

SEMICONDUCTOR DIE PICKUP SYSTEM

BACKGROUND

5 Technical Field

[0001] The present invention relates to a semiconductor die pickup system used in a bonding apparatus (bonding system).

Related Art

[0002] A semiconductor die is manufactured by cutting a 6-inch or 8-inch wafer into a predetermined size. A dicing sheet is attached to the back surface of the wafer and the
10 wafer is cut from the front surface side by a dicing saw or the like, so that the cut semiconductor dies are not separated during the cutting. At this time, the dicing sheet attached to the back surface is cut slightly but not cut off, and holds each semiconductor die. Then, the cut semiconductor dies are picked up one by one from the dicing sheet
15 and sent to the next step such as die bonding.

[0003] As a method for picking up the semiconductor die from the dicing sheet, a method has been proposed in which while the dicing sheet is adsorbed on the front surface of a disk-shaped adsorption piece and the semiconductor die is adsorbed to a collet, the semiconductor die is pushed up by a push-up block disposed in the central portion of the
20 adsorption piece, and the collet is raised to pick up the semiconductor die from the dicing sheet (for example, see FIGS. 9 to 23 in patent literature 1). When the semiconductor die is released from the dicing sheet, it is effective to first release the peripheral portion of the semiconductor die and then release the central portion of the semiconductor die. Therefore, in the conventional technique described in patent literature 1, a method is

adopted in which there are three push-up blocks in which one pushes up the peripheral portion of the semiconductor die, one pushes up the center of the semiconductor die, and one pushes up the middle thereof. Initially the three blocks are raised to a predetermined height, then the middle and center blocks are raised higher than the peripheral block, and finally the center block is raised higher than the middle block.

[0004] In addition, a method has also been proposed, in which while the dicing sheet is adsorbed on the front surface of a disk-shaped ejector cap and the semiconductor die is adsorbed to a collet, the collet and each of the peripheral, middle, and center push-up blocks are raised to a predetermined height higher than the front surface of the ejector cap, and then the height of the collet is maintained at this height, the push-up blocks are descended to positions below the front surface of the ejector cap in the order of the peripheral push-up block and the middle push-up block, to release the dicing sheet from the semiconductor die (for example, see patent literature 2).

[0005] When the dicing sheet is released from the semiconductor die by the methods described in patent literature 1 and 2, as described in FIGS. 40, 42 and 44 of patent literature 1, FIGS. 4A to 4D and 5A to 5D of patent literature 2, the semiconductor die may be bent and deformed together with the dicing sheet while being attached to the dicing sheet before the semiconductor die is released. When the release action of the dicing sheet is continued in the state that the semiconductor die is bent and deformed, the semiconductor die may be damaged, and thus a method has been proposed in which as described in FIG. 31 of patent literature 1, the bending of the semiconductor die is detected according to a variation in the flow rate of sucked air from the collet, and as described in FIG. 43 of patent literature 1, when the intake flow rate is detected, it is determined that the semiconductor die is deformed and the push-up blocks are

temporarily descended, and then the push-up blocks are raised again. Besides, patent literature 3 also discloses that the bending (deflection) of the semiconductor die is detected (discriminated) according to the variation in the flow rate of the suction air from the collet.

5 [Literature of related art]

[Patent literature]

[0006] Patent literature 1: Japanese Patent No. 4945339

Patent literature 2: US Patent No. 8092645 Specification

Patent literature 3: Japanese Patent No. 5813432

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SUMMARY

[Problems to be Solved]

[0007] In recent years, semiconductor dies have become extremely thin; for example, some dies have a thickness of about 20 μm . In contrast, because the thickness of the dicing sheet is about 100 μm , the thickness of the dicing sheet becomes 4 to 5 times the thickness of the semiconductor die. When the thin semiconductor die is to be released from the dicing sheet, the deformation of the semiconductor die following the deformation of the dicing sheet tends to be more notable. According to patent literature 1, because the bending of the semiconductor die is detected and the release action is changed, it is possible that damage to the semiconductor die can be suppressed when the semiconductor die is picked up from the dicing sheet.

[0008] However, since the release action is changed (changed in real time) while the bending of the semiconductor die being picked up is detected, control of the pickup becomes extremely complicated. A series of processing, such as detecting the bending

of the semiconductor die, determining whether to change the release action based on the detection result, changing the release action based on the determination result, or advancing the action without changing the release action, is repeated many times, and thus there is also a concern that the release action takes a long time. Therefore, actually, there are many cases in which the release action is not changed in real time and the release action assuming a semiconductor die that is the most difficult to release is applied uniformly to all the semiconductor dies. However, in this case, a long-time release action is applied to the semiconductor die which is easily released and to which a simplified short-time release action can be applied, and the pickup becomes slow. It is desired to apply a release action suitable for each of the semiconductor dies so that the balance between the suppression of the damage of the semiconductor die and the speeding up of the pickup of the semiconductor die is appropriate for each semiconductor die.

[0009] Incidentally, the releasability of the semiconductor die from the dicing sheet may vary according to the position of the semiconductor die on the wafer. For example, the releasability (easiness of release or difficulty of release) may gradually vary from the semiconductor die near the center to the semiconductor die near the outer periphery on the wafer. Alternatively, for example, the releasability of the semiconductor die in a specific region of the wafer may be significantly different from the releasability of the semiconductor die in another region. This tendency of releasability according to the position of the semiconductor die of the wafer is often common to a plurality of wafers that is continuously picked up. When semiconductor dies of the plurality of wafers are continuously picked up, the pickup speed can be increased by applying a short-time release action to the semiconductor dies located at positions where the semiconductor dies are easily released. A release action suitable for each of the semiconductor dies can

be applied according to the releasability of the semiconductor die at each position to appropriately balance the suppression of damage to the semiconductor die and the speedup of the pickup of the semiconductor die. In order to realize these aims, a structure for grasping the releasability of each semiconductor die according to the position
5 of each semiconductor die of the wafer is required. In addition, after the releasability of each semiconductor die according to the position of each semiconductor die of the wafer is grasped or when the releasability is grasped in advance, a structure for applying the release action suitable for each semiconductor die of the wafer is required.

[0010] The present invention aims to apply a release action (pickup action) suitable for
10 each semiconductor die, so that each semiconductor die can be picked up. Alternatively, the present invention aims to grasp the releasability of each semiconductor die according to the position of each semiconductor die of the wafer.

[Means to Solve Problems]

[0011] The semiconductor die pickup system of the present invention, which is a
15 pickup system that releases semiconductor dies obtained by dicing a wafer from a dicing sheet and picks up the semiconductor dies, includes: a control part that controls a pickup action based on pickup conditions for picking up the semiconductor dies from the dicing sheet; and a generation part that generates association information in which any one of the plurality of pickup conditions is associated with individual information of the
20 semiconductor dies; 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 semiconductor dies.

[0012] In the semiconductor die pickup system of the present invention, the generation part may generate 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 may be determined by the level table and the condition table.

5 **[0013]** In the semiconductor die pickup system of the present invention, the plurality of level values may be values indicating the length of time required for pickup.

[0014] The semiconductor die pickup system of the present invention may include a display unit that displays a screen and a display control unit; the display control unit may display a map image imitating each semiconductor die of the single wafer on the display
10 unit, and add, 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 associated with the level value on the map image.

[0015] The semiconductor die pickup system of the present invention may include an input unit that inputs information; the generation part may receive, from the input unit,
15 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 associate the selected level value with a semiconductor die corresponding to the selected semiconductor die image to generate or update the level table.

[0016] The semiconductor die pickup system according to the present invention may
20 include 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, and 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; the generation part may acquire 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, obtain a correlation value between the actual flow rate information and the expected flow rate information of each of the plurality of semiconductor dies, and associate 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.

[0017] In the semiconductor die pickup system of the present invention, the display control part may display 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 display 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.

[0018] In the semiconductor die pickup system of the present invention, in the level table, each semiconductor die may be associated with a level value that requires a shorter time for pickup from the outer peripheral side toward the inner peripheral side of the single wafer.

[0019] The semiconductor die pickup system of the present invention may include a stage that includes an adsorption surface for adsorbing the back surface of the dicing sheet, and 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; the control part may perform control to switch the opening pressure between the first pressure and the second pressure during pickup of a semiconductor die, and the types of the pickup

conditions may include the number of times for switching the opening pressure between the first pressure and the second pressure.

[0020] In the semiconductor die pickup system of the present invention, the types of the pickup conditions may include a holding time for holding the opening pressure at the first pressure.

[0021] The semiconductor die pickup system of the present invention may include a stepped surface formation mechanism that includes 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; during pickup of a semiconductor die, the control part may perform 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 may include the predetermined time.

[0022] In the semiconductor die pickup system of the present invention, the types of the pickup conditions may include the number of the moving elements that are simultaneously moved from the first position to the second position.

[0023] The semiconductor die pickup system of the present invention may include a collet that adsorbs the semiconductor die, and the types of the pickup conditions may include a waiting time from the landing of the collet on the semiconductor die to the start of lifting of the semiconductor die.

[0024] The semiconductor die pickup system of the present invention, which is a semiconductor die pickup system that picks up semiconductor dies attached to the front

surface of a dicing sheet, includes: 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 die from the dicing sheet during pickup, and a display unit that displays a screen; 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 a single wafer, 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 the single wafer on the display unit, and 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.

[Effect]

[0025] The present invention has an effect that each semiconductor die can be picked up applying a release action (pickup action) suitable for each semiconductor die. Alternatively, the present invention has an effect that the releasability of each semiconductor die according to the position of each semiconductor die of a single wafer can be grasped.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] FIG. 1 is an illustrative diagram showing a system configuration of a semiconductor die pickup system in an embodiment of the present invention.

FIG. 2 is a perspective view showing a stage of the semiconductor die pickup system in the embodiment of the present invention.

FIG. 3 is an illustrative diagram showing a wafer attached to a dicing sheet.

FIG. 4 is an illustrative diagram showing semiconductor dies attached to the
5 dicing sheet.

FIG. 5A is an illustrative diagram showing a configuration of a wafer holder.

FIG. 5B is an illustrative diagram showing the configuration of the wafer holder.

FIG. 6 is an illustrative diagram showing an action at a predetermined level value of the semiconductor die pickup system in the embodiment of the present invention.

