

pressure switching mechanism 80 that switches the pressure of the opening 23 of the stage 20; an adsorption pressure switching mechanism 90 that switches the adsorption pressure of the adsorption surface 22 of the stage 20; a suction mechanism 100 that sucks air from the front surface 18a of the collet 18; a vacuum apparatus 140; a wafer holder horizontal direction drive unit 110 that horizontally drives the wafer holder 10; a stage vertical direction drive unit 120 that vertically drives the stage 20; a collet drive unit 130 that vertically and horizontally drives the collet 18; a control unit 150 that controls the semiconductor die pickup system 500; an input unit 410 serving as a keyboard, a mouse, or the like that inputs information; and a display unit 450 serving as a display that displays a screen.

[0028] The stepped surface formation mechanism 300 and the stepped surface formation mechanism drive unit 400 are accommodated in a base portion 24 of the stage 20. The stepped surface formation mechanism 300 is located at the upper portion 28 of the stage 20, and the stepped surface formation mechanism drive unit 400 is located at the lower portion of the stage 20. The stepped surface formation mechanism 300 includes the plurality of moving elements 30 moving in the vertical direction. By the stepped surface formation mechanism drive unit 400, each front end surface of the plurality of moving elements 30 moves downward as indicated by an arrow a in FIG. 1. Details of the moving elements 30 are described later.

[0029] An opening pressure switching mechanism 80 that switches the pressure of the opening 23 of the stage 20 includes a three-way valve 81 and a drive unit 82 that switches open and close drive of the three-way valve 81. The three-way valve 81 has three ports, the first port is connected to the base portion 24 communicating with the opening 23 of the stage 20 by a pipe 83, the second port is connected to the vacuum apparatus 140 by a

pressure of the opening 23, and the air leakage amount of the collet 18 during the release action of level 4 (pickup action). As shown in (a) of FIG. 18, which shows the height of the front surface 18a of the collet 18, and shows a state in which the collet 18 is moved from a time slightly after time $t=0$ (the height H_{c1}) to time t_2 . At time t_1 during which the collet 18 is being moved, the control unit 150 causes the drive unit 102 of the suction mechanism 100 to switch the three-way valve 101 in a direction of communicating the suction hole 19 of the collet 18 and the vacuum apparatus 140 (as indicated by an arrow 301 in FIG. 7). Thereby, the suction hole 19 becomes a negative pressure, and air flows into the suction hole 19 from the front surface 18a of the collet 18, and thus the suction air flow rate (air leakage amount) detected by the flow rate sensor 106 increases from time t_1 to time t_2 as shown in (f) of FIG. 18. At time t_2 , when the collet 18 lands on the semiconductor die 15, the semiconductor die 15 is adsorbed and fixed on the front surface 18a, and air cannot flow in from the front surface 18a. Thereby, at time t_2 , the air leakage amount detected by the flow rate sensor 106 starts to decrease. As shown in FIG. 6, the height of the front surface 18a of the collet 18 when the collet 18 lands on the semiconductor die 15 becomes a height H_c is obtained by adding the thickness of the dicing sheet 12 and the thickness of the semiconductor die 15 to the height of the front end surfaces 47, 38b, and 38a of the moving elements 45, 40, and 31 (the height H_0 from the surface 22).

[0045] Next, at time t_2 shown in FIG. 18, the control unit 150 outputs a command to switch the adsorption pressure (not shown) of the adsorption surface 22 of the stage 20 from the fourth pressure P_4 close to atmospheric pressure to the third pressure P_3 close to vacuum. According to this command, the drive unit 92 of the adsorption pressure switching mechanism 90 switches the three-way valve 91 in the direction of communicating the adsorption hole 27 and the vacuum apparatus 140. Then, the air in the groove 26 is sucked out to the vacuum apparatus 140 through the adsorption hole 27

as indicated by an arrow 201 in FIG. 7, an arrow 211 in FIG. 10, an arrow 213 in FIG. 11, an arrow 221 in FIG. 13, an arrow 225 in FIG. 14, an arrow 242 in FIG. 16, an arrow 245 in FIG. 17, and the adsorption pressure becomes the third pressure P_3 close to vacuum. Then, the back surface 12b of the dicing sheet 12 at the peripheral edge of the opening 23 is vacuum-sucked to the front surface of the adsorption surface 22 as indicated by an arrow 202 in FIG. 7. Because the front surfaces 47, 38b, and 38a of the moving elements 45, 40, and 31 are at the first position protruding from the adsorption surface 22 of the stage 20 by the height H_0 , a tension force F_1 obliquely downward acts on the dicing sheet 12. This tension force F_1 can be decomposed into a tension force F_2 that tensions the dicing sheet 12 laterally and a tension force F_3 that tensions the dicing sheet 12 downward. The lateral tension force F_2 generates a shear stress τ between the semiconductor die 15 and the front surface 12a of the dicing sheet 12. The shear stress τ causes a deviation between the outer peripheral portion or the peripheral portion of the semiconductor die 15 and the front surface 12a of the dicing sheet 12. This deviation triggers release between the dicing sheet 12 and the outer peripheral portion or the peripheral portion of the semiconductor die 15.

