

CUTTING APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a cutting apparatus.

Description of the Related Art

A cutting apparatus is known which cuts a plate-shaped workpiece such as a semiconductor wafer, a package substrate, a ceramic, or a glass by a cutting blade (see Japanese Patent Laid-Open No. 2016-82083, for example). This kind of cutting apparatus performs cutting processing while supplying cutting water to the cutting blade and a workpiece, and thereby suppressing an effect of processing heat and washing away generated cutting waste.

SUMMARY OF THE INVENTION

In the cutting apparatus described above, the cutting blade rotates at a high speed of 30000 to 100000 rpm. Thus, the cutting water supplied to the cutting blade becomes mist including the cutting waste, and is scattered to the rear (side) of the cutting blade at high speed. Therefore, a processing chamber covering the

cutting blade and a chuck table tends to be filled with the mist. When the exhaust of the processing chamber is insufficient, an adverse effect may be caused in that, for example, an atmosphere including the mist leaks from the processing chamber and enters electric parts and a shaft portion of an actuator, and the cutting waste adheres to the electric parts and the shaft portion of the actuator. Accordingly, a blade cover has been devised in which a duct guiding the mist scattered at high speed in the direction of a rotational axis is provided with a filter in a sponge form to perform gas-liquid separation of the mist.

However, there remains a fear that in the blade cover, the cutting waste may adhere to the filter in the sponge form, and the filter may be clogged.

It is accordingly an object of the present invention to provide a cutting apparatus that can suppress clogging of the blade cover while suppressing a leakage of the mist from the processing chamber.

In accordance with an aspect of the present invention, there is provided a cutting apparatus including a chuck table configured to hold a workpiece, a cutting unit configured to cut the workpiece held on the chuck table by a cutting blade, and a moving unit

configured to move the chuck table and the cutting unit relative to each other. The cutting unit includes a spindle rotatably supported by a spindle housing and fitted with the cutting blade, a blade cover fixed to the spindle housing and configured to cover the cutting blade, and a nozzle configured to supply cutting water to the cutting blade. The blade cover includes a duct configured to receive mist of the cutting water scattered by rotation of the cutting blade at an inlet and guide the mist of the cutting water to an outlet side separated from the inlet, and a gas-liquid separating portion disposed within the duct and configured to separate the mist into gas and liquid. The gas-liquid separating portion includes a collision surface with which the mist scattered by the rotation of the cutting blade collides and a water storing portion configured to store the liquid dropping from the collision surface. The water storing portion extends to the outlet of the duct. The gas of the mist is exhausted from the outlet after passing over a water surface of the water storing portion.

Preferably, in the cutting apparatus, the duct extends from a side of the cutting blade fitted to a front end of the spindle to a rear end of the spindle,

and the collision surface includes a first collision surface intersecting a scattering direction of the mist and a second collision surface with which the mist guided to a rear of the spindle collides.

The cutting apparatus according to one aspect of the present invention produces an effect of being able to suppress clogging of the blade cover while suppressing a leakage of the mist from a processing chamber.

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 some preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view illustrating an example of a configuration of a cutting apparatus according to a first embodiment;

FIG. 2 is a front view of a cutting unit of the cutting apparatus illustrated in FIG. 1;

FIG. 3 is a plan view of the cutting unit illustrated in FIG. 2;

FIG. 4 is a front view of a duct of the cutting unit illustrated in FIG. 2;

FIG. 5 is a perspective view of the duct illustrated in FIG. 4;

FIG. 6 is a sectional view taken along a line VI-VI in FIG. 5;

FIG. 7 is a front view of a cutting unit of a cutting apparatus according to a second embodiment;

FIG. 8 is a plan view of a cutting unit of a cutting apparatus according to a third embodiment; and

FIG. 9 is a sectional view of a duct of the cutting unit illustrated in FIG. 8.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention will be described in detail with reference to the drawings. The present invention is not limited by contents described in the following embodiments. In addition, constituents described in the following include constituents readily conceivable by those skilled in the art and essentially identical constituents. Further, configurations described in the following can be combined with each other as appropriate. In addition, various omissions, replacements, or modifications of configurations can be

performed without departing from the spirit of the present invention.

[First Embodiment]

A cutting apparatus according to a first embodiment of the present invention will be described with reference to drawings. FIG. 1 is a perspective view illustrating an example of a configuration of the cutting apparatus according to the first embodiment. FIG. 2 is a front view of a cutting unit of the cutting apparatus illustrated in FIG. 1. FIG. 3 is a plan view of the cutting unit illustrated in FIG. 2.

