

PROTECTIVE FILM FORMING APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a protective film forming apparatus that coats the upper surface of a wafer with a protective film.

Description of the Related Art

In ablation processing that divides a wafer having devices formed in regions divided by planned dividing lines by irradiating the wafer with a pulsed laser beam of a wavelength absorbable by the wafer along the planned dividing lines of the wafer, the devices are protected by forming a water-soluble protective film on the upper surface of the wafer before the irradiation with the laser beam in order to prevent debris generated, when the wafer is melted by the irradiation with the laser beam, from adhering to the devices. In addition, after the irradiation with the laser beam, the water-soluble protective film is removed together with the debris adhering to the water-soluble protective film by supplying water to the water-soluble protective film.

At a time of formation of the water-soluble protective film on the upper surface of the wafer, a work

set is formed by affixing a lower surface of the wafer to an adhesive surface of an adhesive tape affixed to a ring frame having an opening portion in a center thereof such that the adhesive tape closes the opening portion, and the wafer is supported by the ring frame. Then, an appropriate amount of water-soluble liquid resin is dropped onto the wafer, and the water-soluble liquid resin is spread and dried by spin rotation of the work set. The upper surface of the wafer is thereby coated with the water-soluble protective film.

When the upper surface of the wafer is thus coated with the water-soluble liquid resin by the spin rotation of the work set, the water-soluble resin adheres also to the upper surface of the ring frame. Then, when the resin adheres to the upper surface of the ring frame, the water-soluble resin may have an adhesive force by absorbing moisture in the air, for example. Therefore, when conveying means is to suck and convey the ring frame, the ring frame sticks to a pad of the conveying means due to the adhesive force of the water-soluble resin, and the ring frame cannot be separated from the pad. Accordingly, removal of the water-soluble resin by splashing water to the water-soluble resin adhering to the ring frame has been proposed (see for example Japanese Patent Laid-Open

No. 2017-092379).

SUMMARY OF THE INVENTION

However, the invention described in Japanese Patent Laid-Open No. 2017-092379 splashes water to the ring frame after coating the wafer with the protective film and drying the protective film, dissolves the resin adhering to the ring frame by retaining the water, and removes the resin from the ring frame by jetting air. The removal of the resin thus takes time.

Accordingly, it is an object of the present invention to provide a protective film forming apparatus that can remove a resin adhering to the upper surface of a ring frame efficiently in a case where a protective film is formed on the upper surface of a wafer supported by the ring frame via a tape.

In accordance with an aspect of the present invention, there is provided a protective film forming apparatus for forming a water-soluble protective film on an upper surface of a wafer, the protective film forming apparatus including: a holding table that retains a work set formed by affixing the wafer to a tape that is affixed to a ring frame so as to close an opening of the ring frame; rotating means rotating the holding table

about a center of a holding surface of the holding table; and supplying means supplying a water-soluble resin to the upper surface of the wafer held by the holding table; the supplying means including a resin nozzle that supplies the water-soluble resin to a center of the upper surface of the wafer of the work set held by the holding table, a water nozzle that supplies water to an upper surface of the ring frame of the work set held by the holding table, and an air nozzle that supplies air to the upper surface of the ring frame of the work set held by the holding table, the resin nozzle, the water nozzle, and the air nozzle being disposed on an arm extending in a direction of the holding surface of the holding table, and the air nozzle being disposed downstream of the water nozzle in a direction of rotation of the holding table.

According to the protective film forming apparatus in accordance with the present invention, when the water-soluble protective film is formed on the upper surface of the wafer, the upper surface of the ring frame can also be cleaned efficiently. Hence, according to the present invention, the water-soluble resin is not left on the upper surface of the ring frame, and when the work set having the water-soluble protective film formed thereon is conveyed to a processing table by conveying means, for

example, the water-soluble resin does not adhere to the conveying means.

