

TAPE AFFIXING APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a tape affixing apparatus for affixing a tape to a ring frame and a wafer.

Description of the Related Art

As disclosed in JP 2011-086687A, for example, there is known a tape affixing apparatus that affixes a circular tape, e.g., a circular dicing tape, to a ring frame having a circular opening defined therein, thereby closing the circular opening, and then affixes a wafer to the tape that is exposed through the opening, thereby integrally combining the ring frame and the wafer with each other with the tape.

The tape affixing apparatus described above uses a tape unit including a belt-shaped (band-shaped) protective sheet, hereinafter referred to as a sheet, with a plurality of circular tapes arrayed at equal spaced intervals longitudinally along the sheet and affixed to the sheet. The tape unit is wound into a roll around a spool such that the circular tapes are positioned on an inner side of the sheet. The spool with

the tape unit wound thereon is fitted over a shaft of the tape affixing apparatus. Then, the sheet is gripped and pulled from an end of an outermost layer of the tape unit roll, and a peel plate is pressed against the sheet of the tape unit to form a bend in the tape unit, peeling off a first one of the circular tapes from the sheet.

An end of the circular tape peeled off from the sheet is positioned on the ring frame, and the circular tape is pressed against the ring frame by a rolling roller to affix the end of the circular tape to the ring frame. While progressively peeling off the circular tape from the sheet, the rolling roller presses the circular tape to affix the circular tape to an upper surface of the wafer and an upper surface of the ring frame.

SUMMARY OF THE INVENTION

Since the circular tape is affixed to the wafer and the ring frame while at the same time the circular tape is peeled off from the sheet, there is a spacing between the peel plate and the roller. At the end of processing affixing the circular tape to the wafer and the ring frame, the circular tape drops by gravity from the sheet and is affixed to the ring frame under its own weight. Thereafter, the roller presses the circular tape to the

ring frame. Therefore, when the circular tape is affixed to the ring frame, the circular tape may be wrinkled or air bubbles may be trapped between the circular tape and the ring frame.

A portion of the affixed circular tape that is wrinkled and/or traps air bubbles between itself and the ring frame tends to lack enough bonding power, and may not be expanded sufficiently when the circular tape is expanded to divide the wafer in a dicing process. If the circular tape is not sufficiently expanded, then device chips on the wafer may contact each other, tending to chip themselves, or the circular tape may peel off from the ring frame.

It is therefore an object of the present invention to provide a tape affixing apparatus that is capable of affixing a circular tape to a ring frame and a wafer without wrinkling the circular tape and/or trapping air bubbles between the circular tape and the ring frame.

In accordance with an aspect of the present invention, there is provided a tape affixing apparatus for affixing one at a time of a plurality of circular tapes disposed in a longitudinal array on a belt-shaped sheet of a belt-shaped tape unit and peeled off therefrom to a ring frame and a wafer disposed in an opening

defined in the ring frame, thereby integrally combining the ring frame and the wafer with the circular tape, including a holding table having a ring frame holder for holding the ring frame and a wafer holder for holding the wafer in the opening in the ring frame, a reel-out unit for reeling out the belt-shaped tape unit while rotating, a take-up unit for winding up the belt-shaped sheet from which the circular tape has been peeled off while rotating, a peel plate for contacting the belt-shaped sheet between the reel-out unit and the take-up unit and forming a bend in the belt-shaped tape unit with the belt-shaped sheet inside to peel off the circular tape from the belt-shaped sheet, a tape affixing roller for pressing the circular tape peeled off from the belt-shaped sheet against the ring frame and the wafer to affix the circular tape to the ring frame and the wafer, and an ejector nozzle for ejecting air toward the tape affixing roller from outside of an outer circumference of the ring frame held by the ring frame holder in a direction perpendicular to a rotational shaft on which the tape affixing roller is rotatably mounted. While the circular tape peeled off from the belt-shaped sheet and tending to sag downwardly is being pressed against a side surface of the tape affixing roller by the air ejected

from the ejector nozzle, the tape affixing roller is rotated to affix the circular tape to the ring frame and the wafer.

Preferably, the ejector nozzle ejects the air along an upper surface of the ring frame held by the ring frame holder.