(Cutting Apparatus)

A cutting apparatus 1 illustrated in FIG. 1 according to the first embodiment is an apparatus that cuts (processes) a workpiece 200. In the first embodiment, the workpiece 200 is a wafer such as a semiconductor wafer or an optical device wafer in a disk shape in which silicon, sapphire, gallium, or the like is used as a base material. The workpiece 200 has devices 203 formed in regions demarcated in a lattice manner by a plurality of planned dividing lines 202 formed in a lattice manner on a top surface 201.

In addition, the workpiece 200 in the present invention may be what is generally called a TAIKO

(registered trademark) wafer whose central portion is thinned and which has a thick part formed as an outer circumferential portion of the wafer. The workpiece 200 may be not only a wafer but also a rectangular package substrate having a plurality of devices sealed by a resin, a ceramic substrate, a ferrite substrate, a substrate including at least one of nickel and iron, a glass substrate, or the like. In the first embodiment, the workpiece 200 is supported by an annular frame 205 by affixing an undersurface 204 of the workpiece 200 to an adhesive tape 206 having the annular frame 205 fitted to an outer peripheral edge thereof.

The cutting apparatus 1 illustrated in FIG. 1 is an apparatus that holds the workpiece 200 by a chuck table 10 and performs cutting (corresponding to processing) of the workpiece 200 by a cutting blade 21 along the planned dividing lines 202. As illustrated in FIG. 1, the cutting apparatus 1 includes the chuck table 10 that sucks and holds the workpiece 200 by a holding surface 11, cutting units 20 that cut the workpiece 200 held on the chuck table 10 by cutting blades 21, an imaging unit 30 that photographs the workpiece 200 held on the chuck table 10, and a control unit 100.

In addition, as illustrated in FIG. 1, the cutting

apparatus 1 includes a moving unit 40 that moves the chuck table 10 and the cutting units 20 relative to each other. The moving unit 40 includes an X-axis moving unit 41 that processing-feeds the chuck table 10 in an X-axis direction parallel with a horizontal direction and a lateral direction of an apparatus main body 2, a Y-axis moving unit 42 that indexing-feeds the cutting units 20 in a Y-axis direction parallel with the horizontal direction and a longitudinal direction of the apparatus main body 2 and orthogonal to the X-axis direction, a Z-axis moving unit 43 that cutting-feeds the cutting units 20 in a Z-axis direction parallel with a vertical direction orthogonal to both the X-axis direction and the Y-axis direction, and a rotary moving unit 44 that rotates the chuck table 10 about an axis parallel with the Z-axis direction and is processing-fed in the X-axis direction by the X-axis moving unit 41 together with the chuck table 10. As illustrated in FIG. 1, the cutting apparatus 1 is what is generally called a facing dual type cutting apparatus having two cutting units 20, that is, a twin spindle dicer.

The X-axis moving unit 41 processing-feeds the chuck table 10 and the cutting units 20 relative to each other along the X-axis direction by moving the chuck

table 10 in the X-axis direction as a processing feed direction. The X-axis moving unit 41 moves the chuck table 10 in the X-axis direction between a loading and unloading region 301 into and from which the workpiece 200 is loaded and unloaded and a processing region 302 in which the workpiece 200 held on the chuck table 10 is cut by the cutting units 20.

The Y-axis moving unit 42 indexing-feeds the chuck table 10 and the cutting units 20 relative to each other along the Y-axis direction by moving the cutting units 20 in the Y-axis direction as an indexing feed direction. The Z-axis moving unit 43 cutting-feeds the chuck table 10 and the cutting units 20 relative to each other along the Z-axis direction by moving the cutting units 20 in the Z-axis direction as a cutting feed direction.

The X-axis moving unit 41, the Y-axis moving unit 42, and the Z-axis moving unit 43 include a well-known ball screw provided rotatably about an axis, a well-known motor rotating the ball screw about the axis, and well-known guide rails supporting the chuck table 10 or the cutting units 20 movably in the X-axis direction, the Y-axis direction, or the Z-axis direction.