10 FIG. 7 is an illustrative diagram showing the action at the predetermined level value of the semiconductor die pickup system in the embodiment of the present invention.

FIG. 8 is an illustrative diagram showing the action at the predetermined level value of the semiconductor die pickup system in the embodiment of the present invention.

15 FIG. 9 is an illustrative diagram showing the action at the predetermined level value of the semiconductor die pickup system in the embodiment of the present invention.

FIG. 10 is an illustrative diagram showing the action at the predetermined level value of the semiconductor die pickup system in the embodiment of the present invention.

FIG. 11 is an illustrative diagram showing the action at the predetermined level value of the semiconductor die pickup system in the embodiment of the present invention.

20 FIG. 12 is an illustrative diagram showing the action at the predetermined level value of the semiconductor die pickup system in the embodiment of the present invention.

FIG. 13 is an illustrative diagram showing the action at the predetermined level value of the semiconductor die pickup system in the embodiment of the present invention.

FIG. 14 is an illustrative diagram showing the action at the predetermined level

value of the semiconductor die pickup system in the embodiment of the present invention.

FIG. 15 is an illustrative diagram showing the action at the predetermined level value of the semiconductor die pickup system in the embodiment of the present invention.

FIG. 16 is an illustrative diagram showing the action at the predetermined level value of the semiconductor die pickup system in the embodiment of the present invention.

FIG. 17 is an illustrative diagram showing the action at the predetermined level value of the semiconductor die pickup system in the embodiment of the present invention.

FIG. 18 is a diagram showing a time variation in the height of a collet, the position of a columnar moving element, the position of an intermediate annular moving element, the position of a peripheral annular moving element, the opening pressure, and the air leakage amount of the collet during the action at the predetermined level value of the semiconductor die pickup system in the embodiment of the present invention.

FIG. 19 is a diagram showing an example of a parameter table in the embodiment of the present invention.

FIG. 20 is a diagram showing a time variation in the height of the collet, the position of the columnar moving element, the position of the intermediate annular moving element, the position of the peripheral annular moving element, and the opening pressure during an action at another level value of the semiconductor die pickup system in the embodiment of the present invention.

FIG. 21 is a diagram showing a time variation in the height of the collet, the position of the columnar moving element, the position of the intermediate annular moving element, the position of the peripheral annular moving element, and the opening pressure during an action at still another level value of the semiconductor die pickup system in the embodiment of the present invention.

FIG. 22 is an illustrative diagram of an identification number of each semiconductor die of a single wafer in the embodiment of the present invention.

FIG. 23 is a diagram showing an example of a level table in the embodiment of the present invention.

5 FIG. 24 is an illustrative diagram showing an example of a level value associated with each semiconductor die of the single wafer.

FIG. 25 is a diagram showing a settings display screen in the embodiment of the present invention.

10 FIG. 26 is a diagram showing the settings display screen in the embodiment of the present invention.

FIG. 27 is a diagram showing the settings display screen in the embodiment of the present invention.

15 FIG. 28 is a diagram showing an example of a time variation of the opening pressure, and an expected flow rate variation and actual flow rate variation in a predetermined period of initial release in the embodiment of the present invention.

FIG. 29 is a diagram showing an example of a threshold value table in the embodiment of the present invention.

FIG. 30 is a diagram showing the settings display screen in the embodiment of the present invention.

20 FIG. 31 is a diagram showing the settings display screen in the embodiment of the present invention.

FIG. 32 is a diagram showing the settings display screen in the embodiment of the present invention.

FIG. 33 is an illustrative diagram showing another example of the level value

associated with each semiconductor die of the single wafer.

FIG. 34 is an illustrative diagram showing still another example of the level value associated with each semiconductor die of the single wafer.

FIG. 35 is an illustrative diagram showing still another example of the level value associated with each semiconductor die of the single wafer.

FIG. 36 is a functional block diagram of a control unit in the embodiment of the present invention.

DESCRIPTION OF THE EMBODIMENTS

10 [0027] <Configuration>

Hereinafter, a semiconductor die pickup system according to an embodiment of the present invention is described with reference to the drawings. As shown in FIG. 1, a semiconductor die pickup system 500 of the embodiment includes: a wafer holder 10 that holds a dicing sheet 12 in which a semiconductor die 15 is attached to a front surface 12a and that moves in a horizontal direction; a stage 20 disposed on the lower surface of wafer holder 10 and including an adsorption surface 22 adsorbing a back surface 12b of the dicing sheet 12; a plurality of moving elements 30 that is disposed in an opening 23 arranged on the adsorption surface 22 of the stage 20; a stepped surface formation mechanism 300 that forms a stepped surface with respect to the adsorption surface 22; a stepped surface formation mechanism drive unit 400 that drives the stepped surface formation mechanism 300; a collet 18 that picks up the semiconductor die 15; an opening 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 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 pipe 84, and the third port is connected to a pipe 85 open to the atmosphere. The drive unit 82 causes the first port and the second port to communicate with each other and cuts off the third port, and sets the pressure of the opening 23 as a first pressure P_1 close to

vacuum, or causes the first port and the third port to communicate with each other and cuts off the second port, and sets the pressure of the opening 23 as a second pressure P_2 close to atmospheric pressure, thereby switching the pressure of the opening 23 between the first pressure P_1 and the second pressure P_2 .

5 **[0030]** Similar to the opening pressure switching mechanism 80, the adsorption pressure switching mechanism 90 that switches the adsorption pressure of the adsorption surface 22 of the stage 20 includes a three-way valve 91 having three ports and a drive unit 92 that switches open and close drive of the three-way valve 91; the first port is connected to an adsorption hole 27 communicating with a groove 26 of the stage 20 by a
10 pipe 93, the second port is connected to the vacuum apparatus 140 by a pipe 94, and the third port is connected to a pipe 95 open to the atmosphere. The drive unit 92 causes the first port and the second port to communicate with each other and cuts off the third port, and sets the pressure of the groove 26 or the adsorption surface 22 as a third pressure P_3 close to vacuum, or causes the first port and the third port to communicate with each
15 other and cuts off the second port, and sets the pressure of the groove 26 or the adsorption surface 22 as a fourth pressure P_4 close to atmospheric pressure, thereby switching the pressure of the groove 26 or the adsorption surface 22 between the third pressure P_3 and the fourth pressure P_4 .

[0031] Similar to the opening pressure switching mechanism 80, the suction
20 mechanism 100 that sucks air from the front surface 18a of the collet 18 includes a three-way valve 101 having three ports and a drive unit 102 that switches open and close drive of the three-way valve 101; the first port is connected to a suction hole 19 communicating with the front surface 18a of the collet 18 by a pipe 103, the second port is connected to the vacuum apparatus 140 by a pipe 104, and the third port is connected to a pipe 105

open to the atmosphere. The drive unit 102 causes the first port and the second port to communicate with each other and cuts off the third port, and sucks air from the front surface 18a of the collet 18 to set the pressure of the front surface 18a of the collet 18 as a pressure close to vacuum, or causes the first port and the third port to communicate with each other and cuts off the second port, and sets the pressure of the front surface 18a of the collet 18 as a pressure close to atmospheric pressure. A flow sensor 106 that detects a flow rate of air sucked from the front surface 18a of the collet 18 into the vacuum apparatus 140 (suction air flow rate) is mounted on the pipe 103 connecting the suction hole 19 of the collet 18 and the three-way valve 101.

10 **[0032]** The wafer holder horizontal direction drive unit 110, the stage vertical direction drive unit 120, and the collet drive unit 130 are, for example, those driving the wafer holder 10, the stage 20, and the collet 18 in the horizontal direction, the vertical direction, or the like by a motor and a gear arranged inside.

[0033] The control unit 150 includes a CPU 151 that performs various types of calculation processing or control processing, a storage unit 152, and a device/sensor interface 153; the CPU 151, the storage unit 152, and the device/sensor interface 153 are computers connected by a data bus 154. The storage unit 152 stores: a control program 155 for pickup control of the semiconductor die 15, a settings display program 156 for associating a release action during pickup with each semiconductor die 15 of a single wafer, a level table 159 (see FIG. 23) in which each semiconductor die 15 of the single wafer and a level value of the release action are associated, a parameter table 160 (see FIG. 19) in which the level values and parameter values of various release parameters are associated, an expected flow rate variation 157 which is a time variation of the suction air flow rate detected by the flow rate sensor 106 during pickup when the release of the

semiconductor die 15 from the dicing sheet 12 is good, and an actual flow rate variation 158 which is a time variation of the suction air flow rate actually detected by the flow rate sensor 106 during pickup. FIG. 36 is a functional block diagram of the control unit 150. The control unit 150 functions as a pickup control part 600 (control part) by executing
5 the control program 155. In addition, the control unit 150 also functions as a generation part 602 and a display control unit 604 described later by executing the settings display program 156.

[0034] As shown in FIG. 1, the opening pressure switching mechanism 80, the adsorption pressure switching mechanism 90, the drive units 82, 92 and 102 of the three-
10 way valves 81, 91 and 101 of the suction mechanism 100, the stepped surface formation mechanism drive unit 400, the wafer holder horizontal direction drive unit 110, the stage vertical direction drive unit 120, the collet drive unit 130, and the vacuum apparatus 140 are respectively connected to the device/sensor interface 153, and driven according to commands of the control unit 150. In addition, the flow rate sensor 106 is connected to
15 the device/sensor interface 153, and a detection signal is captured by the control unit 150 and processed. In addition, the input unit 410 and the display unit 450 are also connected to the device/sensor interface 153, input information from the input unit 410 is captured by the control unit 150, and output image information from the control unit 150 is sent to the display unit 450.

[0035] Next, details of the adsorption surface 22 of the stage 20 and the moving
20 elements 30 are described. As shown in FIG. 2, the stage 20 has a cylindrical shape, and the adsorption surface 22 having a planar shape is formed on the upper surface. A square opening 23 is arranged at the center of the adsorption surface 22, and the moving elements 30 are mounted on the opening 23. As shown in FIG. 6, a gap d is arranged between an

inner surface 23a of the opening 23 and an outer peripheral surface 33 of the moving element 30. As shown in FIG. 2, the grooves 26 are arranged around the opening 23 so as to surround the opening 23. The adsorption hole 27 is arranged in each groove 26, and each adsorption hole 27 is connected to the adsorption pressure switching mechanism 90.