[0046] As shown in (e) of FIG. 18, the control unit 150 outputs a command to switch the opening pressure from the second pressure P_2 close to atmospheric pressure to the first pressure P_1 close to vacuum at time t_3 . According to this command, the drive unit 82 of the opening pressure switching mechanism 80 switches the three-way valve 81 in the direction of communicating the opening 23 and the vacuum apparatus 140. Then, the air in the opening 23 is sucked into the vacuum apparatus 140 as indicated by an arrow 206 in FIG. 8, and as shown in (e) of FIG. 18, the opening pressure becomes the first pressure P_1 close to vacuum at time t_4 . Thereby, as indicated by an arrow 203 in FIG. 8, the dicing sheet 12 immediately above the gap d between the inner surface 23a of the

the back surface 12b of the dicing sheet 12 located immediately above the gap d and the front end surface 38a of the peripheral annular moving element 31.

[0055] As shown in (e) of FIG. 18, the control unit 150 outputs a command to switch the opening pressure from the second pressure P_2 close to atmospheric pressure to the

5 first pressure P_1 close to vacuum at time t_7 . According to this command, the drive unit 82 of the opening pressure switching mechanism 80 switches the three-way valve 81 so as to communicate the opening 23 and the vacuum apparatus 140. Thereby, the air in

the opening 23 is sucked into the vacuum apparatus 140 as indicated by an arrow 215 in FIG. 12, and the opening pressure becomes the first pressure P_1 close to vacuum at time

10 t_8 . When the opening pressure decreases from the second pressure P_2 close to atmospheric pressure to the first pressure P_1 close to vacuum, as indicated by an arrow

216 in FIG. 12, the dicing sheet 12 located immediately above (facing) the front end surface 38a of the peripheral annular moving element 31 is tensioned downward so that the back surface 12b contacts the front end surface 38a. Thereby, as indicated by an arrow

15 217 in FIG. 12, a part of the semiconductor die 15 located immediately above the front end surface 38a of the semiconductor die 15 is bent and deformed downward, and separated from

the front surface 18a of the collet 18, and air flows into the adsorption hole 19 of the collet 18 as indicated by an arrow 218 in FIG. 12. The amount of the air leakage flowing into the

suction hole 19 is detected by the flow rate sensor 106. As shown in (f) of FIG. 18, the air

20 leakage amount increases in a period of time t_7 to time t_8 during which the opening pressure decreases. Then, near time t_8 at which the opening pressure reaches the first pressure P_1 ,

the semiconductor die 15 in the region facing the front end surface 38a returns toward the front surface 18a of the collet 18 as indicated by an arrow 224 in FIG. 13. Thereby, the air

leakage amount starts to decrease near time t_8 in (f) of FIG. 18, and when the

the region of the semiconductor die 15 facing the front end surfaces 38a and 38b is also separated from the front surface 18a of the collet 18 and bent and deformed downward as indicated by an arrow 231 in FIG. 15. Then, as indicated by an arrow 232 in FIG. 15, air flows into the suction hole 19 from the space between the front surface 18a of the collet 18 and the semiconductor die 15. The amount of the air leakage flowing into the suction hole 19 is detected by the flow rate sensor 106. As shown in (f) of FIG. 18, the air leakage amount increases in a period of time t11 to time t12 during which the opening pressure decreases. Then, near time t12 at which the opening pressure reaches the first pressure P_1 , the semiconductor die 15 of the region facing the front end surfaces 38a and 38b returns toward the front surface 18a of the collet 18 as indicated by an arrow 244 in FIG. 16. Thereby, the air leakage amount starts to decrease near time t12 in (f) of FIG. 18, and when the semiconductor die 15 is vacuum-adsorbed to the front surface 18a of the collet 18 as shown in FIG. 16, the air leakage amount becomes almost zero. Besides, the time for returning to the front surface 18a of the collet 18 varies according to the releasability between the semiconductor die 15 and the dicing sheet 12.

