

PROCESSING METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a processing method for a workpiece.

Description of the Related Art

Known as a cutting apparatus for cutting a workpiece such as a semiconductor wafer is a cutting apparatus performing kerf check during a cutting operation to detect a size of chipping produced in the wafer (see Japanese Patent Laid-Open No. 2001-129822, for example).

SUMMARY OF THE INVENTION

However, in the cutting apparatus described in Japanese Patent Laid-Open No. 2001-129822, the following problem may arise. When so-called oblique cutting occurs during the cutting operation, the side surface of each chip obtained by dividing the wafer is inclined. If the angle of inclination of the side surface of each chip becomes larger than a predetermined value, each chip may become defective. Accordingly, it is necessary to change a cutting blade in the case of the occurrence of such

oblique cutting.

Conventionally, the occurrence of such oblique cutting is detected in the following manner. When the cutting operation for the wafer is ended, any one of the chips is extracted from the wafer by an operator. Thereafter, the size of this chip extracted is measured by using a microscope to thereby check whether or not the side surface of the chip is inclined. In a case that the side surface of the chip is inclined, the cutting blade is changed. However, this method has the following problem. Although oblique cutting has occurred, the occurrence of the oblique cutting may not be recognized for a certain period of time and the cutting operation for the wafer may be continued, so that a large amount of defective chips may be manufactured. There is another problem such that the operator must extract any one of the chips and measure the size of the chip extracted, that is, such a manual operation is troublesome.

It is therefore an object of the present invention to provide a processing method which can easily determine a timing for determining whether or not the cutting blade is to be changed, thereby preventing the problem that defective chips may continue to be manufactured.

In accordance with an aspect of the present

invention, there is provided a processing method for a workpiece including a cutting step of cutting the workpiece by using a cutting blade, a cut groove forming step of cutting a test piece from one side to the other side thereof by using the cutting blade to thereby form a cut groove, an imaging step of imaging a side surface of the test piece at the one side or the other side after performing the cut groove forming step, thereby forming an image including the cut groove, and a determining step of determining whether or not the cutting blade is to be changed, according to inclination of a side wall of the cut groove detected from the image formed in the imaging step.

The present invention has an effect that the timing for determining whether or not the cutting blade is to be changed can be determined easily, so that it is possible to prevent the problem that defective chips may continue to be manufactured.

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 claim with reference to the attached drawings showing a preferred

embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view depicting a configuration of a processing apparatus for performing a processing method according to a preferred embodiment of the present invention;

FIG. 2 is a perspective view of a table unit included in the processing apparatus depicted in FIG. 1;

FIG. 3 is a view depicting an example of a normal image stored in a normal image storing portion of a control unit included in the processing apparatus depicted in FIG. 1;

FIG. 4 is a flowchart depicting a flow of the processing method according to this preferred embodiment;

FIG. 5 is a schematic sectional view depicting a cutting step of the processing method depicted in FIG. 4;

FIG. 6 is a schematic sectional view depicting a cut groove forming step of the processing method depicted in FIG. 4;

FIG. 7 is a plan view of a test piece processed by the cut groove forming step depicted in FIG. 6;

FIG. 8 is a schematic sectional view depicting an imaging step of the processing method depicted in FIG. 4;

FIG. 9 is a view depicting an example of an image obtained by performing the imaging step depicted in FIG. 8;

FIG. 10 is a view depicting an example of a determining step of the processing method depicted in FIG. 4; and

FIG. 11 is a schematic sectional view depicting an imaging step of a processing method according to a modification of this preferred embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the present invention will now be described in detail with reference to the drawings. The present invention is not limited to this preferred embodiment described below. Further, the components used in this preferred embodiment may include those that can be easily assumed by persons skilled in the art or substantially the same elements as those known in the art. Further, the configurations described below may be suitably combined. Further, the configurations may be variously omitted, replaced, or changed without departing from the scope of the present invention.

(Processing apparatus)

The processing method according to this preferred

embodiment is a method to be performed by a processing apparatus (cutting apparatus) 1 for cutting a workpiece 200 depicted in FIG. 1. As depicted in FIG. 1, the workpiece 200 is a disk-shaped wafer such as a semiconductor wafer and an optical device wafer. The workpiece 200 has a substrate 204 formed of silicon, sapphire, or gallium arsenide, for example. The substrate 204 has a front side 201 and a back side 205 opposite to the front side 201. A plurality of crossing division lines 202 are formed on the front side 201 of the substrate 204 to thereby define a plurality of separate regions where a plurality of devices 203 are individually formed. In this preferred embodiment, the crossing division lines 202 are composed of a plurality of first parallel division lines 202 and a plurality of second parallel division lines 202 perpendicular to the first parallel division lines 202.