Preferably, the ejector nozzle ejects the air at an angle in a range of 0 degree representing a direction parallel to an upper surface of the ring frame upwardly to 45 degrees.

The tape affixing apparatus according to the aspect of the present invention includes the ejector nozzle for ejecting air toward the tape affixing roller from outside of the outer circumference of the ring frame held by the ring frame holder in the direction perpendicular to a rotational shaft on which the tape affixing roller is rotatably mounted. Therefore, while the circular tape peeled off from the belt-shaped sheet and tending to sag downwardly is being pressed against a side surface of the tape affixing roller by the air ejected from the ejector nozzle, the tape affixing roller is rotated to affix the circular tape to the ring frame and the wafer. As a result, the circular tape is affixed to the wafer and the ring frame without wrinkling and/or trapping air bubbles

between the circular tape and the wafer and the ring frame. Therefore, when the circular tape is subsequently expanded to divide the wafer into individual device chips in a dicing process, adjacent ones of the device chips on the wafer are prevented from contacting each other and from chipping themselves.

In a case where the ejector nozzle ejects the air along the upper surface of the ring frame held by the ring frame holder, the ejected air is able to press the circular tape more reliably against the side surface of the tape affixing roller.

In a case where the ejector nozzle ejects the air at an angle in the range of 0 degree representing the direction parallel to the upper surface of the ring frame upwardly to 45 degrees, the ejected air is able to press the circular tape more reliably against the side surface of the tape affixing roller.

The above and other objects, features and advantages of the present invention and the manner of realizing them will become more apparent, and the invention itself will best be understood from a study of the following description and appended claims with reference to the attached drawings showing a preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view illustrating by way of example a tape unit wound into a roll;

FIG. 2 is a perspective view illustrating by way of example a tape affixing apparatus according to an embodiment of the present invention;

FIG. 3 is a side elevational view, partly in cross section, illustrating a manner in which a tape starts being affixed to a ring frame and a wafer on the tape affixing apparatus;

FIG. 4 is a side elevational view, partly in cross section, illustrating a manner in which the tape ends being affixed to the ring frame and the wafer while the tape is being pressed against a side surface of a tape affixing roller by a stream of air ejected along an upper surface of the ring frame on the tape affixing apparatus;

FIG. 5 is an enlarged fragmentary side elevational view, partly in cross section, illustrating a manner in which the tape ends being affixed to the ring frame and the wafer while the tape is being pressed against the side surface of the tape affixing roller by the stream of air ejected along the upper surface of the ring frame on the tape affixing apparatus; and

FIG. 6 is an enlarged fragmentary side elevational view, partly in cross section, illustrating a manner in which the tape ends being affixed to the ring frame and the wafer while the tape is being pressed against the side surface of the tape affixing roller by a stream of air ejected in an angular range of θ degree upwardly to 45 degrees where the θ degree represents a direction parallel to the upper surface of the ring frame according to a modification of the embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Certain directions including X-axis, Y-axis, and Z-axis directions will be used to represent the orientations of some components in the description and drawings to be referred to below. The X-axis directions include a + X direction and a - X direction that are oriented away from each other, the Y-axis directions include a + Y direction and a - Y direction that are oriented away from each other, and the Z-axis directions include a + Z direction and a - Z direction that are oriented away from each other.

A tape unit TU illustrated in FIG. 1 is of a structure where a belt-shaped (band-shaped, web-shaped) tape T5 including a base T51 made of polyethylene, for

example, and an adhesive layer T52 formed on a surface of the base T51, and a belt-shaped protective sheet T1, hereinafter referred to as "sheet T1," for protecting the adhesive layer T52 are affixed to each other.

The belt-shaped tape T5 is precut into a plurality of circular areas that are commensurate in diameter with the opening of a ring frame F (see FIG. 2) shaped as an annular plate to which they are to be affixed. The circular areas act as circular tapes T2 each corresponding in shape to a circular wafer W to which it is to be affixed. The circular tapes T2 are affixed to the protective tape T1 at equal spaced intervals along the longitudinal directions of the protective tape T1, i.e., X-axis directions in FIG. 1. The tape unit TU is wound in a tape roll around a tube or spool T3 with the circular tapes T2 on the inner side of the sheet T1. The circular tapes T2 are larger in diameter than the circular opening (see FIG. 2) of the ring frame F and smaller in diameter than the outside diameter of the ring frame F.

