DESCRIPTION

TITLE OF THE INVENTION: PEELING DEVICE AND HOLDING METHOD

TECHNICAL FIELD

[0001]

The present disclosure relates to a peeling device and a holding method.

BACKGROUND ART

[0002]

Conventionally, a peeling device for peeling two substrates (a processing-target substrate and a support substrate) constituting a bonded substrate from each other has been known. For example, PTL 1 discloses a peeling device for peeling a bonded substrate held by a holding jig including a dicing frame and dicing tape. During peeling, this peeling device causes the dicing tape overlapping the bonded substrate to be suctioned to a lower first holding part, and pushes the dicing frame downward in the vertical direction.

[0003]

The peeling device forms a cut by allowing a blade to enter between the two substrates. The peeling device moves a plurality of suctioning moving parts of an upper second holding part downward to suction the support substrate, and raises the support substrate upward, starting from a suctioning moving part on the blade entry side, thereby separating the processing-target substrate from the support substrate.

CITATION LIST

PATENT LITERATURE

[0004] PTL 1: Japanese Patent Application Laid-Open Publication No. 2015-207776

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0005]

The present disclosure provides a technique capable of stably suctioning a bonded substrate held by a holding jig.

SOLUTION TO THE PROBLEM

[0006]

According to one aspect of the present disclosure, there is provided a peeling device configured to peel a bonded substrate formed by bonding a first substrate and a second substrate, wherein, in a holding jig including a dicing frame having an opening and dicing tape fixed to the dicing frame to close the opening, the bonded substrate is pasted on the dicing tape by being disposed in the opening, the peeling device including: a holding part configured to hold the bonded substrate by suctioning the dicing tape of the holding jig, wherein the holding part includes a center region and an outer peripheral region partitioned from the center region and looping around the center region on an outer side of the center region, the holding part being configured to apply a suctioning pressure for suctioning the dicing tape via each of the center region and the outer peripheral region.

ADVANTAGEOUS EFFECTS OF THE INVENTION

[0007]

According to one aspect, it is possible to suction a bonded substrate held by a holding jig stably.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

[FIG. 1] FIG. 1 is a plan view schematically illustrating a peeling system according to an embodiment.

[FIG. 2] FIG. 2 is a side view schematically illustrating the configuration of a transfer station of a peeling system.

[FIGS. 3] FIG. 3 (A) is a side cross-sectional view illustrating a bonded

substrate, a dicing frame, and dicing tape; and FIG. 3 (B) is a plan view illustrating a bonded substrate, a dicing frame, and dicing tape.

[FIG. 4] FIG. 4 is a partial side cross-sectional view schematically illustrating the configuration of a peeling device according to an embodiment.

[FIG. 5] FIG. 5 is a plan view illustrating a support member, an upper suctioning group, and a blade.

[FIGS. 6] FIG. 6 (A) is a first view illustrating a procedure for peeling a bonded wafer; FIG. 6 (B) is a second view illustrating a procedure for peeling a bonded wafer; FIG. 6 (C) is a third view illustrating a procedure for peeling a bonded wafer; and FIG. 6 (D) is a fourth view illustrating a procedure for peeling a bonded wafer.

[FIGS. 7] FIG. 7 (A) is an enlarged cross-sectional view illustrating dicing tape in which an air bubble is generated, and a bonded wafer; and FIG. 7 (B) is a view illustrating a state in which dicing tape containing an air bubble is placed on a lower chuck according to a reference example.

[FIGS. 8] FIG. 8 (A) is an oblique view illustrating a lower chuck according to a first embodiment; and FIG. 8 (B) is an enlarged cross-sectional view illustrating the lower chuck according to the first embodiment.

[FIG. 9] FIG. 9 is a flowchart illustrating a peeling method including a holding method according to an embodiment.

[FIG. 10] FIG. 10 is a cross-sectional view illustrating suctioning of dicing tape by a lower chuck.

[FIGS. 11] FIG. 11 (A) is an oblique view of a lower chuck according to a second embodiment; and FIG. 11 (B) is an enlarged cross-sectional view illustrating a lower chuck according to the second embodiment.

[FIG. 12] FIG. 12 is a cross-sectional view illustrating a holding jig, a bonded wafer, and a lower chuck in a state in which a dicing frame is pushed down.

DETAILED DESCRIPTION OF THE INVENTION

[0009]

Hereinafter, an embodiment for carrying out the present disclosure will be described with reference to the drawings. In the drawings, the same components are denoted by the same reference numerals, and redundant descriptions may be omitted. The X-axis direction, the Y-axis direction, and the Z-axis direction used in the following description are axial directions perpendicular to each other, the X-axis direction and the Y-axis direction are horizontal directions, and the Z-axis direction is the vertical direction.

[0010]

<Configuration of Peeling System 100>

First, the configuration of a peeling system 100 according to an embodiment of the present disclosure will be described with reference to FIGS. 1 to 2. The peeling system 100 includes a peeling device 7 for peeling a bonded substrate T formed by bonding a first substrate W1 and a second substrate W2. The peeling system 100 is configured as a system in which the bonded substrate T is loaded into the peeling device 7, the bonded substrate T is peeled by the peeling device 7, and the first substrate W1 and the second substrate W2 that have been peeled are each unloaded from the peeling device 7.

[0011]

The first substrate W1 and the second substrate W2 constituting the bonded substrate T are formed in disks having substantially the same shape (same diameter). Hereinafter, as illustrated in FIG. 3 (A), the first substrate W1 may be referred to as an “upper wafer W1”, the second substrate W2 may be referred to as a “lower wafer W2”, and the bonded substrate T may be referred to as a “bonded wafer T”. Hereinafter, of the plate surfaces of the upper wafer W1, the plate surface on the side bonded to the lower wafer W2 is referred to as a “bonding surface W1j”, and the plate surface on the side opposite to the bonding surface W1j is referred to as a “non-bonding surface W1n”. Of the plate surfaces of the lower wafer W2, the plate surface on the side bonded to the upper wafer W1 is referred to as a “bonding surface W2j”, and the plate surface on the side opposite to the bonding surface W2j is referred to as a

"non-bonding surface W2n". Note that the bonded wafer T, the upper wafer W1, and the lower wafer W2 may have shapes other than circles (for example, polygonal shapes and the like).

[0012]

At least one of the upper wafer W1 or the lower wafer W2 is a substrate on which a plurality of electronic circuits are formed on a semiconductor substrate, such as a silicon wafer, a compound semiconductor wafer, and the like. The compound semiconductor wafer is, for example, a GaAs wafer, a SiC wafer, a GaN wafer, or an InP wafer. One of the upper wafer W1 or the lower wafer W2 may be a bare wafer on which no electronic circuits are formed.

[0013]

The example of FIG. 3 (A) illustrates a bonded wafer T in which a support substrate is applied as the upper wafer W1 and a silicon wafer on which electronic circuits are formed is applied as the lower wafer W2. In this case, the thickness of the support substrate (upper wafer W1) is formed to be thicker than the thickness of the lower wafer W2. The material of the support substrate (upper wafer W1) is not particularly limited, and the support substrate (upper wafer W1) may be composed of silicon, or may be composed of quartz glass or the like.

[0014]

The bonding surface W1j of the upper wafer W1 and the bonding surface W2j of the lower wafer W2 are bonded by an adhesive G. The type of the adhesive G is not particularly limited and an appropriate resin material may be selected in accordance with the material of the upper wafer W1 and the material of the lower wafer W2. Alternatively, the upper wafer W1 and the lower wafer W2 may be chemically bonded. For example, the upper wafer W1 and the lower wafer W2 may be bonded by van der Waals force and hydrogen bonding (intermolecular force) by their surfaces (bonding surfaces W1j and W2j) being modified by plasma processing and the modified surfaces being hydrophilized by pure water.

[0015]

Further, as illustrated in FIG. 3 (B), the bonded wafer T has a

notch N at a part of the outer rim thereof in the circumferential direction. For example, the notch N is formed by cutting the outer rims of the upper wafer W1 and the lower wafer W2, respectively. The upper wafer W1 and the lower wafer W2 are bonded such that the notches N of the upper wafer W1 and the lower wafer W2 coincide with each other.