As a modification, the workpiece 200 may be a so-called TAIKO (registered trademark) wafer having a central thin-walled portion and a peripheral thick-walled portion. Further, the workpiece 200 may be a rectangular substrate such as a package substrate, ceramic substrate, ferrite substrate, and substrate including at least one of nickel or iron. For example, the package substrate has

a plurality of devices sealed with resin. As depicted in FIG. 1, a circular adhesive tape 210 is attached to the back side 205 of the substrate 204 of the workpiece 200. The circular adhesive tape 210 has a diameter larger than that of the workpiece 200, and a central portion of the adhesive tape 210 is attached to the back side 205 of the substrate 204 of the workpiece 200. Further, an annular ring frame 211 is attached to a peripheral portion of the circular adhesive tape 210. Thus, the workpiece 200 is supported through the adhesive tape 210 to the ring frame 211.

The processing apparatus 1 depicted in FIG. 1 is a cutting apparatus including a chuck table 10 for holding the workpiece 200 and a cutting blade 21 for cutting (processing) the workpiece 200 held on the chuck table 10 along the division lines 202 to thereby divide the workpiece 200 into individual chips 206. Accordingly, each chip 206 includes a part of the substrate 204 and the device 203. As depicted in FIG. 1, the processing apparatus 1 includes a table unit 2 including the chuck table 10, a pair of cutting units 20 each including the cutting blade 21, an imaging unit 30, and a control unit 100 as control means. The chuck table 10 has a holding surface 11 for holding the workpiece 200 under suction.

Each cutting blade 21 functions to cut the workpiece 200 held on the holding surface 11 of the chuck table 10. The imaging unit 30 functions to image the workpiece 200 held on the holding surface 11 of the chuck table 10. The control unit 100 functions to control the table unit 2, each cutting unit 20, and the imaging unit 30.

As depicted in FIG. 1, the processing apparatus 1 further essentially includes an X moving unit 31, a pair of Y moving units 32, a pair of Z moving units 33, and a rotating unit 34. The X moving unit 31 functions to move the table unit 2 (i.e., the chuck table 10) in the X direction depicted by an arrow X as a work feeding direction parallel to a horizontal direction. The pair of Y moving units 32 function to move the pair of respective cutting units 20 in the Y direction depicted by an arrow Y as an indexing direction parallel to another horizontal direction and perpendicular to the X direction. The pair of Z moving units 33 function to move the pair of respective cutting units 20 in the Z direction depicted by an arrow Z as a cutter feeding direction parallel to a vertical direction and perpendicular to both the X direction and the Y direction. The rotating unit 34 functions to rotate the chuck table 10 about its axis parallel to the Z direction. Thus, the processing

apparatus 1 depicted in FIG. 1 is a two-spindle type dicing saw, or so-called facing dual type cutting apparatus including the two cutting units 20.

The chuck table 10 is a disk-shaped member, and the holding surface 11 for holding the workpiece 200 is formed of porous ceramic, for example. Also, the chuck table 10 is movable in the X direction by the X moving unit 31 so as to be moved between a processing area defined below the cutting units 20 and a standby area where the workpiece 200 is to be loaded to the chuck table 10 or unloaded from the chuck table 10. This standby area is spaced from the processing area in the X direction. The chuck table 10 is rotatable about its axis parallel to the Z direction by the rotating unit 34. The holding surface 11 of the chuck table 10 is connected to a vacuum source (not depicted) for producing a vacuum. Accordingly, when the vacuum source is operated, the vacuum produced from the vacuum source is applied to the holding surface 11, thereby holding the workpiece 200 on the holding surface 11 under suction. In this preferred embodiment, the back side 205 of the workpiece 200 is held through the adhesive tape 210 on the holding surface 11 of the chuck table 10 under suction.

The table unit 2 further includes a table cover 3

provided so as to surround the chuck table 10. The table cover 3 is movable together with the chuck table 10 in the X direction by the X moving unit 31. Further, the rotating unit 34 is also movable together with the chuck table 10 in the X direction by the X moving unit 31. The chuck table 10 is rotatably supported by the rotating unit 34. The table cover 3 has a flat upper surface as a horizontal surface.