The chuck table 10 is in a disk shape. The holding surface 11 that holds the workpiece 200 is formed of a

porous ceramic or the like. In addition, the chuck table 10 is provided so as to be movable by the X-axis moving unit 41 in the X-axis direction between the loading and unloading region 301 and the processing region 302 and is provided so as to be rotatable by the rotary moving unit 44 about an axis parallel with the Z-axis direction. The chuck table 10 is connected to an unillustrated vacuum suction source. The chuck table 10 sucks and holds the workpiece 200 mounted on the holding surface 11 by being sucked by the vacuum suction source. In the first embodiment, the chuck table 10 sucks and holds the undersurface 204 side of the workpiece 200 via the adhesive tape 206. In addition, as illustrated in FIG. 1, a plurality of clamp units 12 that clamp the annular frame 205 are arranged on the periphery of the chuck table 10.

The cutting units 20 are cutting means detachably fitted with the cutting blades 21 that cut the workpiece 200 held on the chuck table 10. The cutting units 20 are each provided so as to be movable in the Y-axis direction by the Y-axis moving unit 42 and movable in the Z-axis direction by the Z-axis moving unit 43 with respect to the workpiece 200 held on the chuck table 10.

As illustrated in FIG. 1, one of the cutting units

20 is provided to one column portion of a gate type supporting frame 3 erected from the apparatus main body 2 via the Y-axis moving unit 42, the Z-axis moving unit 43, and the like. As illustrated in FIG. 1, the other cutting unit 20 is provided to another column portion of the supporting frame 3 via the Y-axis moving unit 42, the Z-axis moving unit 43, and the like. Incidentally, upper ends of the column portions of the supporting frame 3 are coupled to each other by a horizontal beam. The cutting units 20 can position the cutting blades 21 at any positions of the holding surface 11 of the chuck table 10 by the Y-axis moving unit 42 and the Z-axis moving unit 43.

As illustrated in FIG. 2 and FIG. 3, the cutting unit 20 includes a spindle housing 22 provided so as to be movable in the Y-axis direction and the Z-axis direction by the Y-axis moving unit 42 and the Z-axis moving unit 43, a spindle 23 provided to the spindle housing 22 so as to be rotatable about an axis and rotated by an unillustrated motor, and having an end fitted with the cutting blade 21, a blade cover 24 fixed to an end surface 221 of the spindle housing 22, and a nozzle 25 that supplies cutting water to the cutting blade 21.

The cutting blade 21 is a very thin cutting grindstone having substantially a ring shape. In the first embodiment, the cutting blade 21 is what is generally called a hub blade including a circular base 211 in the form of a circular ring and a cutting edge 212 in the form of a circular ring which cutting edge is disposed on an outer peripheral edge of the circular base 211 and cuts the workpiece 200. The cutting edge 212 is formed of abrasive grains such as diamond or cubic boron nitride (CBN) and a bonding material (coupling material) such as a metal or a resin. The cutting edge 212 is formed with a predetermined thickness. Incidentally, in the present invention, the cutting blade 21 may be what is generally called a washer blade formed by only the cutting edge 212.

The spindle 23 is rotated about an axis by the motor, and thereby rotates the cutting blade 21 in the direction of an arrow 400 in FIG. 2. In the first embodiment, the rotational speed of the spindle 23 is equal to or more than 30000 rpm and equal to or less than 100000 rpm. Incidentally, in the present specification, the direction indicated by the arrow 400 will hereinafter be described as the rotational direction of the cutting blade 21. The cutting blade 21 is rotated in the

rotational direction 400 about an axis by the spindle 23. Thus, at a lower end of the cutting edge 212 that cuts the workpiece 200, the cutting blade 21 jets the cutting water in a direction 401 toward the rear side of the rotational direction 400 of the lower end of the cutting edge 212 together with cutting waste produced by cutting the workpiece 200. Incidentally, because the rotational speed of the spindle 23 is a high speed equal to or more than 30000 rpm and equal to or less than 100000 rpm, the cutting water scattered in the direction 401 toward the rear side of the rotational direction 400 from the lower end of the cutting edge 212 of the cutting blade 21 is scattered in a state of mist. Thus, the direction 401 toward the rear side is the scattering direction of the mist from the lower end of the cutting edge 212 of the cutting blade 21, and will hereinafter be described as a scattering direction.

The blade cover 24 covers the cutting blade 21. The blade cover 24 includes a cover main body 241 fixed to the end surface 221 of the spindle housing 22 and covers an upper side of the cutting blade 21, and a front side cover 242 that is fixed to the cover main body 241 and covers a front side of the cutting blade 21 which front side is on the loading and unloading region 301

side. The cover main body 241 has a pair of nozzle supporting members 243 extending downward on the rear side on the processing region 302 side.