[0036] As shown in FIG. 2, the moving element 30 includes a columnar moving element 45 disposed at the center, two intermediate annular moving elements 40 and 41 disposed around the columnar moving element 45, and a peripheral annular moving element 31 disposed around the intermediate annular moving element 40 and disposed at the outermost periphery. Besides, the number of the intermediate annular moving elements is two here, but the number of the intermediate annular moving elements may be one or three or more. In the drawings of FIG. 6 or later, the number of the intermediate annular moving elements 40 is one for the sake of simplicity. As shown in FIG. 6, front end surfaces 47, 38b, and 38a of the columnar moving element 45, the intermediate annular moving element 40, and the peripheral annular moving element 31 are respectively located at a first position protruding from the adsorption surface 22 of the stage 20 by a height H_0 , and constitute the same surface (a stepped surface with respect to the adsorption surface 22). When the semiconductor die 15 is picked up, the peripheral annular moving element 31, the intermediate annular moving element 40, and the columnar moving element 45 are moved in this order from the first position to a second position lower than the first position at predetermined time intervals. Alternatively, these moving elements are simultaneously moved from the first position to the second position in a predetermined combination.

[0037] <Dicing sheet setting step>

Here, a step for setting the dicing sheet 12 to which the semiconductor dies 15 are attached on the wafer holder 10 is described. As shown in FIG. 3, the dicing sheet 12 having adhesiveness is attached to the back surface of a wafer 11, and the dicing sheet 12 is mounted on a ring 13 made of metal. The wafer 11 is handled while being mounted on the ring 13 made of metal via the dicing sheet 12 in this manner. Then, as shown in FIG. 4, the wafer 11 is cut from the front surface side by a dicing saw or the like in a cutting step and becomes each semiconductor die 15. Cutout gaps 14 formed during dicing are formed between the semiconductor dies 15. The depth of the cutout gap 14 reaches from the semiconductor die 15 to a part of the dicing sheet 12, but the dicing sheet 12 is not cut off and each semiconductor die 15 is held by the dicing sheet 12.

[0038] In this manner, the semiconductor die 15 on which the dicing sheet 12 and the ring 13 are mounted is mounted on the wafer holder 10 as shown in FIGS. 5A and 5B. The wafer holder 10 includes an expand ring 16 being annular and having a flange portion and a ring retainer 17 that fixes the ring 13 on the flange of the expand ring 16. The ring retainer 17 is driven by a ring retainer drive unit that is not shown in the direction of moving toward and away from the flange of the expand ring 16. The inner diameter of the expand ring 16 is larger than the diameter of the wafer on which the semiconductor dies 15 are disposed, the expand ring 16 has a predetermined thickness, and the flange which is located on the outer side of the expand ring 16 is mounted on the end surface side in the direction separated from the dicing sheet 12 so as to protrude to the outer side. In addition, the outer periphery of the expand ring 16 on the dicing sheet 12 side has a curved surface configuration so that the dicing sheet 12 can be smoothly stretched when the dicing sheet 12 is mounted on the expand ring 16. As shown in FIG. 5B, the dicing sheet 12 to which the semiconductor dies 15 are attached is substantially planar before

being set on the expand ring 16.

[0039] As shown in FIG. 1, when set on the expand ring 16, the dicing sheet 12 is stretched along the curved surface of the upper portion of the expand ring by a step difference between the upper surface and the flange surface of the expand ring 16, and thus a tension force from the center toward the periphery of the dicing sheet 12 acts on the dicing sheet 12 fixed on the expand ring 16. In addition, because the dicing sheet 12 is extended due to this tension force, the gaps 14 between the semiconductor dies 15 attached on the dicing sheet 12 are widened.

[0040] <Pickup action>

Next, a pickup action of the semiconductor die 15 is described. The releasability of each semiconductor die 15 from the dicing sheet 12 may vary according to the position of each semiconductor die 15 on the single wafer. For example, the easiness of release (ease of release) may gradually increase from the semiconductor die 15 near the outer periphery to the semiconductor die 15 near the center on the wafer. It is considered that when the dicing sheet 12 is set on the expand ring 16 of the wafer holder 10, the vicinity of the center of the dicing sheet 12 is tensioned more than the vicinity of the outer periphery, and thus the easiness of release of the semiconductor die 15 near the center of the wafer is increased. This tendency of releasability of the wafer according to the position of the semiconductor die 15 is often common to a plurality of wafers that is continuously picked up. When the semiconductor dies 15 of the plurality of wafers are continuously picked up, the pickup speed can be increased by applying a simplified short-time release action (pickup action) to the semiconductor die 15 at the position where release is easy, and on the other hand, the damage to the semiconductor die 15 or pickup error can be suppressed by applying a long-time release action (pickup action) to the

semiconductor die 15 at the position where release is difficult. Therefore, in the semiconductor die pickup system 500 of this embodiment, the release action during pickup can be changed for each semiconductor die 15 on the single wafer.

[0041] In the storage unit 152, a level table 159 and a parameter table 160 (condition
5 table) are stored; in the level table 159, an identification number (also referred to as a die identification number or individual information) of each semiconductor die 15 that is added according to the position of each semiconductor die 15 on the single wafer as shown in FIG. 23 is associated with a level value, and in the parameter table 160, the
10 respective level values as shown in FIG. 19 are associated with the parameter values of plural types of release parameters (also referred to as pickup conditions). By the level table 159 and the parameter table 160, the release action (the parameter value of the release parameter) applied to each semiconductor die 15 on the single wafer is associated. In the embodiment, the level values are defined from level 1 which is the shortest time required for the release action (pickup time) to level 8 which is the longest. Before the
15 pickup action, in consideration of the releasability of each semiconductor die 15 according to the position of each semiconductor die 15 on the wafer, an operator or the like associates the level values with each semiconductor die 15 via a settings display screen 460 (see FIG. 25) described later to generate the level table 159. During the pickup action, with reference to the level table 159, the release action (pickup action)
20 according to the associated level value is performed for each semiconductor die 15 on the single wafer. Hereinafter, the pickup of the semiconductor die 15 to which the release action of level 4 of the parameter table 160 is applied is used as an example to describe the pickup action. Besides, the various release parameters of the parameter table 160 and the settings display screen 460 are described later in detail.

[0042] The control unit 150 functions as a pickup control part by executing the control program 155 shown in FIG. 1 and controls the pickup action of the semiconductor die 15. The control unit 150 controls the release action for releasing the semiconductor die 15 from the dicing sheet 12 as a part of the pickup action. First, the control unit 150 causes the wafer holder horizontal direction drive unit 110 to horizontally move the wafer holder 10 to a position above the waiting position of the stage 20. Then, when the wafer holder 10 moves to a predetermined position above the waiting position of the stage 20, the control unit 150 temporarily stops the horizontal movement of the wafer holder 10. As described above, because the front end 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 in the initial state, the control unit 150 causes the stage vertical direction drive unit 120 to raise the stage 20 until the front end surfaces 47, 38b, and 38a of the moving elements 45, 40, and 31 come into close contact with the back surface 12b of the dicing sheet 12 and a region slightly separated from the opening 23 of the adsorption surface 22 comes into close contact with the back surface 12b of the dicing sheet 12. Then, when the front end surfaces 47, 38b, and 38a of the moving elements 45, 40, and 31 and the region slightly separated from the opening 23 of the adsorption surface 22 come into close contact with the back surface 12b of the dicing sheet 12, the control unit 150 stops the rising of the stage 20. Then, the control unit 150 again causes the wafer holder horizontal direction drive unit 110 to adjust the horizontal position so that the semiconductor die 15 to be picked up is immediately above the front end surface (stepped surface) of the moving element 30 slightly protruding from the adsorption surface 22 of the stage 20.

[0043] As shown in FIG. 6, because the size of the semiconductor die 15 is smaller than

that of the opening 23 of the stage 20 and larger than the width or depth of the moving element 30, when the position adjustment of the stage 20 is completed, the outer peripheral end of the semiconductor die 15 is between the inner surface 23a of the opening 23 of the stage 20 and the outer peripheral surface 33 of the moving element 30, that is, immediately above the gap d between the inner surface 23a of the opening 23 and the outer peripheral surface 33 of the moving element 30. In the initial state, the pressure of the groove 26 of the stage 20 or the adsorption surface 22 is atmospheric pressure, and the pressure of the opening 23 is also atmospheric pressure. In the initial state, the front end 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 , and thus the height of the back surface 12b of the dicing sheet 12 in contact with the front end surfaces 47, 38b, and 38a is also the first position protruding from the adsorption surface 22 by the height H_0 . In addition, the back surface 12b of the dicing sheet 12 is slightly floated from the adsorption surface 22 at the peripheral edge of the opening 23, and is in close contact with the adsorption surface 22 in the region separated from the opening 23. When the horizontal position adjustment is completed, the control unit 150 causes the collet drive unit 130 shown in FIG. 1 to descend the collet 18 onto the semiconductor die 15 and land the front surface 18a of the collet 18 on the semiconductor die 15.

[0044] FIG. 18 is a diagram showing a time variation in the height of the collet 18, the position of the columnar moving element 45, the position of the intermediate annular moving element 40, the position of the peripheral annular moving element 31, the opening 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 $t=0$ 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. 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, 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 opening 23 and the outer peripheral surface 33 of the moving element 30 is tensioned downward. In addition, the peripheral portion of the semiconductor die 15 located immediately above the gap d is tensioned to the dicing sheet 12 and bent and deformed

downward as indicated by an arrow 204. Thereby, the peripheral portion of the semiconductor die 15 is separated from the front surface 18a of the collet 18. Due to the deviation generated between the outer peripheral portion of the semiconductor die 15 and the front surface 12a of the dicing sheet 12 when the adsorption pressure becomes the third pressure P_3 close to vacuum, the trigger for releasing from the front surface 12a of the dicing sheet 12 is formed in the peripheral portion of the semiconductor die 15, and thus the peripheral portion of the semiconductor die 15 begins to release from the front surface 12a of the dicing sheet 12 while being bent and deformed as indicated by the arrow 204 in FIG. 8.