Each cutting unit 20 is cutting means including the cutting blade 21 for cutting the workpiece 200 held on the chuck table 10. The cutting blade 21 of each cutting unit 20 is detachably mounted. Each cutting unit 20 is movable in the Y direction by the corresponding Y moving unit 32 with respect to the workpiece 200 held on the chuck table 10 and also movable in the Z direction by the corresponding Z moving unit 33 with respect to the workpiece 200 held on the chuck table 10.

As depicted in FIG. 1, the processing apparatus 1 has a box-shaped base housing 4, and the two cutting units 20 are supported to a double column type support frame 5 composed of two columns 5a and 5b provided on the upper surface of the base housing 4 and a horizontal bar 5c connecting the upper ends of the two columns 5a and 5b. One of the two cutting units 20 is supported through one

of the two Y moving units 32 and one of the two Z moving units 33 to the column 5a, and the other cutting unit 20 is supported through the other Y moving unit 32 and the other Z moving unit 33 to the column 5b.

The cutting blade 21 of each cutting unit 20 can be moved to a desired position above the holding surface 11 of the chuck table 10 by operating the corresponding Y moving unit 32 and the corresponding Z moving unit 33.

Each cutting unit 20 includes a spindle housing 22 movable in the Y direction by the corresponding Y moving unit 32 and also movable in the Z direction by the corresponding Z moving unit 33, a spindle 23 rotatably supported in the spindle housing 22 so as to be rotatable about its axis parallel to the Y direction, and the cutting blade 21 detachably mounted on the spindle 23.

The cutting blade 21 is an annular cutting wheel formed from abrasive and having a very small thickness. In this preferred embodiment, the cutting blade 21 is a so-called hub blade, which includes an annular base (hub) formed of conductive metal and an annular cutting edge fixed to an outer circumferential portion of the annular base. The cutting edge is composed of abrasive grains such as diamond abrasive grains and cubic boron nitride (CBN) abrasive grains and a bond (binder) formed of metal

or resin, for example. The cutting edge has a predetermined thickness. The spindle 23 is adapted to be rotated by a spindle motor (not depicted), and the cutting blade 21 is mounted on a front end portion of the spindle 23. The spindle 23 and the cutting blade 21 of each cutting unit 20 have a common axis parallel to the Y direction.

The imaging unit 30 is fixed to one of the two cutting units 20 so as to be movable with this cutting unit 20. The imaging unit 30 includes an imaging element for imaging a target area of the workpiece 200 to be divided in a condition where the workpiece 200 is held on the chuck table 10. For example, the imaging element is a charge coupled device (CCD) imaging element or a complementary MOS (CMOS) imaging element. The imaging unit 30 functions to image the workpiece 200 held on the chuck table 10 and thereby obtain an image for use in performing alignment between the workpiece 200 and the cutting blade 21. This image obtained by the imaging unit 30 is output to the control unit 100.

The X moving unit 31 functions to move the chuck table 10 of the table unit 2 in the X direction as a work feeding direction, thereby relatively moving the chuck table 10 and each cutting unit 20 in the X direction.

Each Y moving unit 32 functions to move the corresponding cutting unit 20 in the Y direction as an indexing direction, thereby relatively moving the chuck table 10 and the corresponding cutting unit 20 in the Y direction. Each Z moving unit 33 functions to move the corresponding cutting unit 20 in the Z direction as a cutter feeding direction, thereby relatively moving the chuck table 10 and the corresponding cutting unit 20 in the Z direction.

As known in the art, the X moving unit 31 includes an X ball screw rotatable about its axis extending in the X direction, an X motor for rotating the X ball screw about its axis, and a pair of X guide rails for supporting the chuck table 10 so as to allow the movement thereof in the X direction. Similarly, each Y moving unit 32 includes a Y ball screw rotatable about its axis extending in the Y direction, a Y motor for rotating the Y ball screw about its axis, and a pair of Y guide rails for supporting the corresponding cutting unit 20 so as to allow the movement thereof in the Y direction. Similarly, each Z moving unit 33 includes a Z ball screw rotatable about its axis extending in the Z direction, a Z motor for rotating the Z ball screw about its axis, and a pair of Z guide rails for supporting the corresponding cutting unit 20 so as to allow the movement thereof in the Z

direction.