[0016]

As illustrated in FIGS. 3 (A) and 3 (B), the bonded wafer T according to the embodiment is held by a holding jig HJ including a dicing frame F and dicing tape P. The dicing frame F of the holding jig HJ is an annular metal member internally having an opening F1 having a diameter greater than that of the bonded wafer T. The dicing frame F is polygonal or annular in a plan view. The thickness of the dicing frame F is greater than that of the bonded wafer T.

[0017]

The dicing tape P of the holding jig HJ is composed of a flexible resin material having elastic deformability, and an adhesive layer is formed on one surface (upper surface) of the dicing tape P. The periphery of the dicing tape P is adhesively joined to the back surface of the dicing frame F, thereby closing the opening F1 of the dicing frame F. The back surface of the bonded wafer T is fixed to one surface of the dicing tape P in the opening F1 of the dicing frame F. Specifically, the non-bonding surface W2n of the lower wafer W2 is pasted on the adhesive layer on the upper surface of the dicing tape P. The dicing tape P allows the side circumferential surface of the bonded wafer T to be exposed, by displacing the bonded wafer T and the dicing frame F relatively in the thickness direction.

[0018]

Referring back to FIG. 1, the peeling system 100 includes a loading/unloading station 1, a transfer station 2, and a processing station 3. The loading/unloading station 1, the transfer station 2, and the processing station 3 are configured as separable units, and are arranged in this order in the positive direction on the Y-axis.

[0019]

The loading/unloading station 1 performs loading of the bonded wafer T, unloading of the upper wafer W1 and the lower wafer W2 after peeling, and the like. The loading/unloading station 1 includes a mounting part 4 and a first conveyor 5.

[0020]

The mounting part 4 includes a plurality of (in FIG. 1, three) cassette mounting tables for setting cassettes, such as a Front-Opening Unified Pod (FOUP) capable of accommodating a plurality of substrates, and the like. The cassettes mounted on each cassette mounting table include a cassette Ct accommodating a bonded wafer T, a cassette C1 capable of accommodating the upper wafer W1 after being peeled, and a cassette C2 capable of accommodating the lower wafer W2 after being peeled.

[0021]

The first conveyor 5 is disposed adjacently to the Y-axis positive direction side of the mounting part 4, and conveys the bonded wafer T, the upper wafer W1, and the lower wafer W2. The first conveyor 5 includes, for example, a base and a plurality of conveying arms, and performs moving of the substrate held by the conveying arms in the horizontal direction, raising and lowering of the substrate in the vertical direction, rotating of the substrate about the vertical axis of the base, and the like. The first conveyor 5 is an example of a substrate conveyor.

[0022]

The loading/unloading station 1 conveys the bonded wafer T from each cassette Ct to the transfer station 2 by the first conveyor 5, and conveys the upper wafer W1 and the lower wafer W2 after peeling, from the transfer station 2 to the cassettes C1 and C2, respectively.

[0023]

The transfer station 2 transfers the bonded wafer T before peeling, and the upper wafer W1 after peeling and the lower wafer W2 after peeling. As illustrated in FIG. 2, the transfer station 2 includes, for example, a first transfer part 25, a second transfer part 26, a transfer part 27 with a flipper, and an aligner 28. The first transfer part 25, the second

transfer part 26, the transfer part 27 with the flipper, and the aligner 28 are arranged in this order in the upward vertical direction (in the Z-axis positive direction).

[0024]

The bonded wafer T conveyed from the loading/unloading station 1 is mounted on the first transfer part 25. The bonded wafer T mounted on the first transfer part 25 is conveyed to the processing station 3 by a second conveyor 6 described later.

[0025]

The lower wafer W2 after peeling is mounted on the second transfer part 26. The lower wafer W2 after peeling mounted on the second transfer part 26 is conveyed to the loading/unloading station 1 by the first conveyor 5.

[0026]

The upper wafer W1 after peeling is mounted on the transfer part 27 with the flipper. The transfer part 27 with the flipper includes the flipper (not illustrated) for flipping the upper wafer W1 after peeling upside down. After being flipped upside down by the flipper, the upper wafer W1 after peeling mounted on the transfer part 27 with the flipper is conveyed to the loading/unloading station 1 by the first conveyor 5.

[0027]

The aligner 28 performs alignment of a subset or all of the bonded wafer T, the upper wafer W1 after peeling, and the lower wafer W2 after peeling. For example, when aligning the bonded wafer T, the aligner 28 holds and rotates the bonded wafer T, and detects the position of the notch N (see FIG. 3 (B)) of the bonded wafer T during rotation, thereby calculating the eccentricity of the bonded wafer T. The peeling system 100 adjusts the horizontal orientation of the bonded wafer T by appropriately operating the aligner 28 and the first conveyor 5 or the second conveyor 6 based on the eccentricity. This also applies to alignment of the upper wafer W1 and the lower wafer W2.

[0028]

The processing station 3 includes the second conveyor 6 and

the peeling device 7, and peels the bonded wafer T to the upper wafer W1 and the lower wafer W2. For example, in the processing station 3, the second conveyor 6 and the peeling device 7 are arranged in the X-axis direction.

[0029]

The second conveyor 6 conveys the bonded wafer T, and the upper wafer W1 and lower wafer W2 after peeling between the transfer station 2 and the peeling device 7. The second conveyor 6 includes, for example, a base and a plurality of conveying arms, and performs moving of the held substrate in the horizontal direction, raising and lowering of the substrate in the vertical direction, rotating of the substrate about the vertical axis of the base, and the like. The second conveyor 6 is an example of a substrate conveyor.

[0030]

The processing station 3 performs a loading process for loading the bonded wafer T from the transfer station 2 to the peeling device 7 by the second conveyor 6. The processing station 3 separately performs an unloading process for conveying the lower wafer W2 after peeling from the peeling device 7 to the transfer station 2 and an unloading process for conveying the upper wafer W1 after peeling from the peeling device 7 to the transfer station 2 by the second conveyor 6.

[0031]

The peeling device 7 peels the bonded wafer T loaded in by the second conveyor 6 to the upper wafer W1 and the lower wafer W2. The specific configuration and operation of the peeling device 7 will be described later in detail.

[0032]

The peeling system 100 also includes a controller 8 for controlling the operation of the peeling system 100. The controller 8 is a computer including a processor 81, a memory 82, and an input/output interface (not illustrated). The processor 81 is one, or a combination of a plurality, selected from a Central Processing Unit (CPU), a Graphics Processing Unit (GPU), an Application Specific Integrated Circuit (ASIC), a

Field-Programmable Gate Array (FPGA), a circuit composed of a plurality of discrete semiconductors, and the like. The memory 82 includes a non-volatile memory and a volatile memory. The memory 82 stores a program for controlling various processes, and the processor 81 controls the operation of the peeling system 100 by reading out and executing the program stored in the memory 82. In other words, in the present disclosure, the controller 8 is an electronic circuit including a CPU, a GPU, an ASIC, an FPGA, or the like, and executes various control operations described herein by executing instruction codes stored in the memory 82 or by being designed as a circuit for a special application.

[0033]

Under the control of the controller 8, the peeling system 100 first takes out the bonded wafer T from the cassette Ct mounted on the mounting part 4 and mounts the bonded wafer T on the first transfer part 25 of the transfer station 2 by the first conveyor 5 of the loading/unloading station 1. Subsequently, the peeling system 100 takes out the bonded wafer T mounted on the first transfer part 25 and loads it on the aligner 28 by the second conveyor 6 of the processing station 3. The controller 8 calculates the eccentricity of the bonded wafer T by the aligner 28, and performs control for adjusting the position of the bonded wafer T (the horizontal orientation of the bonded wafer T) at which the bonded wafer T is received by the second conveyor 6 based on the eccentricity. Further, the peeling system 100 loads the bonded wafer T into the peeling device 7 from the aligner 28 by the second conveyor 6.

[0034]

Then, the peeling device 7 peels the bonded wafer T to the upper wafer W1 and the lower wafer W2 under the control of the controller 8. The peeling device 7 may include a dedicated control substrate or the like, and control peeling of the bonded wafer T under the control of the control substrate based on a command from the controller 8.