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 depicting a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view depicting a configuration of a processing apparatus and a protective film forming apparatus;

FIG. 2 is an enlarged perspective view depicting a configuration of the protective film forming apparatus;

FIG. 3 is a plan view depicting a state in which supplying means is positioned at a supply position;

FIG. 4 is a plan view depicting a state in which the supplying means is positioned at a standby position;

FIG. 5 is a plan view depicting a state in which a modification of the supplying means is positioned at a resin supply position;

FIG. 6 is a plan view depicting a state in which

the modification of the supplying means is positioned at a ring frame cleaning position; and

FIG. 7 is a plan view depicting a state in which the modification of the supplying means is positioned at a standby position.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A wafer W depicted in FIG. 1 is an example of a workpiece having a substrate in the shape of a circular plate. A device D is formed in each of regions demarcated by the planned dividing lines S in a lattice form on an upper surface of the wafer W. In order to support the wafer W by a ring frame F having a center thereof opened, a tape T is affixed to a lower surface of the ring frame F so as to close an opening of the ring frame F. The wafer W is affixed to the tape T exposed from the opening part of the ring frame F, and the upper surface of the wafer W is exposed facing upward. A work set WS supporting the wafer W via the tape T affixed so as to close the opening of the ring frame F is thus formed. The wafer W is conveyed in the form of the work set WS to a processing apparatus 1, and the formation of a protective film and laser processing are performed on the upper surface of the wafer W.

The processing apparatus 1 includes: an apparatus base 10; and a column 11 erected on a rear side in a Y-axis direction of the apparatus base 10. In addition, the processing apparatus 1 includes: a protective film forming apparatus 2 according to the present invention, the protective film forming apparatus 2 being disposed on a front side in an X-axis direction of the apparatus base 10 so as to adjoin the column 11; a processing table 12 having a holding surface 12a that sucks and holds the wafer W; processing feeding means 14 for processing-feeding the processing table 12 in a processing feed direction (X-axis direction); indexing feeding means 15 for indexing-feeding the processing table 12 in an indexing feed direction (Y-axis direction); conveying means 16 for conveying the wafer W between the processing table 12 and the protective film forming apparatus 2; laser processing means 17 for irradiating the wafer W constituting the work set WS with a laser beam; and control means 18 for controlling various driving mechanisms.

The protective film forming apparatus 2 has a tubular processing chamber 200. The protective film forming apparatus 2 includes: a holding table 20 that holds the work set WS; rotating means 21 for rotating the

holding table 20 about the center of a holding surface 20a of the holding table 20; frame holding means 22 for holding the ring frame F, the frame holding means 22 being disposed on an outer circumferential side of the holding table 20; and supplying means 23 for supplying a water-soluble resin to the upper surface of the wafer W held by the holding table 20.

An upper surface of the holding table 20 constitutes the holding surface 20a that sucks and holds the wafer W. The rotating means 21 has a motor not depicted in the figure. The holding table 20 can be rotated at a predetermined rotational speed by driving of the motor. A plurality of frame holding means 22, four in the example depicted in the figure, for holding the ring frame F are disposed on the outer circumferential side of the holding table 20. The frame holding means 22 includes a frame mounting base 220 on which the ring frame F is mounted and a clamp portion 221 that clamps the ring frame F mounted on the frame mounting base 220.

As depicted in FIG. 2, the supplying means 23 includes: a resin nozzle 24 that supplies the water-soluble resin to the center of the upper surface of the wafer W of the work set WS held by the holding table 20; a water nozzle 25 that supplies water to the upper

surface of the ring frame F of the work set WS held by the holding table 20; and an air nozzle 26 that supplies air to the upper surface of the ring frame F of the work set WS held by the holding table 20. The resin nozzle 24, the water nozzle 25, and the air nozzle 26 are disposed on an arm 27 that extends in a direction of the holding surface of the holding table 20.