Although not depicted, the processing apparatus 1 further includes an X position detecting unit (not depicted) for detecting the X position of the chuck table 10 in the X direction, a Y position detecting unit (not depicted) for detecting the Y position of each cutting unit 20 in the Y direction, and a Z position detecting unit (not depicted) for detecting the Z position of each cutting unit 20 in the Z direction. The X position detecting unit may be composed of a linear scale extending in the X direction and a read head for reading the marks of the linear scale. Similarly, the Y position detecting unit may be composed of a linear scale extending in the Y direction and a read head for reading the marks of the linear scale. The Z position detecting unit may detect the Z position of each cutting unit 20 according to the pulses output from the Z motor included in each Z moving unit 33. The X position of the chuck table 10 is output from the X position detecting unit to the control unit 100. The Y position of each cutting unit 20 is output from the Y position detecting unit to the control unit 100. The Z position of each cutting unit 20 is output from the Z position detecting unit to the control unit 100. The X position, the Y position, and the

Z position of each component of the processing apparatus 1 are defined according to predetermined respective reference positions (not depicted).

The processing apparatus 1 further includes a cassette elevator 40 for mounting a cassette (not depicted) and moving it in the Z direction, a cleaning unit 50 for cleaning the workpiece 200 after cutting, and a transfer unit (not depicted) for taking the workpiece 200 out of the cassette before cutting and storing the workpiece 200 into the cassette after cutting. The transfer unit also functions to transfer the workpiece 200 among the cassette, the chuck table 10, and the cleaning unit 50. The cassette is so configured as to store a plurality of workpieces 200 before cutting and after cutting.

The processing apparatus 1 further includes a test piece chuck table 60. The test piece chuck table 60 is provided on the table cover 3 of the table unit 2. As depicted in FIG. 2, the test piece chuck table 60 is a rectangular plate-shaped member formed of metal. The test piece chuck table 60 has a flat upper surface 61. In this preferred embodiment, the rectangular test piece chuck table 60 is elongated in the Y direction. The upper surface 61 of the test piece chuck table 60 functions as

a mounting surface for mounting a test piece 70 depicted in FIG. 2. The test piece 70 is formed of the same material as that of the substrate 204 of the workpiece 200. The test piece 70 is also a rectangular plate-shaped member such that the shape of the test piece 70 is the same as that of the upper surface 61 as viewed in plan and the size of the test piece 70 is slightly smaller than that of the upper surface 61 as viewed in plan.

A lattice-shaped suction groove 62 is formed in the upper surface 61 of the test piece chuck table 60. The suction groove 62 is connected to a vacuum source (not depicted) for producing a vacuum. The suction groove 62 opens to the upper surface 61. Accordingly, when the vacuum source is operated, the vacuum produced from the vacuum source is applied to the suction groove 62, so that the test piece 70 mounted on the upper surface 61 of the test piece chuck table 60 is held under suction. A rotational drive mechanism 63 for rotating the test piece chuck table 60 is mounted on the table cover 3. The test piece chuck table 60 is supported to the rotational drive mechanism 63 so as to be rotatable about the axis of the rotational drive mechanism 63, which extends in the Y direction. In this preferred embodiment, the rotational drive mechanism 63 functions to rotate the test piece

chuck table 60 by 90 degrees between a horizontal position depicted by a solid line in FIG. 2 where the upper surface 61 of the test piece chuck table 60 is oriented upward and a vertical position depicted by a broken line in FIG. 2 where the upper surface 61 is oriented toward the standby area.

The control unit 100 functions to control each component of the processing apparatus 1 and perform a cutting operation to the workpiece 200 in the processing apparatus 1. The control unit 100 is configured by a computer including a computing unit having a microprocessor such as a central processing unit (CPU), a storing unit having a memory such as a read only memory (ROM) and a random access memory (RAM), and an input/output interface unit. The computing unit functions to perform computing according to a computer program stored in the storing unit and output a control signal through the input/output interface unit to each component of the processing apparatus 1, thereby controlling the processing apparatus 1.

Although not depicted, the control unit 100 is also connected to a display unit such as a liquid crystal display for displaying an operational condition, an image, and the like, an input unit to be used by an operator in

recording information on cutting operation, and a notifying unit 101 (see FIG. 1). Examples of the input unit include a touch panel provided in the display unit and an external input device such as a keyboard. At least one of the touch panel or the external input device may be used. The notifying unit 101 functions to issue at least one of sound or light, thereby notifying the operator.

