

WORKPIECE GRINDING METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a workpiece grinding method for grinding a workpiece such as a wafer by use of a grindstone.

Description of the Related Art

In the manufacturing process of semiconductor devices such as integrated circuits (ICs) and large-scale integration (LSI) circuits to be used for electronic equipment, a back surface of a wafer is ground, and the wafer is thus thinned to a predetermined thickness, for the purpose of size reduction and weight reduction of the semiconductor devices. Particularly, in recent years, attendant on the spread of system in package (SiP) and the like, a grinding technology with which a wafer can be thinned in good yield has been demanded.

However, there is a problem that, when a wafer is ground until the thickness thereof is reduced, for example, to 50 μm or below, the die strength of the wafer is lowered, the wafer becomes liable to be damaged, and it becomes difficult to handle the wafer thereafter.

In view of this problem, for example, Japanese

Patent Laid-open No. 2007-019461 proposes a grinding method in which a wafer is ground at only at a back side of a region where devices are formed, to form a circular recess in a central part, while leaving as a reinforcement part an annular projecting part which has the same thickness as that before grinding on an outer circumference side of the circular recess, whereby the rigidity of the wafer obtained after grinding is enhanced.

In the just-mentioned grinding method, after the wafer is ground by a rough grinding wheel including a grindstone having a coarse particle diameter and having a high grinding force, the wafer is ground by a finish grinding wheel including a grindstone having a fine particle diameter and a low grinding force. In this case, the surface of the wafer ground by the rough grinding wheel is subjected to finish grinding by the finish grinding wheel, whereby a dressing effect is obtained on the finish grinding wheel.

SUMMARY OF THE INVENTION

However, when a bottom surface of the circular recess of the wafer is finished to be flat by the rough grinding wheel, a high dressing effect cannot be obtained at the time of grinding by the finish grinding wheel

later, and, particularly at the time of finish grinding of a highly doped wafer or a hard material wafer, there would arise a problem that the grinding load becomes excessively high, and a spindle motor as a rotational drive source for the finish grinding wheel is put into an overloaded state with the result of generation of heat.

Accordingly, it is an object of the present invention to provide a workpiece grinding method by which a workpiece can be stably ground under a low load.

In accordance with an aspect of the present invention, there is provided a workpiece grinding method for grinding a back surface of a workpiece formed on a front surface thereof with a device region and a peripheral surplus region surrounding the device region, to form a circular recess and an annular projecting part surrounding the circular recess. The grinding method includes a holding step of holding the workpiece on a holding surface of a chuck table, a first grinding step of grinding a part of the back surface corresponding to the device region of the workpiece held by the chuck table, by use of a first grinding wheel to form a first circular recess and an annular projecting part in the back surface of the workpiece, and a second grinding step of grinding at least a bottom surface of the first

circular recess by use of a second grinding wheel including grindstones having a particle diameter smaller than that of the first grinding wheel, after the first grinding step. In the first grinding step, the bottom surface of the first circular recess is ground into a shape of being concentric and differing in thickness in a radial direction from a center to a circumference of the first circular recess. In the second grinding step, the bottom surface of the first circular recess is ground to have a uniform thickness.

According to the present invention, in the first grinding step, the bottom surface of the first circular recess is ground by the first grinding wheel including a grindstone having a large particle diameter to be formed into a non-flat ground surface, and hence, a high dressing effect can be obtained on the second grinding wheel including a grindstone having a small particle diameter at the time when the bottom surface of the circular recess is ground by the second grinding wheel. As a result, the grinding load on the second grinding wheel is suppressed to a low level, and the workpiece can be stably ground with a low load by the second grinding wheel.

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, partially cutaway view depicting a grinding apparatus for carrying out the method of the present invention;

FIG. 2 is a cutaway side view of a major part of the grinding apparatus for carrying out the method of the present invention;

FIG. 3A is a cutaway side view of a chuck table and a first grinding wheel for depicting a first grinding step in the method of the present invention;

FIG. 3B is a perspective view of the chuck table and the first grinding wheel;

FIGS. 4A and 4B are longitudinal sectional views of a wafer ground in the first grinding step of the method of the present invention;

FIGS. 5A to 5C are cutaway side views for depicting a first grinding step according to another mode of the

method of the present invention, in the order of steps;

FIG. 6 is a longitudinal sectional view of the wafer ground in the first grinding step according to the other mode of the method of the present invention;

