

[DESCRIPTION]

[TITLE OF INVENTION]

PICKUP APPARATUS AND PICKUP METHOD

[Technical Field]

5 [0001]

The present invention relates to a pickup apparatus which picks up a semiconductor die from a sheet and a pickup method thereof.

[Background Art]

[0002]

10 Semiconductor dies are manufactured by cutting a wafer having a size of 8 inches or 12 inches into predetermined sizes. A viscoelastic film called a die attach film (DAF), which forms a resin layer between a substrate and a semiconductor die during die bonding, is attached to a back surface of the wafer which has been manufactured. Further, in order for the semiconductor dies that have been cut at the time of cutting the wafer not to be scattered, a
15 dicing sheet is attached to a back surface of the DAF and the wafer is cut together with the DAF from a front surface side using a dicing saw, a laser beam or the like. At this time, the dicing sheet attached to the back surface is slightly notched but is not cut, thereby being in a state of holding each semiconductor die and DAF. In addition, respective semiconductor dies that have been cut are picked up from the dicing sheet one by one together with the DAF and transferred
20 to the next process such as die bonding.

[0003]

As a pickup apparatus that picks up a semiconductor die together with a DAF from a dicing sheet, such a device that initially peels off a peripheral portion of a semiconductor die from a dicing sheet, then peels off a central portion of the semiconductor die from the dicing
25 sheet, and picks up the semiconductor die using a collet has been proposed (see, for example, Patent Literature 1). This pickup apparatus is operated as follows. First, in a state in which

the dicing sheet is attached by suction to a surface of a cylindrical suction stage and the semiconductor die is attached by suction to the collet, an initial peeling column and eject pins disposed at a central portion of the suction stage protrude above the surface of the suction stage to push up the semiconductor die. Also, at the same time, the inside of the suction stage is evacuated to cause initial peeling around the semiconductor die (see FIGS. 4a and 4b of Patent Literature 1). Next, in a state in which the inside of the suction stage is evacuated, the initial peeling column is lowered to the surface of the suction stage, and the central portion of the semiconductor die is peeled off from the dicing sheet (see FIGS. 6a and 6b of Patent Literature 1). Then, the semiconductor die is picked up by the collet.

[Citation List]

[Patent Literature]

[0004]

[Patent Literature 1] Specification of U.S. Patent No. 7,665,204

[Summary of Invention]

[Technical Problem]

[0005]

Meanwhile, in recent years, semiconductor dies have become very thin, and there has been one having a size of about 20 μm , for example. On the other hand, since a thickness of the dicing sheet is about 100 μm , the thickness of the dicing sheet is 4 to 5 times greater than a thickness of the semiconductor die. In the conventional pickup apparatus disclosed in Patent Literature 1, when the inside of the suction stage is evacuated, the semiconductor die and the DAF between the eject pins are bent downward following a downward deformation of the dicing sheet, so that peeling does not occur between the DAF and the dicing sheet, thereby making it difficult to pick up a thin semiconductor die.

[0006]

Therefore, it is an objective of the present invention to pick up a thin semiconductor die

attached to a surface of a sheet via a viscoelastic film from the surface of the sheet together with the viscoelastic film.

[Solution to Problem]

[0007]

5 A pickup apparatus of the present invention is a pickup apparatus that picks up a semiconductor die attached to a surface of a sheet via a viscoelastic film from the surface of the sheet together with the viscoelastic film. The pickup apparatus includes a stage including a suction surface which sucks and holds a back surface of the sheet, a push-up member which is disposed in an opening provided on the suction surface of the stage and a tip of which protrudes
10 from the suction surface to push up the back surface of the sheet, and an opening pressure switching mechanism which switches an opening pressure of the opening between a first pressure close to a vacuum and a second pressure close to atmospheric pressure. The pickup apparatus is characterized in that, when the semiconductor die is picked up together with the viscoelastic film, in a state in which a suction pressure of the suction surface is set to a third
15 pressure close to a vacuum and the back surface of the sheet is pushed up from the suction surface by the push-up member, the opening pressure oscillates between the first pressure and the second pressure at a predetermined frequency in accordance with viscoelastic characteristics of the viscoelastic film.

[0008]

20 In the pickup apparatus of the present invention, the oscillation frequency of the opening pressure between the first pressure and the second pressure may be changed on the basis of a relaxation time of the viscoelastic film.

[0009]

25 In the pickup apparatus of the present invention, the oscillation frequency of the opening pressure between the first pressure and the second pressure may be increased as the relaxation time of the viscoelastic film becomes longer.

[0010]

In the pickup apparatus of the present invention, the oscillation frequency of the opening pressure between the first pressure and the second pressure may be set to be 10 Hz to 50 Hz.

5 [0011]

In the pickup apparatus of the present invention, the push-up member may include a push-up pin set configured of a plurality of push-up pins which pushes up the back surface of the sheet at a plurality of separate positions thereon, and a push-up block configured of a plurality of push-up columns which pushes up the back surface of the sheet on an outward side surrounding
10 the push-up pin set and between the push-up pins, and tips of the push-up pin set and tips of the push-up block may move between a first position higher than the suction surface and a second position lower than the first position. When the semiconductor die is picked up together with the viscoelastic film, the suction pressure may be set at the third pressure, the tips of the push-up pin set and the tips of the push-up block may be set at the first position, and the opening pressure
15 may oscillate between the first pressure and the second pressure at a predetermined frequency in accordance with viscoelastic characteristics of the viscoelastic film, and then the suction pressure may be held at the third pressure, the tips of the push-up block may be set at the second position with the tips of the push-up pin held at the first position, and the opening pressure may oscillate between the first pressure and the second pressure.