As depicted in FIG. 1, the control unit 100 includes a normal image storing portion 102 and a determining portion 103. The normal image storing portion 102 previously stores a normal image 300 depicted in FIG. 3. The normal image 300 is obtained by using a normal cutting blade 21 to cut the test piece 70 from one side 71 to the other side 72 in the X direction and thereby form a cut groove 80 in the test piece 70 and next operating the imaging unit 30 to image the cut groove 80 from one side surface 711 at the one side 71 of the test piece 70. In FIG. 2, reference numeral 712 denotes the other side surface at the other side 72 of the test piece 70, and reference numeral 73 denotes the front side of the test piece 70. That is, the cut groove 80 is formed on the front side 73 of the test piece 70 so as to extend from the one side 71 to the other side 72 in the X

direction. As depicted in FIG. 3, the cut groove 80 has a pair of opposed inner surfaces 81 as side walls. The inner surfaces 81 of the cut groove 80 in the normal image 300 are perpendicular to the front side 73 (upper surface as viewed in FIG. 3) of the test piece 70. The normal image storing portion 102 further previously stores a predetermined distance 301 from the front side 73 of the test piece 70 (i.e., the upper end of the cut groove 80) toward the bottom of the cut groove 80. The predetermined distance 301 is a distance defining a determination position 302 where it is determined whether or not the cutting blade 21 is to be changed, in actually cutting the test piece 70 by using the cutting blade 21 of each cutting unit 20 in the processing apparatus 1. The function of the normal image storing portion 102 is realized by the storing unit in the control unit 100.

The determining portion 103 functions to determine whether or not the cutting blade 21 is to be changed, according to an actual cut groove 80 (which will be hereinafter denoted by reference numeral 80-1 as depicted in FIG. 9) formed by actually using the cutting blade 21 to cut the test piece 70. More specifically, the determining portion 103 functions to determine whether or not the cutting blade 21 is to be changed, according to

inclination of inner surfaces 81-1 of the cut groove 80-1 in an image 400 depicted in FIG. 9. This image 400 is obtained by using the cutting blade 21 to actually cut the test piece 70 from the one side 71 to the other side 72 in the X direction and thereby form the cut groove 80-1 on the front side 73 of the test piece 70 and next operating the imaging unit 30 to image the cut groove 80-1 from the side surface 711 at the one side 71 of the test piece 70. That is, the inner surfaces 81-1 of the cut groove 80-1 are inclined with respect to the front side 73 of the test piece 70 as depicted in FIG. 9. The function of the determining portion 103 is realized by the computing unit, i.e., by the execution of the computer program stored in the storing unit.

(Processing method)

The processing method according to this preferred embodiment is a cutting operation of cutting the workpiece 200 by using the processing apparatus 1. In performing the processing method, the operator previously records information on cutting operation into the control unit 100. Thereafter, the cassette storing a plurality of workpieces 200 to be cut is mounted on the upper surface of the cassette elevator 40. Further, the test piece 70 is mounted on the upper surface 61 of the test piece

chuck table 60 in a condition where the upper surface 61 is oriented upward. Thereafter, the operator inputs the instruction to start the cutting operation of the processing apparatus 1. When the cutting operation is started, the vacuum source connected to the test piece chuck table 60 is operated to hold the test piece 70 on the upper surface 61 of the test piece chuck table 60 under suction.

As depicted in FIG. 4, the processing method for the workpiece 200 according to this preferred embodiment includes a cutting step ST1, cut groove forming step ST4, imaging step ST5, and determining step ST6.

(Cutting step)

FIG. 5 is a schematic sectional view depicting the cutting step ST1 of the processing method depicted in FIG. 4. The cutting step ST1 is a step of cutting the workpiece 200 by using the cutting blade 21. In the cutting step ST1, the transfer unit in the processing apparatus 1 is operated to transfer the workpiece 200 from the cassette to the chuck table 10 set in the standby area. Thereafter, the vacuum source connected to the chuck table 10 is operated to hold the workpiece 200 on the holding surface 11 of the chuck table 10 under suction in a condition where the adhesive tape 210

attached to the back side 205 of the workpiece 200 is in contact with the holding surface 11.

Thereafter, the X moving unit in the processing apparatus 1 is operated to move the chuck table 10 toward the processing area. During the movement of the chuck table 10 in the X direction, the imaging unit 30 is operated to image the workpiece 200 and perform alignment according to an image obtained. Thereafter, the cutting blade 21 is rotated and lowered to cut each division line 202 as relatively moving the workpiece 200 and the cutting unit 20, thereby dividing the workpiece 200 into the individual chips 206 as depicted in FIG. 5. Thereafter, the chuck table 10 is moved from the processing area to the standby area, and the transfer unit is operated to transfer the workpiece 200 (the individual chips 206) from the chuck table 10 to the cleaning unit 50, thereby cleaning the workpiece 200 in the cleaning unit 50. Thereafter, the transfer unit is operated to transfer the workpiece 200 (after cutting and cleaning) from the cleaning unit 50 to the cassette and then store the workpiece 200 (the individual chips 206 supported to the adhesive tape 210) into the cassette.

