

SUCTION STAGE

BACKGROUND OF THE INVENTION

5 Technical Field

[0001] The present invention relates to a structure of a suction stage for suctioning and holding semiconductor dies.

Related Art

[0002] Die bonding apparatuses that bond semiconductor dies picked up from a
10 wafer to a substrate are widely used. In the die bonding apparatus, the semiconductor die picked up from the wafer is temporarily placed on an intermediate stage, the position of the semiconductor die is detected by a camera, and then the semiconductor die is picked up from the intermediate stage by a bonding head to bond the semiconductor die to a predetermined position of a substrate (for example, see patent
15 literature 1).

[Literature of related art]

[Patent literature]

[0003] Paten literature 1: Japanese Patent Laid-Open No. 2013-65711

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SUMMARY

[Problems to be Solved]

[0004] In order to detect the position of the semiconductor die by the camera at the intermediate stage, the semiconductor die is required to be placed flat on a surface of the intermediate stage. Because the semiconductor die is thin and warped upward in many

cases, in order to place the semiconductor die flat on the surface of the intermediate stage, the intermediate stage is configured by a suction stage, and the semiconductor die is suctioned and held on the surface by vacuum.

[0005] At this time, in order for the semiconductor die to be suctioned flat on the surface of the suction stage, it is necessary that the entire semiconductor die is suctioned in a well-balanced manner. In addition, if suction holes that do not suction the semiconductor die are present around the semiconductor die, air may enter through the suction holes and the suction force may be reduced, and thus suction holding of the semiconductor die cannot be detected in some cases. Thus, several types of suction stages having different arrangements of suction holes in accordance with sizes of the semiconductor dies placed on the surface are prepared, and the suction stage is required to be replaced according to the size of the semiconductor die. Thus, there is a problem that a tact time of the bonding becomes long.

[0006] Therefore, an objective of the present invention is to provide a suction stage capable of suitably suctioning and holding semiconductor dies of a plurality of sizes.

[Means to Solve Problems]

[0007] The suction stage of the present invention suction and holds semiconductor dies having different sizes, and includes: an upper plate in which a plurality of suction holes is arranged; a plurality of vacuum flow paths which connects the plurality of suction holes arranged in the upper plate to a vacuum device for each of a plurality of groups corresponding to the sizes of the semiconductor dies; and check valves arranged in at least one of the plurality of vacuum flow paths, wherein the check valves are closed when the suction holes are opened to the atmosphere and are opened when the suction holes are blocked by a semiconductor die.

[0008] In the suction stage of the present invention, the check valves may be valves in which a valve seat surface is rough and a minute leak of air may be generated between a valve body and a valve seat in a closed state.

[0009] In the suction stage of the present invention, the valve seat surface may be an arc-shaped surface in which holes through which air flows are arranged, the valve body may be a band-shaped body configured by an elastic body attached to one end of the valve seat surface, and the check valve may be a valve in which the valve body opens and closes the holes. In addition, in the suction stage of the present invention, the suction holes may be evenly arranged.

10 **[Effect]**

[0010] The present invention can provide a suction stage capable of suitably suctioning and holding semiconductor dies of a plurality of sizes.

BRIEF DESCRIPTION OF THE DRAWINGS

15 **[0011]** FIG. 1 is an illustration diagram showing a configuration of a die bonding apparatus into which a suction stage of the embodiment is incorporated.

FIG. 2 is a perspective view of the suction stage of the embodiment.

FIG. 3 is a cross-section view of the suction stage of the embodiment.

FIG. 4 is a system diagram showing an arrangement of suction holes on a surface of the suction stage of the embodiment and a configuration of a vacuum flow path.

FIG. 5 is an exploded perspective view of a valve portion of the suction stage of the embodiment.

FIG. 6 is a perspective view of a check valve incorporated into the suction

stage of the embodiment.

FIG. 7 is an illustration diagram showing a state before a semiconductor die is placed on the suction stage of the embodiment.

FIG. 8 is an illustration diagram showing a suction holding operation when a
5 small-sized semiconductor die closing suction holes included in a first group is placed on the suction stage of the embodiment.

FIG. 9 is an illustration diagram showing a suction holding operation when a medium-sized semiconductor die closing suction holes included in first and second groups is placed on the suction stage of the embodiment.

10 FIG. 10 is an illustration diagram showing a suction holding operation when a large-sized semiconductor die closing suction holes included in first, second, and third groups is mounted on the suction stage of the embodiment.

DESCRIPTION OF THE EMBODIMENTS

15 **[0012]** A suction stage 20 of the embodiment is described below with reference to the drawings. First, a die bonding apparatus 100 into which the suction stage 20 of the embodiment is incorporated is described with reference to FIG. 1.