The nozzle 25 includes a shower nozzle 251 provided to the front side cover 242 and a pair of cooler nozzles 252 supported by the nozzle supporting members 243 of the cover main body 241. The shower nozzle 251 faces the point of the cutting edge 212 of the cutting blade 21 in the X-axis direction and supplies the cutting water to the point of the cutting edge 212 of the cutting blade 21 during cutting. The cooler nozzles 252 extend in parallel with the X-axis direction and are arranged at a distance from each other in the Y-axis direction. The lower end of the cutting edge 212 of the cutting blade 21 is positioned between the cooler nozzles 252. The cooler nozzles 252 supply the cutting water to the lower end of the cutting edge 212 of the cutting blade 21 during cutting.

(Duct)

In addition, the blade cover 24 has a duct 26 fixed to the rear side of the cover main body 241 which rear side is on the processing region 302 side. FIG. 4 is a front view of the duct of the cutting unit illustrated in FIG. 2. FIG. 5 is a perspective view of the duct

illustrated in FIG. 4. FIG. 6 is a sectional view taken along a line VI-VI in FIG. 5.

The duct 26 receives, at an inlet 261, the mist of the cutting water scattered along the scattering direction 401 from the lower end of the cutting edge 212 of the cutting blade 21 due to the rotation of the cutting blade 21 during cutting, and guides the mist of the cutting water to an outlet 262 side separated from the inlet 261. The duct 26 is formed in a hollow shape internally provided with a passage that makes the inlet 261 and the outlet 262 communicate with each other.

As illustrated in FIG. 4, FIG. 5, and FIG. 6, the duct 26 integrally includes an inlet portion 263 provided with the inlet 261, an extending portion 264 continuous with a side in the Y-axis direction of the inlet portion 263, and an outlet portion 265 continuous with an end of the extending portion 264 and provided with the outlet 262. In the duct 26 according to the first embodiment, the inlet portion 263 is juxtaposed to the cutting blade 21 in the X-axis direction, the extending portion 264 extends in the Y-axis direction from the inlet portion 263, and the extending portion 264 and the outlet portion 265 are arranged next to each other in the Y-axis direction.

The inlet portion 263 is fixed to the processing region 302 side of the cover main body 241 and is formed in a tubular shape in which the inlet 261 facing the cover main body 241 is formed. The mist of the cutting water scattered from the lower end of the cutting edge 212 of the cutting blade 21 enters the inlet portion 263 from the inlet 261. In addition, in the first embodiment, as illustrated in FIG. 5, the inlet portion 263 includes a pair of side walls 266 extending in the X-axis direction and a coupling wall 267 that couples lower ends of the pair of side walls 266 to each other. The side walls 266 and the coupling wall 267 are continuous with an inner edge of the inlet 261. In the first embodiment, one side wall 266 is superposed on a side surface of the cover main body 241.

One end of the extending portion 264 is continuous with an end of the inlet portion 263 which end is on a side far from the cover main body 241. The extending portion 264 is formed in a tubular shape from the one end continuous with the inlet portion 263 such that another end extends to a rear end side of the spindle housing 22 along the Y-axis direction. An upper wall of the extending portion 264 is inclined downward gradually from the one end to the other end. The outlet portion 265 is

formed in a flat tubular shape continuous with a lower end portion of the other end of the extending portion 264 and having the outlet 262 as an opening formed on an upper side. The outlet portion 265 discharges gas of the mist of the cutting water to the outside of the duct 26.

Thus, the duct 26 integrally includes the inlet portion 263, the extending portion 264, and the outlet portion 265, and extends from the side of the cutting blade 21 fitted to an end of the spindle 23 to a rear end of the spindle 23.

In addition, the duct 26 internally has a gas-liquid separating portion 27. The gas-liquid separating portion 27 separates the mist of the cutting water into gas and the cutting water as a liquid. In the first embodiment, the gas-liquid separating portion 27 includes a first collision surface 271 as a collision surface, a second collision surface 272 as a collision surface, and a water storing portion 273.