FIG. 2 illustrates in perspective a tape affixing apparatus 1 according to a preferred embodiment of the present invention. The tape affixing apparatus 1 includes an elongate base block 10 on which various components, to

be described below, of the tape affixing apparatus 1 are mounted. The elongate base block 10 has longitudinal directions extending parallel to the X-axis directions. The tape affixing apparatus 1 is able to produce work sets each including a ring frame F and a wafer W that are integrally combined with each other by a circular tape T2.

As illustrated in FIG. 2, the ring frame F is in the form of an annular flat plate made of a metal such as stainless steel (SUS), for example, and has a circular opening defined therein that has an inside diameter larger than the diameter of the wafer W. The ring frame F has its outer circumferential portion partly cut off along flat lines, providing a pair of first flat surfaces that lie parallel to each other and diametrically opposite each other and a pair of second flat surfaces that lie parallel to each other and diametrically opposite each other. The pair of first flat surfaces and the pair of second flat surfaces are used to position the ring frame F.

The wafer W is a circular semiconductor wafer made of a base material of silicon or the like, for example. The wafer W has a face side, i.e., a lower surface, Wa facing downwardly in FIG. 2 and having a plurality of

devices formed in respective areas demarcated in a grid pattern. The devices are protected by a protective tape, not illustrated, affixed to the face side Wa. The wafer W has a reverse side, i.e., an upper surface, Wb to which a circular tape T2 is to be affixed. The wafer W may be made of a base material other than silicon, e.g., gallium arsenide, sapphire, gallium nitride, ceramic, resin, silicon carbide, or the like, and may be a rectangular packaged substrate or the like.

The base block 10 of the tape affixing apparatus 1 has a horizontal upper surface. A reel-out unit 80 for reeling out the tape unit TU while rotating is disposed above a rear area of the base block 10 in a + X direction. The reel-out unit 80 includes a rotational shaft inserted axially through the spool T3 of the tape unit TU wound in the roll. The rotational shaft of the reel-out unit 80 is coupled to a rotary actuator such as an electric motor, not illustrated. The rotational shaft extends axially in Y-axis directions perpendicular to the X-axis directions in a horizontal plane. The tape unit TU is supported on the rotational shaft for rotation therewith. When the rotational shaft is rotated about its central axis by the rotary actuator, the tape unit TU rotates therewith, unwinding the tape unit TU into the

belt-shaped tape unit TU with the circular tapes T2 on the upper side thereof and delivering the belt-shaped tape unit TU toward a peel plate 15. A pinch roller or the like, not illustrated, for preventing the tape unit TU from sagging, etc. is disposed between the peel plate 15 and the reel-out unit 80.

A take-up unit 82 for winding the sheet T1 from which tapes T2 have been peeled off while rotating is disposed in a position below and behind the reel-out unit 80. The take-up unit 82 has a rotatable shaft for winding up the sheet T1. The rotational shaft of the take-up unit 82 extends in the Y-axis directions and is coupled to a rotary actuator such as an electric motor, not illustrated. The peel plate 15, which is disposed obliquely forwardly and downwardly of the reel-out unit 80, has a tip end for contacting the sheet T1 between the reel-out unit 80 and the take-up unit 82 and forming a sharp bend in the tape unit TU with the sheet T1 inside, around the tip end, peeling off one at a time of the circular tapes T2 from the tape unit TU.

The peel plate 15 is in the form of a slanted plate having a triangular cross-sectional shape as viewed in side elevation along the Y-axis directions. The peel plate 15 has a length along the Y-axis directions that is

equal to or larger than a width of the sheet T1 along the Y-axis directions. The tip end of the peel plate 15 may be rounded to protect the tape unit TU against damage. As illustrated in FIGS. 3 and 4, the tip end of the peel plate 15 presses and bends the sheet T1 into a sharp angle, peeling off one at a time of the circular tapes T2 from the sheet T1.