[0035]

After the peeling by the peeling device 7, the peeling system 100 operates the second conveyor 6 to unload the lower wafer W2 from

the peeling device 7 onto the aligner 28, adjusts the horizontal orientation of the lower wafer W2 by the aligner 28, and conveys the lower wafer W2 to the second transfer part 26. Further, the peeling system 100 takes out the lower wafer W2 from the second transfer part 26 and stores it in the cassette C2 mounted on the loading/unloading station 1 by the first conveyor 5. The cassette C2 is taken out from the loading/unloading station 1 when a certain number of lower wafers W2 have been stored.

[0036]

Further, the peeling system 100 operates the second conveyor 6 at a timing different from the conveyance of the lower wafer W2 to convey the upper wafer W1 from the peeling device 7 onto the aligner 28, adjust the horizontal orientation of the upper wafer W1 by the aligner 28, and convey the upper wafer W1 to the transfer part 27 with the flipper. Further, the peeling system 100 flips the upper wafer W1 upside down by the flipper of the transfer part 27 with the flipper. As a result, the upper wafer W1 enters a state in which the bonding surface W1j faces upward. Thereafter, the peeling system 100 takes out the upper wafer W1 from the transfer part 27 with the flipper and stores it in the cassette C1 mounted in the loading/unloading station 1 by the first conveyor 5. The cassette C1 is taken out from the loading/unloading station 1 when a certain number of upper wafers W1 have been stored.

[0037]

<Configuration of Peeling Device 7>

Next, the configuration of the peeling device 7 according to an embodiment will be described with reference to FIG. 4. The peeling device 7 holds the bonded wafer T to sandwich it in the vertical direction (Z-axis direction), and peels the upper wafer W1 and the lower wafer W2 of the bonded wafer T from each other. The peeling device 7 includes a processing vessel 30 into which the bonded wafer T is loaded, and includes a suctioning peeling part 40, a holding part 50, and a peeling trigger part 60 in the processing vessel 30.

[0038]

The suctioning peeling part 40 performs a peeling operation

for holding the upper wafer W1 of the bonded wafer T by suctioning the non-bonding surface W1n of the upper wafer W1, and pulling the upper wafer W1 upward in the vertical direction. The suctioning peeling part 40 includes a base member 41, a pair of (two) lifting mechanisms 42 provided on the base member 41, a support member 43 supported by the pair of lifting mechanisms 42, and an upper suctioning group 44 supported by the support member 43 and configured to suction the upper wafer W1. The suctioning peeling part 40 further includes a transfer holding part 47 configured to operate to transfer the peeled upper wafer W1 to a conveyor (not illustrated), and push-down parts 48 configured to push down the dicing frame F of the holding jig HJ.

[0039]

The base member 41 is a plate member having an appropriate thickness, and is fixed, for example, directly or indirectly to a ceiling wall (or side wall) of the processing vessel 30. The base member 41 has sufficient rigidity and maintains an attitude extending in the horizontal directions (X-Y axis directions) in the processing vessel 30.

[0040]

The pair of lifting mechanisms 42 are fixed to the top of the base member 41 and are disposed at the same height position with each other. The pair of lifting mechanisms 42 support the support member 43 located vertically under the base member 41, and raises and lowers the support member 43. Each lifting mechanism 42 includes a body part 421, a shaft 422 projecting vertically downward from the body part 421, and a load cell 423 for detecting a load applied to the shaft 422.

[0041]

The body part 421 is attached to the base member 41, and internally includes a drive source, a transmission mechanism (both not illustrated), and the like for vertically raising and lowering the shaft 422. The body part 421 is connected to the controller 8, and raises and lowers the shaft 422 in accordance with the control of the controller 8. The peeling device 7 can raise and lower the shafts 422 of the pair of lifting mechanisms 42 independently from each other.

[0042]

The shaft 422 extends linearly along the vertical direction and supports the support member 43 connected to the lower end of the shaft 422. The load cell 423 detects the load applied to the shaft 422 and transmits the detection result to the controller 8. In peeling of the bonded wafer T, the controller 8 controls the height position of the support member 43 based on the detection result from the load cell 423.

[0043]

The support member 43 is a thin plate-like member and supports the upper suctioning group 44 for suctioning the upper wafer W1. The support member 43 is composed of a metal material or the like, and has both rigidity that allows the support member 43 to support the upper suctioning group 44 and flexibility that allows the support member 43 to elastically deform in the vertical direction. The support member 43 is suspended to bridge the pair of lifting mechanisms 42, and thereby extends substantially parallel with a suctioning surface 51s of the underlying holding part 50. Thus, the lower surface of the support member 43 faces the bonded wafer T held by the holding part 50.

[0044]

As illustrated in FIG. 5, the support member 43 includes a disk 431 and a pair of projecting plates 432 provided on both sides of the disk 431 in the Y-axis direction. The disk 431 and the pair of projecting plates 432 are fixed to each other by a suitable connecting method, such as screwing, welding, bonding, and the like. The disk 431 and the pair of projecting plates 432 may be integrally formed.

[0045]

The disk 431 is formed in a true-circular shape having a diameter approximately equal to the diameter of the upper wafer W1. The center of the disk 431 substantially coincides with the center of the suctioning surface 51s of the holding part 50 described later. The disk 431 overlies the bonded wafer T held by the holding part 50 in a plan view. The disk 431 constitutes a part that directly supports the upper suctioning group 44.

[0046]

The disk 431 has a through-hole 433 penetrating the disk 431 in the thickness direction in a region including the center. The through-hole 433 allows the transfer holding part 47 (see FIG. 4), which will be described later, to pass therethrough to realize holding of the upper wafer W1 by the transfer holding part 47. A plurality of small holes (not illustrated) penetrating the disk 431 in the thickness direction may be provided in the disk 431 to facilitate elastic deformation of the disk 431. Further, ribs and grooves extending in the X-axis direction may be imparted to the disk 431 in a plural number in the Y-axis direction to facilitate elastic deformation of the disk 431 in the Y-axis direction while inhibiting elastic deformation in the X-axis direction of the disk 431.

[0047]

The pair of projecting plates 432 project in opposite directions from each other from the outer periphery of the disk 431 in the Y-axis direction. The shafts 422 of the lifting mechanisms 42 are connected to the projection ends of the projecting plates 432, respectively. Thus, the projecting plates 432 are raised and lowered in the vertical direction (Z-axis direction) by the pair of lifting mechanisms 42. The horizontal attitude of the disk 431 changes in accordance with the height position of each projecting plate 432 (the shaft 422 of the lifting mechanism 42). In particular, when the lifting mechanisms 42 rise and lower independently, the support member 43 is elastically deformed and curved in the Y-axis direction to allow the upper suctioning group 44 to be displaced while being curved (see also FIG. 6 (C)).

[0048]

As illustrated in FIGS. 4 and 5, the upper suctioning group 44 supported by the support member 43 includes a plurality of suctioning bodies 45. Each of the suctioning bodies 45 includes a cylindrical part 451 extending in the vertical direction, a contact part 452 provided at the lower end of the cylindrical part 451, and a suctioning path 453 connected to the cylindrical part 451. A suctioning device 454, such as a vacuum pump or the like, is provided for each of the suctioning paths 453 of the suctioning

bodies 45. By being joined externally, the suctioning paths 453 may be connected to one suctioning device 454.

[0049]

The cylindrical part 451 has a suction space extending in the axial direction therein. The cylindrical part 451 is firmly connected to the disk 431 of the support member 43, and projects from the lower surface of the support member 43. Each of the cylindrical parts 451 has the contact part 452 disposed at the same height in the horizontal posture of the support member 43. A port 455 connected to the suctioning path 453 is provided on the upper surface side of the support member 43 in the cylindrical part 451.

[0050]

The contact part 452 is formed, for example, in a frustoconical shape, a cylindrical shape, or the like, and constitutes a part that directly contacts the non-bonding surface W1n of the upper wafer W1. The contact part 452 is preferably composed of a rubber material or any other resin material. It is preferable that the contact part 452 is formed to have high rigidity (to be made not easily elastically deformable). This is because, if the contact part 452 is elastically deformed largely when the suctioning peeling part 40 is raised, the suctioned part of the upper wafer W1 is also deformed largely, and there is a possibility that the upper wafer W1 or the lower wafer W2 is damaged.