[0013] As shown in FIG. 1, the die bonding apparatus 100 includes a pickup portion 10, an intermediate positioning portion 18, and a bonding portion 70.

20 **[0014]** The pickup portion 10 is a part that picks up a semiconductor die 13 from a surface of a wafer 12 and conveys the semiconductor die 13 to the intermediate positioning portion 18. As shown in FIG. 1, the pickup portion 10 includes a wafer holder 11 for holding the wafer 12, a push-up mechanism 16 for pushing up the semiconductor die 13 from below, and a pickup head 14 including a collet 15 for

picking up the semiconductor die 13 pushed up by the push-up mechanism 16. When the semiconductor die 13 is suctioned on the collet 15, the pickup head 14 transfers the semiconductor die 13 from the pickup portion 10 to the intermediate positioning portion 18 and places the semiconductor die 13 on a surface 21a of the suction stage 20.

5 **[0015]** The intermediate positioning portion 18 includes the suction stage 20 for temporarily suctioning and holding the semiconductor die 13 on the surface 21a, and a camera 48 which is disposed above the surface 21a of the suction stage 20 and captures an image of the semiconductor die 13 suctioned and held on the surface 21a. The suction stage 20 includes an upper plate 21 and a valve portion 50.

10 **[0016]** The bonding portion 70 includes a bonding stage 71 for vacuum-suctioning a substrate 17 on the surface and a bonding head 72 including a bonding tool 73 for picking up the semiconductor die 13 from the surface 21a of the suction stage 20 and bonding the semiconductor die 13 onto the substrate 17.

[0017] Next, the configuration of the suction stage 20 is described with reference to
15 FIGS. 2-6. As shown in FIG. 2, the suction stage 20 has the upper plate 21 in which a large number of suction holes 22 are arranged evenly on the surface 21a, and the valve portion 50 for housing therein a first check valve 61 and a second check valve 62 shown in FIGS. 3 and 5. As shown in FIG. 1, the suction holes 22 are divided into three groups, namely, a first group A1 configured by the suction holes 22 at the center, a third
20 group A3 configured by the outermost suction holes 22, and a second group A2 configured by the suction holes 22 positioned between the first group A1 and the third group A3. The grouping of the suction holes 22 is described later specifically.

[0018] As shown in FIG. 3, a concave portion 23 and step portions 29 and 31 following the concave portion 23 are arranged on the side of a lower surface 21b

opposite to the surface 21a of the upper plate 21. As shown by a broken line in FIG. 2, the concave portion 23 has a size surrounding the outside of the arrangement of the suction holes 22. Two annular convex portions 24 and 25 are projected from a bottom surface 23a of the concave portion 23. The annular convex portion 24 configures a
5 third cavity 28 which is annular and surrounded by a side surface and the bottom surface 23a of the concave portion 23. In addition, the convex portions 24 and 25 configure a second cavity 27 which is annular and surrounded by an inner peripheral surface of the annular convex portion 24 and an outer peripheral surface of the convex portion 25. In addition, an inner peripheral surface of the convex portion 25
10 configures a first cavity 26.

[0019] As shown in FIGS. 2 to 4, the suction holes 22 included in the first group A1 communicate with the first cavity 26, the suction holes 22 included in the second group A2 communicate with the second cavity 27, and the suction holes 22 included in the third group A3 communicate with the third cavity 28. Therefore, the convex portions
15 24 and 25 are also walls that partition the suction holes 22 into the first group A1, the second group A2, and the third group A3.

[0020] An upper packing 29a is fitted in the step portion 29 following the concave portion 23, and a spacer 30a and a lower packing 31a are fitted in the step portion 30 following the step portion 29. An upper surface of the upper packing 29a configures
20 lower surfaces of the first cavity 26, the second cavity 27, and the third cavity 28. In addition, in the upper packing 29a, the spacer 30a, and the lower packing 31a, through holes 33, 36 and 39 are arranged at a first position, through holes 34, 37 and 39 are arranged at a second position, and through holes 32, 35 and 38 are arranged at a third position. The through holes 33, 36 and 39 arranged at the first position configure a

first vacuum flow path 41 communicating with the first cavity 26, the through holes 34, 37 and 40 arranged at the second position configure a second vacuum flow path 42 communicating with the second cavity 27, and the through holes 32, 35 and 38 arranged at the third position configure a third vacuum flow path 43 communicating with the third cavity 28.