For example, as illustrated in FIG. 5, the peel plate 15 is mounted on a movable plate member 161 movably mounted on a plate base 160 that extends obliquely upwardly. The peel plate 15 is disposed opposite a tape affixing roller 30, to be described later, that affixes the circular tape T2 peeled off from the sheet T1 to the ring frame F and the wafer W by pressing the circular tape T2 to the ring frame F and the wafer W. The movable plate member 161 is reciprocally movable obliquely upwardly and downwardly on the plate base 160 by a ball screw mechanism or the like, not illustrated, to position the peel plate 15 appropriately with respect to the tape unit TU. In FIGS. 2 through 4, the plate base 160 and the movable plate member 161 by which the peel plate 15 is movable are omitted from illustration.

As illustrated in FIG. 2, the sheet T1 from which the circular tape T2 has been peeled off by the peel

plate 15 is delivered rearwardly of the peel plate 15 in the + X direction. The sheet T1 is then wound up into a roll on the rotational shaft of the take-up unit 82 as the rotational shaft is rotated about its central axis by the rotary actuator. The rotary actuator of the take-up unit 82 has its torque controlled to control the speed at which to pull the sheet T1 from the tape unit TU in the form of the tape roll on the reel-out unit 80. Between the take-up unit 82 and the peel plate 15, there is disposed a sheet support roller 820 for supporting the sheet T1 from which circular tapes T2 have been peeled off to prevent it from sagging.

As illustrated in FIG. 2, the tape affixing apparatus 1 includes a holding table, i.e., holding means, 2 mounted on the base block 10 and having a ring frame holder 20 for holding the ring frame F and a wafer holder 21 for holding the wafer W in the opening in the ring frame F, and a tape affixing roller 30 for affixing a circular tape T2 peeled off from the sheet T1 to the ring frame F and the wafer W by pressing the circular tape T2 to the ring frame F and the wafer W.

As illustrated in FIGS. 2 and 3, the ring frame holder 20 is of a square shape as viewed in plan, for example, and has an upwardly open cavity 200 defined

centrally therein with the wafer holder 21 housed therein. The ring frame holder 20 has an upper surface 20a acting as a ring frame holding surface that is flat. A plurality of, e.g., four, suction cup housing recesses, not illustrated, are defined in the upper surface 20a of the ring frame holder 20. The suction cup housing recesses house therein respective suction cups 25, illustrated in FIG. 2 only, for attracting the ring frame F under suction on the upper surface 20a of the ring frame holder 20. The suction cups 25 are of a circular shape as viewed in plan and made of an elastically deformable elastic material such as rubber, for example. The suction cups 25 are held in fluid communication with a suction source such as an evacuating apparatus, not illustrated.

The ring frame holder 20 is not limited to the outer profile and structural details that are illustrated in the present embodiment.

On the upper surface 20a of the ring frame holder 20, there are disposed a first fixed positioner 23 in the form of two fixed pins or the like and a first movable positioner 24 in the form of a movable pin or the like that is diametrically opposite the first fixed positioner 23 across the ring frame holder 20 and is movable toward

and away from the first fixed positioner 23 in directions parallel to the upper surface 20a. On the upper surface 20a of the ring frame holder 20, there are also disposed a second fixed positioner 26 in the form of two fixed pins or the like and a second movable positioner 27 in the form of a movable pin or the like that is diametrically opposite the second fixed positioner 26 across the ring frame holder 20 and is movable toward and away from the second fixed positioner 26 in directions parallel to the upper surface 20a. These first fixed positioner 23 and the first movable positioner 24 and the second fixed positioner 26 and the second movable positioner 27 act to position or center the ring frame F on the upper surface 20a.

The directions along which the first fixed positioner 23 and the first movable positioner 24 are positioned opposite each other across the ring frame holder 20 and the directions along which the second fixed positioner 26 and the second movable positioner 27 are positioned opposite each other across the ring frame holder 20 are substantially perpendicular to each other in a horizontal plane on the upper surface 20a.

According to the present embodiment, at least the first fixed positioner 23 and the first movable

positioner 24 or the second fixed positioner 26 and the second movable positioner 27 sandwich therebetween at least either the pair of first flat surfaces or the pair of second flat surfaces on the outer circumference of the ring frame F, thereby positioning or centering the ring frame F in a target position on the upper surface 20a of the ring frame holder 20. Thereafter, the ring frame F is held under suction on the upper surface 20a by the suction cups 25.