[0047] As shown in FIG. 8, when the peripheral portion of the semiconductor die 15 is separated from the front surface 18a of the collet 18, air flows into the suction hole 19 of the collet 18 as indicated by an arrow 205 in FIG. 8. The flow rate of the inflow air (air leakage amount) is detected by the flow rate sensor 106. Thereby, as shown in (f) of FIG. 18, the air leakage amount that turned to decrease at time t_2 and continued to decrease starts to increase again at time t_3 . Specifically, as the opening pressure from time t_3 to time t_4 decreases from the second pressure P_2 close to atmospheric pressure to the first pressure P_1 close to vacuum, the semiconductor die 15 is tensioned downward together with the dicing sheet 12 and bent and deformed, and thus the amount of air leakage flowing into the suction hole 19 of the collet 18 increases from time t_3 to time t_4 .

[0048] Then, as shown in (e) of FIG. 18, the control unit 150 keeps the opening 23 of the stage 20 at the first pressure P_1 close to vacuum in a period from time t_4 to time t_5 (time HT4). This time HT4 is a “holding time of first pressure” of level 4 defined in the parameter table 160 of FIG. 19. The HT4 is 130 ms in the example of FIG. 19. While being held at the first pressure P_1 , as indicated by an arrow 207 in FIG. 9, the peripheral

portion of the semiconductor die 15 returns to the front surface 18a the collet 18 due to the vacuum of the suction hole 19 of the collet 18 and the elasticity of the semiconductor die 15. Thereby, the air leakage amount turns to decrease at time t_4 in (f) of FIG. 18 and continues to decrease, and the air leakage amount is almost zero slightly before time t_5 when the semiconductor die 15 is vacuum-adsorbed to the front surface 18a of the collet 18. At this time, the peripheral portion of the semiconductor die 15 is released from the front surface 12a of the dicing sheet 12 located immediately above the gap d (initial release). Then, 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 t_5 . 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 pipe 85 open to the atmosphere and the opening 23. Thereby, because air flows into the opening 23 as indicated by an arrow 210 in FIG. 10, as shown in (e) of FIG. 18, the opening pressure increases from the first pressure P_1 close to vacuum to the second pressure P_2 close to atmospheric pressure from time t_5 to time t_6 .

[0049] The period of times t_1 to t_6 in FIG. 18 is the initial release. When the releasability between the semiconductor die 15 and the dicing sheet 12 is poor (the easiness of release is low), after the peripheral portion of the semiconductor die 15 is tensioned to the dicing sheet 12 as indicated by the arrow 204 in FIG. 8, it takes a lot of time for the peripheral portion of the semiconductor die 15 to return to the front surface 18a of the collet 18 as indicated by the arrow 207 in FIG. 9. In this semiconductor die 15, the release between the peripheral portion of the semiconductor die 15 and the dicing sheet 12 is promoted applying a release action (level value) in which the opening pressure

is held at the first pressure P_1 for a long time (from time t_4 to time t_5 in (e) of FIG. 18) or the opening pressure is frequently switched between the first pressure P_1 close to vacuum and the second pressure P_2 close to atmospheric pressure.

[0050] In contrast, when the releasability between the semiconductor die 15 and the dicing sheet 12 is good (the easiness of release is high), after the peripheral portion of the semiconductor die 15 is tensioned to the dicing sheet 12 as indicated by an arrow 204 in FIG. 8, it takes a short time for the peripheral portion of the semiconductor die 15 to return to the front surface 18a of the collet 18 as indicated by the arrow 207 in FIG. 9. In this semiconductor die 15, the pickup speed is increased applying a release action (level value) in which the opening pressure is held at the first pressure P_1 for a short time or the opening pressure is switched less number of times between the first pressure P_1 close to vacuum and the second pressure P_2 close to atmospheric pressure. Besides, in an example of level 4 of FIG. 18, the opening pressure during the initial release is switched once (when switching from the second pressure P_2 to the first pressure P_1 and then from the first pressure P_1 to the second pressure P_2 is counted as once). This is the “number of switches of opening pressure during initial release” of level 4 (FSN4) defined in the parameter table 160 of FIG. 19.

[0051] In addition, as described above, because the time until the peripheral portion of the semiconductor die 15 returns to the front surface 18a of the collet 18 after being tensioned to the dicing sheet 12 varies according to the easiness of release of the semiconductor die 15, the time variation of the air leakage amount (actual flow variation) detected by the flow sensor 106 also varies. Therefore, as described in detail later, it is possible to determine the easiness of release of the semiconductor die 15 from the dicing sheet 12 based on the actual flow rate variation.

[0052] The description of the pickup action is continued. At t_6 in FIG. 18, when the opening pressure increases to the second pressure P_2 close to atmospheric pressure, as indicated by an arrow 212 in FIG. 10, the dicing sheet 12 located immediately above the gap d that is tensioned downward at the vacuum returns upward due to a tension force
5 applied when fixed to the wafer holder 10. In addition, the dicing sheet 12 at the peripheral edge of the opening 23 is in a state of being slightly floated from the adsorption surface 22 due to the above tension force.

[0053] When the opening pressure reaches the second pressure P_2 close to atmospheric pressure at time t_6 as shown in (e) of FIG. 18, as shown in (d) of FIG. 18, the control unit
10 150 outputs a command to set the height of the front end surface 38a of the peripheral annular moving element 31 to the second position lower than the first position (the initial position at which the height from the adsorption surface 22 is H_0) by a height H_1 . According to this command, the stepped surface formation mechanism drive unit 400 shown in FIG. 1 is driven to lower the peripheral annular moving element 31 as indicated
15 by an arrow 214 in FIG. 11. The front end surface 38a of the peripheral annular moving element 31 is moved to the second position lower than the first position (initial position) by the height H_1 and slightly lower than the adsorption surface 22 (the position lower than the adsorption surface 22 by a height (H_1-H_0)).

[0054] Next, the control unit 150 keeps the state from time t_6 to time t_7 as shown in
20 FIG. 18. At this time, because the pressure of the opening 23 becomes the second pressure P_2 close to atmospheric pressure, as shown in FIG. 11, a gap is formed between 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 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 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 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. 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 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 semiconductor die 15 is vacuum-adsorbed to the front surface 18a of the collet 18 as shown in FIG. 13, the air leakage amount returns to almost zero. At this time, the region of the semiconductor die 15 facing the front end surface 38a is released from the front

surface 12a of the dicing sheet 12. Besides, the time until the region of the semiconductor die 15 facing the front end surface 38a returns to the front surface 18a of the collet 18 as indicated by the arrow 224 in FIG. 13 after being tensioned to the dicing sheet 12 as indicated by the arrow 217 in FIG. 12 varies according to the releasability
5 between the semiconductor die 15 and the dicing sheet 12.

[0056] Next, as shown in (e) of FIG. 18, the control unit 150 outputs a command to increase the opening pressure from the first pressure P_1 close to vacuum to the second pressure P_2 close to atmospheric pressure at time t_9 . According to this command, the drive unit 82 of the opening pressure switching mechanism 80 switches the three-way
10 valve 81 so as to communicate the opening 23 and the pipe 85 open to the atmosphere. Thereby, air flows into the opening 23 as indicated by an arrow 220 in FIG. 13, and the pressure of the opening 23 increases to the second pressure P_2 close to atmospheric pressure at time t_{10} . Thereby, as indicated by an arrow 223 in FIG. 13, the dicing sheet 12 immediately above the gap d is separated from the front end surface 38a of the
15 peripheral annular moving element 31 and displaced upward.

[0057] At time t_{10} in FIG. 18, the control unit 150 outputs a command to move the front end surface 38b of the intermediate annular moving element 40 to the second position lower than the first position (the position at which the height from the adsorption surface 22 is H_0) by the height H_1 , and a command to move the front end surface 38a of
20 the peripheral annular moving element 31 at the second position to a third position lower than the first position (initial position) by the height H_2 (the position lower than the adsorption surface 22 by $H_2 - H_0$). According to this command, the stepped surface formation mechanism drive unit 400 shown in FIG. 1 is driven to lower the intermediate annular moving element 40 as indicated by an arrow 227 in FIG. 14, and lower the

peripheral annular moving element 31 as indicated by an arrow 226. The front end surface 38b of the intermediate annular moving element 40 moves to the second position lower than the first position (the position higher than the adsorption surface by the height H_0) by the height H_1 (the position lower than the adsorption surface 22 by H_1-H_0), and the front end surface 38a of the peripheral annular moving element 31 moves to the third position lower than the first position (initial position) by the height H_2 (the position lower than the adsorption surface 22 by H_2-H_0). Thereby, as shown in FIG. 14, the front end surfaces 38a, 38b, and 47 are stepped surfaces having steps with respect to each other and become stepped surfaces with respect to the adsorption surface 22.

[0058] Next, the control unit 150 keeps the state from time t_{10} to time t_{11} as shown in FIG. 18. Then, 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_{11} in (e) of FIG. 18. 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 228 in FIG. 15, and the opening pressure becomes the first pressure P_1 close to vacuum at time t_{12} . Then, as indicated by arrows 229 and 230 in FIG. 15, the dicing sheet 12 is tensioned toward the front end surface 38a of the peripheral annular moving element 31 descended to the third position and the front end surface 38b of the intermediate annular moving element 40 descended to the second position, and displaced downward. Accordingly, 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 atmosphere. In this state, as shown in FIG. 16, the semiconductor die 15 of the region corresponding to the front end surface 47 of the columnar moving element 45 is attached to the dicing sheet 12, but most of the region of the semiconductor die 15 is released from the dicing sheet 12.

[0060] Next, at time t14 in FIG. 18, the control unit 150 outputs a command to move the front end surface 47 of the columnar movement element 45 to the second position lower than the first position (the position at which the height from the adsorption surface 22 is H_0) by the height H_1 , and a command to move the front end surface 38b of the intermediate annular moving element 40 at the second position to the third position lower than the first position (initial position) by the height H_2 (the position lower than the adsorption surface 22 by H_2-H_0). According to this command, the stepped surface formation mechanism drive unit 400 shown in FIG. 1 is driven to lower the columnar moving element 45 as indicated by an arrow 260 in FIG. 17, and lower the intermediate annular moving element 40 as indicated by an arrow 246. The front end surface 47 of the columnar movement element 45 moves to the second position lower than the first position (the position higher than the adsorption surface by the height H_0) by the height H_1 , and the front end surface 38b of the intermediate annular moving element 40 moves to the third position lower than the first position (initial position) by the height H_2 . Thereby, as shown in FIG. 17, the semiconductor die 15 is released from the dicing sheet 12.