[0051]

The suctioning device 454 is connected to the controller 8 and performs the suctioning operation based on the control of the controller 8. Each of the suctioning bodies 45 suctions the upper wafer W1 by applying a suctioning pressure to the contact part 452 from the suctioning device 454 via the suctioning path 453 and the cylindrical part 451 while the contact part 452 is in contact with the non-bonding surface W1n of the upper wafer W1.

[0052]

In the example illustrated in FIG. 5, five suctioning bodies 45 are provided on the support member 43. A pair of the suctioning bodies 45

are arranged on the Y-axis negative side in the support member 43 to be adjacent in the X-axis direction across the projecting plate 432. Another pair of the suctioning bodies 45 are arranged on the through-hole 433 side in the support member 43 (on the Y-axis negative side of the center of the support member 43) to be adjacent in the X-axis direction across the through-hole 433. The remaining one suctioning body 45 is provided on the Y-axis positive side in the support member 43 (at a position adjacent to the projecting plate 432 on the Y-axis negative side). However, the number and arrangement of the suctioning bodies 45 can be designed in a desirable manner.

[0053]

As illustrated in FIG. 4, the upper suctioning group 44 includes a plurality of distance sensors 46 fixed to the base member 41. The controller 8 can calculate the height (position in the vertical direction) of the upper wafer W1 by each distance sensor 46 measuring the distance to the faced bonded wafer T (upper wafer W1). The controller 8 can recognize the progress of peeling, for example, by calculating the height of the upper wafer W1 in the peeling operation.

[0054]

The transfer holding part 47 of the suctioning peeling part 40 is installed on the base member 41 and holds the upper wafer W1 by suctioning the non-bonding surface W1n of the upper wafer W1 after peeling held by the upper suctioning group 44. The transfer holding part 47 includes a base part 471, a plurality of suctioning pads 472, a plurality of contact pads 473, and a base part-lifting mechanism 474 (FIG. 4 illustrates one suctioning pad 472 and one contact pad 473 representatively).

[0055]

The base part 471 is formed in a cylindrical shape extending in the vertical direction and passed through a through-hole (not illustrated) in the base member 41. The base part 471 supports the plurality of suctioning pads 472 and the plurality of contact pads 473 on its lower end surface. The base part 471 is connected to the base part-lifting

mechanism 474 and is raised and lowered in the vertical direction by the base part-lifting mechanism 474. When the base part 471 is lowered, it passes through the through-hole 433 in the support member 43.

[0056]

The plurality of suctioning pads 472 are composed of a rubber material or the like, and have, for example, a bellows shape, to be able to follow displacement of the upper wafer W1 in the vertical direction and the horizontal direction. Each of the suctioning pads 472 is connected to a suctioning device 476, such as a vacuum pump or the like, via a suctioning path 475. The suctioning device 476 is connected to the controller 8, and performs the suctioning operation based on the control of the controller 8. The transfer holding part 47 generates suctioning pressures (negative pressures) in the plurality of suctioning pads 472 via the suctioning path 475 and the base part 471, thereby suctioning the non-bonding surface W1n of the upper wafer W1.

[0057]

On the other hand, the plurality of contact pads 473 are formed of a resin material in a hemispherical shape or the like, and contact the non-bonding surface W1n of the upper wafer W1 suctioned by the suctioning pads 472. With the amount of projection from the base part 471 adjustable by an adjustment part (not illustrated), the contact pads 473 assist detachment of the upper wafer W1 from the transfer holding part 47.

[0058]

The base part-lifting mechanism 474 vertically displaces the plurality of suctioning pads 472 and the plurality of contact pads 473 by raising and lowering the base part 471 under the control of the controller 8. For example, the base part-lifting mechanism 474 raises and lowers the plurality of suctioning pads 472 and the plurality of contact pads 473 between a standby position, a re-holding position for suctioning the upper wafer W1 after peeling, held by the upper suctioning group 44, and a transfer position for transferring the upper wafer W1 to the second conveyor 6.

[0059]

The push-down parts 48 of the suctioning peeling part 40 are provided on the outer periphery of the base member 41 (on the radially outer side of the pair of lifting mechanisms 42), and push down the dicing frame F downward in the vertical direction at an appropriate timing. For example, four push-down parts 48 are provided at circumferential positions corresponding to the dicing frame F conveyed into the holding part 50. The number of push-down parts 48 is not particularly limited.

[0060]

Each push-down part 48 includes a pressing pad 481, a shaft member 482, and a moving mechanism 483. The pressing pad 481 is composed of an elastic member, such as rubber or the like. The shaft member 482 is supported movably in the vertical direction by the moving mechanism 483, and the pressing pad 481 is attached to the lower end part of the shaft member 482. The moving mechanism 483 is fixed to the base member 41 and connected to the controller 8 to lower and raise the shaft member 482 under the control of the controller 8.

[0061]

Meanwhile, the holding part 50 of the peeling device 7 is provided from the vertically middle part to the lower part of the processing vessel 30, and holds the holding jig HJ holding the bonded wafer T by suctioning the holding jig HJ. The holding part 50 includes a disk-shaped lower chuck 51, a pillar 52 for supporting the lower chuck 51, a rotary lifting mechanism 53 for rotating, and raising and lowering the lower chuck 51, and a frame holding part 54 for holding the dicing frame F on the radial outer side of the lower chuck 51.

[0062]

The lower chuck 51 fixes the bonded wafer T during peeling, by suctioning the dicing tape P of the holding jig HJ holding the bonded wafer T. The structure of the lower chuck 51 will be described later in detail.

[0063]

When mounting the bonded wafer T on the holding part 50,

the position of the bonded wafer T is adjusted such that the center of the bonded wafer T (the lower wafer W2) coincides with the center of the lower chuck 51. The lower chuck 51 internally includes a plurality of lift pins (not illustrated), and the bonded wafer T is mounted on the lower chuck 51 by raising and lowering each lift pin.

[0064]

The rotary lifting mechanism 53 can rotate the lower chuck 51 and can displace the lower chuck 51 in the peeling direction (vertical direction) orthogonal to a direction in which a blade 61 is inserted. For example, the rotary lifting mechanism 53 internally includes a drive source for rotating the pillar 52, a drive source for raising and lowering the pillar 52, and a transmission mechanism for transmitting the driving forces of the drive sources (all not illustrated). The rotary lifting mechanism 53 is connected to the controller 8, and rotates the lower chuck 51 about the vertical axis, and raises and lowers the lower chuck 51 under the control of the controller 8.

[0065]

The frame holding part 54 holds the dicing frame F pushed down by the push-down parts 48, by suctioning the dicing frame F in the pushed-down state. The frame holding part 54 includes a plurality of suctioning pads 541 and a support 542 for supporting the suctioning pads 541. The suctioning pads 541 are composed of an elastic member, such as rubber or the like, and, for example, four suctioning pads 541 are provided at equal intervals at circumferential positions corresponding to the dicing frame F. As an example, the suctioning pads 541 may be provided at positions facing the plurality of push-down parts 48 in the vertical direction, respectively. The number of suctioning pads 541 is not particularly limited.

[0066]

Each suctioning pad 541 internally includes an intake port (not illustrated). Each suctioning pad 541 is connected to a suctioning device 545, such as a vacuum pump or the like, via the support 542, a suctioning pipe 543 connected to the support 542, and a suctioning path

544 connected to the suctioning pipe 543. The upper end (intake port) of the suctioning pad 541 is disposed under the suctioning surface 51s of the lower chuck 51 in the vertical direction. The suctioning device 545 applies a suctioning pressure to each suctioning pad 541 under the control of the controller 8.

[0067]

The support 542 is supported by a lower base part 546 and projects vertically at appropriate positions (in the circumferential direction at positions corresponding to the dicing frame F) to hold the suctioning pads 541. The lower base part 546 is formed in a disk shape and fixes the support 542 and the pillar 52. A rotary shaft (not illustrated) of the rotary lifting mechanism 53 is connected to the lower surface of the lower base part 546.