The arm 27 illustrated in the present embodiment is configured to include a first arm 27a and a second arm 27b shorter than the first arm 27a. A flow passage in which a fluid flows is formed within the first arm 27a and the second arm 27b. The first arm 27a is formed so as to have a length such that an end of the first arm 27a is positioned to a central side of the holding table 20. The end of the first arm 27a is bent downward. The resin nozzle 24 is attached to the end of the first arm 27a. A resin supply source is connected to the resin nozzle 24.

The second arm 27b is formed so as to have a length such that an end of the second arm 27b is positioned on the outer circumferential side of the holding table 20. The end of the second arm 27b is bent downward. The water nozzle 25 is attached to the end of the second arm 27b. A water supply source is connected to the water nozzle 25. The air nozzle 26 is disposed on a lateral side of the

first arm 27a which lateral side is opposite from the side where the water nozzle 25 is disposed. A plurality of injection ports 260 depicted in FIG. 3 are formed in the air nozzle 26 so as to be aligned on a straight line. An air supply source is connected to the air nozzle 26.

A rotary shaft 28 having an axis in a vertical direction is connected to another end of the arm 27. A motor capable of normal rotation and reverse rotation is connected to the rotary shaft 28. When the rotary shaft 28 is rotated by driving of the motor, the arm 27 turns in a horizontal direction above the wafer W held on the holding table 20, so that the resin nozzle 24, the water nozzle 25, and the air nozzle 26 can be moved simultaneously. Thus, the resin nozzle 24 can be radially moved in a reciprocating manner in a radial region from an outer peripheral edge of the work set WS held on the holding table 20 to a central part of the wafer W, and the water nozzle 25 and the air nozzle 26 can be moved radially in a reciprocating manner on an upward side of the ring frame F of the work set WS held on the holding table 20. The supplying means 23 can move the resin nozzle 24, the water nozzle 25, and the air nozzle 26 by one driving source to a desired position without causing the resin nozzle 24, the water nozzle 25, and the air

nozzle 26 to interfere with each other.

In addition, the supplying means 23 has the air nozzle 26 disposed downstream of the water nozzle 25 in a rotational direction of the holding table 20. Therefore, when the water-soluble resin adhering to the upper surface of the ring frame F is to be removed, an air is supplied from the air nozzle 26 to the upper surface of the ring frame F while a cleaning water is supplied from the water nozzle 25 to the upper surface of the ring frame F. The cleaning water flowing to the downstream side in the rotational direction of the holding table 20 can be thereby blown off to the outside of the ring frame F by the air. Thus, the supplying means 23 can form a water-soluble protective film on the upper surface of the wafer W, and simultaneously dissolve and remove the water-soluble resin adhering to the upper surface of the ring frame F by the cleaning water. Cleaning efficiency is consequently improved.

The conveying means 16 depicted in FIG. 1 includes: a holding part 160 that holds the work set WS; a ball screw 161 that extends in the X-axis direction; a motor 162 that is connected to one end of the ball screw 161; a pair of guide rails 163 that extend in parallel with the ball screw 161; and a moving part 164 that can move in

the X-axis direction while supporting the holding part 160. The pair of guide rails 163 is in sliding contact with the moving part 164. The ball screw 161 is screwed into a nut formed in a central portion of the moving part 164. Rotation of the ball screw 161 driven by the motor 162 in a state in which the holding part 160 holds the work set WS moves the moving part 164 in the X-axis direction along the guide rails 163, so that the work set WS can be conveyed between the processing table 12 and the holding table 20. A plurality of frame holding means 13 for holding the ring frame F are disposed on an outer circumferential side of the processing table 12. The frame holding means 13 include a frame mounting base 130 on which the ring frame F is mounted and a clamp portion 131 that clamps the ring frame F mounted on the frame mounting base 130.