As illustrated in more detail in FIG. 3, the wafer holder 21, which has a circular outer profile, includes an attracting member 210 made of a porous material for attracting the wafer W under suction thereon and a frame 211 that is of a vertically recessed cross-sectional shape having an upwardly open cavity defined therein and supports the attracting member 210 thereon. The attracting member 210 is fitted in the cavity in the frame 211 and held in fluid communication with the suction source, not illustrated. The attracting member 210 has a flat upper holding surface 210a. When a suction force, i.e., a negative pressure, produced by the suction source is transmitted to the holding surface 210a, the wafer holder 21 holds the wafer W under suction on the holding surface 210a.

A height of the upper surface 20a of the ring frame holder 20 is selected such that when the wafer W is held on the holding surface 210a of the wafer holder 21 and the ring frame F is held on the upper surface 20a of the ring frame holder 20, the upper surface of the ring frame F and the upper surface Wb of the wafer W lie substantially flush with each other.

As illustrated in FIGS. 2 and 3, the base block 10 supports thereon a holding table moving mechanism, i.e., holding table moving means, 13 for reciprocally moving the wafer holder 21 and the ring frame holder 20 in the X-axis directions. The holding table moving mechanism 13 includes a ball screw 130 having a central axis extending in the X-axis directions, a pair of guide rails 131 extending parallel to the ball screw 130 and disposed one on each side of the ball screw 130, and an electric motor 132 coupled to an end of the ball screw 130 for rotating the ball screw 130 about its central axis. The ring frame holder 20 has a nut, not illustrated, on its lower surface that is threaded over the ball screw 130. When the electric motor 132 is energized, it rotates the ball screw 130 about its central axis, causing the nut to move the wafer holder 21 and the ring frame holder 20 reciprocally along the X-axis directions while the wafer

holder 21 and the ring frame holder 20 are being guided by the guide rails 131.

As illustrated in FIG. 2, the tape affixing roller 30 is disposed in a position above the path along which the ring frame holder 20 is movable and in the vicinity of the tip end of the peel plate 15 that has been lowered to an affixing position. The tape affixing roller 30 has an axial length that is equal to or larger than a width of the ring frame holder 20 along the Y-axis directions, and is rotatably supported on a roller frame, not illustrated. The tape affixing roller 30 is rotatably mounted on a roller rotational shaft 32, hereinafter referred to as a rotational shaft 32. The tape affixing roller 30 has its axis extending across the ring frame holder 20 in the Y-axis directions, and is vertically movable by a roller lifting and lowering mechanism, i.e., roller lifting and lowering means, 31 (see FIG. 5).

As illustrated in FIGS. 2 and 3, the tape affixing apparatus 1 includes an ejector nozzle 35 for ejecting air in a - X direction that is perpendicular in a horizontal plane to the rotational shaft 32 of the tape affixing roller 30, from outside of the outer circumference of the ring frame F held by the ring frame holder 20 toward the tape affixing roller 30.

Specifically, a nozzle rest 36 is disposed centrally on a side surface of the ring frame holder 20 that faces in the + X direction, and horizontally protrudes from the side surface of the ring frame holder 20 in the + X direction. The ejector nozzle 35 is mounted on the nozzle rest 36.

The ejector nozzle 35 is of an L-shaped profile as viewed in side elevation, for example, and has an air ejection port 350 that is oriented in the - X direction in FIGS. 2 and 3. A stream of air that is ejected from the air ejection port 350 flows in the - X direction along the upper surface of the ring frame F held by the ring frame holder 20. As illustrated in FIG. 3, the ejector nozzle 35 is held in fluid communication with an air supply source 359 such as an air compressor for supplying compressed air.

The air ejection port 350 of the ejector nozzle 35 may be positioned to face at least a central area of a side surface of the tape affixing roller 30 in its longitudinal directions, i.e., the Y-axis directions, because the ejector nozzle 35 is required to be able to press an outer circumferential portion of the circular tape T2 to be finally affixed to the ring frame F against the side surface of the tape affixing roller 30. The

ejector nozzle 35 is positioned behind the first fixed positioner 23 in the + X direction. The stream of air ejected from the ejector nozzle 35 flows between the two fixed pins of the first fixed positioner 23. Therefore, the ejected stream of air is not obstructed by the first fixed positioner 23.