[0068]

The frame holding part 54 can suction and hold the dicing frame F by utilizing a negative pressure generated by suctioning by the suctioning device 545. The holding part 50 can displace (rotate, and raise and lower) the bonded wafer T held by the lower chuck 51 and the dicing frame F held by the frame holding part 54 integrally by the rotary lifting mechanism 53.

[0069]

Meanwhile, the peeling trigger part 60 of the peeling device 7 is disposed on a lateral side of the suctioning peeling part 40 and the holding part 50, and, in the peeling between the upper wafer W1 and the lower wafer W2 of the bonded wafer T, forms a cut part CP (see FIG. 6 (B)) radially inward from the outer rim of the bonded wafer T. The peeling trigger part 60 includes the blade 61, a blade sliding mechanism 62, and a blade lifting mechanism 63.

[0070]

The blade 61 is a peeling member having an acute-angled-blade edge extending in the Y-axis positive direction. In a plan view, the blade 61 is formed in a rectangular shape that is shorter in the Y-axis direction and longer in the X-axis direction (see also FIG. 5). The length of

the blade 61 in the Y-axis direction, that is, the length of the blade 61 in the longitudinal direction, may be set to an appropriate dimension in the range of, for example, 50 mm to 150 mm. The length of the blade 61 in the longitudinal direction according to the embodiment is 100 mm.

[0071]

The blade sliding mechanism 62 includes a movable body 621 for supporting the blade 61 and a fixed body 622 for supporting the movable body 621 slidably. The movable body 621 supports the blade 61 such that the blade 61 projects in the Y-axis positive direction, and reciprocates in the Y-axis direction relative to the fixed body 622 by being driven by a drive source (not illustrated). That is, the blade 61 is advanced in the Y-axis positive direction and retracted in the Y-axis negative direction by the blade sliding mechanism 62.

[0072]

The blade lifting mechanism 63 is fixed to, for example, an end part of the base member 41 on the Y-axis negative direction side, and moves the blade sliding mechanism 62 in the vertical direction. Thus, the peeling trigger part 60 can adjust the height position of the blade 61.

[0073]

After adjusting the height position of the blade 61 by using the blade lifting mechanism 63, the peeling trigger part 60 advances the blade 61 in the Y-axis negative direction by using the blade sliding mechanism 62. With this advance, the blade edge of the blade 61 enters the adhesive G between the upper wafer W1 and the lower wafer W2 from the lateral side of the bonded wafer T, thereby forming a cut part CP between the upper wafer W1 and the lower wafer W2 (see FIG. 6 (B)). The cut part CP is a part at which the bonding surface W1j of the upper wafer W1 is separated from the bonding surface W2j of the lower wafer W2 with the adhesive G bonding them in the vicinity of the outer rim of the bonded wafer T broken.

[0074]

<Procedure for Peeling Bonded Wafer T>

The peeling device 7 configured as described above peels the

bonded wafer T according to the procedure illustrated in FIGS. 6 (A) to 6 (D) under the control of the controller 8.

[0075]

Specifically, as illustrated in FIG. 6 (A), after the bonded wafer T integrated with the dicing frame F is mounted on the holding part 50, the peeling device 7 applies suctioning pressure to the lower chuck 51 to fix the bonded wafer T to the lower chuck 51 via the dicing tape P. Further, the peeling device 7 lowers the push-down parts 48 downward in the vertical direction and pushes down the dicing frame F by the push-down parts 48. Here, the part of the dicing tape P located on the outer side of the lower chuck 51 is deformed obliquely downward to allow displacement of the dicing frame F. Further, the peeling device 7 operates the frame holding part 54 to apply suctioning pressure to the suctioning pads 541 to hold the pushed-down dicing frame F on the frame holding part 54. Thus, a lateral side of the bonded wafer T faces the blade 61 of the peeling trigger part 60.

[0076]

Next, as illustrated in FIG. 6 (B), the peeling device 7 inserts the blade 61 of the peeling trigger part 60 between the upper wafer W1 and the lower wafer W2 of the bonded wafer T to perform a cut part-forming operation for forming a cut part CP.

[0077]

Thereafter, as illustrated in FIG. 6 (C), the peeling device 7 lowers the upper suctioning group 44 by the pair of lifting mechanisms 42 to suction the upper wafer W1 by each suctioning body 45. Further, the peeling device 7 raises the lifting mechanism 42 on the Y-axis negative direction side to curve the support member 43 on the Y-axis negative direction side. Thus, the suctioning bodies 45 on the Y-axis negative direction side rise and roll up the Y-axis negative direction side of the upper wafer W1, to start the peeling operation for separating the upper wafer W1 from the lower wafer W2. By rising slowly, the lifting mechanism 42 increases the curving degree of the support member 43 gradually, which progresses the peeling between the upper wafer W1 and the lower

wafer W2 from the Y-axis negative direction side to the Y-axis positive direction side.

[0078]

When the peeling between the upper wafer W1 and the lower wafer W2 progresses to some degree (for example, when the peeling exceeds the center of the bonded wafer T), the peeling device 7 raises also the lifting mechanism 42 on the Y-axis positive direction side to separate the upper wafer W1 from the lower wafer W2, as illustrated in FIG. 6 (D). The bonding force between the upper wafer W1 and the lower wafer W2 has weakened by the latter half of the peeling operation, after which the peeling can thus progress smoothly.

[0079]

As described above, the peeling device 7 can peel the upper wafer W1 and the lower wafer W2 from each other by operating the suctioning peeling part 40, the holding part 50, and the peeling trigger part 60 conjunctively.

[0080]

In a state in which the bonded wafer T is pasted on the dicing tape P of the holding jig HJ, as illustrated in FIG. 7 (A), an air bubble B might enter. For example, when a silicon wafer having a plurality of semiconductor devices (dies) on which electronic circuits are formed is used as the lower wafer W2, the non-bonding surface W2n of the lower wafer W2 has projections w2p projecting by about several tens of micrometers immediately under the scribe lines between the semiconductor devices. Therefore, when the lower wafer W2 and the dicing tape P are pasted to each other, an air bubble B might enter between the facing surfaces thereof might (or become entrapped therebetween).

[0081]

When the entrapped air bubble B is large, the dicing tape P is swelled largely downward in the vertical direction. When the holding jig HJ and the bonded wafer T containing the large air bubbles B are held by the lower chuck 51, the holding jig HJ and the bonded wafer T are mounted thereon while being inclined as illustrated in FIG. 7 (B). FIG. 7 (B)

illustrates the inclinations of the holding jig HJ and the bonded wafer T exaggeratedly. In this case, even if the lower chuck 51 applies suctioning pressure, air around the bonded wafer T is suctioned, to lower the suctioning pressure on the bonded wafer T. The holding part 50 according to the embodiment is configured to stably and firmly hold the holding jig HJ and the bonded wafer T even when such an air bubble B is generated.

[0082]

<First Embodiment>

Specifically, as illustrated in FIGS. 8 (A) and 8 (B), the lower chuck 51 according to a first embodiment includes a suctioning body 511 and a recessed housing 512 for housing the suctioning body 511.

[0083]

The suctioning body 511 is formed in a disk shape having an appropriate thickness, and has a true-circular suctioning surface 51s on its upper surface for holding the bonded wafer T via the dicing tape P. The diameter of the suctioning surface 51s is set to be equal to the diameter of the lower wafer W2 of the bonded wafer T or slightly greater than the diameter of the lower wafer W2. When the diameter of the lower wafer W2 is 300 mm, the diameter of the suctioning surface 51s is preferably set to be, for example, 306 mm (approximately 101% to 104% the diameter of the lower wafer W2).

[0084]

The suctioning body 511 is a porous member composed of a resin material, such as polychlorotrifluoroethylene (PCTFE). The suctioning surface 51s of the suctioning body 511 has a flat shape free of processed grooves, holes, or the like. Thus, the lower chuck 51 can have the suctioning surface 51s exhibit a suctioning pressure through the thickness direction of the suctioning body 511. In other words, the lower chuck 51 according to the embodiment is a porous chuck that applies suctioning pressure via the porous matrix.