20 [0012]

In the pickup apparatus of the present invention, the push-up member may include a push-up pin set configured of a plurality of push-up pins which pushes up the back surface of the sheet at a plurality of separate positions thereon, and a push-up block configured of a plurality of push-up columns which pushes up the back surface of the sheet on an outward side surrounding
25 the push-up pin set and between the push-up pins, and tips of the push-up pin set and tips of the push-up block may move between a third position higher than the suction surface and a fourth

position lower than the third position. When the semiconductor die is picked up together with the viscoelastic film, the suction pressure may be set at the third pressure, the tips of the push-up pin set and the tips of the push-up block may be set at a fifth position between the third position and the fourth position, and the opening pressure may oscillate between the first pressure and the second pressure at a predetermined frequency in accordance with viscoelastic characteristics of the viscoelastic film, and then the suction pressure may be held at the third pressure, the tips of the push-up pin set may be set at the third position with the tips of the push-up block held at the fifth position, and the opening pressure may oscillate between the first pressure and the second pressure.

[0013]

In the pickup apparatus of the present invention, the push-up member may include a push-up pin set configured of a plurality of push-up pins which pushes up the back surface of the sheet at a plurality of separate positions thereon, and a push-up block configured of a plurality of push-up columns which pushes up the back surface of the sheet on an outward side surrounding the push-up pin set and between the push-up pins, and tips of the push-up pin set and tips of the push-up block may move between a third position higher than the suction surface and a fourth position lower than the third position. When the semiconductor die is picked up together with the viscoelastic film, the suction pressure may be set at the third pressure, the tips of the push-up pin set and the tips of the push-up block may be set at a fifth position between the third position and the fourth position, and the opening pressure may oscillate between the first pressure and the second pressure at a predetermined frequency in accordance with viscoelastic characteristics of the viscoelastic film, and then, with the suction pressure held at the third pressure, the tips of the push-up pin set may be set at the third position and the tips of the push-up block may be set at the fourth position, and the opening pressure may oscillate between the first pressure and the second pressure.

[0014]

In the pickup apparatus of the present invention, the fourth position may be a position the same as that of the suction surface or a position lower than the suction surface.

[0015]

A pickup method of the present invention is a pickup method for picking up a
5 semiconductor die attached to a surface of a sheet via a viscoelastic film from the surface of the
sheet together with the viscoelastic film, and is characterized by preparing a pickup apparatus
that includes a stage including a suction surface which sucks and holds a back surface of the
sheet, a push-up member which is disposed in an opening provided on the suction surface of the
stage and a tip of which protrudes from the suction surface to push up the back surface of the
10 sheet, and an opening pressure switching mechanism which switches an opening pressure of the
opening between a first pressure close to a vacuum and a second pressure close to atmospheric
pressure, and then, in a state in which the suction pressure of the suction surface is set to a third
pressure close to a vacuum and the back surface of the sheet is pushed up from the suction
surface with the push-up member, oscillating the opening pressure between the first pressure and
15 the second pressure at a predetermined frequency in accordance with viscoelastic characteristics
of the viscoelastic film to pick up the semiconductor die together with the viscoelastic film.

[0016]

In the pickup method of the present invention, the oscillation frequency of the opening
pressure between the first pressure and the second pressure may be changed on the basis of a
20 relaxation time of the viscoelastic film.

[0017]

In the pickup method of the present invention, the oscillation frequency of the opening
pressure between the first pressure and the second pressure may be increased as the relaxation
time of the viscoelastic film becomes longer.

25 [0018]

In the pickup method of the present invention, the oscillation frequency of the opening

pressure between the first pressure and the second pressure may be set to be 10 Hz to 50 Hz.

[Advantageous Effects of Invention]

[0019]

5 The present invention can pick up a thin semiconductor die attached to a surface of a sheet via a viscoelastic film together with the viscoelastic film from the surface of the sheet.

[Brief Description of Drawings]

[0020]

FIG. 1 is a system diagram showing a configuration of a pickup apparatus of an embodiment.

10 FIG. 2 is a perspective view showing a stage of the pickup apparatus shown in FIG. 1.

FIG. 3 is an explanatory diagram showing deformation of a semiconductor die, a viscoelastic film, and a sheet.

FIG. 4 is a physical model of a laminate of the semiconductor die, the viscoelastic film and the sheet.

15 FIG. 5 is a diagram showing change in peeling force between the sheet and the viscoelastic film when an oscillating pressure is applied to a lower surface of the sheet according to the physical model shown in FIG. 4.

FIG. 6 is a graph showing a relationship between a relaxation time of the viscoelastic film and an optimum frequency of a pressure oscillation.

20 FIG. 7 is an explanatory diagram showing an operation of the pickup apparatus shown in FIG. 1 (an initial state).

FIG. 8 is an explanatory diagram showing an operation of the pickup apparatus shown in FIG. 1 (a periphery peeled state).

25 FIG. 9 is an explanatory diagram showing an operation of the pickup apparatus shown in FIG. 1 (a substantially fully peeled state).

FIG. 10 is a graph showing oscillation of an opening pressure during the operations

shown in FIGS. 7 to 9.

FIG. 11 is an explanatory diagram showing another operation of the pickup apparatus shown in FIG. 1 (a periphery peeled state).

