

WAFER PROCESSING METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a wafer processing method used in processing of a wafer on which a device is formed in each of plural regions on a front surface segmented by planned dividing lines.

Description of the Related Art

In a manufacturing process of device chips incorporated into pieces of electronic equipment such as mobile phones and personal computers, for example, plural planned dividing lines (streets) are set on the front surface of a wafer composed of a semiconductor such as silicon or an insulator such as sapphire. Furthermore, a device such as an integrated circuit (IC) or a light emitting diode (LED) is formed in each region on the front surface segmented by the planned dividing lines.

The wafer on the front surface of which the devices are formed in the respective regions is divided along the planned dividing lines by using a cutting apparatus, a laser processing apparatus, or the like after a back surface side is processed by a method such as grinding or polishing until the wafer is thinned to a desired

thickness, for example. Thereby, plural device chips each including the above-described device are obtained.

Incidentally, when the wafer is processed by the method such as grinding or polishing, the wafer becomes thin and strength thereof lowers. Therefore, it is not easy to convey, as a single object, the wafer processed by the method such as grinding or polishing without breakage thereof. Thus, a method in which a wafer is integrated with an annular frame by using an adhesive tape before the wafer is processed has been proposed (for example, refer to Japanese Patent Laid-open No. Hei 10-284449 and Japanese Patent Laid-open No. Hei 11-40520).

SUMMARY OF THE INVENTION

However, when the wafer integrated with the annular frame by using the adhesive tape is processed by the method such as grinding or polishing, dust generated from the wafer in the processing (processing dust) adheres to an adhesive layer of the adhesive tape exposed between the wafer and the frame. For example, when this dust drops off from the adhesive tape when the wafer is conveyed, a conveyance route, an apparatus, and so forth are contaminated.

Thus, an object of the present invention is to

provide a wafer processing method that can prevent contamination of the conveyance route, the apparatus, and so forth.

In accordance with an aspect of the present invention, there is provided a wafer processing method for grinding or polishing a back surface of a wafer on which a device is formed in each of a plurality of regions on a front surface segmented by planned dividing lines. The wafer processing method includes: a frame unit forming step of positioning the wafer in an opening of a frame, the opening having a size that allows housing of the wafer, and executing thermocompression bonding of a thermocompression bonding sheet to the front surface of the wafer and the frame to form a frame unit in which the wafer and the frame are integrated through the thermocompression bonding sheet; a holding step of holding the frame unit by a chuck table of a processing apparatus; a processing step of grinding or polishing the back surface of the wafer by a processing unit of the processing apparatus; and a cleaning step of unloading the frame unit from the chuck table and cleaning the wafer that has been processed.

Preferably, in the frame unit forming step, the thermocompression bonding of the thermocompression

bonding sheet to the wafer and the frame is executed in a state in which a planarization member that keeps flatness of the thermocompression bonding sheet is disposed between the wafer and the frame.

Furthermore, preferably, in the processing step, the back surface of the wafer is polished by a dry system with use of a polishing pad containing abrasive grains.

Moreover, the thermocompression bonding sheet is preferably a polyolefin-based sheet. The polyolefin-based sheet is preferably any of a polyethylene sheet, a polypropylene sheet, and a polystyrene sheet.

When the polyolefin-based sheet is the polyethylene sheet, preferably, thermocompression bonding of the polyethylene sheet is executed at a temperature of 120°C to 140°C in the frame unit forming step. When the polyolefin-based sheet is the polypropylene sheet, preferably, thermocompression bonding of the polypropylene sheet is executed at a temperature of 160°C to 180°C in the frame unit forming step. In addition, when the polyolefin-based sheet is the polystyrene sheet, preferably, thermocompression bonding of the polystyrene sheet is executed at a temperature of 220°C to 240°C in the frame unit forming step.

Furthermore, the thermocompression bonding sheet is

preferably a polyester-based sheet. The polyester-based sheet is preferably a polyethylene terephthalate sheet or a polyethylene naphthalate sheet.

When the polyester-based sheet is the polyethylene terephthalate sheet, preferably, thermocompression bonding of the polyethylene terephthalate sheet is executed at a temperature of 250°C to 270°C in the frame unit forming step. Moreover, when the polyester-based sheet is the polyethylene naphthalate sheet, preferably, thermocompression bonding of the polyethylene naphthalate sheet is executed at a temperature of 160°C to 180°C in the frame unit forming step.

In the wafer processing method according to the aspect of the present invention, the thermocompression bonding sheet that does not have an adhesive layer is used instead of an adhesive tape having an adhesive layer when the wafer and the frame are integrated. Therefore, differently from the case in which an adhesive tape is used, an adhesive layer is not exposed between the wafer and the frame. Accordingly, even when dust generated from the wafer in processing is deposited on the thermocompression bonding sheet between the wafer and the frame, the dust can be easily removed from the thermocompression bonding sheet by later cleaning.

Therefore, even when the wafer is conveyed after the cleaning, the situation does not occur in which dust drops off from the thermocompression bonding sheet and a conveyance route, an apparatus, and so forth are contaminated. As above, with the wafer processing method according to the aspect of the present invention, contamination of the conveyance route, the apparatus, and so forth can be prevented.