An ionizer 6 for destaticizing or neutralizing the circular tape T2 that has been affixed to the wafer W and the ring frame F is disposed in a position above the holding table 2 that has been moved in the - X direction past the tape affixing roller 30 as illustrated in FIG. 6. The ionizer 6 should preferably, but not necessarily, be of a nozzle-type pulsed alternating current (AC) ionizer. As illustrated in FIGS. 2 and 3, the ionizer 6 includes an ionizing nozzle 60 having ejection ports 60a for facing the circular tape T2 affixed to the ring frame F held on the holding table 2 in Z-axis directions, and an air source 61 held in fluid communication with the ionizing nozzle 60.

As illustrated in FIG. 2, the ionizing nozzle 60 is of an elongate shape having a length extending in the Y-axis directions across the holding table 2. The ionizing nozzle 60 ejects ionized air to the circular tape T2 that moves below the ionizing nozzle 60 over an area ranging

from an outer circumferential edge of the circular tape T2 across the center thereto to an opposite outer circumferential edge of the circular tape T2. However, the ionizing nozzle 60 is not limited to such an ionizing air ejecting pattern.

An example of operation of the tape affixing apparatus 1 illustrated in FIG. 2 will be described below.

First, the wafer W is placed on the wafer holder 21 of the holding table 2 while in substantially central alignment therewith, and the ring frame F is placed on the ring frame holder 20. Then, the suction source, not illustrated, is actuated to hold the wafer W under suction on the holding surface 210a of the wafer holder 21 and also to hold the ring frame F on the upper surface 20a of the ring frame holder 20.

The reel-out unit 80 rotates to unwind and deliver the tape unit TU toward the peel plate 15.

Then, the holding table moving mechanism 13 moves the holding table 2 in the - X direction to bring the ring frame holder 20 that is holding the ring frame F thereon closely to a position directly below the tape affixing roller 30. Thereafter, the roller lifting and lowering mechanism 31, not illustrated in FIG. 2, is

actuated to lower the tape affixing roller 30 until the tape affixing roller 30 to a height or vertical position where it can affix the circular tape T2 to the ring frame F held by the ring frame holder 20.

The peel plate 15 is lowered to a tape peeling position where the tape unit TU passes through a gap between the tip end of the peel plate 15 and the outer circumferential side surface of the tape affixing roller 30. The gap is small enough for the tape unit TU to scrape therethrough. Therefore, the tip end of the peel plate 15 is disposed above the upper surface of the ring frame F held by the ring frame holder 20. A distance between the upper surface of the ring frame F and the tip end of the peel plate 15 is equal to or smaller than a radius of the tape affixing roller 30. As illustrated in FIGS. 3 and 4, the above distance is reduced by placing the peel plate 15 at an angle that makes the peel plate 15 nearly horizontal, though the nearly horizontal peel plate 15 tends to make the tape affixing apparatus 1 larger in the X-axis directions. On the other hand, as illustrated in FIGS. 5 and 6, the distance is increased by placing the peel plate 15 at an angle that makes the peel plate 15 nearly vertical. According to the present invention, the tape affixing apparatus 1 incorporates a

mechanism for ejecting air to press the circular tape T2 against the tape affixing roller 30 as described later, the mechanism being effectively used with the nearly vertical peel plate 15. The nearly vertical peel plate 15 makes the tape affixing apparatus 1 smaller in the X-axis directions. The tip end of the peel plate 15 contacts and press the sheet T1 of the tape unit TU, forming a sharp bend in the tape unit TU with the sheet T1 inside, around the tip end, peeling off the circular tape T2 from the tape unit TU. The circular tape T2 peeled off from the tape unit TU is delivered below the tape affixing roller 30.

As illustrated in FIG. 3, while the tape unit TU is being delivered to the peel plate 15 by the reel-out unit 80, the tape affixing roller 30 rotates at a predetermined rotational speed. As the ring frame holder 20 and the wafer holder 21 are delivered in the - X direction by the holding table moving mechanism 13, the circular tape T2 is pressed against the upper surface of the ring frame F held by the ring frame holder 20 by the tape affixing roller 30.