[0061] The control unit 150 outputs a command to raise the collet 18 at time t15 in FIG. 18. According to this command, the collet drive unit 130 shown in FIG. 1 drives the motor to raise the collet 18 as shown in FIG. 17. When the collet 18 rises, the semiconductor die 15 is picked up in a state of being adsorbed by the collet 18.

[0062] After the semiconductor die 15 is picked up, at time t16, the control unit 150 returns the front end surfaces 38a, 38b, and 47 of the moving elements 31, 40, and 45 to the first position and switches, the adsorption pressure of the adsorption surface 22 of the stage 20 from the third pressure P_3 close to vacuum to the fourth pressure P_4 close to

atmospheric pressure by the adsorption pressure switching mechanism 90. Thereby, the pickup is completed.

[0063] The period from time t_6 to time t_{16} in FIG. 18 described above is the main release. In this main release, by moving the front end surfaces from the first position to the second position in the order from the outer moving element 30 to the inner moving element 30, and switching the opening pressure between the first pressure P_1 and the second pressure P_2 , the region closer to the inner side than the peripheral portion of the semiconductor die 15 is released from the front surface 12a of the dicing sheet 12. Besides, in the main release described above, the opening pressure is switched between the first pressure P_1 and the second pressure P_2 , but each moving element 30 may be moved in order in the state where the opening pressure is held at the first pressure close to vacuum.

[0064] Here, the release parameters of the release action in FIG. 18 described above are confirmed. The release action in FIG. 18 described above is performed by applying the parameter values of the release parameters defined by level 4 of the parameter table 160 of FIG. 19. Specifically, the parameter values of the following release parameters are applied. The “number of switching of opening pressure during initial release (when switching from the second pressure P_2 to the first pressure P_1 and then from the first pressure P_1 to the second pressure P_2 is counted as once, the same applies below)” is $FSN_4 = 1$. The “number of switching of opening pressure during main release” is $SSN_4 = 2$. The “holding time of first pressure” which is a time for holding the opening pressure at the first pressure P_1 is $HT_4 = 130$ ms. The “number of moving elements descended simultaneously” is $DN_4 = 0$. The “descending time interval between moving elements” when the front end surfaces of the moving elements 30 are descended in order

from the first position to the second position is $IT4 = 240$ ms. In addition, the “collet waiting time”, which is a time from the landing of the collet 18 on the semiconductor die 15 to the start of the lifting of the semiconductor die 15, is $WT4 = 710$ ms. Then, the “pickup time” is $PT4 = 820$ ms.

5 **[0065]** <Parameter table>

Here, the parameter table 160 in FIG. 19 is described in more detail. The parameter value of each release parameter in the parameter table 160 has the following tendency according to the variation of the level value. As shown in FIG. 19, the “number of switches of opening pressure during initial release” increases from level 1 to level 8.

10 However, this does not mean that the number of switches always increases every time the level value varies, and the number of switches may be the same for a plurality of adjacent level values. The same applies to the other release parameters and does not mean that the parameter value varies every time the level value varies, and the parameter value may be the same for a plurality of adjacent level values. The “number of switches of opening

15 pressure during main release” increases from level 1 to level 8. In addition, the “holding time of first pressure” is lengthened from level 1 to level 8. The “descending time interval between moving elements” is lengthened from level 1 to level 8. In addition, the “collet waiting time” is lengthened from level 1 to level 8. The “pickup time” varies as the level value varies, and becomes longer from level 1 toward level 8. Besides, the

20 “pickup time” is similar to the “collet waiting time”, but includes, in addition to the collet waiting time, the time until the collet 18 is descended from a predetermined position to land on the semiconductor die 15 and the time for the semiconductor die 15 to rise to a predetermined position after the lifting of the semiconductor die 15 is started. Besides, the parameter table 160 in FIG. 19 can also be referred to as a “condition table”, and the

release parameter can also be referred to as a “pickup parameter”. The specific parameter values shown in FIG. 19 are merely examples and obviously may be other values.

[0066] Here, as an example of the release action other than the release action of level 4 described above, the release actions of level 1 and level 8 are described. First, the release action of level 8 is described. Level 8 is a level value to be associated with the semiconductor die 15 that is extremely difficult to release. FIG. 20 is a diagram showing the height of the collet 18, the position of the columnar moving element 45, the position of the intermediate annular moving element 40, the position of the peripheral annular moving element 31, and the opening pressure of the opening 23 during the release action of level 8. The following can be understood by comparing the release action of level 8 in FIG. 20 with the release action of level 4 in FIG. 18.

[0067] In the release action of level 8 in FIG. 20, the “number of switches of opening pressure during initial release” is increased to four times (FSN8). Thereby, even when the periphery of the semiconductor die 15 is difficult to release from the dicing sheet 12, the periphery of the semiconductor die 15 can be sufficiently released from the dicing sheet 12. It is an image of shaking off the dicing sheet 12 attached to the periphery of the semiconductor die 15 by switching the opening pressure many times, and release can be reliably performed though it takes time. In addition, in FIG. 20, the “holding time of first pressure” (HT8) during the initial release is set to 150 ms (see FIG. 19, and the same applies below; for the detailed parameter values, see the same drawing) and lengthened. Thereby, the periphery of the semiconductor die 15 can be promoted to be naturally released from the dicing sheet 12. Besides, in the example of FIG. 19, there is no great difference in the “holding time of first pressure” between levels 4 and 8, but it is also

considered to make the difference larger.

[0068] In addition, in the release action of level 8 in FIG. 20, the “number of switches of opening pressure during main release” is increased to four times (SSN8). Thereby, even when the region closer to the inner side than the periphery of the semiconductor die 15 is difficult to release from the dicing sheet 12, reliable release can be performed so as to shake off the dicing sheet 12 attached to the semiconductor die 15. In FIG. 20, the “holding time of first pressure” (HT8) during the actual release is set to 150 ms and lengthened. Thereby, the region closer to the inner side than the periphery of the semiconductor die 15 can be promoted to be naturally released from the dicing sheet 12.

Besides, in the parameter table 160 shown in FIG. 19, the “holding time of first pressure” (HT8) is common between the initial release and the main release, but the “holding time of first pressure” different between the initial release and the main release may be defined in the parameter table 160. In addition, as shown in FIG. 20, when there is a plurality of time for holding at the first pressure P_1 by switching the opening pressure a plurality of times during the initial release or during the main release, each of the plurality of “holding time of first pressure” may be defined in the parameter table 160 and the parameter values thereof may be different from each other. For example, the plurality of “holding time of first pressure” is arranged in the order of application in the release action and defined in the parameter table 160.

[0069] In addition, in the release action of level 8 in FIG. 20, the “descending time interval between moving elements” (IT8) is set to 450 ms and lengthened. If the time from descending the front end surface 38a of the peripheral annular moving element 31 from the first position to the second position until descending the front end surface 38b of the intermediate annular moving element 40 from the first position to the second

position is lengthened, the region of the semiconductor die 15 facing the front end surface 38a of the peripheral annular moving element 31 can be promoted to be naturally released from the dicing sheet 12. Similarly, the time from descending the front end surface 38b of the intermediate annular moving element 40 from the first position to the second position until descending the front end surface 47 of the columnar moving element 45 from the first position to the second position is lengthened, the region of the semiconductor die 15 facing the front end surface 38b of the intermediate annular moving element 40 can be promoted to be naturally released from the dicing sheet 12. Besides, the descending time interval between the peripheral annular moving element 31 and the intermediate annular moving element 40 and the descending time interval between the intermediate annular moving element 40 and the columnar moving element 45 may be different, and in this case, each descending time interval is defined in the parameter table 160. Besides, as shown in FIG. 2, the number of the intermediate annular moving elements 40 and 41 may be two or more, and in this case, descending is performed in the order from the intermediate annular moving element 40 on the outer peripheral side to the intermediate annular moving element 41 on the inner peripheral side. When the number of the intermediate annular moving elements 40 and 41 is two or more in this manner, the descending time interval between the intermediate annular moving element 40 and another intermediate annular moving element 41 may be defined in the parameter table 160. Besides, for example, the time from a time point at which the pickup action is started (time t1 in FIG. 20) to a time point at which the peripheral annular moving element 31 (the moving element 30 to be descended first) is descended from the first position to the second position may be defined in the parameter table 160.

[0070] In addition, in the release action of level 8 in FIG. 20, the “collet waiting time”

(WT8) is set to 1590 ms and lengthened. Then, in FIG. 20, the “pickup time” (PT8) is 1700 ms, which is long.

[0071] Next, the release action of level 1 is described. Level 1 is a level value to be associated with the semiconductor die 15 that is extremely easy to release. FIG. 21 is a diagram showing the height of the collet 18, the position of the columnar moving element 45, the position of the intermediate annular moving element 40, the position of the peripheral annular moving element 31, and the opening pressure of the opening 23 during the release action of level 1. The following can be understood by comparing the release action of level 1 in FIG. 21 with the release action of level 4 in FIG. 18.

[0072] In the release action of level 1 of FIG. 21, the “holding time of first pressure” (HT1) during the initial release is set to 100 ms and shortened. When the semiconductor die 15 is easily released from the dicing sheet 12, the periphery of the semiconductor die 15 is sufficiently released from the dicing sheet 12 even if the “holding time of first pressure” is shortened. By shortening the “holding time of first pressure” in this manner, the time required for the release action can be shortened.

[0073] In addition, in the release action of level 1 in FIG. 21, the “number of switches of opening pressure during main release” is reduced to once (SSN1). 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 sufficiently released from the dicing sheet 12 even if the “number of switches of opening pressure during main release” is once. In addition, in FIG. 21, the front end surfaces 38a, 38b, and 47 of the three 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, 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 different according to the level value, that is, the release action (pickup action) is made different. It is possible to suppressing damage to the semiconductor die 15 or pickup error during pickup by associating a level value close to level 8 with the semiconductor

die 15 of the single wafer at the position where release is difficult to perform the release action. In contrast, it is possible to perform the pickup in a short time by associating a level value close to level 1 with the semiconductor die 15 of the single wafer at the position where release is easy to perform the release action. Besides, the plurality of level values can be referred to as values indicating the length of time required for pickup. The parameter value of each release parameter can be referred to as a “pickup condition”, and the parameter values of levels 1 to 8 of the same type of release parameter (for example, the “number of switching of opening pressure during initial release”) are “a plurality of pickup conditions”. In addition, the type of release parameter shown in FIG. 19 can be defined as the “type of pickup condition”.