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 schematically illustrating a wafer;

FIG. 2 is a perspective view illustrating how the wafer and so forth are placed on a chuck table;

FIG. 3 is a perspective view illustrating how a thermocompression bonding sheet and so forth are placed over the chuck table;

FIG. 4 is a perspective view illustrating how the thermocompression bonding sheet is thermocompression-bonded to the wafer and a frame by using a heat gun;

FIG. 5 is a perspective view illustrating how the thermocompression bonding sheet is thermocompression-bonded to the wafer and the frame by using a heat roller;

FIG. 6A is a perspective view schematically illustrating how the thermocompression bonding sheet is cut;

FIG. 6B is a perspective view schematically illustrating a completed frame unit;

FIG. 7A is a perspective view illustrating how the frame unit is placed on a chuck table;

FIG. 7B is a perspective view illustrating a state in which the frame unit is held by the chuck table;

FIG. 8 is a perspective view illustrating how a back surface side of the wafer is processed;

FIG. 9 is a perspective view illustrating how the wafer is cleaned;

FIG. 10A is a perspective view illustrating how a modified layer is formed in the wafer;

FIG. 10B is a sectional view illustrating how the modified layer is formed in the wafer; and

FIG. 11 is a perspective view illustrating how the

frame unit is loaded onto an expanding apparatus.

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 schematically illustrating a wafer 1 to be processed by a wafer processing method according to the present embodiment. The wafer 1 is formed into a circular disc shape by using a semiconductor such as silicon (Si), silicon carbide (SiC), gallium nitride (GaN), or gallium arsenide (GaAs) or an insulator such as sapphire (Al_2O_3), soda glass, borosilicate glass, or quartz glass (SiO_2), for example.

A front surface 1a of the wafer 1 is segmented into plural regions by plural planned dividing lines (streets) 3 that intersect each other. Furthermore, a device 5 such as an IC or an LED is formed in each region segmented by the planned dividing lines 3 on the front surface 1a of the wafer 1. By dividing the wafer 1 along the planned dividing lines 3, plural device chips each including the device 5 are obtained.

In the present embodiment, first, the wafer 1 is integrated with an annular frame by a thermocompression bonding sheet to form a frame unit (frame unit forming

step). For this purpose, first, the wafer 1 and so forth are held by a chuck table. FIG. 2 is a perspective view illustrating how the wafer 1 and so forth are placed on a chuck table 2. As illustrated in FIG. 2, the chuck table 2 includes a frame body 2a that is formed of a metal such as stainless steel and has a circular column shape and a holding plate 2b that is disposed in a recessed part of an upper surface of the frame body 2a and has a circular disc shape, for example.

The holding plate 2b is formed into a porous shape by using a material such as ceramic, for example, and an upper surface of the holding plate 2b serves as a holding surface 2c that holds the wafer 1 and so forth. A lower surface side of the holding plate 2b is connected to a suction source 2e such as a vacuum pump through an evacuation path (not illustrated) formed inside the frame body 2a, a valve 2d connected to the evacuation path, and so forth. By opening the valve 2d to connect the holding plate 2b to the suction source 2e, it becomes possible to cause a negative pressure generated by the suction source 2e to act on the holding surface 2c and suck the wafer 1 and so forth by the holding surface 2c.

Specifically, first, the wafer 1 and a frame 7 are placed on the holding surface 2c of the chuck table 2.

The frame 7 is formed by using a metal such as aluminum, for example, and its diameter is smaller than that of the holding surface 2c. Furthermore, an opening 7a with a diameter larger than that of the wafer 1 is formed at a central part of the frame 7. That is, the frame 7 is formed into an annular shape. The wafer 1 and the frame 7 are disposed on the holding surface 2c of the chuck table 2 in such a manner that the wafer 1 is positioned in the opening 7a of the frame 7, so that the wafer 1 is housed in the opening 7a.

When the wafer 1 and the frame 7 are placed on the holding surface 2c of the chuck table 2, the valve 2d is set to a closed state to prevent the negative pressure generated by the suction source 2e from acting on the holding surface 2c. Furthermore, in the present embodiment, the wafer 1 is placed on the holding surface 2c in such a manner that the front surface 1a is oriented upward and a back surface 1b is oriented downward.

After the wafer 1 and the frame 7 are placed on the holding surface 2c of the chuck table 2, the thermocompression bonding sheet is placed over the holding surface 2c of the chuck table 2 and the thermocompression bonding sheet is brought into contact with the front surface 1a of the wafer 1 and an upper

surface of the frame 7. FIG. 3 is a perspective view illustrating how a thermocompression bonding sheet 9 and so forth are placed over the chuck table 2.

As illustrated in FIG. 3, the thermocompression bonding sheet 9 is formed into a film shape having an outer diameter larger than that of the holding surface 2c of the chuck table 2 with a resin having flexibility or the like and has substantially flat front surface and back surface. The thermocompression bonding sheet 9 is a polyolefin-based sheet or a polyester-based sheet typically and does not have an adhesive layer (glue layer) having an adhesive force.

The polyolefin-based sheet is a sheet formed of a polymer synthesized by using alkene as monomers and, for example, is transparent or semitransparent to visible light. As such polyolefin-based sheets, there are a polyethylene sheet, a polypropylene sheet, a polystyrene sheet, and so forth. However, there is no particular limit on the polyolefin-based sheet that can be used as the thermocompression bonding sheet 9. For example, the polyolefin-based sheet may be opaque.

