer from the plate-shaped member to remove the
adhesion layer, after the support plate removal step.