FIG. 12 is an explanatory diagram showing another operation of the pickup apparatus
5 shown in FIG. 1 (substantially fully peeled state).

FIG. 13 is an explanatory diagram showing another operation of the pickup apparatus shown in FIG. 1 (substantially fully peeled state).

[Description of Embodiments]

[0021]

10 <Configuration of pickup apparatus>

Hereinafter, a pickup apparatus 100 of an embodiment will be described with reference to the drawings. The pickup apparatus 100 of the present embodiment picks up a semiconductor die 15 attached to a surface 12a of a resin sheet 12 via a viscoelastic film 11 from the surface 12a of the sheet 12 together with the viscoelastic film 11.

15 [0022]

As shown in FIG. 1, the pickup apparatus 100 of the present embodiment includes a wafer holder 10 which holds the sheet 12, a stage 20 that sucks and holds the sheet 12, a push-up member 30 provided in an opening 23 of the stage 20, a drive mechanism 50 which is provided in a casing 21 of the stage 20 to drive the push-up member 30 up and down, a collet 18 which
20 picks up the semiconductor die 15, a vacuum pump 61, and a control unit 70 which controls driving of the pickup apparatus 100.

[0023]

The wafer holder 10 has an annular expanding ring 16, and a ring retainer 17 which fixes a metal ring 13 attached to a periphery of the sheet 12 on a flange of the expanding ring 16.
25 When the sheet 12 is set on the expanding ring 16, the sheet 12 is stretched along a curved surface at a top portion of the expanding ring as much as a level difference between an upper

surface of the expanding ring 16 and a surface of the flange, whereby a tensile force from a center of the sheet 12 toward the periphery acts thereon. Since the sheet 12 is extended by the tensile force, gaps 14 are formed between semiconductor dies 15 and viscoelastic films 11 which has been attached on the sheet 12. Further, the wafer holder 10 can be moved in a horizontal direction and a vertical direction by a moving mechanism (not shown).

[0024]

As shown in FIG. 2, the stage 20 has a cylindrical shape, and a suction surface 22 that sucks a back surface 12b of the sheet 12 to be attached thereto is formed on an upper surface thereof. A quadrangular opening 23 that communicates with the inside of the casing 21 is provided at a center of the suction surface 22, and the push-up member 30 that protrudes from the suction surface 22 to push up the back surface 12b of the sheet 12 is disposed in the opening 23. The push-up member 30 is configured of a push-up pin set 32 and a push-up block 34. The push-up pin set 32 is configured of a plurality of needle-shaped push-up pins 31 that pushes up the back surface 12b of the sheet 12 at a plurality of separate positions thereon. The push-up block 34 is configured of a plurality of quadrangular columnar push-up columns 33 that pushes up the back surface 12b of the sheet 12 between the push-up pins 31 and on an outward side surrounding the push-up pin set 32. Double suction grooves 26 are provided around the opening 23 to surround the opening 23. Each suction groove 26 is provided with suction holes 27.

[0025]

As shown in FIG. 1, the drive mechanism 50 that drives the push-up pin set 32 and the push-up block 34 constituting the push-up member 30 in the vertical direction is accommodated in the casing 21 of the stage 20. The drive mechanism 50 includes a motor 51, a cam 52 which converts rotational movement of the motor 51 into a vertical movement, a cam follower 53 which abuts the cam 52, a rod 54 to which the cam follower 53 is attached and which moves in the vertical direction in accordance with rotation of the motor 51, and a conversion mechanism

55 which converts the vertical movement of the rod 54 into vertical movement of the push-up pin set 32 and the push-up block 34.

[0026]

5 The collet 18 has a holding surface 18a that sucks and holds the semiconductor die 15 at its tip. Suction holes 19 are provided in the holding surface 18a. The collet 18 is moved in the horizontal direction and the vertical direction by a collet drive unit 80.

[0027]

10 The inside of the casing 21 communicates with the vacuum pump 61 through a pipe 63. Since the opening 23 of the stage 20 communicates with the suction surface 22 and the inside of the casing 21, the vacuum pump 61 is connected to the opening 23 through the pipe 63 and the casing 21. Further, the suction holes 27 communicate with the vacuum pump 61 through a pipe 64. The suction holes 19 of the collet 18 communicate with the vacuum pump 61 through a pipe 65. In addition, three-way valves 67, 68 and 69 are disposed in the respective pipes 63, 64 and 65. A pressure sensor 62 that detects a suction pressure of the vacuum pump 61 is attached to a suction pipe 66 of the vacuum pump 61. Since the three-way valves 67, 68 and 69 can switch respective communicating directions between a vacuum pump side and an atmosphere open side, in the case of switching to the vacuum pump side, the casing 21, the suction grooves 26, and the suction holes 19 of the collet 18 are evacuated by communicating with the vacuum pump 61. On the contrary, in the case of switching to the atmosphere open side, air is introduced into the casing 21, the suction grooves 26, and the suction holes 19 of the collet 18 by communicating with an atmosphere open end to break the vacuum. The three-way valve 67 is connected to the casing 21 via the pipe 63 and switches a pressure P of the opening 23 of the casing 21 between a vacuum and atmospheric pressure, which corresponds to an opening pressure switching mechanism described in the claims. Also, a compressed air source higher in pressure than atmospheric pressure may be connected to the atmosphere open side of the three-way valve 67 so that the pressure P of the opening 23 of the casing 21 may be switched

between a vacuum and a pressure slightly higher than atmospheric pressure.