The polyester-based sheet is a sheet formed of a polymer synthesized by using dicarboxylic acid (compound having two carboxyl groups) and diol (compound having two

hydroxyl groups) as monomers and is, for example, transparent or semitransparent to visible light. As such polyester-based sheets, there are a polyethylene terephthalate sheet, a polyethylene naphthalate sheet, and so forth. However, there is no particular limit on the polyester-based sheet that can be used as the thermocompression bonding sheet 9. For example, the polyester-based sheet may be opaque.

The above-described polyolefin-based sheet and polyester-based sheet do not exhibit adhesiveness at room temperature, and therefore it is impossible to stick them to the wafer 1 and the frame 7 at room temperature. On the other hand, the polyolefin-based sheet and the polyester-based sheet exhibit thermoplasticity. Therefore, for example, when the polyolefin-based sheet or the polyester-based sheet is heated to a temperature near a melting point in the state in which a pressure is applied to bring the sheet into tight contact with the wafer 1 and the frame 7, this sheet partly melts to be bonded to the wafer 1 and the frame 7 (thermocompression bonding).

Thus, by this thermocompression bonding, the wafer 1, the frame 7, and the thermocompression bonding sheet 9 can be integrated and a frame unit can be formed. In the

present embodiment, before the above-described thermocompression bonding sheet 9 is placed on the holding surface 2c of the chuck table 2, a planarization member (flatness keeping member) 11 is disposed between the wafer 1 and the frame 7. That is, the planarization member 11 is made to intervene between the chuck table 2 and the thermocompression bonding sheet 9.

The planarization member 11 is a film-shaped member typified by a release paper, a plate-shaped member whose surface is coated by a fluorine-based resin such as polytetrafluoroethylene, or the like, for example, and has substantially flat front surface and back surface. By making such a planarization member 11 intervene between the chuck table 2 and the thermocompression bonding sheet 9, transfer of recesses and protrusions of the porous holding surface 2c to the thermocompression bonding sheet 9 in the thermocompression bonding is avoided. That is, it becomes easy to keep the flatness of the thermocompression bonding sheet 9.

As a result, dust generated in processing adheres to the thermocompression bonding sheet 9 less readily. Therefore, it becomes possible to easily remove the dust from the thermocompression bonding sheet 9 by later cleaning even when the dust is deposited on the

thermocompression bonding sheet 9. Although the planarization member 11 of the present embodiment is formed into an annular shape corresponding to a gap between the wafer 1 and the frame 7 in plan view, the shape of the planarization member 11 can be changed in a desired manner within a range in which the flatness of the thermocompression bonding sheet 9 can be properly kept.

After the thermocompression bonding sheet 9 and the planarization member 11 are placed over the holding surface 2c of the chuck table 2, the thermocompression bonding sheet 9 is thermocompression-bonded to the front surface 1a of the wafer 1 and the frame 7. FIG. 4 is a perspective view illustrating how the thermocompression bonding sheet 9 is thermocompression-bonded to the wafer 1 and the frame 7 by using a heat gun 4. In FIG. 4, a structure of the wafer 1 and so forth disposed under the thermocompression bonding sheet 9 is illustrated by dashed lines.

When the thermocompression bonding of the thermocompression bonding sheet 9 is executed, first, the valve 2d is switched to an open state and a negative pressure by the suction source 2e is caused to act on the holding surface 2c. Thereupon, the thermocompression

bonding sheet 9 is pressed toward the holding surface 2c by an atmospheric pressure and is brought into tight contact with the wafer 1 and the frame 7. However, because the planarization member 11 is disposed between the wafer 1 and the frame 7, the thermocompression bonding sheet 9 is not brought into tight contact with the holding surface 2c in a region between the wafer 1 and the frame 7.

In this state, the thermocompression bonding sheet 9 is heated. As illustrated in FIG. 4, the heat gun 4 used for the heating of the thermocompression bonding sheet 9 is disposed above the chuck table 2. The heat gun 4 internally includes a heating mechanism such as an electrically-heated wire and a blowing mechanism such as a fan, and heats air and jets the air downward. When a hot wind 4a is supplied downward from the heat gun 4 to the thermocompression bonding sheet 9 and the thermocompression bonding sheet 9 is heated to a predetermined temperature in the state in which the thermocompression bonding sheet 9 is brought into tight contact with the wafer 1 and the frame 7 by the atmospheric pressure, the thermocompression bonding sheet 9 is thermocompression-bonded to the wafer 1 and the frame 7.

A different apparatus from the heat gun 4 may be used for the thermocompression bonding of the thermocompression bonding sheet 9. FIG. 5 is a perspective view illustrating how the thermocompression bonding sheet 9 is thermocompression-bonded to the wafer 1 and the frame 7 by using a heat roller 6. Also in FIG. 5, the structure of the wafer 1 and so forth disposed under the thermocompression bonding sheet 9 is illustrated by dashed lines.

Also when the thermocompression bonding of the thermocompression bonding sheet 9 is executed by using the heat roller 6, first, the valve 2d is switched to the open state and a negative pressure by the suction source 2e is caused to act on the holding surface 2c. Thereupon, the thermocompression bonding sheet 9 is pressed toward the holding surface 2c by the atmospheric pressure and is brought into tight contact with the wafer 1 and the frame 7.

In this state, the thermocompression bonding sheet 9 is heated. As illustrated in FIG. 5, the heat roller 6 that is used for the heating of the thermocompression bonding sheet 9 and has a circular column shape (circular cylindrical shape) is disposed above the chuck table 2. The heat roller 6 internally includes a heat source and

rotates around a rotation axis substantially parallel to the holding surface 2c.