Thereafter, the control unit 100 of the processing apparatus 1 determines whether or not the operation of

the processing apparatus 1 is to be ended (step ST2). More specifically, when the cutting operation for all of the workpieces 200 stored in the cassette is finished, the control unit 100 of the processing apparatus 1 determines that the operation of the processing apparatus 1 is to be ended, whereas when at least one of the workpieces 200 to be cut is left in the cassette, the control unit 100 determines that the operation of the processing apparatus 1 is to be continued.

When the control unit 100 of the processing apparatus 1 determines that the operation of the processing apparatus 1 is to be ended (step ST2: Yes), the operation of the processing apparatus 1, i.e., the processing method is ended. In contrast, when the control unit 100 of the processing apparatus 1 determines that the operation of the processing apparatus 1 is to be continued (step ST2: No), the control unit 100 determines whether or not the present timing is a timing for determining whether or not the cutting blade 21 is to be changed (step ST3).

The timing for determining whether or not the cutting blade 21 is to be changed, i.e., whether or not the replacement of the cutting blade 21 is required is previously set according to the material of the workpiece

200 to be cut and the material of the cutting edge of the cutting blade 21, for example. Whether or not the cutting blade 21 is to be changed may be determined every time the cutting operation for each workpiece 200 is ended or every time the cutting operation for a predetermined number of workpieces 200 is ended, for example. This determination timing is stored as a part of the information on cutting operation into the storing unit of the control unit 100. Further, in the present invention, whether or not the cutting blade 21 is to be changed may be determined every time the cutting operation for a predetermined number of division lines 202 in each workpiece 200 is ended, i.e., during the cutting operation for the workpiece 200 held on the chuck table 10. In this case, whether or not the cutting blade 21 is to be changed may be determined every time the cutting operation for all the first parallel division lines 202 or all the second parallel division lines 202 is ended, in which the first parallel division lines 202 and the second parallel division lines 202 are perpendicular to each other.

When the control unit 100 of the processing apparatus 1 determines that the present timing is not the timing for determining whether or not the cutting blade

21 is to be changed (step ST3: No), the program returns to the cutting step ST1, whereas when the control unit 100 of the processing apparatus 1 determines that the present timing is the timing for determining whether or not the cutting blade 21 is to be changed (step ST3: Yes), the program proceeds to the cut groove forming step ST4. (Cut groove forming step)

FIG. 6 is a schematic sectional view depicting the cut groove forming step ST4 of the processing method depicted in FIG. 4. FIG. 7 is a plan view of the test piece 70 processed by performing the cut groove forming step ST4 of the processing method depicted in FIG. 4. The cut groove forming step ST4 is a step of cutting the test piece 70 from one side 71 to the other side 72 in the X direction by using the cutting blade 21, thereby forming a cut groove 80-1.

In the preferred embodiment, in the cut groove forming step ST4, the control unit 100 of the processing apparatus 1 causes the imaging unit 30 to image the test piece 70 held on the test piece chuck table 60 under suction and then make an alignment between the test piece 70 and the cutting edge of the cutting blade 21 according to an image obtained. Thereafter, as depicted in FIG. 5, the test piece 70 and the cutting unit 20 are relatively

moved in the X direction. At the same time, as depicted in FIG. 6, the cutting blade 21 is rotated and lowered to cut the test piece 70 from one side 71 to the other side 72 in the X direction, thereby forming the cut groove 80-1 in the workpiece 200 as depicted in FIG. 7. Thereafter, the program proceeds to the imaging step ST5. While the cut groove 80-1 is formed in the test piece 70 so as to extend from the one side 71 to the other side 72 in the X direction in this preferred embodiment, the cut groove 80-1 may be formed so as to extend from the one side 71 to any mid point not reaching the other side 72 in the X direction. That is, when the cutting blade 21 is relatively moved to the mid point in the test piece 70, the cutting blade 21 may be raised from the test piece 70. (Imaging step)

FIG. 8 is a schematic sectional view depicting the imaging unit ST5 of the processing method depicted in FIG. 4. FIG. 9 is a view depicting an example of an image 400 obtained in the imaging step ST5 of the processing method depicted in FIG. 4. The imaging step ST5 is a step of imaging the side surface 711 of the test piece 70 at the one side 71 or the side surface 712 of the test piece 70 at the other side 72, thereby forming the image 400 including the cut groove 80-1.