FIG. 7A is a cutaway side view of the chuck table and a second grinding wheel for depicting a second grinding step in the method of the present invention;

FIG. 7B is a perspective view of the chuck table and the second grinding wheel;

FIG. 8 is an enlarged detailed view of part A of FIG. 7A;

FIG. 9 is a longitudinal sectional view of the wafer ground in the second grinding step of the method of the present invention;

FIG. 10A is a partial side view of the second grinding wheel and the wafer for depicting a first other mode of the second grinding step of the present invention;

FIG. 10B is a partial longitudinal sectional view of the wafer ground in the first other mode of the second grinding step;

FIG. 11A is a partial side view of the second grinding wheel and the wafer for depicting a second other mode of the second grinding step of the present

invention; and

FIG. 11B is a partial longitudinal sectional view of the wafer ground in the second other mode of the second grinding step.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the present invention will be described below with reference to the attached drawings. First, a configuration of a grinding apparatus for carrying out a grinding method according to the present invention will be described with reference to FIGS. 1 and 2. Note that, in the following description, directions indicated by arrows in FIG. 1 are an X-axis direction (front-rear direction), a Y-axis direction (left-right direction), and a Z-axis direction (vertical direction).

A grinding apparatus 1 depicted in FIG. 1 grinds a disk-shaped wafer W, which is a workpiece, and includes the following constituent elements. The grinding apparatus 1 includes, as main constituent elements thereof, a chuck table 10 that is rotated around a rotational axis CL1 orthogonal to a circular holding surface 10a, an upper surface, of the chuck table 10 while holding the wafer W on the holding surface 10a, a grinding unit 20 that grinds the wafer W held under

suction on the holding surface 10a of the chuck table 10, a thickness measuring instrument 30 that measures the thickness of the wafer W during grinding, a vertical movement mechanism 40 that moves the grinding unit 20 up and down in the Z-axis direction (vertical direction), an inclination adjustment mechanism 50 that adjusts the inclination of the chuck table 10, and a horizontal movement mechanism 60 that moves the chuck table 10 in a horizontal direction (Y-axis direction).

Here, the wafer W includes a single crystal silicon base material, and its front surface directed downward in the state depicted in FIG. 1 is formed with a plurality of unillustrated devices, the devices being protected by a protective tape stuck to the front surface of the wafer W. The wafer W has its front surface (in FIG. 1, its lower surface) held under suction on the holding surface 10a of the chuck table 10, and has its back surface (in FIG. 1, its upper surface) ground by grindstones 25b of the grinding unit 20 while being supplied with grinding water.

Next, configurations of the chuck table 10, the grinding unit 20, the thickness measuring instrument 30, the vertical movement mechanism 40, the inclination adjustment mechanism 50, and the horizontal movement

mechanism 60 which are the main constituent elements of the grinding apparatus 1 will be described individually.

The chuck table 10 is a disk-shaped member, and a disk-shaped porous member 10A formed of a porous ceramic or the like is assembled into a central part of the chuck table 10. The porous member 10A has its upper surface constituting the holding surface 10a for holding thereon the disk-shaped wafer W under suction. Note that the porous member 10A is selectively connected to an unillustrated suction source such as a vacuum pump.

Here, the chuck table 10 is driven to rotate around the rotational axis CL1 by an unillustrated rotation mechanism. In other words, as depicted in FIG. 2, the chuck table 10 includes a shaft 11 integrally extending toward a vertically lower side from the center thereof, and the shaft 11 is rotatably supported by a disk-shaped flange 12.

Incidentally, as depicted in FIG. 1, the grinding apparatus 1 according to the present embodiment includes a rectangular box-shaped base 2 elongate in the Y-axis direction (front-rear direction), and the chuck table 10 fronts on a rectangular opening 3 which opens in the base 2 and which is elongate in the Y-axis direction. In addition, that part of the opening 3 which opens in an

upper surface of the base 2 in the periphery of the chuck table 10 is covered by a rectangular plate-shaped cover 4, and those parts of the opening 3 which are on the front and rear sides (-Y direction and +Y direction) of the cover 4 are covered respectively by bellows-like extendable and contractible covers 5 and 6 that move together with the cover 4 to extend or contract. Hence, whatever position on the Y-axis the chuck table 10 is located at, the opening 3 is normally closed with the cover 4 and the extendable and contractible covers 5 and 6, so that no foreign matter enters the base 2 via the opening 3.