For example, in the state in which the heat roller 6 is heated, the heat roller 6 is brought into tight contact with one end of the thermocompression bonding sheet 9 over the chuck table 2. Then, the chuck table 2 and the heat roller 6 are relatively moved in a direction perpendicular to the rotation axis of the heat roller 6. More specifically, the chuck table 2 and the heat roller 6 are relatively moved in such a manner that the heat roller 6 moves along a linear path that passes through one end of the wafer 1 and another end of the wafer 1 located on an opposite side to the one end across a central part of the wafer 1.

Thereby, the heat roller 6 rolls on the thermocompression bonding sheet 9 in the state of being in tight contact with the thermocompression bonding sheet 9, and the thermocompression bonding sheet 9 is thermocompression-bonded to the wafer 1 and the frame 7. When the chuck table 2 and the heat roller 6 are relatively moved while a downward pressure is applied from the heat roller 6 to the thermocompression bonding sheet 9, the thermocompression bonding sheet 9 can be thermocompression-bonded to the wafer 1 and the frame 7

by a pressure higher than the atmospheric pressure. Furthermore, a surface of the heat roller 6 may be coated by a fluorine-based resin typified by polytetrafluoroethylene, or the like.

It is also possible, needless to say, to execute the thermocompression bonding of the thermocompression bonding sheet 9 by using a different apparatus from the heat gun 4 and the heat roller 6. For example, a member like an iron having a substantially flat lower surface may be heated and be brought into tight contact with the thermocompression bonding sheet 9. Furthermore, the thermocompression bonding sheet 9 may be heated by using a light source that radiates light with such a wavelength as to be absorbed by the thermocompression bonding sheet 9. As such a light source, there is an infrared lamp typically.

It is desirable to heat the thermocompression bonding sheet 9 to a temperature equal to or lower than the melting point in the above-described thermocompression bonding. This is because, if the thermocompression bonding sheet 9 is heated to a temperature exceeding the melting point, the thermocompression bonding sheet 9 melts and it becomes impossible to keep the shape of the sheet in some cases.

Furthermore, it is desirable to heat the thermocompression bonding sheet 9 to a temperature equal to or higher than a softening point in the thermocompression bonding. This is because it is impossible to properly execute the thermocompression bonding in some cases if the temperature of the thermocompression bonding sheet 9 does not reach the softening point. That is, it is desirable that the thermocompression bonding sheet 9 be heated to a temperature that is equal to or higher than the softening point and is equal to or lower than the melting point.

Incidentally, the thermocompression bonding sheet 9 does not have a definite softening point in some cases. In such a case, it is desirable that the thermocompression bonding sheet 9 be heated to a temperature that is equal to or higher than a temperature lower than the melting point by 20°C and is equal to or lower than the melting point. Proper thermocompression bonding is implemented by heating the thermocompression bonding sheet 9 to such a temperature.

Specifically, when the thermocompression bonding sheet 9 is a polyethylene sheet, it is preferable to execute thermocompression bonding of the thermocompression bonding sheet 9 at a temperature of

120°C to 140°C. Furthermore, when the thermocompression bonding sheet 9 is a polypropylene sheet, it is preferable to execute thermocompression bonding of the thermocompression bonding sheet 9 at a temperature of 160°C to 180°C. Moreover, when the thermocompression bonding sheet 9 is a polystyrene sheet, it is preferable to execute thermocompression bonding of the thermocompression bonding sheet 9 at a temperature of 220°C to 240°C.

Furthermore, when the thermocompression bonding sheet 9 is a polyethylene terephthalate sheet, it is preferable to execute thermocompression bonding of the thermocompression bonding sheet 9 at a temperature of 250°C to 270°C. Moreover, when the thermocompression bonding sheet 9 is a polyethylene naphthalate sheet, it is preferable to execute thermocompression bonding of the thermocompression bonding sheet 9 at a temperature of 160°C to 180°C.

The temperature in the above-described thermocompression bonding is the temperature of the thermocompression bonding sheet 9 and is not the temperature set in the apparatus (heat gun 4, heat roller 6, or the like) used in the thermocompression bonding of the thermocompression bonding sheet 9. In the apparatus

used in the thermocompression bonding of the thermocompression bonding sheet 9, a temperature exceeding the melting point of the thermocompression bonding sheet 9 can be set.

When the thermocompression bonding sheet 9 has been thermocompression-bonded to the wafer 1 and the frame 7, for example, the valve 2d is switched to the closed state and the negative pressure by the suction source 2e is interrupted. Thereafter, the thermocompression bonding sheet 9 is cut along the frame 7 and a part that protrudes outward from the frame 7 in the thermocompression bonding sheet 9 is removed. FIG. 6A is a perspective view schematically illustrating how the thermocompression bonding sheet 9 is cut. The cutting of the thermocompression bonding sheet 9 may be executed in the state in which the valve 2d is opened.

For the cutting of the thermocompression bonding sheet 9, a circular annular cutter 10 illustrated in FIG. 6A is used, for example. For example, a rotation shaft having an axial center substantially parallel to the holding surface 2c of the chuck table 2 is inserted in an opening at a center of the cutter 10, and the cutter 10 is supported in a rotatable state by this rotation shaft.