[0059] Next, as shown in (e) of FIG. 18, the control unit 150 outputs a command to switch the opening pressure from the first pressure P_1 close to vacuum to the second pressure P_2 close to atmospheric pressure at time t13. According to this command, the drive unit 82 of the opening pressure switching mechanism 80 switches the three-way valve 81 so as to communicate the opening 23 and the pipe 85 open to the atmosphere. Then, air flows into the opening 23 as indicated by an arrow 241 in FIG. 16 and the opening pressure increases, and thus the dicing sheet 12 is displaced upward as indicated by an arrow 243 in FIG. 16. As shown in (e) of FIG. 18, at time t14, the opening pressure becomes the second pressure P_2 close to the atmospheric pressure. In this state, as shown in FIG.

moving elements 30 (the peripheral annular moving element 31, the intermediate annular moving element 40, the columnar moving element 45) are simultaneously descended from the first position to the second position or lower at time $ts1$, and the “number of moving elements descended simultaneously” is increased to three (DN1). When the semiconductor die 15 is easily released from the dicing sheet 12, the region closer to the inner side than the periphery of the semiconductor die 15 is immediately released from the dicing sheet 12 even if the plurality of moving elements 30 are simultaneously descended. Besides, when the peripheral annular moving element 31 and the intermediate annular moving element 40 are simultaneously descended and the columnar moving element 45 is descended after a predetermined time, the “number of moving elements descended simultaneously” is two. Besides, in the parameter table 160 of FIG. 19, two release parameters of the “number of moving elements descended simultaneously” and the “descending time interval between moving elements” are defined, but instead of the two release parameters, the “descending time interval between the annular moving element 31 and the intermediate annular moving element 40”, the “descending time interval between the intermediate annular moving element 40 and the columnar moving element 45”, and the “descending time interval between the intermediate annular moving element 40 and another intermediate annular moving element 41” can be defined. In this case, one or more of these descending time intervals are set to 0 in order to simultaneously descend the plurality of moving elements 30.

[0074] In addition, in the release action of level 1 in FIG. 21, the “collet waiting time” (WT1) is set to 460 ms and shortened. Then, in FIG. 21, the “pickup time” (PT1) is 570 ms, which is short.

[0075] As described above, the parameter value of each release parameters is made

may be added to each semiconductor die image 482 of the map image 480.

[0081] The operator or the like can edit the level table 159 read on the map image 480 of the settings display screen 460. This is described after describing a method of newly generating the level table 159. Besides, in the embodiment, the mouse is used to move
5 the pointer 478 or select the button, but a joystick or the like may also be used.

[0082] FIG. 26 is a diagram showing an example of the settings display screen 460 when the level table 159 is newly generated. The operator or the like moves the pointer 478 to the “new creation” button 468 and clicks the button 468, and thereby the settings display screen 460 becomes a screen for newly creating the level table 159. At this time,
10 a temporary level table 159 in which the default level values are associated with all the semiconductor dies 15 of the single wafer is created, and colors corresponding to the default level values are added to the semiconductor die images 482 of the map image 480. In FIG. 26, the default level value is level 3, and a color (white) corresponding to level 3 is added to each semiconductor die image 482 (as semiconductor die image 482a shown
15 in FIG. 27). From this state, the operator or the like associates a desired level value with each semiconductor die image 482 and thereby associates the level value with the semiconductor die 15 corresponding to each semiconductor die image 482.

[0083] Specifically, first, as shown in FIG. 26, the pointer 478 is moved to a button 466 having a desired level value (level 5 in FIG. 26), and the button 466 is clicked to select
20 the level value. Then, as shown in FIG. 27, the pointer 478 is moved to a semiconductor die image 482b to be associated with the selected level value, and the semiconductor die image 482b is clicked. Thereby, the selected level value is associated with the semiconductor die corresponding to the clicked semiconductor die image 482b. In addition, a color according to the selected level value is added to the semiconductor die

WHAT IS CLAIMED IS:

1. A semiconductor die pickup system, which releases semiconductor dies obtained by dicing a wafer from a dicing sheet and picks up the semiconductor dies, comprising:

- 5 a collet that adsorbs the semiconductor dies,
 a suction mechanism that is connected to the collet and sucks air from the front surface of the collet,
 a flow rate sensor that detects a suction air flow rate of the suction mechanism,
 a control part that controls a pickup action based on pickup conditions for
10 picking up the semiconductor dies from the dicing sheet;
 an acquire part that acquires actual flow rate information indicating a time variation of the suction air flow rate detected by the flow rate sensor during pickup of semiconductor dies; and
 a generation part that generates association information in which any one of
15 the plurality of pickup conditions is associated with individual information of the semiconductor dies based on the acquired actual flow rate information;
 wherein the control part performs
 control to pick up the semiconductor dies from the dicing sheet according to the association information associated with each semiconductor die during pickup of the
20 semiconductor dies.

2. The semiconductor die pickup system according to claim 1,

wherein the generation part generates:

a level table in which each semiconductor die of a single wafer is associated with a level value that is an identifier of the plurality of pickup conditions, and

a condition table in which any one of the plurality of level values is associated with any one of the pickup conditions; and

the association information is determined by the level table and the condition table.