The mist scattered by the rotation of the cutting blade 21 collides with the first collision surface 271 and the second collision surface 272. The first collision surface 271 separates the mist into gas and the cutting water when the mist of the cutting water entering the inside of the duct 26 from the inlet 261 along the

scattering direction 401 collides with the first collision surface 271. The first collision surface 271 in the first embodiment is an inner surface that faces the inlet 261 of the inlet portion 263 in the X-axis direction. The first collision surface 271 intersects the scattering direction 401 in which the mist of the cutting water is scattered from the lower end of the cutting edge 212 of the cutting blade 21. The mist that collides with the first collision surface 271 but is not separated into gas and the cutting water is guided to the outlet portion 265, that is, the other end side of the extending portion 264 which other end side is in the rear of the spindle 23, along an arrow 402 in FIG. 3 and FIG. 6.

The second collision surface 272 separates the mist into gas and the cutting water when the mist that is not separated into gas and the cutting water even when the mist collides with the first collision surface 271 collides with the second collision surface 272. The second collision surface 272 in the first embodiment is an inner surface of the upper wall of the extending portion 264. The mist guided from the first collision surface 271 to the other end side of the extending portion 264 collides with the second collision surface 272. The water storing portion 273 stores the cutting

water that is separated from the gas by colliding with the first collision surface 271 and the second collision surface 272 and drops from the collision surfaces 271 and 272. The water storing portion 273 in the first embodiment is formed by the inner surface of the outlet portion 265. The water storing portion 273 therefore extends to the outlet 262 of the duct 26.

Thus, the cutting apparatus 1 according to the first embodiment does not have a filter in a sponge form which filter has a water absorbing property or the like within the duct 26 of the blade cover 24.

The imaging unit 30 is fixed to the cutting unit 20 so as to move integrally with the cutting unit 20. The imaging unit 30 includes an imaging element that photographs a region to be divided in the workpiece 200 before cutting which workpiece is held on the chuck table 10. The imaging element is, for example, a charge-coupled device (CCD) imaging element or a complementary metal-oxide semiconductor (CMOS) imaging element. The imaging unit 30 obtains an image for carrying out alignment that aligns the workpiece 200 and the cutting blade 21 with each other, for example, by photographing the workpiece 200 held on the chuck table 10, and outputs the obtained image to the control unit 100.

In addition, the cutting apparatus 1 includes an unillustrated X-axis direction position detecting unit for detecting the position in the X-axis direction of the chuck table 10, an unillustrated Y-axis direction position detecting unit for detecting the position in the Y-axis direction of the cutting unit 20, and an unillustrated Z-axis direction position detecting unit for detecting the position in the Z-axis direction of the cutting unit 20. The X-axis direction position detecting unit and the Y-axis direction position detecting unit can be formed by a linear scale parallel with the X-axis direction or the Y-axis direction and a read head. The Z-axis direction position detecting unit detects the position in the Z-axis direction of the cutting unit 20 by pulses of a motor. The X-axis direction position detecting unit, the Y-axis direction position detecting unit, and the Z-axis direction position detecting unit output the position in the X-axis direction of the chuck table 10 or the position in the Y-axis direction or the Z-axis direction of the cutting unit 20 to the control unit 100. Incidentally, in the first embodiment, the position in the X-axis direction, the Y-axis direction, and the Z-axis direction of each constituent of the cutting apparatus 1 is defined as a position with a

predetermined reference position, not illustrated, as a reference.

In addition, the cutting apparatus 1 includes a cassette elevator 60 that is mounted with a cassette 61 housing the workpiece 200 before and after cutting and moves the cassette 61 in the Z-axis direction, a cleaning unit 70 that cleans the workpiece 200 after the cutting, and a transfer unit 80 that loads and unloads the workpiece 200 into and from the cassette 61 and transfers the workpiece 200.

In addition, as illustrated in FIG. 1, the cutting apparatus 1 includes a processing chamber wall 6 that suppresses diffusion of the cutting water by surrounding the outside of the processing region 302 and an exhaust duct 8 for a processing chamber. In the first embodiment, the processing chamber wall 6 forms, within the cutting apparatus 1, a processing chamber 303 that houses the chuck table 10 located in the processing region 302 and the cutting unit 20. The exhaust duct 8 has one end continuous with the processing chamber wall 6 and exhausts an atmosphere within the processing chamber wall 6, that is, within the processing chamber 303 to the outside of the cutting apparatus 1 by an unillustrated exhaust fan or the like.