At the same time, the take-up unit 82 winds up the sheet T1 from which the circular tape T2 has been peeled off.

While the tape affixing roller 30 is pressing the circular tape T2 against the ring frame F and the wafer W, the holding table 2 is moved in the - X direction to a position beyond the tape affixing roller 30 by the holding table moving mechanism 13, as illustrated in FIGS. 4 and 5. The circular tape T2 is now affixed to the wafer W and the ring frame F, producing a work set in which the wafer W and the ring frame F are integrally combined with each other by the circular tape T2.

As illustrated in FIG. 5, in the tape affixing apparatus 1 according to the present embodiment, the outer circumferential portion of the circular tape T2 that remains affixed to the sheet T1 is prevented by air ejected from the ejector nozzle 35 from sagging down onto the ring frame F by gravity when the circular tape T2 is entirely peeled off from the sheet T1. Specifically, when the air supply source 359 supplies compressed air to the ejector nozzle 35, the air ejection port 350 ejects a stream of air toward the tape affixing roller 30 from outside of the outer circumference of the ring frame F held by the ring frame holder 20. At this time, the stream of air ejected from the air ejection port 350 flows along the upper surface of the ring frame F held by the ring frame holder 20, impinges upon the lower

surface, i.e., the adhesive layer, of the circular tape T2, and flows upwardly to support the circular tape T2 from below that is peeled off from the sheet T1 and tends to sag downwardly. The stream air thus presses the circular tape T2 against the side surface of the tape affixing roller 30 so as to extend along the side surface of the tape affixing roller 30, which affixes the circular tape T2 to the wafer W and the ring frame F. As a result, the circular tape T2 is affixed to the wafer W and the ring frame F without wrinkling and/or trapping air bubbles between the circular tape T2 and the wafer W and the ring frame F. Therefore, when the circular tape T2 is subsequently expanded to divide the wafer W into individual device chips in a dicing process, adjacent ones of the device chips on the wafer W are prevented from contacting each other and from chipping themselves.

FIG. 6 illustrates an ejector nozzle 37 according to a modification of the above embodiment, used in place of the ejector nozzle 35 illustrated in FIG. 5, for ejecting a stream of air to prevent the outer circumferential portion of the circular tape T2 that remains affixed to the sheet T1 from sagging down onto the ring frame F by gravity when the circular tape T2 is entirely peeled off from the sheet T1.

Specifically, the ejector nozzle 37 illustrated in FIG. 6 is integrally incorporated in the ring frame holder 20 and includes an air inlet port 370 that is open at a side surface of the ring frame holder 20 and an air ejection port 371 connected to the air inlet port 370 via an air flow channel defined in the ring frame holder 20, the air ejection port 371 being open at the upper surface of the ring frame holder 20 behind the first fixed positioner 23. The air inlet port 370 is held in fluid communication with the air supply source 359. The ring frame holder 20 includes an air guide 205 having a round edge surface for guiding a stream of air ejected vertically upwardly from the air ejection port 371 to flow obliquely upwardly above the holding table 2. The stream of air ejected vertically upwardly from the air ejection port 371 changes its direction along the round edge surface of the air guide 205, and then flows along and parallel to an upper surface of the air guide 205 and then on the upper surface of the ring frame F held by the ring frame holder 20 toward the tape affixing roller 30. A flow uniformizing plate 375 is disposed obliquely upwardly of the air guide 205 for uniformizing the stream of air ejected from the ejector nozzle 37 and guided by the air guide 205 into a uniform stream of air directed

toward the tape affixing roller 30.

As illustrated in FIG. 6, when the air supply source 359 supplies compressed air to the ejector nozzle 37, the air ejection port 371 ejects a stream of air toward the tape affixing roller 30 from outside of the outer circumference of the ring frame F held by the ring frame holder 20. The stream of air is ejected from the air ejection port 371 at an angle adjustable by changing the angle of the flow uniformizing plate 375, in a range of 0 degree representing a direction parallel to the upper surface of the ring frame F upwardly, i.e., clockwise from 0 degree in FIG. 6, to 45 degrees. As described above, the stream of air impinges upon the lower surface of the circular tape T2 and flows upwardly to support the circular tape T2 from below that is peeled off from the sheet T1 and tends to sag downwardly. The stream air thus presses the circular tape T2 against the side surface of the tape affixing roller 30 so as to extend along the side surface of the tape affixing roller 30, which affixes the circular tape T2 to the wafer W and the ring frame F. As a result, the circular tape T2 is affixed to the wafer W and the ring frame F without wrinkling and/or trapping air bubbles between the circular tape T2 and the wafer W and the ring frame F.