5 3. The semiconductor die pickup system according to claim 2,
wherein the plurality of level values are values indicating the length of time required for pickup.

4. The semiconductor die pickup system according to claim 2 or 3, further comprising:

10 a display unit that displays a screen, and
a display control part;
wherein the display control part
displays a map image imitating each semiconductor die of the single wafer on the display unit, and

15 adds, to a semiconductor die image corresponding to the semiconductor die with which the level value is associated, at least one of color, pattern, letter, number, and symbol according to the level value on the map image.

5. The semiconductor die pickup system according to claim 4, further comprising:

20 an input unit that inputs information,
wherein the generation part
receives, from the input unit, selection of one or more semiconductor die images on the map image and selection of one level value from the plurality of level values, and

associates the selected level value with a semiconductor die corresponding to the selected semiconductor die image to generate or update the level table.

6. The semiconductor die pickup system according to claim 4, further comprising:

5 a storage unit that stores expected flow rate information indicating a time variation of the suction air flow rate detected by the flow rate sensor during pickup of a semiconductor die when the release of the semiconductor die from the dicing sheet is good;

wherein the acquire part

10 acquires the actual flow rate information indicating a time variation of the suction air flow rate detected by the flow rate sensor during pickup of each semiconductor die of the single wafer,

the generation part obtains a correlation value between the actual flow rate information and the expected flow rate information of each of the plurality of semiconductor dies, and

15 associates the level value with each of the plurality of semiconductor dies based on each of the plurality of correlation values to generate or update the level table.

7. The semiconductor die pickup system according to claim 6,

wherein the display control part

20 displays the correlation value of each semiconductor die corresponding to each semiconductor die image on each semiconductor die image or near each semiconductor die image on the map image of the display unit, or

displays the correlation value of the semiconductor die corresponding to a specific semiconductor die image at a predetermined position on the screen in the display

unit.

8. The semiconductor die pickup system according to claim 3,
wherein in the level table, each semiconductor die is associated with a level
value that requires a shorter time for pickup from the outer peripheral side toward the
5 inner peripheral side of the single wafer.

9. The semiconductor die pickup system according to claim 2 or 3, further
comprising;

a stage that comprises an adsorption surface for adsorbing the back surface of
the dicing sheet, and

10 an opening pressure switching mechanism that switches an opening pressure
of an opening arranged on the adsorption surface of the stage between a first pressure
close to vacuum and a second pressure close to atmospheric pressure;

wherein the control part performs control to switch the opening pressure
between the first pressure and the second pressure during pickup of a semiconductor die,

15 and

the types of the pickup conditions comprise the number of times for switching
the opening pressure between the first pressure and the second pressure.

10. The semiconductor die pickup system according to claim 9,

wherein the types of the pickup conditions comprise a holding time for holding
20 the opening pressure at the first pressure.

11. The semiconductor die pickup system according to claim 9, further
comprising:

a stepped surface formation mechanism that comprises a plurality of moving
elements each disposed in the opening and having a front end surface moving between a

first position higher than the adsorption surface and a second position lower than the first position and that forms a stepped surface with respect to the adsorption surface,

wherein during pickup of a semiconductor die, the control part performs control for causing each of the plurality of moving elements to sequentially move at a predetermined time interval or simultaneously move in a predetermined combination of the moving elements from the first position to the second position, and

the types of the pickup conditions comprise the predetermined time.

12. The semiconductor die pickup system according to claim 11,

wherein the types of the pickup conditions comprise the number of the moving elements that are simultaneously moved from the first position to the second position.

13. The semiconductor die pickup system according to claim 2 or 3, comprising:

wherein the types of the pickup conditions comprise a waiting time from the landing of the collet on the semiconductor die to the start of lifting of the semiconductor die.

14. A semiconductor die pickup system, which picks up semiconductor dies attached to the front surface of a dicing sheet, comprising:

a collet that adsorbs the semiconductor die,

a suction mechanism that is connected to the collet and sucks air from the front surface of the collet,

a flow rate sensor that detects a suction air flow rate of the suction mechanism,

a control unit that controls a release action for releasing the semiconductor dies from the dicing sheet during pickup, and

a display unit that displays a screen;

wherein the control unit

acquires an actual flow rate variation that is a time variation of the suction air flow rate detected by the flow rate sensor during pickup of each semiconductor die of the single wafer,

5 obtains the releasability that is easiness of release or difficulty of release of each of the plurality of semiconductor dies from the dicing sheet based on the actual flow rate variation of each of the plurality of semiconductor dies,

displays a map image imitating each semiconductor die of a single wafer on the display unit, and

10 adds, to a semiconductor die image corresponding to the semiconductor die for which the releasability is obtained, at least one of color, pattern, letter, number and symbol according to the releasability of the semiconductor die on the map image.