The control unit 100 makes the cutting apparatus 1 perform processing operation on the workpiece 200 by controlling each of the above-described units of the cutting apparatus 1. Incidentally, the control unit 100 is a computer including an arithmetic processing apparatus having a microprocessor such as a central processing unit (CPU), a storage apparatus having a memory such as a read only memory (ROM) or a random access memory (RAM), and an input-output interface apparatus. The arithmetic processing apparatus of the control unit 100 performs arithmetic processing according to a computer program stored in the storage apparatus and outputs a control signal for controlling the cutting apparatus 1 to the above-described constituents of the cutting apparatus 1 via the input-output interface apparatus.

In addition, the control unit 100 is connected with a display unit 102, which is formed by a liquid crystal display apparatus or the like displaying the state of the processing operation, an image, or the like, and an input unit used when an operator registers processing content information or the like. The input unit is formed by at least one of a touch panel provided to the display unit 102 and an external input apparatus such as a keyboard.

The cutting apparatus 1 having the above-described configuration starts processing operation when an operator registers processing content information in the control unit 100 and mounts the cassette 61 housing workpieces 200 on the cassette elevator 60, and the control unit 100 receives an instruction to start the processing operation from the operator. When the cutting apparatus 1 starts the processing operation, the cutting apparatus 1 rotates the spindle 23 about the axis, and the transfer unit 80 extracts one workpiece 200 from within the cassette 61 and places the undersurface 204 side of the workpiece 200 on the holding surface 11 of the chuck table 10 via the adhesive tape 206.

The cutting apparatus 1 sucks and holds the workpiece 200 on the holding surface 11 via the adhesive tape 206 and sandwiches the annular frame 205 by the clamp units 12. The cutting apparatus 1 moves the chuck table 10 to a position below the imaging unit 30 by the moving unit 40, images the workpiece 200 sucked and held on the chuck table 10 by the imaging unit 30, and carries out alignment.

The cutting apparatus 1 performs cutting by making the cutting blade 21 cut into a planned dividing line 202 of the workpiece 200 until the cutting blade 21 reaches

the adhesive tape 206 while moving the cutting blade 21 and the workpiece 200 relative to each other along the planned dividing line 202 by the moving unit 40, on the basis of the processing content information, and supplying the cutting water from the nozzles 251 and 252. After the cutting apparatus 1 cuts all of the planned dividing lines 202 of the workpiece 200, the cutting apparatus 1 transfers the workpiece 200 to the cleaning unit 70 by the transfer unit 80, cleans the workpiece 200 by the cleaning unit 70, and thereafter carries the workpiece 200 into the cassette 61 by the transfer unit 80.

The cutting apparatus 1 cuts the workpieces 200 within the cassette 61 in order. The cutting apparatus 1 ends the processing operation when the cutting apparatus 1 has cut all of the workpieces 200 within the cassette 61. In addition, in the cutting apparatus 1, the mist of the cutting water scattered from the lower end of the cutting edge 212 of the cutting blade 21 during the cutting is guided into the inlet portion 263 of the duct 26 through the inlet 261 along the scattering direction 401, and collides with the first collision surface 271, so that a part of the mist of the cutting water is separated into gas and the cutting water. In the cutting

apparatus 1, the mist not separated into gas and the cutting water after entering the inside of the inlet portion 263 of the duct 26 and colliding with the first collision surface 271 collides with the second collision surface 272 and is separated into gas and the cutting water.

The cutting apparatus 1 stores the cutting water separated from the mist and dropping from the collision surfaces 271 and 272 within the water storing portion 273 disposed in the outlet portion 265 and discharges the cutting water overflowing an upper end of the water storing portion 273 to the outside of the duct 26 through the outlet 262. In addition, the cutting apparatus 1 makes the mist not separated into the gas and the liquid pass over the water surface of the cutting water stored within the water storing portion 273 of the duct 26, and thereby makes the mist come into contact with the cutting water and further separates the mist into the gas and the liquid. The gas and the mist not separated into the gas and the liquid are exhausted from the outlet 262 to the outside of the duct 26. In addition, the cutting apparatus 1 according to the first embodiment exhausts the atmosphere within the processing chamber wall 6, that is, within the processing chamber 303 through the exhaust

duct 8 to the outside of the cutting apparatus 1 while the cutting apparatus 1 performs the processing operation.