[0085]

The suctioning body 511 is partitioned into a center region R1 and an outer peripheral region R2 that loops around the center region

on the outer side of the center region. A partition wall 515 that projects from a bottom wall 512a of the housing 512 and partitions the suctioning body 511 is provided in the suctioning body 511. The partition wall 515 forms a loop in an annular shape concentrically with respect to the center of the lower chuck 51 and forms a boundary between the true-circular center region R1 and the annular outer peripheral region R2. The partition wall 515 blocks mutual communication between the porous matrix in the center region R1 and the porous matrix in the outer peripheral region R2. Because the partition wall 515 is formed throughout the thickness direction of the suctioning body 511, the center region R1 and the outer peripheral region R2 can be airtightly partitioned in the thickness direction.

[0086]

The material of the partition wall 515 is not particularly limited as long as it has airtightness, and may be a resin material or a metal material. The partition wall 515 may be composed of the same material as the suctioning body 511 to have airtightness. In addition, as the partition wall 515, the suctioning body 511 in which one is provided in advance may be used. For example, in the manufacture of the suctioning body 511, an integrated suctioning body 511 can be formed by preparing an airtight member as the partition wall 515, forming the suctioning body 511 for the center region R1 inside the member, and forming the suctioning body 511 for the outer peripheral region R2 outside the member. Alternatively, the partition wall 515 may be formed integrally with the housing 512.

[0087]

When the diameter of the suctioning body 511 is 300 mm, for example, the diameter of the partition wall 515 is set to 200 mm. When converted into a radius, the partition wall 515 is set to have a radius of 50 mm with respect to the radius of 150 mm of the suctioning body 511. In other words, the ratio of the radius of the center region R1 to the width of the outer peripheral region R2 in the radial direction in a plan view of the suctioning surface 51s is 2:1. The ratio of the ranges over which the center region R1 and the outer peripheral region R2 are formed may be

appropriately set in accordance with the suctioning pressure generated via the suctioning surface 51s and the like. For example, the width of the outer peripheral region R2 in the radial direction may be greater than the radius of the center region R1.

[0088]

Meanwhile, the housing 512 has the bottom wall 512a covering the bottom surface of the suctioning body 511, and a side wall 512b projecting from the outer rim of the bottom wall 512a upward in the vertical direction and covering the outer circumferential surface of the suctioning body 511. The housing 512 is composed of a metal material, such as aluminum or the like.

[0089]

The housing 512 according to the embodiment houses the suctioning body 511 in the entirety of the recess on the inner side of the bottom wall 512a and the side wall 512b. However, a small suctioning space may be formed in the housing 512 between the suctioning body 511 and the bottom wall 512a by fixing the outer circumferential surface of the suctioning body 511 in a housed state of the suctioning body 511.

[0090]

The holding part 50 applies a suctioning pressure to each of the center region R1 and the outer peripheral region R2 of the suctioning body 511 housed in the housing 512. Therefore, the holding part 50 includes a first suctioning pressure-applying part 513 for applying a suctioning pressure to the center region R1 and a second suctioning pressure-applying part 514 for applying a suctioning pressure to the outer peripheral region R2 separately.

[0091]

The first suctioning pressure-applying part 513 includes a suctioning pipe 513a fixed to penetrate the bottom wall 512a of the housing 512, and a suctioning path 513b connected to the suctioning pipe 513a. The first suctioning pressure-applying part 513 also includes a suctioning device 513c connected to the suctioning path 513b outside the processing vessel 30 (see also FIG. 4). The suctioning device 513c may be a

vacuum pump or the like, and can communicate with the controller 8. The suctioning device 513c applies an appropriate suctioning pressure to the center region R1 of the suctioning body 511 via the suctioning path 513b and the suctioning pipe 513a based on the target pressure commanded by the controller 8.

[0092]

The second suctioning pressure-applying part 514 also includes a suctioning pipe 514a, a suctioning path 514b, and a suctioning device 514c like the first suctioning pressure-applying part 513. The suctioning device 514c applies an appropriate suctioning pressure to the outer peripheral region R2 of the suctioning body 511 via the suctioning path 514b and the suctioning pipe 514a based on the target pressure commanded by the controller 8.

[0093]

The peeling device 7 according to the first embodiment is basically configured as described above, and a peeling method including a holding method for holding the holding jig HJ and the bonded wafer T will be described with reference to FIGS. 9 and 10. The controller 8 controls, for example, steps S101 to S107 illustrated in FIG. 9 as the peeling method.

[0094]

The peeling system 100 performs a loading process for loading the holding jig HJ and the bonded wafer T into the peeling device 7, and mounting the holding jig HJ on the holding part 50 (step S101: step (A)). In the loading process, the second conveyor 6 conveys the bonded wafer T held by the holding jig HJ, loads the bonded wafer T into the processing vessel 30 of the peeling device 7, and aligns the center of the bonded wafer T with the center of the suctioning surface 51s of the lower chuck 51. The peeling device 7 raises the lift pins from the suctioning surface 51s to receive the bonded wafer T, and then lowers the lift pins to mount the bonded wafer T on the suctioning surface 51s.

[0095]

Next, the peeling device 7 operates the first suctioning pressure-applying part 513 and the second suctioning pressure-applying

part 514 to suction the bonded wafer T to the suctioning body 511 of the lower chuck 51 via the dicing tape P (step S102: step (B)). Specifically, as illustrated in FIG. 10, the holding part 50 suctions the dicing tape P at both the center region R1 and the outer peripheral region R2.

[0096]

Here, the lower chuck of the conventional peeling device does not divide the suctioning body into a plurality of regions. Instead, a uniform suctioning pressure is generated over the entire suctioning surface. In this case, the suctioning pressure is diffused over the entire part of the dicing tape P overlain by the bonded wafer T, resulting in a low local suctioning pressure. For example, as illustrated in FIG. 7 (B), when the dicing tape P locally projects downward in the vertical direction due to the air bubble B, the low local suctioning pressure cannot suction the bonded wafer T to the degree that the air bubble B is crushed.

[0097]

On the other hand, the lower chuck 51 of the peeling device 7 according to the embodiment has a suctioning pressure applied to the center region R1 by the first suctioning pressure-applying part 513, and has a suctioning pressure applied to the outer peripheral region R2 by the second suctioning pressure-applying part 514. In other words, the suctioning pressure is not diffused over the entire part of the dicing tape P overlain by the bonded wafer T, and independent suctioning pressures are generated for the center region R1 and the outer peripheral region R2, respectively. Therefore, the lower chuck 51 can increase the local pressure of the suctioning surface 51s, and can consequently suction the entire part of dicing tape P overlain by the bonded wafer T with a strong suctioning force. For example, even when the dicing tape P locally projects downward in the vertical direction due to the air bubble B, it is possible to suction the bonded wafer T by crushing the air bubble B.

[0098]

In addition, the first suctioning pressure-applying part 513 and the second suctioning pressure-applying part 514 can apply different suctioning pressures to the center region R1 and the outer peripheral

region R2, respectively. For example, in FIG. 10, the suctioning pressure via the center region R1 is higher than the suctioning pressure via the outer peripheral region R2. Thus, the lower chuck 51 can suction the dicing tape P more strongly via the center region R1. For example, when the suctioning peeling part 40 raises the upper wafer W1 upward in the vertical direction, the lower wafer W2 is prevented from following the upper wafer W1.

[0099]

The lower chuck 51 may have the same suctioning pressure set in the center region R1 and the outer peripheral region R2. Alternatively, the lower chuck 51 may have the suctioning pressure in the outer peripheral region R2 set to be higher than the suctioning pressure in the center region R1. Thus, the lower chuck 51 can suction the dicing tape P more strongly in the outer peripheral region R2, and, for example, can facilitate insertion of the blade 61 into the bonded wafer T when the peeling trigger part 60 forms the cut part CP. As can be understood from the above, the lower chuck 51 may change the suctioning pressure in the center region R1 and the suctioning pressure in the outer peripheral region R2 with elapse of time. Thus, the lower chuck 51 can suction the lower wafer W2 with a suitable suctioning pressure for each process content.

[0100]

The first suctioning pressure-applying part 513 and the second suctioning pressure-applying part 514 may synchronize or vary the timing to apply the suctioning pressure to the center region R1 and the timing to apply the suctioning pressure to the outer peripheral region R2. For example, when an uplifting warpage projecting upward in the vertical direction is generated around the center of the bonded wafer T, the suctioning pressure may be applied first to the center region R1 and then to the outer peripheral region R2. Conversely, when a dented warpage projecting downward in the vertical direction is generated around the center of the bonded wafer T, the suctioning pressure may be applied first to the outer peripheral region R2 and then to the center region R1.