The processing feeding means 14 includes: a ball screw 140 that extends in the X-axis direction; a motor 141 that is connected to one end of the ball screw 140; a pair of guide rails 142 that extend in parallel with the ball screw 140; and an X-axis base 143 that can move in the X-axis direction. The processing table 12 is supported on one surface of the X-axis base 143. The pair of guide rails 142 is in sliding contact with another

surface of the X-axis base 143. The ball screw 140 is screwed into a nut formed in a central portion of the X-axis base 143. Rotation of the ball screw 140 driven by the motor 141 moves the X-axis base 143 in the X-axis direction along the guide rails 142, so that the processing table 12 can be processing-fed in the X-axis direction.

The indexing feeding means 15 includes: a ball screw 150 that extends in the Y-axis direction; a motor 151 that is connected to one end of the ball screw 150; a pair of guide rails 152 that extend in parallel with the ball screw 150; and a Y-axis base 153 that can move in the Y-axis direction. The processing table 12 is supported on one surface of the Y-axis base 153 via the processing feeding means 14. The pair of guide rails 152 is in sliding contact with another surface of the Y-axis base 153. The ball screw 150 is screwed into a nut formed in a central portion of the Y-axis base 153. Rotation of the ball screw 150 driven by the motor 151 moves the Y-axis base 153 in the Y-axis direction along the guide rails 152, so that the processing table 12 can be indexing-fed in the Y-axis direction.

The laser processing means 17 includes: a casing 170 that extends in the Y-axis direction; and a

processing head 171 that is disposed on an end of the casing 170. An oscillator that oscillates a laser beam of a wavelength absorbable by the water-soluble resin is housed within the casing 170. A condensing lens (not depicted) for condensing the laser beam oscillated from the oscillator is included within the processing head 171.

The control means 18 includes a Central Processing Unit (CPU) and a storage element such as a memory or the like. The control means 18 can for example perform control such that fluids are jetted from the resin nozzle 24, the water nozzle 25, and the air nozzle 26 of the supplying means 23 at the same time. The control means 18 can also perform control such that the resin nozzle 24 jets the fluid in different timing than the water nozzle 25 and the air nozzle 26 jet the fluids. In addition, the memory of the control means 18 stores conditions for forming the water-soluble protective film, laser processing conditions, information on the wafer W as a processing target, and the like.

An example of operation of the protective film forming apparatus 2 will next be described in detail. The work set WS is prepared, and then a protective film is formed on the upper surface of the wafer W before laser processing means 7 performs laser processing on the upper

surface of the wafer W. First, as depicted in FIG. 1, the work set WS is mounted on the holding table 20, the wafer W is sucked and held on the holding surface 20a by actuating a suction source not depicted in the figure, and the ring frame F is held by the frame holding means 22.

As depicted in FIG. 2, when the rotary shaft 28 is rotated in, for example, a counterclockwise direction by the motor, the arm 27 turns in the horizontal direction with respect to the holding surface 20a of the holding table 20, and moves the supplying means 23 from a standby position SP to a supply position P1, as depicted in FIG.

3. The standby position SP is a position at which the resin nozzle 24, the water nozzle 25, and the air nozzle 26 are each retracted from an upward side of the work set WS. The supply position P1 is a position at which the resin nozzle 24 is positioned above the center of the wafer W, and the water nozzle 25 and the air nozzle 26 are positioned above the ring frame F.

When the holding table 20 is rotated by the rotating means 21 depicted in FIG. 2, the work set WS is rotated in the direction of an arrow A, for example. The resin nozzle 24 drops a predetermined amount of water-soluble resin to the upper surface of the wafer W to coat

the upper surface of the wafer W with the predetermined amount of water-soluble resin. A water-soluble liquid resin such for example as PVP (polyvinylpyrrolidone), PVA (polyvinyl alcohol), or the like is used as the water-soluble resin. Then, a centrifugal force occurring on the holding table 20 causes the water-soluble resin to flow from the center of the wafer W to the outer peripheral edge of the wafer W, and spread over the entire upper surface of the wafer W.