As described above, in the cutting apparatus 1 according to the first embodiment, the duct 26 that receives the mist at the inlet 261 thereof and guides the mist to the outlet 262 side includes the collision surfaces 271 and 272 with which the mist including the cutting waste collides and the water storing portion 273 that stores the cutting liquid dropping from the collision surfaces 271 and 272, and the water storing portion 273 is disposed in the outlet portion 265 of the duct 26. Thus, the cutting water resulting from the gas-liquid separation at the collision surfaces 271 and 272 is supplied to the water storing portion 273 at all times, the mist not separated into the gas and the liquid within the duct 26 passes over the water surface of the cutting water stored within the water storing portion 273, and the gas of the mist is exhausted from the outlet 262. Therefore, the cutting apparatus 1 can not only separate the mist into the gas and the liquid by the collision surfaces 271 and 272 but also separate the mist into the gas and the liquid by making the mist pass over the water surface of the cutting water stored within the

water storing portion 273, so that the cutting apparatus 1 has a high gas-liquid separation effect and suppresses filling of the processing chamber 303 with the mist. As a result, the cutting apparatus 1 can suppress a leakage of the mist from within the processing chamber 303.

In addition, in the cutting apparatus 1, the duct 26 of the blade cover 24 does not include a filter in a sponge form. Thus, the inside of the duct 26 is not clogged with the cutting waste, and there is also an effect of a low frequency of maintenance of the duct 26 and the like. As a result, the cutting apparatus 1 according to the first embodiment produces an effect of being able to suppress the clogging of the inside of the duct 26 of the blade cover 24 while suppressing a leakage of the mist from the processing chamber 303.

In addition, the cutting apparatus 1 according to the first embodiment includes the first collision surface 271 intersecting the scattering direction 401 of the mist from the lower end of the cutting edge 212 of the cutting blade 21 and the second collision surface 272 with which the mist guided to the rear of the spindle 23 along the arrow 402 after colliding with the first collision surface 271 collides. The cutting apparatus 1 can therefore make the mist collide with each of the

collision surfaces 271 and 272 surely.

[Second Embodiment]

A cutting apparatus according to a second embodiment of the present invention will be described with reference to drawings. FIG. 7 is a front view of a cutting unit of the cutting apparatus according to the second embodiment. Incidentally, in FIG. 7, the same parts as in the first embodiment are identified by the same reference numerals, and description thereof will be omitted.

A duct 26-2 of the cutting apparatus 1-2 according to the second embodiment is the same as in the first embodiment except that the duct 26-2 does not include the first collision surface 271 and, as illustrated in FIG. 7, the inlet portion 263, the extending portion 264, and the outlet portion 265 are aligned with each other in the X-axis direction. In the cutting apparatus 1-2 according to the second embodiment, the mist of the cutting water scattered from the lower end of the cutting edge 212 of the cutting blade 21 during cutting is guided to the inside of the inlet portion 263 of the duct 26-2 through the inlet 261 along the scattering direction 401, and the mist collides with the second collision surface 272, so that a part of the mist is separated into gas and the

cutting water.

The cutting apparatus 1-2 stores the cutting water separated from the mist and dropping from the second collision surface 272 within the water storing portion 273 disposed in the outlet portion 265 and discharges the cutting water overflowing the upper end of the water storing portion 273 to the outside of the duct 26-2 through the outlet 262. In addition, the cutting apparatus 1 makes the mist not separated into the gas and the liquid pass over the water surface of the cutting water stored within the water storing portion 273 of the duct 26-2, and thereby makes the mist come into contact with the cutting water and further separates the mist into the gas and the liquid. The gas and the mist not separated into the gas and the liquid are exhausted from the outlet 262 to the outside of the duct 26.

In the cutting apparatus 1-2 according to the second embodiment, the duct 26-2 that receives the mist at the inlet 261 thereof and guides the mist to the outlet 262 includes the second collision surface 272 and the water storing portion 273, and the water storing portion 273 is disposed in the outlet portion 265 of the duct 26-2. Thus, as in the first embodiment, the cutting water resulting from the gas-liquid separation at the

second collision surface 272 is supplied to the water storing portion 273 at all times, the mist not separated into the gas and the liquid within the duct 26-2 passes over the water surface of the cutting water stored within the water storing portion 273, and the gas of the mist is exhausted from the outlet 262. As a result, the cutting apparatus 1-2 according to the second embodiment can not only separate the mist into the gas and the liquid by the second collision surface 272 but also separate the mist into the gas and the liquid by making the mist pass over the water surface of the cutting water stored within the water storing portion 273. The cutting apparatus 1-2 therefore produces a high gas-liquid separation effect. In addition, because the duct 26-2 of the blade cover 24 does not include a filter in a sponge form, the cutting apparatus 1-2 produces an effect of being able to suppress clogging of the inside of the duct 26-2 of the blade cover 24 while suppressing a leakage of the mist from the processing chamber 303 as in the first embodiment.