[0101]

Further, as described above, the suctioning surface 51s is formed to have an area slightly larger than that of the lower wafer W2. Therefore, the outer peripheral region R2 can also suction a part of the dicing tape P that is not overlain by the bonded wafer T. In other words, the lower chuck 51 can increase the suctioning force for the dicing tape P by having a suctioning area that is increased with respect to the dicing tape P as a whole.

[0102]

Referring back to FIG. 9, after fixing the bonded wafer T to the lower chuck 51, the peeling device 7 pushes down the dicing frame F by the push-down parts 48, and suctions the dicing frame F by the frame holding part 54 (step S103, see also FIG. 6 (A)). Thus, the holding part 50 can fix the bonded wafer T and the dicing frame F integrally. The bonded wafer T enters a state in which the adhesive G between the upper wafer W1 and the lower wafer W2 is exposed laterally, because the dicing frame F is pushed down.

[0103]

In this state, the peeling device 7 operates the peeling trigger part 60 to form a cut part CP in the bonded wafer T (step S104: step (B), see also FIG. 6 (B)). Here, as the lower chuck 51 firmly suctions the lower wafer W2, the suctioning peeling part 40 does not need to suction the upper wafer W1. After forming the cut part CP, the peeling trigger part 60 sets the blade 61 in a standby state. Thus, when the peeling operation is started, the peeling between the upper wafer W1 and the lower wafer W2 can be started from the Y-axis negative direction side where the upper wafer W1 is on the blade 61.

[0104]

Thereafter, the peeling device 7 moves the pair of lifting mechanisms 42 to lower the plurality of suctioning bodies 45 of the upper suctioning group 44, and suctions the non-bonding surface W1n of the upper wafer W1 by the respective suctioning bodies 45 (step S105). The suctioning of the upper wafer W1 by the upper suctioning group 44 may be performed before step S103.

[0105]

Next, the peeling device 7 shifts to the peeling operation, and raises the Y-axis negative direction side of the upper suctioning group 44 to separate the upper wafer W1 on the Y-axis negative direction side from the lower wafer W2 (step S106). Here, the shaft 422 of the lifting mechanism 42 on the Y-axis negative direction side of the pair of lifting mechanisms 42 is raised to raise the suctioning bodies 45 on the Y-axis negative direction side (see also FIG. 6 (C)). Thus, the upper wafer W1 on the Y-axis negative direction side starts to be peeled from the lower wafer W2. A counterclockwise moment illustrated in FIG. 6 (C) is generated in the upper wafer W1. Therefore, the upper suctioning group 44 can pull up the upper wafer W1 to roll up the upper wafer W1 from the Y-axis negative direction side.

[0106]

When the lifting mechanism 42 on the Y-axis negative direction side is raised to some extent, the peeling device 7 starts raising the lifting mechanism 42 on the Y-axis positive direction side to raise the entire upper wafer W1 (see also FIG. 6 (D)). At this stage, the peeling of the upper wafer W1 from the lower wafer W2 has progressed to the Y-axis positive direction side from the center of the bonded wafer T. Therefore, the peeling device 7 can raise the upper wafer W1 while inhibiting damage to the upper wafer W1, and can support the upper wafer W1 horizontally at the re-holding position.

[0107]

Thereafter, the peeling system 100 shifts to the unloading process for unloading the upper wafer W1 and lower wafer W2 after peeling from the peeling device 7 (step S107). In the unloading process, the peeling device 7 returns the peeling trigger part 60 to the initial position and lowers the lower chuck 51. Thereafter, the peeling device 7 cancels the suctioning of the lower wafer W2 by the lower chuck 51 and the suctioning by the frame holding part 54, and raises the plurality of lift pins to float the lower wafer W2 from the suctioning surface 51s. The peeling system 100 advances the second conveyor 6 to under the lower wafer W2, transfers

the lower wafer W2 to the second conveyor 6 as the lifting pins are lowered, and unloads the lower wafer W2 from the peeling device 7. Further, the peeling device 7 holds the upper wafer W1 that has been held by the suctioning bodies 45 of the upper suctioning group 44 at the re-holding position, by the transfer holding part 47. Then, the peeling system 100 suctions and holds the non-bonding surface W1n of the upper wafer W1 by the second conveyor 6 that is advanced above the suctioning pads 472 of the transfer holding part 47 in the vertical direction, and unloads the upper wafer W1 from the peeling device 7 by the second conveyor 6.

[0108]

As described above, the peeling device 7 can suction the bonded wafer T held by the holding jig HJ stably by the center region R1 and the outer peripheral region R2 of the lower chuck 51. For example, even when the air bubble B is formed between the lower wafer W2 and the dicing tape P, the center region R1 and the outer peripheral region R2 can fix the bonded wafer T to the dicing tape P with a strong suctioning force. As a result, the peeling device 7 can stably perform the formation of the cut part CP in the bonded wafer T by the peeling trigger part 60, the peeling operation by the suctioning peeling part 40, and the like.

[0109]

In addition, by including the porous suctioning body 511, the holding part 50 can stably suction the dicing tape P by the flat suctioning surface 51s. In particular, with the center region R1 and the outer peripheral region R2 provided in the suctioning body 511, independent suctioning pressures can be applied to the suctioning surface 51s, allowing the dicing tape P to be firmly held. Furthermore, with the diameter of the suctioning body 511 greater than the diameter of the lower wafer W2, the holding part 50 can also suction the part of the dicing tape P that is not overlain by the bonded wafer T, allowing the suctioning of the dicing tape P to be firmer.

[0110]

Further, by including the first suctioning pressure-applying part 513 and the second suctioning pressure-applying part 514 separately,

the peeling device 7 can apply independent suctioning pressures to the center region R1 and the outer peripheral region R2. Further, the first suctioning pressure-applying part 513 and the second suctioning pressure-applying part 514 apply different suctioning pressures to the center region R1 and the outer peripheral region R2, allowing the bonded wafer T to be held more appropriately.

[0111]

The peeling device 7 according to the present disclosure is not limited to the above-described embodiment, and can assume various modifications. For example, the peeling device 7 is not limited to the configuration including the porous suctioning body 511, and may use a block-shaped chuck having no porous matrix. In this case, the suctioning surface 51s may be provided with a plurality of holes and grooves, to which the suctioning pressure may be applied, or may be provided with a plurality of ribs such that suctioning pressure may be applied via holes formed in the bottom surface between the ribs.

[0112]

<Second Embodiment>

A lower chuck 51A according to the second embodiment is different from the lower chuck 51 according to the first embodiment in that a groove 516 for suctioning the dicing tape P is provided in the side wall 512b of the housing 512 enclosing the suctioning body 511. In the second embodiment, components having the same configuration or the same function as those of the first embodiment are denoted by the same reference numerals and detailed description thereof may be omitted.

[0113]

More specifically, the lower chuck 51A includes the porous suctioning body 511 and the housing 512 for housing the suctioning body 511. However, the diameter of the suctioning body 511 of the lower chuck 51A is set to be equal to the diameter of the lower wafer W2. For example, the diameter of the suctioning surface 51s of the suctioning body 511 is 300 mm.

[0114]

The suctioning body 511 of the lower chuck 51A is a continuous member not divided by the partition wall 515 as in the first embodiment. The bottom wall 512a of the housing 512 is connected to the first suctioning pressure-applying part 513. Therefore, the first suctioning pressure-applying part 513 applies a uniform (undivided) suctioning pressure to the entire suctioning surface 51s of the suctioning body 511.

[0115]

Meanwhile, the housing 512 includes the circular bottom wall 512a and the side wall 512b that forms a loop in an annular shape as in the first embodiment, but the width of the side wall 512b in the radial direction is greater than the width of the side wall 512b in the radial direction in the first embodiment. The width of the side wall 512b in the radial direction depends on the size of the dicing frame F, yet is preferably set in a range of, for example, approximately 5 mm to 10 mm.