[0028]

The control unit 70 includes a central processing unit (CPU) 71 which performs arithmetic processing, a memory 72 which stores control programs and data, and a device/sensor interface 73, and is a computer in which the CPU 71, the memory 72, and the device/sensor interface 73 are connected via a data bus 74. The motor 51 of the drive mechanism 50 that drives the push-up member 30, the vacuum pump 61, the collet drive unit 80, the three-way valves 67, 68 and 69, and the moving mechanism of the wafer holder 10 (not shown) are connected to the device/sensor interface 73 and are driven by commands of the control unit 70. Also, the pressure sensor 62 is connected to the device/sensor interface 73, and detection signals thereof are processed by the control unit 70.

[0029]

<Vibrational response of laminate of semiconductor die, viscoelastic film and sheet>

As shown in FIG. 3, since the semiconductor die 15 is attached to the sheet 12 via the viscoelastic film 11, the semiconductor die 15, the viscoelastic film 11 and the sheet 12 are a laminate as shown in FIG. 3. Also, in FIG. 3, reference signs 15a, 11a, and 12a indicate respective front surfaces of the semiconductor die 15, viscoelastic film 11, and sheet 12, and reference signs 15b, 11b, and 12b indicate respective back surfaces of the semiconductor die 15, viscoelastic film 11, and sheet 12. A thickness of the semiconductor die 15 is thinner than a thickness of the sheet 12, and a bending rigidity of the semiconductor die 15 is lower than that of the sheet 12. Here, when the pressure P of the opening 23 of the stage 20 shown in FIGS. 1 and 2 is evacuated, the sheet 12 is curved and deformed convexly downward as shown in FIG. 3. The semiconductor die 15 and the viscoelastic film 11 having bending rigidity smaller than that of the sheet 12 follow the sheet 12 and are curved and deformed convexly downward.

[0030]

The laminate of the semiconductor die 15, the viscoelastic film 11 and the sheet 12 that

are deformed as described above can be handled as a physical model as shown in FIG. 4. As shown in FIG. 4, the semiconductor die 15 that is an individual elastic body is represented by a combination of a mass 41 and a spring 42 that exhibits bending rigidity. Similarly, as shown in FIG. 4, the sheet 12 that is an individual elastic body can be represented by a combination of a mass 46 and a spring 47 that exhibits bending rigidity. On the other hand, the viscoelastic film 11 that is a viscoelastic body can be expressed as an object in which a mass 43, a spring 44 that exhibits bending rigidity, and a dashpot 45 that exhibits viscosity are connected in series. Thus, as shown in FIG. 4, the laminate of the semiconductor die 15, the viscoelastic film 11 and the sheet 12 can be handled as a physical model in which the mass 41 and the spring 42, the mass 43 and the spring 44 and the dashpot 45, and the mass 46 and the spring 47 are connected in series.

[0031]

When the pressure P applied to a lower end of the sheet 12 shown in FIG. 4 oscillates, an oscillating external force of pressure $P \times$ pressure receiving area A is applied to the physical model. When the pressure P oscillating as shown in FIG. 5 is input as an external force at a lower end of the physical model shown in FIG. 4, the solid semiconductor die 15 and the sheet 12 change without delay in response to a change of the pressure P with the elapse of time, while a displacement of the viscoelastic film 11 changes with a delay with respect to the change of the pressure P with the elapse of time. For this reason, a displacement difference occurs between the sheet 12 and the viscoelastic film 11. Due to the displacement difference, as shown by a dashed line in FIG. 5, a peeling force F_p in a direction of peeling the front surface 11b of the viscoelastic film 11 from the front surface 12a of the sheet 12 is generated. The peeling force F_p between the sheet 12 and the viscoelastic film 11 varies depending on a frequency f of the oscillation of the pressure P that is the external force, and a relaxation time τ of the viscoelastic film 11.

[0032]

Therefore, when an appropriate frequency f of the oscillation of the pressure P is

selected in accordance with the relaxation time τ of the viscoelastic film 11, the peeling force F_p can be maximized at a time t_1 that is delayed by a time Δt from a time t_0 at which the pressure P is lowest, as shown in FIG. 5.

[0033]

5 The time Δt shown in FIG. 5 becomes shorter as the relaxation time τ of the viscoelastic film 11 becomes longer, that is, characteristics of the viscoelastic film 11 becomes closer to elastic characteristics, and becomes longer as the relaxation time τ of the viscoelastic film 11 becomes shorter, that is, the characteristics of the viscoelastic film 11 becomes closer to viscosity characteristics. Therefore, by setting the frequency f of the oscillation of the pressure
10 P to be higher when the relaxation time τ of the viscoelastic film 11 is long and setting the frequency f of the oscillation of the pressure P to be lower when the relaxation time τ of the viscoelastic film 11 is short, it is possible to obtain a large peeling force F_p at the time t_1 that is delayed by the time Δt from the time t_0 at which the pressure P is lowest.