The grinding unit 20 includes a spindle motor 22 accommodated in a holder 21, a spindle 23 driven to rotate around a vertical rotational axis CL2 by the spindle motor 22, a disk-shaped mount 24 attached to a lower end of the spindle 23, and a first grinding wheel 25 (second grinding wheel 25') detachably mounted to a lower surface of the mount 24. Here, the first grinding wheel 25 and the second grinding wheel 25' (see FIG. 7) include disk-shaped bases 25a and 25a', and pluralities of grindstones 25b and 25b' attached to respective lower surfaces of the bases 25a and 25a' in an annular pattern. Note that the particle diameter of the grindstones 25b'

of the second grinding wheel 25' is set smaller than the particle diameter of the grindstones 25b of the first grinding wheel 25. Here, lower surfaces of the grindstones 25b and 25b' constitute grinding surfaces that make contact with the wafer W.

The thickness measuring instrument 30 is a height gauge that measures the thickness of the wafer W held by the chuck table 10 during grinding, and includes a first probe 31 that makes contact with the upper surface of the wafer W and a second probe 32 that makes contact with the upper surface of the chuck table 10. By subtracting the upper surface height of the chuck table 10 measured by the second probe 32 from the upper surface height of the wafer W measured by the first probe 31, the thickness of the wafer W during grinding can be measured on a real-time basis.

The vertical movement mechanism 40 is a mechanism for moving up and down the grinding unit 20 along the vertical direction (Z-axis direction), and, as depicted in FIGS. 1 and 2, is disposed on a -Y axis direction end face (front surface) of a rectangular box-shaped column 41 standing vertically on a +Y axis direction end part (rear end part) of the upper surface of the base 2. The vertical movement mechanism 40 moves up and down a

rectangular plate-shaped movable plate 42 attached to a back surface of the holder 21 provided in the grinding unit 20, along a pair of left and right guide rails 43 in the Z-axis direction together with the holder 21 and the spindle 23 held by the holder 21 as well as the first grinding wheel 25 (second grinding wheel 25'). Here, the pair of left and right guide rails 43 are disposed on the front surface of the column 41 vertically and in parallel to each other.

In addition, a rotatable ball screw 44 stands vertically along the Z-axis direction (vertical direction) between the left and right guide rails 43, and an upper end of the ball screw 44 is coupled to a servo motor 45 that is a drive source and is capable of forward rotation and reverse rotation. Here, the servo motor 45 is attached in a vertically disposed state through a rectangular plate-shaped bracket 46 attached to an upper surface of the column 41. In addition, a lower end of the ball screw 44 is rotatably supported on the column 41 by a bearing 47 (see FIG. 2), and a nut member 48 (see FIG. 2) mounted in a manner horizontally projecting from a back surface of the movable plate 42 toward the rear side (+Y axis direction) is in screw engagement with the ball screw 44.

Hence, when the servo motor 45 is driven to put the ball screw 44 into forward or reverse rotation, the movable plate 42 to which the nut member 48 in screw engagement with the ball screw 44 is attached moves up or down along the Z axis together with the grinding unit 20.

The inclination adjustment mechanism 50 is a mechanism for adjusting the inclination of the chuck table 10, and, as depicted in FIG. 2, includes two actuators 51 (in FIG. 2, only one of them is depicted) and one pivot 52 which are disposed between the chuck table 10 and the flange 12 disposed on a lower side of the chuck table 10. Note that the two actuators 51 and the one pivot 52 are disposed at equal angular pitches (120° pitches) in a circumferential direction.

Here, by moving a rod 51a up or down, each actuator 51 inclines the chuck table 10 with the pivot 52 as a center, to adjust the inclination of the holding surface 10a relative to a horizontal plane. In other words, as depicted in FIG. 3A, each actuator 51 adjusts the chuck table 10 in such a manner that the rotational axis CL1 thereof is inclined by an illustrated angle α relative to the rotational axis CL2 of the spindle 23 and the grindstones 25b.

The horizontal movement mechanism 60 is a mechanism

for moving the chuck table 10 in the horizontal direction (Y-axis direction), and, as depicted in FIG. 2, includes a rectangular block-shaped slider 61 attached to a lower surface of the flange 12 accommodated inside the base 2, a rotatable ball screw 62 inserted in screw engagement with the slider 61 and extending in the Y-axis direction (front-rear direction), and a servo motor 63 as a drive source coupled to an axial directional one end (the right end in FIG. 2) of the ball screw 62. Note that the ball screw 62 is rotatably supported on the base 2 by a pair of front and rear bearings 64 and 65.