[0076] <Level table>

Next, the level table 159 is described in detail. FIG. 22 is an illustrative diagram of the identification number (die identification number, individual information) of each semiconductor die 15 of the single wafer, and FIG. 23 is a diagram showing an example of the level table 159. As shown in FIG. 22, an identification number composed of the position in the X direction (X coordinate) and the position in the Y direction (Y coordinate) of each semiconductor die 15 of the single wafer 11 is associated with each semiconductor die 15. For example, the semiconductor die 15 closest to the upper left of the wafer 11 has a position in the X direction of “1” and a position in the Y direction of “9”, and thus is associated with an identification number “1-9”; similarly, a semiconductor die 15 at the right of this semiconductor die 15 has a position in the X direction of “1” and a position in the Y direction of “10”, and thus is associated with an identification number “1-10”.

[0077] As shown in FIG. 23, the level table 159 associates the identification number (die identification number, individual information) of each semiconductor die with the

level value. That is, the level table 159 associates each semiconductor die of the single wafer with the level value that is an identifier of the parameter values (the plurality of pickup conditions) of the release parameters. By the level table 159 and the parameter table 160, the release action according to the level value is associated with each semiconductor die 15 of the single wafer. By the level table 159 and the parameter table 160, association information is determined in which one pickup condition (parameter value) among the plurality of pickup conditions (parameter values of levels 1 to 8) for various release parameters and individual information (identification information) of the semiconductor die are associated.

[0078] FIG. 24 is a diagram in which each semiconductor die 15 of the single wafer is shaded or hatched according to the level value associated with each semiconductor die 15 according to the level table 159 in FIG. 23. As described above, the easiness of release (ease of release) may gradually increase from the semiconductor die 15 near the outer periphery to the semiconductor die 15 near the center of the single wafer. In this case, as shown in FIG. 24, the level value to be associated decreases from the semiconductor die 15 near the outer periphery to the semiconductor die 15 near the center of the wafer (the release action is simplified, and the time required for the release action becomes short). In FIG. 24, level 7 is associated with the outermost peripheral semiconductor dies 15e (semiconductor dies with hatching of the upper left diagonal), and level 6 is associated with semiconductor dies 15d (semiconductor dies with hatching of the upper right diagonal) on the inner peripheral side of the semiconductor dies 15e, level 5 is associated with semiconductor dies 15c (semiconductor dies with a dark gray color) on the inner peripheral side of the semiconductor dies 15d, level 4 is associated with semiconductor dies 15b (semiconductor dies with a light gray color) on the inner

peripheral side of the semiconductor dies 15c, and level 3 is associated with semiconductor dies 15a (semiconductor dies with a white color) near the center. Besides, in FIGS. 25 to 27 and 30 to 35 described below, the same shading or hatching as that of FIG. 24 added to each semiconductor die 15 or each semiconductor image (described later) means that the same level value as each level value of FIG. 24 is associated. As shown in FIG. 24, it is possible to suppress damage to the semiconductor die or pickup error during pickup by applying a release action (high level value) that promotes sufficient release to the semiconductor die 15 at the position where release is difficult, and to perform a short-time pickup applying a simple release action (low level value) to the semiconductor die 15 at the position where release is easy. Because the releasability of each semiconductor die 15 according to the position of each semiconductor die 15 on a plurality of wafers exhibits the same tendency, the level table 159 as shown in FIGS. 23 and 24 is used to continuously pick up the semiconductor dies 15 of the plurality of wafers.

[0079] <Settings display screen>

Next, the settings display screen 460 for the operator or the like to generate or edit (update) the level table 159 is described. FIGS. 25 to 27 are diagrams showing an example of the settings display screen 460. The control unit 150 displays the settings display screen 460 on the display unit 450 (display) by executing the settings display program 156 stored in the storage unit 152, and receives reading, generation, and update of the level table 159. The control unit 150 functions as a display control part and thereby displays the settings display screen 460 on the display unit 450. In addition, as described later, by executing the settings display program 156, an instruction to automatically acquire the releasability of each semiconductor die 15 according to the position of each semiconductor die 15 of the wafer is received. As shown in FIG. 25, the settings display screen 460 includes: a

map image 480 imitating each semiconductor die of the single wafer and composed of a large number of semiconductor die images 482, an operation button group 464 composed of various operation buttons 468, and a level value button group 462 composed of buttons 466 of “level 1” to “level 8”.

5 **[0080]** When a level value is already associated with each semiconductor die 15 as shown in FIGS. 23 and 24, that is, when the level table 159 has already been generated, the operator or the like can display association relationships defined in the level table 159 on the map image 480 of the settings display screen 460. Specifically, the operator or the like uses the mouse (input unit 410) to move a pointer 478 on the settings display
10 screen 460 to the position of the “read” button 468 as shown in FIG. 25, and clicks (selects) this button. Thereby, the association relationships defined in the level table 159 are read and the association relationships are displayed on the map image 480. Specifically, on the map image 480, a color according to the level value corresponding to each semiconductor die 15 is added to each of the semiconductor die images 482 associated
15 with each semiconductor die 15. FIG. 25 shows a case in which the level table 159 having the association relationship between each semiconductor die 15 and the level value shown in FIGS. 23 and 24 is read. In this manner, by adding the color according to the level value to each semiconductor die image 482, the operator or the like can easily grasp which level value is associated with the semiconductor die at each position. Besides,
20 the color according to the level value has been added to each semiconductor die image 482, but at least of color, pattern, letter, number, and symbol according to the level value 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 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, 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. 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 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 image 482b. In FIG. 27, a state is shown in which three semiconductor die images 482b are clicked, and thereby a color according to the selected level 5 is added to the semiconductor die images 482b. The operator or the like thus creates or edits the level

table 159 by repeating the selection of the level value and the selection of the semiconductor die image (semiconductor die) with which the selected level value is associated. The control unit 150 functions as a generation part and receives the selection of the level value and the selection of the semiconductor die image (semiconductor die).

5 **[0084]** Then, when the level table 159 has been created or edited, the pointer 478 is moved to the “overwrite” button 468 and the button 468 is clicked (selected), to thereby create (generate) the level table 159. When the “overwrite save” button 468 is clicked, the control unit 150 functions as a generation part and generates the level table 159. Besides, when there is a plurality of level tables 159, in order to identify each level table
10 159, a form is considered in which a file name is assigned to the level table 159 and stored in the storage unit 152, and the file name is specified to read the level table 159 from the storage unit 152 during reading. In this form, the “save as” button 468 is clicked by the pointer 478, a file name is given from the keyboard or the like of the input unit 410, and the level table 159 is stored in the storage unit 152. Besides, in this case, when the “save
15 as” button 468 is clicked, the control unit 150 functions as a generation part and generates the level table 159. Then, when the “read” button 468 described above is clicked by the pointer 478, the desired level table 159 is read on the settings display screen 460 by specifying the file name of the level table 159 to be read from the plurality of level tables 159.

20 **[0085]** Even when the level table 159 is edited (updated) after the level table 159 is read on the map image 480 of the settings display screen 460 as shown in FIG. 25 described above, the same method as in the case of the new creation described above is used. That is, in FIG. 25, after the button 466 having a desired level value is clicked (selected) by the pointer 478, the semiconductor die image 482 (semiconductor die)

desired to be changed to the selected level value is clicked by the pointer 478. Thereby, the selected level value is associated with the semiconductor die 15 corresponding to the clicked semiconductor die image 482, and the semiconductor die image 482 is colored according to the level value.

5 [0086] While the level table 159 is read on the settings display screen 460, that is, while a color according to the level value is added to each semiconductor die image 482 of the map image 480, the operator or the like presses a pickup execution button that is not shown and thereby starts the pickup of the semiconductor die 15. Besides, the pickup execution button may have a form in which a button displayed on the screen is clicked by
10 the mouse of the input unit 410 or a form in which a physically existing button is pressed by the operator or the like with a hand or a finger. The pickup execution button is pressed, and thereby the control unit 150 executes the control program 155 stored in the storage unit 152 to perform the pickup of the semiconductor die 15. At this time, the release action is performed on each semiconductor die 15 of each wafer according to the
15 level table 159 read on the map image 480 of the settings display screen 460.

[0087] <Acquisition of releasability of each semiconductor die on single wafer>

Next, acquisition of the releasability of each semiconductor die 15 of the single wafer is described. The operator or the like can associate a more accurate level value with each semiconductor die 15 by grasping the releasability (ease of release or difficulty of release)
20 of each semiconductor die 15 according to the position of each semiconductor die 15 of the wafer. Therefore, the semiconductor die pickup system 500 of the embodiment can automatically acquire the releasability of each semiconductor die according to the position of each semiconductor die of the wafer. The automatic acquisition of the releasability of each semiconductor die 15 is described below in detail.

[0088] <Detection method for releasability>

First, a detection method for the releasability of the semiconductor die 15 from the dicing sheet 12 performed by the semiconductor die pickup system 500 is described. The releasability of the semiconductor die 15 from the dicing sheet 12 can be detected
5 from the time variation (actual flow rate variation) of the suction air flow rate of the collet 18 detected by the flow rate sensor 106.