[0021] As shown in FIG. 3, the first vacuum flow path 41 is connected to a through hole 52 arranged in a base 51 of the valve portion 50. In addition, the second vacuum flow path 42 and the third vacuum flow path 43 communicate with a first valve housing concave portion 55a and a second valve housing concave portion 55b of the base 51.

As shown in FIG. 5, through holes 53a and 53b are respectively arranged on bottom surfaces of the first second valve housing concave portion 55a and the second valve housing concave portion 55b. The through holes 52, 53a and 53b are connected to a vacuum device 45 via a pipe 54. A pressure sensor 46 for detecting the pressure of the pipe is arranged in the pipe 54.

[0022] As shown in FIGS. 3 to 5, a first check valve 61 is housed in the first valve housing concave portion 55a communicating with the second vacuum flow path 42 and the through hole 53a, and a second check valve 62 is housed in the second valve housing concave portion 55b communicating with the third vacuum flow path 43 and the through hole 53b. As shown in FIG. 4, the first check valve 61 is oriented to block a flow of air from the suction holes 22 included in the second group A2 toward the vacuum device 45, and the second check valve 62 is oriented to block a flow of air from the suction holes 22 included in the third group A3 toward the vacuum device 45.

[0023] Next, configurations of the first check valve 61 and the second check valve 62 are described with reference to FIG. 6. The first check valve 61 and the second

check valve 62 have the same structure. As shown in FIG. 6, the first check valve 61 and the second check valve 62 include a substantially rectangular parallelepiped main body 63 having an arc-shaped valve seat surface 64 in which a hole 66 for air to flow through is arranged, and a valve body 65 which is a band-shaped body configured by an elastic body attached to one end of the valve seat surface 64. The valve seat surface 64 is rough and an arithmetic average roughness Ra may be, for example, about 1.6. The valve body 65 is a metal plate having a smooth surface. The hole 66 communicates with a hole 69 arranged in a side surface of the main body 63 by flow paths 67 and 68 arranged inside the main body. As shown in FIG. 5, when the first check valve 61 and the second check valve 62 are assembled to the first valve housing concave portion 55a and the second valve housing concave portion 55b, the hole 69 arranged in the side surface of the main body 63 communicates with the vacuum device 45 from the through holes 53a and 53b. In addition, a gap D between a front end of the valve body 65 on the hole 66 side and wall surfaces of the first valve housing concave portion 55a and the second valve housing concave portion 55b communicates with the second vacuum flow path 42 and the third vacuum flow path 43.

[0024] When the hole 69 is evacuated by the vacuum device 45 connected to the hole 69, the valve body 65 is suctioned to the valve seat surface 64 in the hole 66 and seals the hole 66 as shown by an arrow 95 in FIG. 6. Thereby, the first check valve 61 and the second check valve 62 are closed. In addition, when the pressure in the hole 69 reaches the atmospheric pressure, the valve body 65 is separated from the valve seat surface 64 by its own elastic force and opens the hole 66, and the first check valve 61 and the second check valve 62 are closed. However, because the valve seat surface 64 is rough, even when the first check valve 61 and the second check valve 62 are closed, a

minute leak of air is generated between the valve seat surface 64 and the valve body 65.

[0025] Next, with reference to FIGS. 7 to 10, operation of each portion when the semiconductor die 13 is suctioned to the suction stage 20 is described.

[0026] First, with reference to FIG. 7, a state in which the vacuum device 45 is
5 activated before suctioning the semiconductor die 13 is described. In this state, because the surface 21a of the upper plate 21 of the suction stage 20 is at atmospheric pressure, when the vacuum device 45 is started, the holes 69 in the first check valve 61 and the second check valve 62 communicating with the vacuum device 45 and the flow
10 paths 67 and 68 communicating with the holes 69 are evacuated, the valve bodies 65 are suctioned to the valve seat surfaces 64, and the holes 66 in the valve seat surfaces 64 are sealed. Thus, the first check valve 61 and the second check valve 62 are closed, and the second vacuum flow path 42 and the third vacuum flow path 43 are also closed. On the other hand, because the first vacuum flow path 41 communicating with the
15 suction holes 22 included in the first group A1 is opened to the atmosphere, air is suctioned into the vacuum device 45 from the first vacuum flow path 41. At this time, the pressure sensor 46 at an inlet of the vacuum device 45 has a pressure higher than -60 Pa to -70 Pa, for example, about -10 Pa, which is an ultimate pressure when the semiconductor die 13 is suctioned on the surface 21a.

[0027] Next, a case is described where a small-sized semiconductor die 13a is
20 placed on the front surface 21a as shown in FIG. 8. The small-sized semiconductor die 13a has the same size as the broken line indicating an outer periphery of the first group A1 shown in FIG. 4, and has a size with which surfaces of the suction holes 22 included in the first group A1 are covered and the suction holes 22 included in the second group A2 and the third group A3 are not covered.