When the thermocompression bonding sheet 9 is cut,

first, the cutter 10 is positioned above the frame 7. At this time, the axial center of the rotation shaft of the cutter 10 is positioned above a straight line that passes through a center of the holding surface 2c of the chuck table 2 and is parallel to the holding surface 2c, for example. Next, the cutter 10 is lowered and is pressed against the thermocompression bonding sheet 9. Then, the cutter 10 is moved along the frame 7 in this state. Thereby, a cutting trace 9a to cut the thermocompression bonding sheet 9 is formed in the thermocompression bonding sheet 9.

When the thermocompression bonding sheet 9 is cut, ultrasonic vibrations (vibrations with a frequency in an ultrasonic band) may be given to the cutter 10. Furthermore, when the thermocompression bonding sheet 9 is cut, the thermocompression bonding sheet 9 may be cooled to be cured. This makes it possible to cut the thermocompression bonding sheet 9 more easily.

By moving the cutter 10 and forming the cutting trace 9a that surrounds the opening 7a, the thermocompression bonding sheet 9 is separated into an outside part that protrudes from the frame 7 and an inside part, with the cutting trace 9a being a boundary. Thereafter, by removing the outside part of the

thermocompression bonding sheet 9, a frame unit 13 in which the wafer 1 and the frame 7 are integrated through the thermocompression bonding sheet 9 is completed.

FIG. 6B is a perspective view schematically illustrating the completed frame unit 13. When the outside part of the thermocompression bonding sheet 9 is removed, this outside part of the thermocompression bonding sheet 9 that should be removed may be heated. Furthermore, ultrasonic vibrations may be given to the outside part of the thermocompression bonding sheet 9 that should be removed. This makes it possible to remove the outside part of the thermocompression bonding sheet 9 more easily.

After the frame unit 13 is formed, the frame unit 13 is held by a chuck table of a processing apparatus used for processing of the wafer 1 such that the back surface 1b of the wafer 1 can be properly processed (holding step). FIG. 7A is a perspective view illustrating how the frame unit 13 is placed on a chuck table 12.

As illustrated in FIG. 7A, the chuck table 12 included in the processing apparatus includes a frame body 12a that is formed of a metal such as stainless steel and has a circular column shape and a holding plate

12b that is disposed at an upper part of the frame body 12a and has a circular disc shape, for example. The frame body 12a has a peripheral part 12c in which an upper surface is substantially flat and a central part 12d that protrudes upward inside the peripheral part 12c and has a circular truncated cone shape. The holding plate 12b is disposed at an upper end part of the central part 12d.

The holding plate 12b is formed into a porous shape by using a material such as ceramic, for example, and an upper surface of the holding plate 12b serves as a holding surface 12e that holds the part of the frame unit 13 corresponding to the wafer 1. Meanwhile, plural suction ports 12f are made in the upper surface of the peripheral part 12c of the frame body 12a and the part of the frame unit 13 corresponding to the frame 7 is held by the peripheral part 12c.

A lower surface side of the holding plate 12b and the plural suction ports 12f are connected to a suction source 12h such as a vacuum pump through an evacuation path (not illustrated) formed inside the frame body 12a, a valve 12g connected to the evacuation path, and so forth. By opening the valve 12g to connect the holding plate 12b and the suction ports 12f to the suction source 12h, it becomes possible to cause a negative pressure

generated by the suction source 12h to act on the holding surface 12e and the suction ports 12f and suck the frame unit 13.

A rotational drive source (not illustrated) such as a motor is joined to a lower part of the chuck table 12. The chuck table 12 rotates around a rotation axis substantially perpendicular to the above-described holding surface 12e, for example.

When the frame unit 13 is held by the chuck table 12, first, the frame unit 13 is placed on the chuck table 12 in such a manner that the wafer 1 is positioned above the holding plate 12b and the frame 7 is positioned above the peripheral part 12c. At this time, the valve 12g is set to a closed state to prevent the negative pressure generated by the suction source 12h from acting on the holding surface 12e and the suction ports 12f. Furthermore, in the present embodiment, the frame unit 13 is placed on the chuck table 12 in such a manner that the back surface 1b is oriented upward and the front surface 1a is oriented downward.

After the frame unit 13 is placed on the chuck table 12, the valve 12g is switched to an open state and the negative pressure generated by the suction source 12h is caused to act on the holding surface 12e and the

suction ports 12f. Thereby, the frame unit 13 is held by the chuck table 12 because of the negative pressure that acts on the holding surface 12e and the suction ports 12f.

FIG. 7B is a perspective view illustrating the state in which the frame unit 13 is held by the chuck table 12. As described above, the central part 12d of the chuck table 12 protrudes to an upper side relative to the peripheral part 12c. Therefore, the wafer 1 is positioned on the upper side relative to the frame 7. Thus, interference between a tool and the frame 7 when the wafer 1 is processed can be prevented.

After the frame unit 13 is held by the chuck table 12, the side of the back surface 1b of the wafer 1 is processed by a processing unit of the processing apparatus (processing step). More specifically, the back surface 1b of the wafer 1 is polished by a dry system with use of a processing unit to which a polishing pad containing abrasive grains is mounted. FIG. 8 is a perspective view illustrating how the side of the back surface 1b of the wafer 1 is processed.