[0116]

The lower chuck 51 includes the groove 516 in the upper surface of the side wall 512b. The groove 516 is set at a constant depth from the upper surface of the side wall 512b and extends along the circumferential direction of the side wall 512b, thereby forming an annular shape in a plan view. The suctioning pipe 514a is connected to the bottom of the groove 516 at a suitable position in the circumferential direction. Although FIG. 11 illustrates an example in which one suctioning pipe 514a is connected, it is preferable that a plurality of suctioning pipes 514a are provided at equal intervals in the circumferential direction of the side wall 512b. The respective suctioning pipes 514a are connected to corresponding suctioning paths 514b branched at an intermediate position, and are connected to one suctioning device 514c via the suctioning paths 514b. That is, the suctioning pipes 514a, the suctioning paths 514b, and the suctioning device 514c constitute a second suctioning pressure-applying part 514 for applying suctioning pressure to the groove 516.

[0117]

The groove 516 applies the suctioning pressure from the

second suctioning pressure-applying part 514 along the circumferential direction, and suctions the dicing tape P on the radially outer side of the part thereof that is overlain by the bonded wafer T. For example, the groove 516 applies a suctioning pressure stronger than (different from) the suctioning pressure applied via the suctioning body 511 to the dicing tape P. However, the suctioning pressure via the groove 516 may be set desirably. As described above, in the second embodiment, the entire suctioning surface 51s of the suctioning body 511 is equivalent to the center region for suctioning the part of the dicing tape P overlain by the bonded wafer T, and the groove 516 provided on the outer side of the center region is equivalent to the outer peripheral region for suctioning the part of the dicing tape P where the bonded wafer T does not exist. The lower chuck 51A can suction the dicing tape P on the radially outer side of the bonded wafer T and the dicing tape P even if the dicing tape P bulges due to an air bubble B entrapped between the bonded wafer T and the dicing tape P. As a result, the lower chuck 51 can suction the entirety of the dicing tape P with a strong suctioning force.

[0118]

The upper surface of the side wall 512b of the housing 512 has a tapered part 517 along the outer rim thereof on the radially outer side of the groove 516. The tapered part 517 is an inclined surface inclined from the upper surface downward in the vertical direction, and loops annularly along the circumferential direction of the side wall 512b. As illustrated in FIG. 12, the tapered part 517 inclines the dicing tape P during the peeling operation. Thus, when the blade 61 of the peeling trigger part 60 is inserted between the upper wafer W1 and the lower wafer W2 of the bonded wafer T, the peeling device 7 can keep the dicing tape P away favorably. Therefore, the peeling device 7 can insert the blade 61 stably by preventing the dicing tape P from sticking to the blade 61.

[0119]

In addition, the tapered part 517 can mitigate application of a locally large force to the dicing tape P. For example, even when the dicing tape P is pushed downward in the vertical direction in the above

configuration in which the side wall 512b overhangs outward in the radial direction, the load on the dicing tape P can be reduced with the dicing tape P inclined gently by the tapered part 517.

[0120]

As described above, even the lower chuck 51A according to the second embodiment can suction the bonded wafer T held by the holding jig HJ stably. As a result, the peeling device 7 can peel the bonded wafer T favorably. In particular, the lower chuck 51A can hold the dicing tape P more reliably by suctioning the part of the dicing tape P that is not overlain by the bonded wafer T by the groove 516. Further, with the groove 516 formed in the upper surface of the side wall 512b of the housing 512, the lower chuck 51A can apply suctioning pressure smoothly to the part faced with the groove 516.

[0121]

Further, the lower chuck 51 can reduce a force that might be applied locally to the dicing tape P, by providing the tapered part 517 on the side wall 512b. Further, the peeling device 7 can reduce sticking of the dicing tape P to the blade 61 by inclining the dicing tape P by the tapered part 517, and can perform insertion of the blade 61 stably.

[0122]

The peeling device 7 and the holding method according to the embodiments disclosed herein are exemplary and not restrictive in all respects. The embodiments can be modified and improved in various forms without departing from the scope and spirit of the appended claims. The particulars described in the above embodiments can be constructed in other ways to the extent that no inconsistency occurs and can be combined to the extent that no inconsistency occurs.

[0123]

The present application claims priority to Japanese Patent Application No. 2024-047034, filed with the Japan Patent Office on March 22, 2024, the entire contents of which are hereby incorporated by reference.

REFERENCE SIGNS LIST

[0124] 7 peeling device
50 holding part
F dicing frame
F1 opening
HJ holding jig
P dicing tape
R1 center region
R2 outer peripheral region
T bonded wafer (bonded substrate)
W1 upper wafer (first substrate)
W2 lower wafer (second substrate)

CLAIMS

[Claim 1]

A peeling device configured to peel a bonded substrate formed by bonding a first substrate and a second substrate,

wherein, in a holding jig including a dicing frame having an opening and dicing tape fixed to the dicing frame to close the opening, the bonded substrate is pasted on the dicing tape by being disposed in the opening,

the peeling device comprising:

a holding part configured to hold the bonded substrate by suctioning the dicing tape of the holding jig,

wherein the holding part includes a center region and an outer peripheral region partitioned from the center region and looping around the center region on an outer side of the center region, the holding part being configured to apply a suctioning pressure for suctioning the dicing tape via each of the center region and the outer peripheral region.

[Claim 2]

The peeling device according to claim 1,

wherein the holding part includes a porous suctioning body via which the suctioning pressure is applied to the dicing tape.

[Claim 3]

The peeling device according to claim 2,

wherein the holding part includes a partition wall configured to partition the center region and the outer peripheral region, the partition wall being in the suctioning body.

[Claim 4]

The peeling device according to claim 2,

wherein a diameter of the suctioning body is greater than a diameter of the second substrate facing the suctioning body.

[Claim 5]

The peeling device according to claim 1,

wherein the holding part includes a groove that constitutes the outer peripheral region and via which the suctioning pressure is applied for suctioning the dicing tape on an outer side of an outer rim of the bonded substrate.

[Claim 6]

The peeling device according to claim 5,

wherein the holding part includes: a porous suctioning body via which the suctioning pressure is applied to the dicing tape; and a side wall covering an outer circumferential surface of the suctioning body, and wherein the groove is formed in an annular shape in the upper surface of the side wall.

[Claim 7]

The peeling device according to any one of claims 1 to 6, further comprising:

a first suctioning pressure-applying part configured to apply the suctioning pressure to the center region; and

a second suctioning pressure-applying part configured to apply the suctioning pressure to the outer peripheral region.

[Claim 8]

The peeling device according to claim 7,

wherein the first suctioning pressure-applying part and the second suctioning pressure-applying part apply different suctioning pressures to the center region and the outer peripheral region, respectively.

[Claim 9]

The peeling device according to any one of claims 1 to 6,

wherein the holding part includes a tapered part looping annularly along an outer rim of a surface of the holding part on which the dicing tape is held.

[Claim 10]

The peeling device according to claim 9, further comprising:

a push-down part configured to push down the dicing frame of the holding jig suctioned to the holding part;

a frame holding part configured to hold the dicing frame pushed down; and

a peeling trigger part configured to insert a blade into an outer circumferential surface of the bonded substrate to form a cut part, the outer circumferential surface being exposed by pushing down the dicing frame,

wherein, in a state in which the dicing frame is pushed down, the tapered part inclines the dicing tape in a direction away from the blade.

[Claim 11]

The peeling device according to any one of claims 1 to 6, further comprising:

a suctioning peeling part configured to suction the first substrate of the bonded substrate and move the first substrate in a

direction away from the second substrate.

[Claim 12]

A holding method for holding a bonded substrate formed by bonding a first substrate and a second substrate,

wherein, in a holding jig including a dicing frame having an opening and dicing tape fixed to the dicing frame to close the opening, the bonded substrate is pasted on the dicing tape by being disposed in the opening,

the holding method comprising:

(A) mounting the holding jig on a holding part; and

(B) holding the bonded substrate by suctioning the dicing tape of the holding jig mounted on the holding part,

wherein, in the (B), a suctioning pressure for suctioning the dicing tape is applied via each of a center region of the holding part and an outer peripheral region partitioned from the center region and looping around the center region on an outer side of the center region.