Hence, when the servo motor 63 is driven to put the ball screw 62 into forward or reverse rotation, the slider 61 in screw engagement with the ball screw 62 slides in the Y-axis direction (front-rear direction) along the ball screw 62, and, therefore, the chuck table 10 also moves along the Y-axis direction together with the slider 61. As a result, the wafer W held under suction on the holding surface 10a of the chuck table 10 also moves along the Y-axis direction.

Next, the method for grinding the wafer W which is carried out using the grinding apparatus 1 configured as above will be described.

The grinding method according to the present

invention is a method for grinding the wafer W through (1) a holding step, (2) a first grinding step, and (3) a second grinding step which will be described below, and each of the steps will be described individually below.

In the holding step, the wafer W is held under suction on the holding surface 10a of the chuck table 10 as depicted in FIGS. 3A and 3B. In other words, when the wafer W is placed on the holding surface 10a of the chuck table 10, the porous member 10A of the chuck table 10 is connected to the unillustrated suction source. Then, the porous member 10A is evacuated by the suction source, and a negative pressure is generated at the porous member 10A, so that the wafer W is pulled by the negative pressure and is held under suction on the holding surface 10a of the chuck table 10. Note that a peripheral edge of the wafer W is chamfered in a projecting arcuate shape having a curved surface.

In the first grinding step, the wafer W held under suction on the holding surface 10a of the chuck table 10 in the holding step is ground by the first grinding wheel 25 of the grinding unit 20. In other words, the horizontal movement mechanism 60 is driven to move the chuck table 10 in the +Y axis direction (rearward), and the wafer W held under suction on the holding surface 10a

of the chuck table 10 is positioned under the first grinding wheel 25 of the grinding unit 20. In this instance, the positions of the grindstones 25b of the first grinding wheel 25 and the wafer W are set at such positions that a central circular part (a part corresponding to a device region of the front surface) of the wafer W on an inner side by a predetermined width b from the peripheral edge of the upper surface (to-be-ground surface) of the wafer W, namely, on an inner side of a circle C depicted by a long and two short dashes line in FIG. 3B, is to be ground by the grindstones 25b. Note that an annular region on an outer side of the circle C depicted in FIG. 3B of the wafer W is a region corresponding to a peripheral surplus region surrounding the device region from the periphery.

In addition, as depicted in FIG. 3A, by the inclination adjustment mechanism 50 depicted in FIG. 2, the rotational axis CL1 of the chuck table 10 is inclined by an angle α relative to the rotational axis CL2 of the spindle 23 (the grindstones 25b) such that the holding surface 10a of the chuck table 10 is inclined by the same angle α relative to the horizontal plane. In other words, the grinding surfaces (bottom surfaces) of the grindstones 25b and the upper surface of the wafer W are

set non-parallel.

Then, from the above-mentioned state, the chuck table 10 is driven to rotate in a direction indicated by arrows in FIGS. 3A and 3B (counterclockwise direction) at a predetermined speed by the unillustrated rotation mechanism with the rotational axis CL1 as a center, and the spindle motor 22 of the grinding unit 20 depicted in FIG. 1 is started to drive the first grinding wheel 25 to rotate in the same direction as the chuck table 10 (counterclockwise direction) at a predetermined speed with the vertical rotational axis CL2 as a center.

From the state in which the chuck table 10 and the first grinding wheel 25 (grindstones 25b) are being rotated at the respective predetermined speeds in the same direction (counterclockwise direction), the grinding unit 20 is moved vertically downward (in the -Z axis direction) by the vertical movement mechanism 40 depicted in FIGS. 1 and 2 to such a position that the grinding surfaces (lower surfaces) of the grindstones 25b make contact with the upper surface of the wafer W held under suction on the holding surface 10a of the chuck table 10. As a result, that central part of the upper surface of the wafer W which corresponds to the device region is subjected to rough grinding by the grindstones 25b, and,

as depicted in FIGS. 4A and 4B, a first circular recess W11 is formed in the central part (the part corresponding to the device region of the lower surface) of the upper surface of the wafer W, and an unground annular projecting part W2 having an original thickness and a width b is formed as a reinforcement part in a radially outer side of the central part (in the part corresponding to the peripheral surplus region of the lower surface).