Therefore, when the circular tape T2 is subsequently expanded to divide the wafer W into individual device chips, adjacent ones of the device chips on the wafer W are prevented from contacting each other and from chipping themselves. If the stream of air ejected from the ejector nozzle 37 impinged perpendicularly upon the circular tape T2 peeled off from the sheet T1, but not affixed to the wafer W and the ring frame F, then the circular tape T2 would tend to sag and extend along the tape affixing roller 30. The stream of air ejected at an angle in the range of 0 degree to 45 degrees as described above is effective to prevent the circular tape T2 from sagging along the tape affixing roller 30.

After the circular tape T2 is affixed to the wafer W and the ring frame F, producing a work set, while air is being ejected toward the tape affixing roller 30 from the ejector nozzle 35 illustrated in FIG. 5 or the ejector nozzle 37 illustrated in FIG. 6, the air source 61 illustrated in FIG. 5 supplies air to the ionizing nozzle 60, which ejects positively charged ionized air and negatively charged ionized air in essentially equal amounts to the circular tape T2 of the work set that travels below the ionizing nozzle 60, destaticizing or neutralizing the circular tape T2 that has been charged

when peeled off from the sheet T1. Thereafter, the wafer W that can be handled as the work set through the ring frame F is transported by a feed unit, not illustrated, to a dicing apparatus or the like where the wafer W is diced or otherwise processed.

The tape affixing apparatus according to the present invention is not limited to the embodiment and the modification described above, i.e., the structural details of the tape affixing apparatus 1 illustrated in the accompanying drawings. Various changes and modifications may be made therein within the scope of the present invention.

The present invention is not limited to the details of the above described preferred embodiment. The scope of the invention is defined by the appended claims and all changes and modifications as fall within the equivalence of the scope of the claims are therefore to be embraced by the invention.

WHAT IS CLAIMED IS:

1. A tape affixing apparatus for affixing one at a time of a plurality of circular tapes disposed in a longitudinal array on a belt-shaped sheet of a belt-shaped tape unit and peeled off therefrom to a ring frame and a wafer disposed in an opening defined in the ring frame, thereby integrally combining the ring frame and the wafer with the circular tape, comprising:

a holding table having a ring frame holder for holding the ring frame and a wafer holder for holding the wafer in the opening in the ring frame;

a reel-out unit for reeling out the belt-shaped tape unit while rotating;

a take-up unit for winding up the belt-shaped sheet from which the circular tape has been peeled off while rotating;

a peel plate for contacting the belt-shaped sheet between the reel-out unit and the take-up unit and forming a bend in the belt-shaped tape unit with the belt-shaped sheet inside to peel off the circular tape from the belt-shaped sheet;

a tape affixing roller for pressing the circular tape peeled off from the belt-shaped sheet against the ring frame and the wafer to affix the circular tape to

the ring frame and the wafer; and

an ejector nozzle for ejecting air toward the tape affixing roller from outside of an outer circumference of the ring frame held by the ring frame holder in a direction perpendicular to a rotational shaft on which the tape affixing roller is rotatably mounted,

wherein while the circular tape peeled off from the belt-shaped sheet and tending to sag downwardly is being pressed against a side surface of the tape affixing roller by the air ejected from the ejector nozzle, the tape affixing roller is rotated to affix the circular tape to the ring frame and the wafer.

2. The tape affixing apparatus according to claim 1,

wherein the ejector nozzle ejects the air along an upper surface of the ring frame held by the ring frame holder.

3. The tape affixing apparatus according to claim 1,

wherein the ejector nozzle ejects the air at an angle in a range of 0 degree representing a direction parallel to an upper surface of the ring frame upwardly to 45 degrees.