The supplying means 23 forms a water-soluble protective film on the upper surface of the wafer W by coating the upper surface of the wafer W with the predetermined amount of water-soluble resin from the resin nozzle 24, and at the same time, the supplying means 23 supplies a cleaning water from the water nozzle 25 to the upper surface of the ring frame F and jets an air from the plurality of injection ports 260 of the air nozzle 26 to the upper surface of the ring frame F. Thus, even when the water-soluble resin adheres to the upper surface of the ring frame F, the cleaning water removes the water-soluble resin, and the centrifugal force generated by the rotation of the holding table 20 and the air blow off the cleaning water including the water-soluble resin to the outside of the ring frame F.

After a desired water-soluble protective film is formed so as to cover the entire upper surface of the wafer W, the rotary shaft 28 is rotated clockwise, for example, by the motor, as depicted in FIG. 4, and thereby the arm 27 turns in the horizontal direction with respect to the holding surface 20a of the holding table 20 and moves the supplying means 23 from the supply position P1 to the standby position SP. Thereafter, the conveying means 16 depicted in FIG. 1 conveys the work set WS to the processing table 12, and the laser processing means 17 performs predetermined laser processing on the upper surface of the wafer W.

Thus, in the protective film forming apparatus 2 according to the present invention, the supplying means 23 includes: the resin nozzle 24 that supplies the water-soluble resin to the center of the upper surface of the wafer W of the work set WS held by the holding table 20; the water nozzle 25 that supplies water to the upper surface of the ring frame F of the work set WS held by the holding table 20; and the air nozzle 26 that supplies air to the upper surface of the ring frame F of the work set WS held by the holding table 20. The resin nozzle 24, the water nozzle 25, and the air nozzle 26 are disposed on the arm 27 extending in the direction of the holding

surface of the holding table 20. The air nozzle 26 is disposed downstream of the water nozzle 25 in the rotational direction of the holding table 20. Therefore, when the water-soluble protective film is formed on the upper surface of the wafer W, the upper surface of the ring frame F can also be cleaned efficiently. Hence, the water-soluble resin is not left on the upper surface of the ring frame F. Then, when the conveying means 16 conveys the work set WS on which the water-soluble protective film is formed to the processing table 12, the water-soluble resin does not adhere to the conveying means 16.

While the above-described supplying means 23 has a configuration suitable for simultaneously performing protective film formation on the upper surface of the wafer W and the cleaning of the ring frame F, the supplying means 23 is not limited to such a configuration. For example, supplying means 23A depicted in FIG. 5 is a modification of the above-described supplying means 23, and is configured to be able to perform protective film formation and frame cleaning separately from each other. As with the supplying means 23, the supplying means 23A includes a resin nozzle 24a, a water nozzle 25a, and an air nozzle 26a. The resin nozzle 24a, the water nozzle

25a, and the air nozzle 26a are disposed on an arm 29 that extends in the direction of the holding surface of the holding table 20.

Flow passages in which fluids flow are formed within the arm 29. The arm 29 is formed so as to have a length such that an end of the arm 29 is positioned to the central side of the holding table 20. The resin nozzle 24a is disposed on the end of the arm 29. The water nozzle 25a is disposed on the end of the arm 29 on an opposite side from the side where the resin nozzle 24a is disposed. The air nozzle 26a is disposed on the water nozzle 25a side and on a lateral side of the arm 29. As in the above-described supplying means 23, a rotary shaft 28a having an axis in the vertical direction is connected to another end of the arm 29. A motor (not depicted) capable of normal rotation and reverse rotation is connected to the rotary shaft 28a.

The supplying means 23A can be moved to each of a resin supply position P2, a ring frame cleaning position P3, and a standby position SP. The resin supply position P2 is a position at which the resin nozzle 24a is positioned above the center of the wafer W. The ring frame cleaning position P3 is a position at which the water nozzle 25a and the air nozzle 26a are positioned

above the ring frame F.