[0034]

15 Here, the relaxation time τ of the viscoelastic film 11 indicates viscoelastic characteristics of the viscoelastic film 11 and is a physical property value measured by a general viscoelasticity measuring device (a rheometer). According to the inventor's research, it has been found that, in the case in which the relaxation time τ of the viscoelastic film 11 is 10 to 20 (ms), a large peeling force F_p is obtained by setting the frequency f of the oscillation of the
20 pressure P to 10 Hz to 50 Hz. More preferably, by setting the frequency f of the oscillation of the pressure P to 10 Hz to 40 Hz, a larger peeling force F_p can be obtained. More preferably, by setting the frequency f of the oscillation of the pressure P to 10 Hz to 30 Hz, a larger peeling force F_p can be obtained. More preferably, by setting the frequency f of the oscillation of the pressure P to 20 Hz, even larger peeling force F_p can be obtained. Further, the frequency f of
25 the oscillation of the pressure P set to be 20 Hz is an example and the present invention is not limited thereto. In other aspects, the frequency f of the oscillation of the pressure P is 10, 11,

12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, and 50 Hz, and it may be within a range between any two of these frequencies.

[0035]

5 <Application to pickup apparatus>

As described above, when the oscillation of the pressure P is applied to the laminate of the semiconductor die 15, the viscoelastic film 11 and the sheet 12 at the predetermined frequency f in accordance with the relaxation time τ of the viscoelastic film 11, a large peeling force F_p can be generated between the viscoelastic film 11 and the sheet 12. The pickup
10 apparatus 100 of the present embodiment is an application of this principle, and is a device in which, when the semiconductor die 15 is picked up together with the viscoelastic film 11, by oscillating the pressure P of the opening 23 between a first pressure P_1 close to a vacuum and a second pressure P_2 close to atmospheric pressure at the predetermined frequency f , a large peeling force F_p is generated between the viscoelastic film 11 and the sheet 12 to pick up the
15 semiconductor die 15 and the viscoelastic film 11 from the sheet 12. Also, as long as the second pressure P_2 is a pressure close to atmospheric pressure, in addition to the pressure the same as atmospheric pressure, it includes a pressure a little higher than atmospheric pressure and a pressure a little lower than atmospheric pressure.

[0036]

20 Here, oscillating the pressure P of the opening 23 between the first pressure P_1 close to a vacuum and the second pressure P_2 close to atmospheric pressure may include a case in which there is more than one cycle of the oscillation of the pressure P between the first pressure P_1 and the second pressure P_2 , and means, for example, that such a variation of the pressure P in which the pressure P of the opening 23 is lowered from the second pressure P_2 close to atmospheric
25 pressure to the first pressure P_1 close to a vacuum and then returns to the second pressure P_2 close to atmospheric pressure occurs once or more.

[0037]

<Operations of pickup apparatus>

Hereinafter, operations of the pickup apparatus 100 will be described with reference to FIGS. 7 to 10. In the following description, the frequency f of the pressure oscillation is assumed to be 20 Hz.

[0038]

As shown in FIG. 7, the control unit 70 adjusts horizontal and vertical positions of the wafer holder 10 using the moving mechanism (not shown) such that the back surface 12b of the sheet 12 on which the semiconductor die 15 and the viscoelastic film 11 are attached abuts the suction surface 22 of the stage 20 and horizontal positions of the semiconductor die 15 and the viscoelastic film 11 are directly above the opening 23. Then, the control unit 70 sets the three-way valve 68 to the vacuum pump side and lowers the pressure of the suction grooves 26 of the stage 20 using the vacuum pump 61, thereby sucking the back surface 12b of the sheet 12 to be fixed to the suction surface 22. In this state, the tips 31a and 33a of the push-up pins 31 and the push-up columns 33 are in a second position which is on the same plane as the suction surface 22.

[0039]

Next, the control unit 70 sets the three-way valve 67 to the vacuum pump side at time t_1 shown in FIG. 10 and lowers the pressure P of the opening 23 of the stage 20 from the second pressure P_2 close to the atmospheric pressure using the vacuum pump 61. In addition, substantially simultaneously with the start of lowering the pressure of the opening 23, as shown in FIG. 8, the control unit 70 raises respective tips 31a and 33a of the push-up pins 31 and the push columns 33 of the push-up pin set 32 and the push-up block 34 to a first position higher by a height H_1 than the suction surface 22 using the drive mechanism 50. Further, the control unit 70 sets the three-way valve 69 to the vacuum pump side and lowers the pressure of the suction holes 19 of the collet 18. As shown in FIG. 8, since the sheet 12 around the opening 23 is fixed

by suction to the suction surface 22, the sheet 12 is pulled obliquely downward in accordance with ascent of the tips 31a and 33a of the push-up pins 31 and the push-up columns 33. Also, the sheet 12 is pulled downward due to the pressure P of the opening 23.

[0040]

At this time, the semiconductor die 15 is sucked to be attached to the holding surface 18a of the collet 18 due to the vacuum of the suction holes 19. However, during the time t1 to t2 in FIG. 10 in which the pressure P of the opening 23 is decreased from the second pressure P2 close to atmospheric pressure to the first pressure P1 close to a vacuum, the semiconductor die 15 is separated from the holding surface 18a of the collet 18, and the semiconductor die 15 and the viscoelastic film 11 are curved downward following the sheet 12 as shown in FIG. 3. For this reason, the viscoelastic film 11 and the sheet 12 are not separated from each other. However, in the case in which the holding surface 18a of the collet 18 is an elastic body such as rubber, since the semiconductor die 15 is thin, an outer peripheral portion of the semiconductor die 15 is curved and deformed into a convex shape with a slight pressing force as shown in FIG. 3, so that a peeling resistance force is generated. In this case, the collet 18 causes the semiconductor die 15 to wait in the air with a slight gap therebetween. Even when the collet 18 is not in contact with the semiconductor die 15, if the peeling is completed with no influence on the peeling process in the present case, the semiconductor die 15 is sucked and held by the collet 18.