As illustrated in FIG. 8, a processing unit (polishing unit) 14 is disposed above the chuck table 12. The processing unit 14 includes a spindle 16 having an

axial center substantially perpendicular to the holding surface 12e of the chuck table 12, for example. The spindle 16 is supported by a raising-lowering mechanism (not illustrated) and moves in an upward-downward direction. Furthermore, a rotational drive source (not illustrated) such as a motor is joined to an upper end side of the spindle 16.

A mounter 18 with a circular disc shape is fixed to a lower end part of the spindle 16. To a lower surface of the mounter 18, a polishing tool 20 configured into a circular disc shape with substantially the same size as the mounter 18 is mounted. The polishing tool 20 includes a circular-disc-shaped base 20a that is formed of a material such as a metal or a resin and is in contact with the mounter 18 and a circular-disc-shaped polishing pad 20b bonded to a lower surface of the base 20a. The polishing pad 20b is formed by mixing abrasive grains of diamond, silica, or the like into a resin such as polyurethane, for example. However, there is no limit on the material and so forth of the polishing pad 20b.

When the back surface 1b of the wafer 1 is polished, while the chuck table 12 and the spindle 16 are individually rotated, for example, the spindle 16 is lowered at a desired speed and a lower surface of the

polishing pad 20b is brought into contact with the back surface 1b of the wafer 1. Thereby, the polishing pad 20b is pressed against the wafer 1 with a pressure according to the speed of the lowering of the spindle 16, and the back surface 1b of the wafer 1 is polished. In the present embodiment, because the wafer 1 is polished by a dry system, slurry (polishing liquid) or the like does not need to be supplied to the back surface 1b of the wafer 1.

After completion of the processing of the wafer 1, the frame unit 13 is unloaded from the above-described chuck table 12, and the wafer 1 that has been processed is cleaned (cleaning step). Specifically, the valve 12g is switched to the closed state to prevent the negative pressure generated by the suction source 12h from acting on the holding surface 12e and the suction ports 12f. Thereafter, the frame unit 13 is unloaded from the chuck table 12.

FIG. 9 is a perspective view illustrating how the wafer 1 is cleaned. After the frame unit 13 is unloaded from the chuck table 12, as illustrated in FIG. 9, the wafer 1 is held by a spinner table 22 with a structure similar to that of the chuck table 12 in such a manner that the back surface 1b is exposed upward, for example.

Then, a fluid for cleaning is jetted downward from a nozzle 24 for cleaning disposed above the spinner table 22 toward the wafer 1.

As the fluid for cleaning, a mixture fluid (binary fluid) obtained by mixing a liquid such as water and a gas such as air can be used, for example. Needless to say, only a liquid such as water may be jetted from the nozzle 24 to clean the wafer 1. It is desirable to rotate the spinner table 22 as illustrated in FIG. 9 when the fluid is jetted from the nozzle 24. Furthermore, the fluid may be jetted while the nozzle 24 is swung in a radial direction of the wafer 1, for example.

In the wafer processing method according to the present embodiment, the thermocompression bonding sheet 9 that does not have an adhesive layer is used instead of an adhesive tape having an adhesive layer when the wafer 1 and the frame 7 are integrated. Therefore, an adhesive layer is not exposed between the wafer 1 and the frame 7 differently from the case in which an adhesive tape having an adhesive layer is used. Thus, even when dust generated when the wafer 1 is processed (processing dust) is deposited on the thermocompression bonding sheet 9 between the wafer 1 and the frame 7, the dust can be easily removed from the thermocompression bonding sheet 9

by this cleaning.

Furthermore, in the wafer processing method according to the present embodiment, when the thermocompression bonding sheet 9 is thermocompression-bonded to the wafer 1 and the frame 7, recesses and protrusions of the porous holding surface 2c of the chuck table 2 are not transferred to the thermocompression bonding sheet 9 because the planarization member 11 is made to intervene between the chuck table 2 and the thermocompression bonding sheet 9. That is, the flatness of the thermocompression bonding sheet 9 is kept, and the dust generated in the processing adheres to the thermocompression bonding sheet 9 less readily. Therefore, even when the dust is deposited on the thermocompression bonding sheet 9, the dust can be easily removed from the thermocompression bonding sheet 9 by this cleaning.

After the wafer 1 is cleaned, optional treatment can be further executed for the wafer 1 and so forth. In the present embodiment, an inside of the wafer 1 is modified along the planned dividing lines 3 to form modified layers that serve as points of origin of dividing. Thereafter, the wafer 1 is divided along the modified layers (dividing step). FIG. 10A is a

perspective view illustrating how a modified layer 3a is formed in the wafer 1. FIG. 10B is a sectional view illustrating how the modified layer 3a is formed in the wafer 1.

As illustrated in FIG. 10A and FIG. 10B, when the modified layer 3a is formed in the wafer 1, a laser processing apparatus including a chuck table (not illustrated) that holds the wafer 1 and a laser processing unit 26 disposed above the chuck table is used, for example.

The chuck table is joined to a rotational drive source (not illustrated) such as a motor and can rotate around a rotation axis substantially perpendicular to an upper surface of the chuck table. Furthermore, the chuck table is supported by a movement mechanism (not illustrated) and can move in a processing feed direction and an indexing feed direction that are substantially parallel to the upper surface of the chuck table and are substantially perpendicular to each other.