[0089] FIG. 28 is a diagram showing the time variation in the opening pressure during the initial release and the air leakage amount (suction air flow rate) of the collet 18 detected by the flow rate sensor 106, and the meaning of each timing of t1, t2, t3, and t4
10 is the same as those timings shown in FIG. 18. A solid line 157 in the graph of the air leakage amount in FIG. 28 indicates the expected flow rate variation 157 which is a time variation of the air leakage amount when the release of the semiconductor die 15 from the dicing sheet 12 is good (when the easiness of release is extremely high), and the expected flow rate variation 157 is stored in the storage unit 152 in advance.
15 Specifically, the expected flow rate variation 157 stored in the storage unit 152 may be a set of many suction air flow rates acquired at a predetermined sampling cycle, and may be the suction air flow rates associated with many discrete times t. A one-dot dashed line 158a and a two-dot dashed line 158b in the graph of the air leakage amount in FIG. 28 are examples of the actual flow rate variation 158 which is a time variation of the air
20 leakage amount actually detected when the semiconductor die 15 is picked up from the dicing sheet 12. The actual flow rate variation 158 is stored in the storage unit 152 every time the semiconductor die 15 is picked up. Specifically, the actual flow rate variation 158 stored in the storage unit 152 may be in a form that can be compared with the expected flow rate variation 157. For example, similar to the expected flow rate variation 157,

the actual flow rate variation 158 may be a set of many suction air flow rates acquired at a predetermined sampling cycle, and may be the suction air flow rates associated with many discrete times t . Besides, the actual flow rate variation can be referred to as “actual flow rate information”, and the expected flow rate variation can be referred to as
5 “expected flow rate information”.

[0090] When the release of the semiconductor die 15 from the dicing sheet 12 is good, if the opening pressure starts to vary toward the first pressure P_1 close to vacuum at time t_3 , the periphery of the semiconductor die 15 is separated from the front surface 18a of the collet 18 (see FIG. 8), but the periphery of the semiconductor die 15 immediately
10 returns to the front surface 18a of the collet 18 (see FIG. 9). Therefore, as the expected flow rate variation 157 in FIG. 28, the air leakage amount starts to increase from time t_3 , but immediately turns to decrease (turns to decrease at time tr_exp). In the expected flow rate variation 157, the increased air leakage amount is small.

[0091] In contrast, when the releasability of the semiconductor die 15 from the dicing
15 sheet 12 is poor (when the easiness of release is low), if the opening pressure starts to vary toward the first pressure P_1 close to vacuum at time t_3 , the periphery of the semiconductor die 15 is separated from the front surface 18a of the collet 18, and the periphery of the semiconductor die 15 returns to the front surface 18a of the collet 18 after some time. Therefore, as the actual flow rate variation 158a in FIG. 28, the air leakage
20 amount starts to increase at time t_3 , continues to increase, and then turns to decrease at time tr_rel later than time tr_exp . In addition, in the actual flow rate variation 158a, the increased air leakage amount is large.

[0092] In addition, when the releasability of the semiconductor die 15 from the dicing sheet 12 is extremely poor (when the easiness of release is extremely low), after the

periphery of the semiconductor die 15 is separated from the front surface 18a of the collet 18, the periphery of the semiconductor die 15 does not return to the front surface 18a of the collet 18 even after some time. Therefore, as the actual flow rate variation 158b in FIG. 28, the air leakage amount remains large even at time t_{c_end} when a predetermined time has elapsed from time t_4 at which the opening pressure reaches the first pressure P_1 close to vacuum.

[0093] In this manner, as the releasability of the semiconductor die 15 from the dicing sheet 12 deteriorates, the actual flow rate variation 158 deviates from the expected flow rate variation 157. Therefore, the actual flow rate variation 158 is compared with the expected flow rate variation 157, and it is determined that the closer the actual flow rate variation 158 is to the expected flow rate variation 157, the better the releasability is (the higher the easiness of release is). Alternatively, it is determined that the stronger the correlation between the actual flow rate variation 158 and the expected flow rate variation 157, the better the releasability (the higher the easiness of release). In the embodiment, the actual flow rate variation 158 and the expected flow rate variation 157 are compared to obtain the correlation value thereof. The correlation value is a value of 0-1.0, which is 1.0 when the actual flow rate variation 158 and the expected flow rate variation 157 completely match each other, and it is determined that the closer the correlation value is to 0-1.0, the higher the easiness of release is. Besides, in the embodiment, the range of the correlation value is set as 0-1.0, but it is evident that the correlation value may not be in this range.

[0094] The period for comparing the actual flow rate variation 158 and the expected flow rate variation 157 is, for example, time t_1 (the time at which air is started to be sucked from the front surface 18a of the collet 18) to time t_{c_end} (the time when a

predetermined time has elapsed from time t_4 at which the opening pressure initially reaches the first pressure P_1) in FIG. 28, which is part of the initial release period.

Alternatively, the comparison period may be a period from time t_3 (the time at which the opening pressure starts to vary toward the first pressure P_1) to t_{c_end} , which is a part of

the initial release period. In addition, the comparison period may also be another period.

[0095] Besides, as the releasability of the semiconductor die 15 from the dicing sheet 12, a value other than the correlation value between the actual flow rate variation 158 and the expected flow rate variation 157 may be obtained. For example, it may be

determined that the smaller the difference between the value of the expected flow rate

variation 157 at time t_{c_end} in FIG. 28 and the value of the actual flow rate variation 158 at the same time, the better the releasability (the higher the release easiness). In addition,

for example, it may be determined that the smaller the difference between time t_{r_exp} that is a timing at which the air leakage flow rate in the expected flow rate variation 157

varies from increase to decrease and time t_{r_rel} that is a timing at which the air leakage

flow rate in the actual flow rate variation 158 varies from increase to decrease, the higher the release easiness. In addition, for example, it may be determined that the smaller the

difference between the maximum value of the air leakage flow rate of the expected flow rate variation 157 detected after time t_3 in FIG. 28 and the maximum value of the air

leakage flow rate of the actual flow rate variation 158 detected after the same time, the

higher the release easiness.

[0096] In addition, it is also considered to detect the releasability of the semiconductor die 15 from the dicing sheet 12 without using the expected flow rate variation 157. For

example, it may be determined that the smaller the value of the actual flow rate variation

158 at time t_{c_end} in FIG. 28, the better the releasability (the higher the release easiness).

Besides, the correlation value or an index value indicating the releasability of the semiconductor die 15 from the dicing sheet 12 instead of the correlation value, which is obtained based on the actual flow rate variation 158, may be referred to as an “evaluation value”.

5 **[0097]** <Display of releasability on settings display screen>

Next, a method for displaying the releasability of the semiconductor die 15 from the dicing sheet 12 detected as described above on the settings display screen 460 is described.

When trying to grasp the releasability of each semiconductor die 15 at the position of each semiconductor die 15 of the single wafer, as shown in FIG. 30, the operator or the
10 like clicks the “automatic acquisition” button 468 by the pointer 478. Thereby, the control unit 150 executes the control program 155 of the storage unit 152 to pick up each semiconductor die 15 of the single wafer by the release action (pickup action) of a predetermined level value. At this time, the control unit 150 functions as a generation part, and every time the semiconductor die 15 is picked up, acquires the actual flow rate
15 variation 158, obtains the correlation value between the actual flow rate variation 158 and the expected flow rate variation 157, and stores the actual flow rate variation 158 and the correlation value in the storage unit 152.

[0098] Then, the control unit 150 (generation part) compares the correlation value with threshold values TH1 and TH2 of each level value of a threshold value table 161 shown
20 in FIG. 29 every time the semiconductor die 15 is picked up. FIG. 29 is an example of the threshold table 161, and the threshold table 161 is a table stored in the storage unit 152 in advance and determining which level value should be applied to the semiconductor die 15 based on the correlation value. In the threshold table 161, the range of each level value is set by the lower threshold value TH1 and the upper threshold value TH2, and the

higher threshold values TH1 and TH2 are set for the lower level value. For example, the range of level 4 is 0.81 (lower threshold TH1) to 0.85 (upper threshold TH2), the range of level 1 is 0.96 (lower threshold TH1) or more, and the range of level 8 is 0.65 (upper threshold TH2) or less. The control unit 150 (generation part) searches to which level value range the obtained correlation value belongs, and acquires the level value to which the correlation value belongs. For example, if the obtained correlation value is 0.78, level 5 (range: 0.76-0.80) is acquired. In this manner, the control unit 150 acquires the level value to which the correlation value belongs from the threshold value table 161 every time each semiconductor die 15 of the single wafer is picked up. Then, the control unit 150 associates the level value with the semiconductor die 15 (die identification number) for which the correlation value is obtained. That is, the control unit 150 (generation part) creates the level table 159. Then, as shown in FIG. 30, the control unit 150 adds a color according to the level value to each semiconductor die image 482 of the map image 480 based on the gradually created level table 159.

[0099] In this manner, the magnitude of the correlation value (release easiness) of each semiconductor die 15 is represented on the map image 480 stepwise by the level value. By looking at the map image 480 as shown in FIG. 30, the operator or the like can easily grasp which position of the semiconductor die has what degree of release easiness. In addition, because the level table 159 is created by only clicking the “automatic acquisition” button 468, the level table 159 can be directly applied when each semiconductor die of the plurality of wafers thereafter is picked up. In addition, the operator or the like can also automatically edit the level table 159 in which the level value is associated with each semiconductor die 15 as shown in FIG. 30. That is, similar to the case of editing the level table 159 described above, the semiconductor die image 482 of the map image 480

that is desired to change the level value may be selected by the pointer 478 after the button 466 of a desired level value is selected by the pointer 478 on the settings display screen 460 of FIG. 30. Besides, here, the color according to the level value is added to each semiconductor die image 482 of the map image 480, but at least one of color, pattern, letter, number, and symbol varying more finely according to the magnitude of the correlation value (release easiness) may be added to each semiconductor die image 482.

[0100] Furthermore, the semiconductor die pickup system 500 of the embodiment has a structure in which the operator or the like can grasp the releasability of each semiconductor die 15 of the single wafer in detail. As shown in FIG. 31, a balloon 486 appears when the pointer 478 is moved to a predetermined semiconductor die image 482c of the map image 480, and the waveform of the actual flow rate variation and the correlation value of the semiconductor die 15 corresponding to the semiconductor die image 482c at which the pointer 478 is located are displayed in the balloon 486. In the balloon 486 shown in FIG. 31, the actual flow rate variation is displayed by the solid line, and the expected flow rate variation is also displayed by the broken line. In this manner, because the actual flow rate variation and the correlation value of each semiconductor die 15 are displayed on the settings display screen 460, the operator or the like can know the releasability of each semiconductor die 15 in detail. Besides, on the map image 480, the correlation value of each semiconductor die 15 corresponding to each semiconductor die image 482 may be added to each semiconductor die image 482. Alternatively, the correlation value of the semiconductor die 15 corresponding to the specific one or more semiconductor die images 482 may be displayed at a predetermined position on the settings display screen 460.