Here, in the present embodiment, as above-mentioned, the rotational axis CL1 of the chuck table 10 is inclined by the angle α relative to the rotational axis CL2 of the spindle 23 (grindstones 25b) by the inclination adjustment mechanism 50 depicted in FIG. 2 such that the holding surface 10a of the chuck table 10 is inclined by the angle α relative to the horizontal plane, so that the grinding surfaces (bottom surfaces) of the grindstones 25b and the upper surface (to-be-ground surface) of the wafer W are set non-parallel. Hence, as depicted in FIG. 4A or 4B, a bottom surface of the first circular recess W11 is formed into a shape of being concentric and differing in thickness in the radial direction from the center to the circumference of the first circular recess W11. Note that, in the first grinding step, the bottom surface of the first circular recess W11 of the wafer W

undergoes rough grinding by a thickness including such a thickness that a grinding damage P (see FIG. 8) generated in the first grinding step can be removed by the grinding in the next second grinding step.

Here, in the first grinding step, as another method for forming the bottom surface of the first circular recess W11 into the shape of being concentric and differing in thickness in the radial direction from the center to the circumference of the first circular recess W11, a method depicted in FIGS. 5A to 5C may be adopted.

In particular, as depicted in FIG. 5A, in a state in which the rotational axis CL1 of the chuck table 10 and the rotational axis CL2 of the grindstones 25b are kept parallel to each other, the first grinding wheel 25 is moved vertically downward by a predetermined amount by the vertical movement mechanism 40 depicted in FIGS. 1 and 2, whereby, as depicted in FIG. 5B, a vertical inner circumferential wall W21 is formed at a peripheral part of the wafer W by the rotating grindstones 25b, and the annular projecting part W2 is thus formed at the peripheral part of the wafer W (wall surface forming step).

Next, as depicted in FIG. 5C, while moving the chuck table 10 and the wafer W held thereon horizontally

in a direction indicated by an arrow in FIG. 5C (rightward) by the horizontal movement mechanism 60 depicted in FIG. 2, in such a manner that the rotational axis CL1 of the chuck table 10 is brought closer to the rotational axis CL2 of the first grinding wheel 25 (the grindstones 25b), the first grinding wheel 25 (the grindstones 25b) is moved up and down by the vertical movement mechanism 40. As a result, as depicted in FIG. 6, the first circular recess W11 in the shape of being concentric and differing in thickness in the radial direction from the center to the circumference is formed in the central part of the wafer W (bottom surface forming step).

In the second grinding step, the bottom surface of the first circular recess W11 formed in the central part of the wafer W in the first grinding step is subjected to finish grinding to have a uniform thickness t (see FIG. 9) by use of the grindstones 25b' of the second grinding wheel 25', whereby a second circular recess W12 is formed. In other words, in the second grinding step, as depicted in FIG. 7, in a state in which the rotational axis CL1 of the chuck table 10 and the rotational axis CL2 of the second grinding wheel 25' are kept parallel to each other and vertical, the chuck table 10 and the second grinding

wheel 25' are driven to rotate at respective predetermined rotational speeds in a direction indicated by arrows depicted (counterclockwise direction), whereby the second grinding wheel 25' is lowered by a predetermined amount from the state depicted in FIG. 7A by the vertical movement mechanism 40.

As a result, the bottom surface of the first circular recess W11 formed in the wafer W in the first grinding step undergoes finish grinding by the grindstones 25b', whereby the second circular recess W12 having a smooth and flat bottom surface is formed in the central part of the wafer W as depicted in FIG. 9. Note that, as above-mentioned, in the first grinding step, the bottom surface of the first circular recess W11 of the wafer W undergoes rough grinding by a thickness including such a thickness that the grinding damage P (see FIG. 8) generated in the first grinding step can be removed by the grinding in the second grinding step, and the grinding damage P generated in the first grinding step is removed in the second grinding step. Accordingly, the grinding damage P would not be left in the second circular recess W12.

Incidentally, the second grinding step may alternatively be performed in the following manner. In

particular, as depicted in FIG. 10A, the vertical outer circumferential wall (the inner circumferential wall of the annular projecting part W2) W21 of the first circular recess W11 formed in the first grinding step is ground vertically at a broken-line position on the radially outer side than the outer circumferential wall W21, whereby an outer circumferential wall (the inner circumferential wall of the annular projecting part W2) W22 of the second circular recess W12 is formed on the radially outer side than the outer circumferential wall W21 of the first circular recess W11 formed in the first grinding step, so that the area of the second circular recess W12 is enlarged as depicted in FIG. 10B.