For example, the laser processing unit 26 includes a laser oscillator (not illustrated) that generates a laser beam 26a with such a wavelength as to be transmitted through the wafer 1 and a processing head 26b that emits downward the laser beam 26a generated by the

laser oscillator and focuses the laser beam 26a on a position at a desired height. By irradiating the wafer 1 with the laser beam 26a from the laser processing unit 26 in such a manner that the laser beam 26a is focused inside the wafer 1 held by the chuck table, the inside of the wafer 1 can be modified and the modified layer 3a can be formed.

When the modified layer 3a is formed in the wafer 1, the frame unit 13 is held by the chuck table in such a manner that the back surface 1b of the wafer 1 is exposed upward, for example. Next, the chuck table is rotated and one of the planned dividing lines 3 is made parallel to the processing feed direction. Furthermore, the chuck table is moved in the processing feed direction and the indexing feed direction in such a manner that the processing head 26b is positioned above an extended line of the planned dividing line 3.

Then, the processing head 26b is adjusted in such a manner that a focal point 26c of the laser beam 26a is positioned at a position that is higher than the front surface 1a of the wafer 1 and is lower than the back surface 1b of the wafer 1. In this state, while irradiation with the laser beam 26a from the laser processing unit 26 is executed, the chuck table is moved

in the processing feed direction (processing feed).
Thereby, the inside of the wafer 1 is irradiated with the laser beam 26a along the target planned dividing line 3 and the modified layer 3a can be formed inside the wafer 1. In FIG. 10A, modified layers 3a are illustrated by dashed lines.

Conditions applied when the wafer 1 is irradiated with the laser beam 26a are as follows, for example. However, the conditions relating to the irradiation with the laser beam 26a are not limited thereto and can be changed in a desired manner according to the material and so forth of the wafer 1.

Wavelength: 1064 nm

Repetition frequency: 50 kHz

Average output power: 1 W

Speed of processing feed: 200 mm/sec

After the modified layer 3a is formed inside the wafer 1 along the target planned dividing line 3, the chuck table is moved in the indexing feed direction and irradiation with the laser beam 26a is similarly executed along another one of the planned dividing lines 3. Such a procedure is repeated and, for example, after the modified layer 3a is formed along all the planned dividing lines 3 extending along the same direction, the

chuck table is rotated and the modified layer 3a is formed along the planned dividing lines 3 along another direction by the same procedure. The above-described procedure is repeated until the modified layer 3a is formed along all of the planned dividing lines 3.

In the wafer processing method according to the present embodiment, the frame unit 13 is formed by using the thermocompression bonding sheet 9 that does not have an adhesive layer, and dust generated when the wafer 1 is processed is properly removed by cleaning. Thus, even when the thermocompression bonding sheet 9 exposed between the wafer 1 and the frame 7 is irradiated with the laser beam 26a, a situation does not occur in which dust that adheres to the thermocompression bonding sheet 9 evaporates to contaminate the processing head 26b, the wafer 1, and so forth.

Furthermore, in the wafer processing method according to the present embodiment, the thermocompression bonding sheet 9 that does not have an adhesive layer is used. Therefore, differently from the case in which an adhesive tape having an adhesive layer is used, a situation does not occur in which the adhesive layer melts due to the laser beam 26a transmitted through the wafer 1 (leakage light) and the adhesive layer

adheres to the side of the front surface 1a of the wafer 1. Thus, the quality of device chips obtained by dividing the wafer 1 can be kept favorable.

After the modified layers 3a are formed in the wafer 1, for example, the thermocompression bonding sheet 9 is expanded in the radial direction by an expanding apparatus and the wafer 1 is divided. FIG. 11 is a perspective view illustrating how the frame unit 13 is loaded onto an expanding apparatus 28. The expanding apparatus 28 includes a circular cylindrical drum 30 and a frame holding unit 32 disposed to surround the drum 30.

The frame holding unit 32 includes a support table 34 having a circular opening of a diameter larger than an outer diameter of the drum 30. The part of the frame unit 13 corresponding to the frame 7 is placed on an upper surface of the support table 34. Furthermore, plural clamps 36 for fixing the frame 7 are disposed at an outer circumferential part of the support table 34.

The support table 34 is supported by raising-lowering mechanisms 38 for raising and lowering the frame holding unit 32. The raising-lowering mechanisms 38 are each an air cylinder including a cylinder case 42 fixed to a base 40 on the lower side and a piston rod 44 whose lower side is partly inserted in the cylinder case 42,

for example. The support table 34 is fixed to upper end parts of the piston rods 44 and the raising-lowering mechanisms 38 raise and lower the frame holding unit 32 by moving up and down the piston rods 44.

The drum 30 is disposed in the opening of the support table 34. A lower part of the drum 30 is fixed to the base 40. An inner diameter of the drum 30 is larger than the diameter of the wafer 1 and the outer diameter of the drum 30 is smaller than an inner diameter of the frame 7 and the diameter of the opening of the support table 34. In a region inside the drum 30, a push-up mechanism 46 that can push up the thermocompression bonding sheet 9 of the frame unit 13 held by the frame holding unit 32 from the lower side is disposed.

When the thermocompression bonding sheet 9 is expanded, first, as illustrated in FIG. 11, a height of the upper surface of the support table 34 is adjusted to a height of an upper end of the drum 30, and the part of the frame unit 13 corresponding to the frame 7 is placed on the upper surface of the support table 34. Thereafter, the frame 7 is fixed by the clamps 36. Thereby, the upper end of the drum 30 gets contact with a lower surface of the thermocompression bonding sheet 9 between the wafer 1 and the frame 7.