[0041]

When the pressure P of the opening 23 reaches the first pressure P1 close to a vacuum at time t2 shown in FIG. 10, the control unit 70 switches the three-way valve 67 to the atmosphere open side to introduce air to the inside of the casing 21. Thus, the pressure P of the opening 23 rapidly increases from the first pressure P1 at time t2 toward the second pressure P2 close to atmospheric pressure and returns to the second pressure P2 close to atmospheric pressure at time t3.

[0042]

In the pickup apparatus 100, as shown in FIG. 10, an air suction speed of the vacuum pump 61 and a vacuum opening speed of the opening 23 performed by the three-way valve 67 are adjusted such that a time $\Delta t_2 (= t_3 - t_1)$ from the time t_1 when the pressure P of the opening 23 starts to decrease until the time t_3 when the pressure P of the opening 23 reaches the first pressure P_1 close to a vacuum and returns to the second pressure P_2 again becomes 50 (ms) $= (1/20 \text{ Hz} \times 1000)$ which is one period of 20 Hz that is the predetermined period.

[0043]

For this reason, as shown in FIG. 10, a maximum peeling force F_p is generated between the viscoelastic film 11 and the sheet 12 after time Δt_1 lapses from the time when the pressure P of the opening 23 reaches the second pressure P_2 close to a vacuum. Due to the peeling force F_p , initial peeling occurs between a peripheral portion of the viscoelastic film 11 and the sheet 12 between time t_2 and time t_3 , that is, as shown in FIG. 8, during a vacuum break time.

[0044]

Next, the control unit 70 sets the three-way valve 67 to the vacuum pump side again and starts lowering the pressure P of the opening 23 of the stage 20 from the second pressure P_2 close to the atmospheric pressure using the vacuum pump 61. In addition, substantially simultaneously with the start of lowering the pressure P of the opening 23, as shown in FIG. 9, the control unit 70 lowers each tip 33a of the push-up columns 33 to the same height as that of the suction surface 22, that is, to the second position lower by the height H_1 than the first position, while the position of each tip 31a of the push-up pins 31 is maintained at the first position by the drive mechanism 50. As a result, a portion of the sheet 12 that has been pushed up by the push-up columns 33 is pulled downward due to the pressure lower than the atmospheric pressure in the opening 23 and is bent downward.

[0045]

At this time, the semiconductor die 15 and the viscoelastic film 11 also follow the sheet

12 and are bend downward. In this state, the viscoelastic film 11 and the sheet 12 at the portion of the sheet 12 pushed up by the push-up columns 33 are not separated from each other.

[0046]

Next, when the pressure P of the opening 23 reaches the first pressure P1 close to a vacuum, the control unit 70 switches the three-way valve 67 to the atmosphere open side to introduce air to the inside of the casing 21. Thus, the pressure P of the opening 23 rises from the first pressure P1 toward the second pressure P2 close to the atmospheric pressure and returns to the second pressure P2 close to the atmospheric pressure.

[0047]

In the state of FIG. 9, the time Δt_2 from when the pressure P of the opening 23 is lowered from the second pressure P2 to the first pressure P1 until it returns to the second pressure P2 may be set to be $50 \text{ (ms)} = (1/20 \text{ Hz} \times 1000)$ which is one period of 20 Hz, similarly to the aforementioned case in which the pressure P of the opening 23 oscillates at a frequency of 20 Hz between the second pressure P2 and the first pressure P1 in the state shown in FIG. 8, by adjusting the air suction speed of the vacuum pump 61 and the vacuum opening speed of the opening 23 via the three-way valve 67, or may be adjusted to be longer than the above.

[0048]

In the case in which the time Δt_2 is adjusted to 50 (ms), as described with reference to FIG. 8, the maximum peeling force F_p is generated between the sheet 12 and the viscoelastic film 11 during the pressure P of the opening 23 returns from the first pressure P1 to the second pressure P2, and the peeling between the sheet 12 and the viscoelastic film 11 occurs in the portion of the sheet 12 that has been pushed up by the push-up columns 33 with the maximum peeling force F_p .

[0049]

On the other hand, in the case in which the time Δt_2 is longer than 50 (ms), for example, the vacuum break starts after a while from when it reaches the first pressure P1 from the second

pressure P2, the peeling occurs between the sheet 12 and the viscoelastic film 11 due to a force with which the semiconductor die 15 at the portion between the push-up pins 31 tends to return to an original flat state from the state of being deformed and curved convexly downward based on its elastic force during the pressure P of the opening 23 is maintained at the second pressure P2 in the process of returning to the second pressure P2 close to the atmospheric pressure. This is because, in the region between the push-up pins 31, the semiconductor die 15 is supported like a doubly supported beam by the tips 31a of the push-up pins 31 and thus the rigidity increases as compared to the peripheral portion shown in FIG. 8, whereby the peeling between the sheet 12 and the viscoelastic film 11 is facilitated due to the rigidity of the semiconductor die 15.

[0050]

In addition, when the pressure P of the opening 23 returns to the second pressure P2 close to atmospheric pressure, the peeling occurs between the sheet 12 and the viscoelastic film 11 at a central portion thereof. Then, the control unit 70 raises the collet 18 using the collet drive unit 80 and picks up the semiconductor die 15 and the viscoelastic film 11 from the sheet 12.