In the preferred embodiment, in the imaging step ST5, the processing apparatus 1 causes the rotational drive mechanism 63 to rotate the test piece chuck table 60 by 90 degrees about the axis extending in the Y direction, so that the upper surface 61 of the test piece chuck table 60 is oriented toward the standby area. In this preferred embodiment, as depicted in FIG. 8, the side surface 711 of the test piece 70 at the one side 71 is imaged by the imaging unit 30 in the imaging step ST5, so that the image 400 depicted in FIG. 9 is obtained. Thereafter, the program proceeds to the determining step ST6.

(Determining step)

FIG. 10 is a view depicting an example of the determining step ST6 of the processing method depicted in FIG. 4. The determining step ST6 is a step of determining whether or not the cutting blade 21 is to be changed, according to the inclination of the inner surfaces 81-1 of the cut groove 80-1 as detected from the image 400.

In the preferred embodiment, in the determining step ST6, the cut groove 80 (depicted by a broken line in FIG. 10) in the normal image 300 is superimposed on the cut groove 80-1 in the actual image 400. More specifically, the upper end of the cut groove 80 in the

normal image 300 is superimposed on the upper end of the cut groove 80-1 in the actual image 400. The control unit 100 detects a distance 401 between the inner surface 81-1 of the cut groove 80-1 in the actual image 400 and the inner surface 81 of the cut groove 80 in the normal image 300 on the same side (i.e., on the left side or on the right side as viewed in FIG. 10) at the predetermined determination position 302. As the result of this detection, the control unit 100 determines whether or not this distance 401 detected is equal to or less than a predetermined allowable value. When the control unit 100 determines that this distance 401 is equal to or less than the predetermined allowable value and therefore determines that the replacement of the cutting blade 21 is not required (step ST6: No), the program returns to the cutting step ST1. Thus, in the determining step ST6, the control unit 100 determines whether or not the cutting blade 21 is to be changed, according to the inclination of the inner surfaces 81-1 of the cut groove 80-1 as detected from the actual image 400.

In the determining step ST6, when the control unit 100 determines that the distance 401 detected in the actual image 400 is larger than the predetermined allowable value and therefore determines that the

replacement of the cutting blade 21 is required (step ST6: Yes). Thereafter, the program proceeds to step ST7 to operate the notifying unit 101. Thereafter, the operation of the processing apparatus 1, that is, the processing method according to this preferred embodiment is ended. The method for determining whether or not the cutting blade 21 is to be changed in the determining step ST6 is not limited to the above method. For example, the outline of the cut groove 80 in the normal image 300 may be compared with the outline of the cut groove 80-1 in the actual image 400. Further, the inner surfaces 81-1 of the cut groove 80-1 in the actual image 400 may be compared with an imaginary line forming the inner surfaces of an ideal cut groove.

As described above, in the processing method and the processing apparatus 1 according to this preferred embodiment, the test piece 70 is cut to form the cut groove 80-1, and the side surface 711 of the test piece 70 is next imaged to obtain the image 400. Thereafter, it is determined whether or not the cutting blade 21 is to be changed, according to the inclination of the inner surfaces 81-1 of the cut groove 80-1 as detected from the actual image 400. Accordingly, as compared with the related art, the timing for determining whether or not

the cutting blade 21 is to be changed can be determined easily in the processing method and the processing apparatus 1 according to this preferred embodiment, so that it is possible to prevent the problem that defective chips 206 may continue to be manufactured.

(Modification)

A processing method according to a modification of the above preferred embodiment will now be described with reference to FIG. 11. FIG. 11 is a schematic sectional view depicting an imaging step of the processing method according to this modification. In FIG. 11, the same parts as those in the above preferred embodiment are denoted by the same reference numerals, and the description thereof will be omitted.

Referring to FIG. 11, there is depicted a processing apparatus 1-1 for performing the processing method according to this modification. The processing apparatus 1-1 includes a second imaging unit 90 for obtaining the actual image 400 in addition to the imaging unit 30. The second imaging unit 90 is located aside the test piece chuck table 60 in the X direction. In the imaging step ST5 of the processing method according to this modification, the test piece 70 is held on the upper surface 61 of the test piece chuck table 60 under suction

in a condition where the upper surface 61 is oriented upward, and the side surface 721 of the test piece 70 at the other side 72 is imaged by the second imaging unit 90 to thereby obtain the actual image 400.