[0101] <Effect>

The semiconductor die pickup system 500 described above stores, in the storage unit 152, association information (level table 159 and parameter table 160) in which each semiconductor die 15 on the single wafer and one pickup condition (parameter value) of the plurality of pickup conditions (parameter values of levels 1 to 8) for various release parameters are associated. Then, when each semiconductor die 15 of the single wafer is picked up, referring to the association information, the semiconductor die 15 is released from the dicing sheet 12 according to the release action associated with each semiconductor die 15 and picked up. Therefore, the release action suitable for each semiconductor die 15 on the single wafer can be applied to perform the pickup. In addition, according to the semiconductor die pickup system 500 described above, the releasability of each semiconductor die 15 according to the position of each semiconductor die 15 of the single wafer can be grasped.

[0102] <Other>

In the embodiment described above, the settings display screen 460 is a screen for performing creation, update, or the like of the level table 159. However, each parameter value of the parameter table 160 (condition table) may be set on the settings display screen 460. For example, as shown in FIG. 32, a window 490 for setting the parameter value is displayed on the settings display screen 460, so that the parameter value can be set. Specifically, first, the button 466 of the level value for which the parameter value is desired to be set is selected (clicked) by the pointer 478, and then the “detailed setting” button 470 is clicked by the pointer 478. Thereby, the window 490 for setting the parameter value of the release parameter of the selected level value appears as shown in FIG. 32. Then, a text box 492 of the parameter value desired to be changed or newly set in the window 490 is clicked by the pointer 478, and the parameter value is input from

the keyboard of the input unit 410. When all the parameter values have been input, the “save” button 472 in the window 490 is clicked by the pointer 478. Thereby, the parameter value of the release parameter of the selected level value is changed or newly set. The control unit 150 functions as a generation part to update or generate the parameter table 160 by clicking the “save” button 472 when this parameter value is received. In this manner, if each parameter value of the parameter table 160 can be changed and set on the settings display screen 460, the parameter value of the release parameter of each level value can be adjusted extremely easily.

[0103] In addition, in the embodiment described above, the case, in which the easiness of release (ease of release) gradually increases from the semiconductor die 15 near the outer periphery toward the semiconductor die 15 near the center of the wafer, is used as an example to give description. However, there are various other releaseable patterns of each semiconductor die 15 according to the position of each semiconductor die 15 on the wafer. A film referred to as DAF (die attachment film) may be attached to the back surface of the semiconductor die 15. After being picked up together with the semiconductor die 15 while being attached to the back surface of the semiconductor die 15, the DAF functions as an adhesive between the semiconductor die 15 and the substrate when the semiconductor die 15 is die-bonded to the substrate. In the state where the semiconductor die 15 is attached to the dicing sheet 12, the DAF exists between the semiconductor die 15 and the dicing sheet 12. In order to improve the releasability between the DAF attached to the back surface of the semiconductor die 15 and the dicing sheet 12, ultraviolet rays may be irradiated to the dicing sheet 12 before each semiconductor die 15 of the wafer is picked up. The irradiation with ultraviolet rays reduces the adhesive force of the dicing sheet 12. The irradiation with ultraviolet rays

may be uneven, and the releasability of each semiconductor die 15 may vary according to the position of each semiconductor die 15 of the single wafer. Due to this factor, the releasability of each semiconductor die 15 according to the position of each semiconductor die 15 on the wafer has various patterns, and the operator or the like grasps it and associates an appropriate level value with each semiconductor die 15 of the single wafer. For example, it is considered to divide the wafer into two or more pieces (four pieces in FIG. 33) in the peripheral direction as shown in FIG. 33, and associate different level values with the semiconductor dies 15a, 15b, 15c, and 15d belonging to each of the plurality of divided portions. Alternatively, for example, it is considered to divide the wafer into two or more pieces (six pieces in FIG. 34) in the radial direction as shown in FIG. 34, and associate different level values with the semiconductor dies 15a, 15b, 15c, 15d, 15e, and 15f belonging to each of the plurality of divided portions. Alternatively, for example, it is considered to partially divide the wafer as shown in FIG. 35, and associate different level values with the semiconductor dies 15a, 15b, 15c, and 15d belonging to each of the portions.

[0104] In addition, in the embodiment described above, the correlation value between the actual flow rate variation and the expected flow rate variation is obtained as an index for grasping the releasability of the semiconductor die 15. The correlation value is a value of 0-1.0, and the larger the value is, the more easily the semiconductor die 15 is released from the dicing sheet 12, which is the release easiness. In contrast, the value obtained by subtracting the correlation value from 1.0 (1.0-correlation value) is a value of 0-1.0, and the larger the value is, the more difficultly the semiconductor die 15 is released from the dicing sheet 12, which is the difficulty of release. Instead of the correlation value (release easiness), the difficulty of release can be used as an index for

grasping the releasability of the semiconductor die 15. In the embodiment described above, the threshold value table 161 in FIG. 29 (a table in which the larger threshold values TH1 and TH2 are set for the lower level value) on the basis of the correlation value (release easiness) and the range of values taken by the correlation value (0-1.0) is used to associate the level value with each semiconductor die 15. However, the threshold value table 161 (a table in which the smaller threshold values TH1 and TH2 are set for the lower level value) on the basis of the difficulty of release (1.0-correlation value) and the range of values for difficulty of release (0-1.0) may be used to associate the level value with each semiconductor die 15. Besides, the easiness of release or the difficulty of release can be referred to as the releasability.

[0105] In addition, in the embodiment described above, the period during which the expected flow rate variation 157 and the actual flow rate variation 158 are compared for obtaining the correlation value is a predetermined period in the initial release. However, the period for comparing the expected flow rate variation 157 and the actual flow rate variation 158 may be the entire period of the initial release, the entire period of the main release, the predetermined period in the main release, the combination period of the initial release and the main release, or the like. The expected flow rate variation 157 is stored in the storage unit 152 in advance only for a period of being compared with the actual flow rate variation 158.

[0106] In addition, in the release action described above, the adsorption pressure of the adsorption surface 22 of the stage 20 is held at the third pressure P_3 close to vacuum during the initial release and the main release. However, during the initial release or the main release, or during the initial release and the main release, the adsorption pressure may be switched once or several times between the third pressure P_3 close to vacuum and

the fourth pressure P_4 close to atmospheric pressure. That is, as one of the release parameters in the parameter table 160, the “number of switches of adsorption pressure” which is the number of times for switching the adsorption pressure of the adsorption surface 22 of the stage 20 between the third pressure P_3 and the fourth pressure P_4 may be set. In the parameter table 160, the parameter value is set such that the higher the level value, the larger the “number of switches of adsorption pressure”. In the manner of associating a high level value with the semiconductor die 15 having poor releasability and increasing the “number of switches of adsorption pressure”, the release of the semiconductor die 15 from the dicing sheet 12 is promoted.

10 [0107] In addition, in the embodiment described above, as shown in FIG. 36, one control unit 150 functions as the pickup control part 600, the generation part 602, and the display control part 604. However, the semiconductor die pickup system 500 may include two or more control units 150; for example, one control unit 150 may function as the pickup control part 600, and another control unit 150 may function as the generation part 602 and the display control unit 604.

[0108] The semiconductor die pickup system 500 can also be referred to as a semiconductor die pickup apparatus. In addition, the semiconductor die pickup system 500 can be a part of a bonding apparatus (bonder, bonding system) or a die bonding apparatus (die bonder, die bonding system), and can also be called by these names.

20 [0109] <Appendix>

Although the embodiments of the present invention have been described above, the present invention is not limited to these embodiments, and it is evident that the present invention can be implemented in various forms without departing from the scope of the present invention.

[Reference Signs List]

5	[0110] 10	wafer holder
	11	wafer
	12	dicing sheet
	12a	front surface
	12b	back surface
10	13	ring
	14	gap
	15, 15a, 15b, 15c, 15d, 15e, 15f	semiconductor die
	16	expand ring
	17	ring retainer
15	18	collet
	18a	front surface
	19	suction hole
	20	stage
	22	adsorption surface
20	23	opening
	23a	inner surface
	24	base portion
	26	groove
	27	adsorption hole
20	30	moving element
	31	peripheral annular moving element
	33	outer peripheral surface

	38a, 38b, 47	front end surface
	40, 41	intermediate annular moving element
	45	columnar moving element
	80	opening pressure switching mechanism
5	81, 91, 101	three-way valve
	82, 92, 102	drive unit
	83-85, 93-95, 103-105	pipes
	90	adsorption pressure switching mechanism
	100	suction mechanism
10	106	flow rate sensor
	110	wafer holder horizontal direction drive unit
	120	stage vertical direction drive unit
	130	collet drive unit
	140	vacuum apparatus
15	150	control unit
	151	CPU
	152	storage unit
	153	device/sensor interface
	154	data bus
20	155	control program
	156	settings display program
	157	expected flow rate variation
	158, 158a, 158b	actual flow rate variation
	159	level table

	160	parameter table
	161	threshold value table
	300	stepped surface formation mechanism
	400	stepped surface formation mechanism drive unit
5	410	input unit
	450	display unit
	460	settings display screen
	462	level value button group
	464	operation button group
10	466, 468, 470, 472	button
	478	pointer
	480	map image
	482 , 482a, 482b, 482c	semiconductor die image
	486	balloon
15	490	window
	492	text box
	500	semiconductor die pickup system
	600	pickup control part (control part)
	602	generation part
20	604	display control part

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 control part that controls a pickup action based on pickup conditions for picking up the semiconductor dies from the dicing sheet; and

 a generation part that generates association information in which any one of the plurality of pickup conditions is associated with individual information of the semiconductor dies;

10 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 semiconductor dies.

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

15 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

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

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,
comprising:

a display unit that displays a screen, and

a display control part;

5 wherein the display control part

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

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
10 symbol according to the level value on the map image.

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

an input unit that inputs information,

wherein the generation part

receives, from the input unit, selection of one or more semiconductor die
15 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, comprising:

20 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,
and

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;

5 wherein the generation part

 acquires 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,

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

 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

15 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
20 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 inner peripheral side of the single wafer.

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

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

5 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,

10 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

15 the opening pressure at the first pressure.

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

20 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.

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

a collet that adsorbs the semiconductor die,

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
10 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
15 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;

20 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,

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

- 5 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.