[0051]

As described above, the pickup apparatus 100 of the embodiment can pick up the thin semiconductor die 15 attached to the surface 12a of the sheet 12 via the viscoelastic film 11 from the surface 12a of the sheet 12 together with the viscoelastic film 11.

[0052]

In the above description, although it has been described that, in the case where the initial peeling occurs between the peripheral portion of the viscoelastic film 11 and the sheet 12 as shown in FIG. 8, the control unit 70 oscillates the pressure P of the opening 23 only once between the second pressures P2 close to atmospheric pressure and the first pressure P1 close to a vacuum, that is, lowers the pressure P of the first pressure P1 from the second pressure P2 and then returns it to the second pressure P2, the oscillation of the pressure P is not limited to one

cycle, and for example, as shown by a broken line in FIG. 10, the pressure P may oscillate between the second pressure P2 and the first pressure P1 for two cycles. In this case, since the time at which the peeling force Fp is maximized occurs twice, the peeling between the sheet 12 and the viscoelastic film 11 can be more preferably performed.

5 [0053]

Next, another operation of the pickup apparatus 100 will be described with reference to FIGS. 11 and 12. Description of the same operations as those described above with reference to FIGS. 7 to 10 will be omitted.

[0054]

10 In the present operation, after the initial state shown in FIG. 7, as shown in FIG. 11, the control unit 70 raises each tip 31a of the push-up pins 31 and each tip 33a of the push-up columns 33 to a fifth position at a height H2 from the suction surface 22, and then oscillates the pressure P of the opening 23 between the second pressure P2 and the first pressure P1 for one cycle only at a frequency of 20 Hz. Thereafter, with the position of each tip 33a of the push-up
15 columns 33 maintained at the fifth position, the control unit 70 raises the tips 31a of the push-up pins 31 up to a third position which is higher than the fifth position and at a height H3 from the suction surface 22, and oscillates the pressure P of the opening 23 between the second pressure P2 and the first pressure P1. In this case, the position of the suction surface 22 is a fourth position described in the claims.

20 [0055]

Also with the above operation, similarly to the case described above, the pickup apparatus 100 can pick up the thin semiconductor die 15 attached to the surface 12a of the sheet 12 via the viscoelastic film 11 from the surface 12a of the sheet 12 together with the viscoelastic film 11.

25 [0056]

Next, another operation of the pickup apparatus 100 will be described with reference to

FIG. 13. In the present operation, after the initial state shown in FIG. 7 is shifted to the initial peeling state as shown in FIG.11, as shown in FIG. 13, the control unit 70 lowers a position of each tip 33a of the push-up columns 33 to the fourth position that is the same height as the suction surface 22 and raises the tips 31a of the push-up pins 31 to the third position which is higher than the fifth position and is at the height H3 from the suction surface 22, and oscillates the pressure P of the opening 23 between the second pressure P2 and the first pressure P1. In this case, the position of the suction surface 22 is the fourth position described in the claims.

[0057]

Also with the above operation, similarly to the cases described above, the pickup apparatus 100 can pick up the thin semiconductor die 15 attached to the surface 12a of the sheet 12 via the viscoelastic film 11 from the surface 12a of the sheet 12 together with the viscoelastic film 11.

[Reference Signs List]

[0058]

- 15 10 Wafer holder
- 11 Viscoelastic film
- 11a, 12a, 15a Front surface
- 11b, 12b, 15b Back surface
- 12 Sheet, 13 Ring
- 20 14 Gap
- 15 Semiconductor die
- 16 Expanding ring
- 18 Collet
- 18a Holding surface
- 25 19 Suction hole
- 20 Stage

	21 Casing
	22 Suction surface
	23 Opening
	26 Suction groove
5	27 Suction hole
	30 Push-up member
	31 Push-up pin
	31a, 33a Tip
	32 Push-up pin set
10	33 Push-up column
	34 Push-up block
	41, 43, 46 Mass
	42, 44, 47 Spring
	45 Dashpot
15	50 Drive mechanism
	51 Motor
	52 Cam
	53 Cam follower
	54 Rod
20	55 Conversion mechanism
	61 Vacuum pump
	62 Pressure sensor
	63, 64, 65 Pipe
	66 Suction pipe
25	67, 68, 69 Three-way valve
	70 Control unit

	71 CPU
	72 Memory
	73 Device/sensor interface
	74 Data bus
5	80 Collet drive unit
	100 Pick-up device

[CLAIMS]

[Claim 1]

A pickup apparatus which picks up a semiconductor die attached to a surface of a sheet via a viscoelastic film from the surface of the sheet together with the viscoelastic film,
5 comprising:

a stage including a suction surface which sucks and holds a back surface of the sheet;

a push-up member which is disposed in an opening provided on the suction surface of the stage, and a tip of the push-up member protrudes from the suction surface to push up the back surface of the sheet; and

10 an opening pressure switching mechanism which switches an opening pressure of the opening between a first pressure close to a vacuum and a second pressure close to atmospheric pressure,

wherein, when the semiconductor die is picked up together with the viscoelastic film, in a state in which a suction pressure of the suction surface is set to a third pressure close to a vacuum and the back surface of the sheet is pushed up from the suction surface by the push-up member, the opening pressure oscillates between the first pressure and the second pressure at a predetermined frequency in accordance with viscoelastic characteristics of the viscoelastic film.
15

[Claim 2]

The pickup apparatus according to claim 1, wherein the oscillation frequency of the opening pressure between the first pressure and the second pressure is changed on the basis of a relaxation time of the viscoelastic film.
20

[Claim 3]

The pickup apparatus according to claim 2, wherein the oscillation frequency of the opening pressure between the first pressure and the second pressure increases as the relaxation time of the viscoelastic film becomes longer.
25

[Claim 4]

The pickup apparatus according to claim 2, wherein the oscillation frequency of the opening pressure between the first pressure and the second pressure is 10 Hz to 50 Hz.