As similar to the imaging unit 30, the second imaging unit 90 includes an imaging element for imaging the side surface 721 of the test piece 70 at the other side 72. This imaging element may be a CCD imaging element or a CMOS imaging element, for example.

In the processing method and the processing apparatus 1-1 according to this modification, the test piece 70 is cut to form a cut groove 80-1 in the cut groove forming step ST4, and the side surface 721 of the test piece 70 is imaged by the second imaging unit 90 in the imaging step ST5. Thereafter, as similarly to the above preferred embodiment, in the determining step ST6, it is determined whether or not the cutting blade 21 is to be changed, according to the inclination of the inner surfaces 81-1 of the cut groove 80-1 as detected from the actual image 400 obtained in the imaging step ST5. Accordingly, as similar to the above preferred embodiment, this modification has an effect that the timing for determining whether or not the cutting blade 21 is to be changed can be determined easily, so that it is possible

to prevent the problem that defective chips 206 may continue to be manufactured.

The present invention is not limited to the above preferred embodiment, but various modifications may be made without departing from the scope of the present invention. While the imaging step ST5 and the determining step ST6 are performed after ending the cutting operation for the workpiece 200 in the above preferred embodiment, the imaging step ST5 and the determining step ST6 may be performed during the cutting operation for the workpiece 200.

Further, in a case that the processing apparatus 1 or 1-1 as a cutting apparatus includes a pair of cutting units 20 as in the above preferred embodiment, the processing apparatus 1 or 1-1 may include a pair of test piece chuck tables 60 corresponding to the pair of cutting units 20, in which each test piece chuck table 60 is provided with the rotational drive mechanism 63. In this case, the pair of test piece chuck tables 60 are preferably located on respective sides of the pair of cutting units 20, in a condition where the chuck table 10 is interposed between the pair of test piece chuck tables 60.

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 claim and all changes and modifications as fall within the equivalence of the scope of the claim are therefore to be embraced by the invention.

WHAT IS CLAIMED IS:

1. A processing method for a workpiece,
comprising:

a cutting step of cutting the workpiece by using a
cutting blade of a cutting unit in a processing
apparatus;

an actual cut groove forming step of cutting a test
piece from one side to the other side thereof by using
the cutting blade to thereby form an actual cut groove;

an actual imaging step of imaging a side surface of
the test piece at the one side or the other side after
performing the actual cut groove forming step, thereby
forming an actual image including the actual cut groove;

a normal image storing step of previously storing a
normal image of a cut groove obtained by using a normal
cutting blade and next imaging the cut groove from one
side surface at the one side of the test piece; and

a determining step of determining whether or not
the cutting blade is to be changed, according to
inclination of a side wall of the actual cut groove
detected from the images formed in the actual imaging
step and the normal image storing step,

wherein

in the normal image storing step, inner surfaces of

the cut groove in the normal image are perpendicular to a front side of the test piece, and

in the determining step,

a distance between an inner surface of the cut groove in the actual image and the inner surface of the cut groove in the normal image on a same side at a predetermined determination position is detected, and

the distance detected is compared with a predetermined allowable value.

2. The processing method according to claim 1, wherein, in the determining step:

when the distance between the inner surface of the cut groove in the actual image and the inner surface of the cut groove in the normal image on the same side at the predetermined determination position is larger than the predetermined allowable value, and therefore determines that replacement of the cutting blade is required, a notifying unit is operated to notify an operator; and

when the distance between the inner surface of the cut groove in the actual image and the inner surface of the cut groove in the normal image on the same side at the predetermined determination position is equal to or less than the predetermined allowable value, and

therefore determines that the replacement of the cutting blade is not required, the processing method is returned to the cutting step.

3. The processing method according to claim 2, wherein the notifying unit functions to issue at least one of sound or light.

4. The processing method according to claim 1, wherein

the test piece is mounted on a test piece chuck table; and

a lattice-shaped suction groove is formed in an upper surface of the test piece chuck table.

5. The processing method according to claim 1, wherein in the determining step, the cut groove in the normal image is superimposed on the cut groove of the actual image.

6. The processing method according to claim 1, wherein the actual imaging step and the determining step may be performed during the cutting operation of the workpiece.