Next, the frame holding unit 32 is lowered by the raising-lowering mechanisms 38, and the upper surface of the support table 34 is moved to the lower side relative to the upper end of the drum 30. As a result, the drum 30 rises relative to the support table 34, and the thermocompression bonding sheet 9 is pushed up by the drum 30 to be radially expanded. When the thermocompression bonding sheet 9 is expanded, an outward force in the radial direction acts on the wafer 1. Accordingly, the wafer 1 is divided into plural device chips, with the modified layers 3a being the points of origin.

After the wafer 1 is divided, the formed plural device chips may each be picked up. For example, the push-up mechanism 46 is positioned below a device chip as a target of the pick-up. Then, while the device chip is pushed up by the push-up mechanism 46, this device chip is picked up by a collet (not illustrated) or the like disposed on the upper side.

As described above, in the wafer processing method according to the present embodiment, the thermocompression bonding sheet 9 that does not have an adhesive layer is used instead of an adhesive tape having an adhesive layer when the wafer 1 and the frame 7 are

integrated. Therefore, differently from the case in which an adhesive tape is used, an adhesive layer is not exposed between the wafer 1 and the frame 7.

Accordingly, even when dust generated from the wafer 1 in processing is deposited on the thermocompression bonding sheet 9 between the wafer 1 and the frame 7, the dust can be easily removed from the thermocompression bonding sheet 9 by later cleaning. Therefore, even when the wafer 1 is conveyed after the cleaning, a situation does not occur in which a conveyance route of the wafer 1, an apparatus used in a next treatment, and so forth are contaminated by dust that drops off from the thermocompression bonding sheet 9. As above, with the wafer processing method according to the present embodiment, contamination of the conveyance route, the apparatus, and so forth can be prevented.

The present invention is not limited to the description of the above-described embodiment and can be carried out with various changes. For example, the back surface 1b of the wafer 1 is polished by a dry system in the above-described embodiment. However, the back surface 1b of the wafer 1 may be ground or may be polished by a wet system. Also in these cases, dust deposited on the

thermocompression bonding sheet 9 can be easily removed by cleaning.

Furthermore, in the above-described embodiment, the wafer 1 is polished by a dry system before the modified layers 3a are formed inside the wafer 1. However, it is also possible to grind or polish the wafer 1 after the modified layers 3a are formed inside the wafer 1.

Moreover, instead of the modified layers 3a that serve as the points of origin in dividing of the wafer 1, grooves or the like along the planned dividing lines 3 may be formed by using a cutting blade obtained by dispersing abrasive grains in a binder.

Besides, structures, methods, and so forth according to the above-described embodiment and modification examples can be modified to be carried out 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 wafer processing method for grinding or polishing a back surface of a wafer on which a device is formed in each of a plurality of regions on a front surface segmented by planned dividing lines, the wafer processing method comprising:

a frame unit forming step of positioning the wafer in an opening of a frame, the opening having a size that allows housing of the wafer, and executing thermocompression bonding of a thermocompression bonding sheet to the front surface of the wafer and the frame to form a frame unit in which the wafer and the frame are integrated through the thermocompression bonding sheet;

a holding step of holding the frame unit by a chuck table of a processing apparatus;

a processing step of grinding or polishing the back surface of the wafer by a processing unit of the processing apparatus; and

a cleaning step of unloading the frame unit from the chuck table and cleaning the wafer that has been processed.

2. The wafer processing method according to claim 1, wherein

in the frame unit forming step, the

thermocompression bonding of the thermocompression bonding sheet to the wafer and the frame is executed in a state in which a planarization member that keeps flatness of the thermocompression bonding sheet is disposed between the wafer and the frame.

3. The wafer processing method according to claim 1 or claim 2, wherein

in the processing step, the back surface of the wafer is polished by a dry system with use of a polishing pad containing abrasive grains.

4. The wafer processing method according to any of claim 1 to claim 3, wherein

the thermocompression bonding sheet is a polyolefin-based sheet.

5. The wafer processing method according to claim 4, wherein

the polyolefin-based sheet is any of a polyethylene sheet, a polypropylene sheet, and a polystyrene sheet.

6. The wafer processing method according to claim 5, wherein

thermocompression bonding of the polyethylene sheet is executed at a temperature of 120°C to 140°C in the frame unit forming step when the polyolefin-based sheet is the polyethylene sheet, thermocompression bonding of

the polypropylene sheet is executed at a temperature of 160°C to 180°C in the frame unit forming step when the polyolefin-based sheet is the polypropylene sheet, and thermocompression bonding of the polystyrene sheet is executed at a temperature of 220°C to 240°C in the frame unit forming step when the polyolefin-based sheet is the polystyrene sheet.

7. The wafer processing method according to any of claim 1 to claim 3, wherein

the thermocompression bonding sheet is a polyester-based sheet.

8. The wafer processing method according to claim 7, wherein

the polyester-based sheet is a polyethylene terephthalate sheet or a polyethylene naphthalate sheet.

9. The wafer processing method according to claim 8, wherein

thermocompression bonding of the polyethylene terephthalate sheet is executed at a temperature of 250°C to 270°C in the frame unit forming step when the polyester-based sheet is the polyethylene terephthalate sheet, and thermocompression bonding of the polyethylene naphthalate sheet is executed at a temperature of 160°C to 180°C in the frame unit forming step when the

polyester-based sheet is the polyethylene naphthalate sheet.