[Claim 5]

5 The pickup apparatus according to claim 3, wherein the oscillation frequency of the opening pressure between the first pressure and the second pressure is 10 Hz to 50 Hz.

[Claim 6]

The pickup apparatus according to any one of claims 2 to 5,

wherein the push-up member includes a push-up pin set configured of a plurality of push-up pins which pushes up the back surface of the sheet at a plurality of separate positions
10 thereon, and a push-up block configured of a plurality of push-up columns which pushes up the back surface of the sheet on an outward side surrounding the push-up pin set and between the push-up pins, and tips of the push-up pin set and tips of the push-up block move between a first position higher than the suction surface and a second position lower than the first position,

when the semiconductor die is picked up together with the viscoelastic film, the suction
15 pressure is set at the third pressure, the tips of the push-up pin set and the tips of the push-up block are set at the first position, and the opening pressure oscillates between the first pressure and the second pressure at the predetermined frequency in accordance with the viscoelastic characteristics of the viscoelastic film, and

then, the suction pressure is held at the third pressure, the tips of the push-up block are
20 set at the second position with the tips of the push-up pin held at the first position, and the opening pressure oscillates between the first pressure and the second pressure.

[Claim 7]

The pickup apparatus according to any one of claims 2 to 5,

wherein the push-up member includes a push-up pin set configured of a plurality of
25 push-up pins which pushes up the back surface of the sheet at a plurality of separate positions thereon, and a push-up block configured of a plurality of push-up columns which pushes up the

back surface of the sheet on an outward side surrounding the push-up pin set and between the push-up pins, and tips of the push-up pin set and tips of the push-up block move between a third position higher than the suction surface and a fourth position lower than the third position,

when the semiconductor die is picked up together with the viscoelastic film, the suction pressure is set at the third pressure, the tips of the push-up pin set and the tips of the push-up block are set at a fifth position between the third position and the fourth position, and the opening pressure oscillates between the first pressure and the second pressure at the predetermined frequency in accordance with the viscoelastic characteristics of the viscoelastic film, and

then, the suction pressure is held at the third pressure, the tips of the push-up pin set are set at the third position with the tips of the push-up block held at the fifth position, and the opening pressure oscillates between the first pressure and the second pressure.

[Claim 8]

The pickup apparatus according to any one of claims 2 to 5,

wherein the push-up member includes a push-up pin set configured of a plurality of push-up pins which pushes up the back surface of the sheet at a plurality of separate positions thereon, and a push-up block configured of a plurality of push-up columns which pushes up the back surface of the sheet on an outward side surrounding the push-up pin set and between the push-up pins, and tips of the push-up pin set and tips of the push-up block move between a third position higher than the suction surface and a fourth position lower than the third position,

when the semiconductor die is picked up together with the viscoelastic film, the suction pressure is set at the third pressure, the tips of the push-up pin set and the tips of the push-up block are set at a fifth position between the third position and the fourth position, and the opening pressure oscillates between the first pressure and the second pressure at the predetermined frequency in accordance with the viscoelastic characteristics of the viscoelastic film, and

then, with the suction pressure held at the third pressure, the tips of the push-up pin set are set at the third position and the tips of the push-up block are set at the fourth position, and the opening pressure oscillates between the first pressure and the second pressure.

[Claim 9]

5 The pickup apparatus according to claim 7, wherein the fourth position is a position the same as that of the suction surface or a position lower than the suction surface.

[Claim 10]

The pickup apparatus according to claim 8, wherein the fourth position is a position the same as that of the suction surface or a position lower than the suction surface.

10 [Claim 11]

A pickup method for picking up a semiconductor die attached to a surface of a sheet via a viscoelastic film from the surface of the sheet together with the viscoelastic film, comprising:

preparing a pickup apparatus that includes a stage including a suction surface which
sucks and holds a back surface of the sheet, a push-up member which is disposed in an opening
15 provided on the suction surface of the stage and a tip of the push-up member protrudes from the
suction surface to push up the back surface of the sheet, and an opening pressure switching
mechanism which switches an opening pressure of the opening between a first pressure close to
a vacuum and a second pressure close to atmospheric pressure, and

then, in a state in which the suction pressure of the suction surface is set to a third
20 pressure close to a vacuum and the back surface of the sheet is pushed up from the suction
surface with the push-up member, oscillating the opening pressure between the first pressure and
the second pressure at a predetermined frequency in accordance with viscoelastic characteristics
of the viscoelastic film to pick up the semiconductor die together with the viscoelastic film.

[Claim 12]

25 The pickup method according to claim 11, wherein the oscillation frequency of the
opening pressure between the first pressure and the second pressure is changed on the basis of a

relaxation time of the viscoelastic film.

[Claim 13]

The pickup method according to claim 12, wherein the oscillation frequency of the opening pressure between the first pressure and the second pressure increases as the relaxation
5 time of the viscoelastic film becomes longer.

[Claim 14]

The pickup method according to claim 12 or 13, wherein the oscillation frequency of the opening pressure between the first pressure and the second pressure is 10 Hz to 50 Hz.