When a protective film is to be formed on the upper surface of the wafer W by using the supplying means 23A, the rotary shaft 28a is rotated counterclockwise, for example, by the motor, and thereby the arm 29 turns in the horizontal direction with respect to the holding surface 20a of the holding table 20 and moves the supplying means 23A from the standby position SP to the resin supply position P2. The work set WS is rotated in the direction of an arrow B, for example, by rotating the holding table 20 by the rotating means 21 depicted in FIG. 2. The resin nozzle 24a drops a predetermined amount of water-soluble resin to the upper surface of the wafer W to coat the upper surface of the wafer W with the predetermined amount of water-soluble resin. Then, a centrifugal force occurring on the holding table 20 causes the water-soluble resin to flow from the center of the wafer W to the outer peripheral edge of the wafer W, and spread over the entire upper surface of the wafer W. A desired water-soluble protective film is thus formed so as to cover the entire upper surface of the wafer W.

When the water-soluble protective film is formed on the upper surface of the wafer W, the rotary shaft 28a is rotated clockwise, for example, by the motor, as depicted

in FIG. 6, and thereby the arm 29 turns in the horizontal direction with respect to the holding surface 20a of the holding table 20 and moves the supplying means 23A from the resin supply position P2 to the ring frame cleaning position P3. A cleaning water is supplied from the water nozzle 25a to the upper surface of the ring frame F, and an air is jetted from the plurality of injection ports 260 of the air nozzle 26a to the upper surface of the ring frame F. Thus, even when the water-soluble resin adheres to the upper surface of the ring frame F, the cleaning water removes the water-soluble resin, and the centrifugal force generated by the rotation of the holding table 20 and the air blow off the cleaning water including the water-soluble resin to the outside of the ring frame F and dry the ring frame F.

After a desired water-soluble protective film is formed so as to cover the entire upper surface of the wafer W and the upper surface of the ring frame F is cleaned, the rotary shaft 28a is further rotated clockwise by the motor, as depicted in FIG. 7, and thereby the arm 29 turns in the horizontal direction with respect to the holding surface 20a of the holding table 20 and moves the supplying means 23A from the ring frame cleaning position P3 to the standby position SP.

Thereafter, the conveying means 16 depicted in FIG. 1 conveys the work set WS to the processing table 12, and the laser processing means 17 performs predetermined laser processing on the upper surface of the wafer W. The supplying means 23A can move the resin nozzle 24a, the water nozzle 25a, and the air nozzle 26a to desired positions by one driving source without causing the resin nozzle 24a, the water nozzle 25a, and the air nozzle 26a to interfere with each other.

While the protective film forming apparatus 2 depicted in the foregoing embodiment is configured to be incorporated in the processing apparatus 1, the protective film forming apparatus 2 may be a configuration of a single body independent from the processing apparatus 1.

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 claims are therefore to be embraced by the invention.

WHAT IS CLAIMED IS:

1. A protective film forming apparatus for forming a water-soluble protective film on an upper surface of a wafer, the protective film forming apparatus comprising:

a holding table that retains a work set formed by affixing the wafer to a tape that is affixed to a ring frame so as to close an opening of the ring frame;

rotating means rotating the holding table about a center of a holding surface of the holding table; and

supplying means supplying a water-soluble resin to the upper surface of the wafer held by the holding table;

the supplying means including

a resin nozzle that supplies the water-soluble resin to a center of the upper surface of the wafer of the work set held by the holding table,

a water nozzle that supplies water to an upper surface of the ring frame of the work set held by the holding table, and

an air nozzle that supplies air to the upper surface of the ring frame of the work set held by the holding table,

the resin nozzle, the water nozzle, and the air nozzle being disposed on an arm extending in a direction of the holding surface of the holding table, and

the air nozzle being disposed downstream of the water nozzle in a direction of rotation of the holding table.