[Third Embodiment]

A cutting apparatus according to a third embodiment of the present invention will be described with reference to drawings. FIG. 8 is a plan view of a cutting unit of

the cutting apparatus according to the third embodiment. FIG. 9 is a sectional view of a duct of the cutting unit illustrated in FIG. 8. Incidentally, in FIG. 8 and FIG. 9, the same parts as in the first embodiment are identified by the same reference numerals, and description thereof will be omitted.

The duct 26-3 of the cutting apparatus 1-3 according to the third embodiment is the same as in the first embodiment except that the gas-liquid separating portion 27 includes a third collision surface 274 as a collision surface, as illustrated in FIG. 8 and FIG. 9. The third collision surface 274 of the duct 26-3 of the cutting apparatus 1-3 according to the third embodiment separates the mist into gas and liquid when the mist guided from the extending portion 264 to the outlet portion 265 collides with the third collision surface 274. In the third embodiment, the third collision surface 274 is an inner surface of an erect wall 268 erected from an external wall that is most distant from the extending portion 264 and faces the extending portion 264 in the Y-axis direction among external walls constituting the outlet portion 265.

In the cutting apparatus 1-3 according to the third embodiment, the duct 26-3 that receives the mist at the

inlet 261 thereof and guides the mist to the outlet 262 includes the collision surfaces 271, 272, and 274 and the water storing portion 273, and the water storing portion 273 is disposed in the outlet portion 265 of the duct 26-3. Thus, the cutting water resulting from the gas-liquid separation at the collision surfaces 271, 272, and 274 is supplied to the water storing portion 273 at all times, and the mist not separated into the gas and the liquid within the duct 26-3 passes over the water surface of the cutting water stored within the water storing portion 273 and is exhausted from the outlet 262. As a result, the cutting apparatus 1-3 according to the second embodiment can not only separate the mist into the gas and the liquid by the collision surfaces 271, 272, and 274 but also separate the mist into the gas and the liquid by making the mist pass over the water surface of the cutting water stored within the water storing portion 273. The cutting apparatus 1-3 therefore produces a high gas-liquid separation effect. In addition, because the duct 26-3 of the blade cover 24 does not include a filter in a sponge form, the cutting apparatus 1-3 produces an effect of being able to suppress clogging of the inside of the duct 26-3 of the blade cover 24 while suppressing a leakage of the mist from the processing chamber 303 as

in the first embodiment.

In addition, the duct 26-3 of the cutting apparatus 1-3 according to the third embodiment includes the third collision surface 274 in addition to the first collision surface 271 and the second collision surface 272. The duct 26-3 therefore produces a higher gas-liquid separation effect than the duct 26 according to the first embodiment.

It is to be noted that the present invention is not limited to the foregoing embodiments and modifications. That is, the present invention can be modified and carried out in various manners without departing from the gist of the present invention.

The present invention is not limited to the details of the above described preferred embodiments. 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 cutting apparatus comprising:
a chuck table configured to hold a workpiece;
a cutting unit configured to cut the workpiece held on the chuck table by a cutting blade; and
a moving unit configured to move the chuck table and the cutting unit relative to each other,
the cutting unit including a spindle rotatably supported by a spindle housing and fitted with the cutting blade, a blade cover fixed to the spindle housing and configured to cover the cutting blade, and a nozzle configured to supply cutting water to the cutting blade,
the blade cover including
a duct configured to receive mist of the cutting water scattered by rotation of the cutting blade at an inlet and guide the mist of the cutting water to an outlet side separated from the inlet, and a gas-liquid separating portion disposed within the duct and configured to separate the mist into gas and liquid,
the gas-liquid separating portion including
a collision surface with which the mist scattered by the rotation of the cutting blade collides and a water storing portion configured to store the liquid dropping from the collision surface,

the water storing portion extending to the outlet of the duct, and the gas being exhausted from the outlet after passing over a water surface of the water storing portion.

2. The cutting apparatus according to claim 1, wherein

the duct extends from a side of the cutting blade fitted to a front end of the spindle to a rear end of the spindle, and

the collision surface includes a first collision surface intersecting a scattering direction of the mist and a second collision surface with which the mist guided to a rear of the spindle collides.