Further alternatively, conversely to the above description, the second grinding step may be performed in the following manner. In particular, as depicted in FIG. 11A, vertical grinding by the grindstones 25b' is conducted at a broken-line position on a radially inner side than the vertical outer circumferential wall (the inner circumferential wall of the annular projecting part W2) W21 of the first circular recess W11 formed in the first grinding step, whereby an outer circumferential wall (the inner circumferential wall of the annular projecting part W2) W23 of the second circular recess W12

is formed on the radially inner side than the outer circumferential wall W21 of the first circular recess W11 formed in the first grinding step, so that the area of the second circular recess W12 is reduced as depicted in FIG. 11B.

As has been described above, in the grinding method according to the present invention, the bottom surface of the first circular recess W11 of the wafer W is ground by the first grinding wheel 25 having a larger particle diameter in the first grinding step to be a non-flat ground surface, specifically, a ground surface having a shape of being concentric and differing in thickness in the radial direction from the center to the circumference of the first circular recess W11, and, hence, in the subsequent second grinding step, a high dressing effect can be obtained on the second grinding wheel 25' having a smaller particle diameter when the bottom surface of the first circular recess W11 is ground by the second grinding wheel 25'. As a result, there is obtained an effect that the grinding load on the second grinding wheel 25' can be suppressed to a low level, and that the wafer W can be stably ground by the second grinding wheel 25' with a low load to form the second circular recess W12.

Note that, while the method for grinding the disk-shaped wafer has been described above, the present invention is similarly applicable also to a grinding method for any workpiece other than the wafer.

Other than the above-mentioned points, the present invention is not limited in application to the above-described embodiment, and, naturally, various modifications are possible within the scope of the technical thought described in the claims, the specification, and the drawings.

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 in the invention.

WHAT IS CLAIMED IS:

1. A workpiece grinding method for grinding a back surface of a workpiece formed on a front surface thereof with a device region and a peripheral surplus region surrounding the device region, to form a circular recess and an annular projecting part surrounding the circular recess, the workpiece grinding method comprising:

a holding step of holding the workpiece on a holding surface of a chuck table;

a first grinding step of grinding a part of the back surface corresponding to the device region of the workpiece held by the chuck table, by use of a first grinding wheel to form a first circular recess and an annular projecting part in the back surface of the workpiece; and

a second grinding step of grinding at least a bottom surface of the first circular recess by use of a second grinding wheel including grindstones having a particle diameter smaller than that of the first grinding wheel, after the first grinding step,

wherein, in the first grinding step, the bottom surface of the first circular recess is ground into a shape of being concentrical and differing in thickness in a radial direction from a center to a circumference of

the first circular recess, and,

in the second grinding step, the bottom surface of the first circular recess is ground to have a uniform thickness.

2. The workpiece grinding method according to claim 1, wherein, in the first grinding step, the bottom surface of the first circular recess is ground into a shape of being concentric and differing in thickness in a state in which a grinding surface of the first grinding wheel and the holding surface are positioned in a non-parallel state.

3. The workpiece grinding method according to claim 1,

wherein the first grinding step includes

a wall surface forming step of bringing the grinding surface of the first grinding wheel and the holding surface closer to each other in a state in which the grinding surface of the first grinding wheel and the holding surface are positioned in a parallel state, to form a wall surface of the annular projecting part, and

a bottom surface forming step of bringing the grinding surface of the first grinding wheel and the holding surface closer to each other and bringing a rotational axis of the first grinding wheel and a

rotational axis of the chuck table closer to each other, to grind the bottom surface of the first circular recess into a shape of being concentric and differing in thickness in the radial direction, after the wall surface forming step.

4. The workpiece grinding method according to claim 1, wherein, in the second grinding step, the bottom surface of the first circular recess is ground by a grinding amount of not less than such a grinding amount that a grinding damage generated in the first grinding step is removable, after the bottom surface of the first circular recess is ground into the shape of being concentric and differing in thickness in the radial direction in the first grinding step.

5. The workpiece grinding method according to claim 4, wherein, in the first grinding step, the bottom surface of the first circular recess is formed into a shape of differing in thickness by an amount corresponding to such a grinding amount that the grinding damage generated in the first grinding step is removable by grinding in the second grinding step.