[0028] As shown in FIG. 8, when the small-sized semiconductor die 13a is placed on the surface 21a, the surfaces of the suction holes 22 included in the first group A1 are covered. Thereby, the first vacuum flow path 41 is evacuated and the semiconductor die 13a is suctioned on the surface 21a. Because the suction holes 22 are evenly arranged, the entire semiconductor die 13a is vacuum-held on the surface 21a in a well-balanced manner. Because the first check valve 61 and the second check valve 62 close the second vacuum flow path 42 and the third vacuum flow path 43, when the air that entered the first vacuum flow path 41 is suctioned by the vacuum device 45, the pressure of the first vacuum flow path 41 reaches -60 Pa to -70 Pa, which is the ultimate pressure when the semiconductor die 13 is suctioned on the surface 21a. Thereby, the pressure sensor 46 arranged at the inlet pressure of the vacuum device 45 also detects a pressure of -60 Pa to -70 Pa, and a control device not shown detects that the semiconductor die 13a is suctioned and held. Then, the control device acquires an image of the semiconductor die 13a by the camera 48 and performs position detection.

[0029] Next, with reference to FIG. 9, a case is described where a medium-sized semiconductor die 13b is placed on the surface 21a. The medium-sized semiconductor die 13b has the same size as the broken line indicating an outer periphery of the second group A2 shown in FIG. 4, and has a size that covers the surfaces of the suction holes 22 included in the first group A1 and the second group A2. However, the size of medium-sized semiconductor die 13b does not cover the suction holes 22 included in the third group A3.

[0030] As described above with reference to FIG. 7, in a state where the vacuum device 45 is activated before suctioning the semiconductor die 13, the first check valve 61 and the second check valve 62 are closed, and the second vacuum flow path 42 and

the third vacuum flow path 43 are closed. The first vacuum flow path 41 is opened to the atmosphere, and air flows from the first vacuum flow path 41 toward the vacuum device 45. At this time, an inlet pressure of the vacuum device 45 is, for example, about -10 Pa.

5 **[0031]** Next, as shown in FIG. 9, when the medium-sized semiconductor die 13b is placed on the front surface 21a, the semiconductor die 13b covers the surfaces of the suction holes 22 included in the first group A1 and the second group A2. Thereby, first, the first vacuum flow path 41 is evacuated, and a central portion of the semiconductor die 13b is suctioned on the surface 21a. In the closed state, the first
10 check valve 61 has a minute leak of air, and thus when the second vacuum flow path 42 is covered by the semiconductor die 13b, the air that entered the second vacuum flow path 42 flows into the vacuum device 45 through the first check valve 61 as shown by an arrow 92 in FIG. 9. Thus, the pressure in the second vacuum flow path 42 gradually decreases toward vacuum. Then, when a pressure difference between the
15 pressure in the second vacuum flow path 42 and the pressure in the flow paths 67 and 68 inside the main body 63 decreases, the elastic force making the valve body 65 separate from the valve seat surface 64 is greater a force pressing the valve body 65 against the valve seat surface 64, and thus the valve body 65 is moved upward as indicated by an arrow 91 in FIG. 9, and the first check valve 61 is opened.

20 **[0032]** Thereby, the second vacuum flow path 42 is brought into the same vacuum state as the first vacuum flow path 41, and a peripheral portion of the semiconductor die 13b is suctioned on the surface 21a. Because the suction holes 22 are evenly arranged, the entire semiconductor die 13b is vacuum-held on the surface 21a in a well-balanced manner by the suction holes 22 included in the first group A1 and the suction holes 22

included in the second group A2.

[0033] Similarly as described above with reference to FIG. 8, because the third vacuum flow path 43 is closed by the second check valve 62, when the air that entered the first vacuum flow path 41 and the second vacuum flow path 42 is suctioned by the vacuum device 45, the pressure of the first vacuum flow path 41 and the second vacuum flow path 42 reaches -60 Pa to -70 Pa, which is the ultimate pressure when the semiconductor die 13b is suctioned on the surface 21a. Thereby, the pressure sensor 46 arranged at the inlet pressure of the vacuum device 45 also detects a pressure of -60 Pa to -70 Pa, and the control device not shown detects that the semiconductor die 13b is suctioned and held. Then, the control device acquires an image of the semiconductor die 13b by the camera 48 and performs position detection.

[0034] Next, with reference to FIG 10, a case is described where a large-sized semiconductor die 13c is placed on the surface 21a. The large-sized semiconductor die 13c has a size to cover all the suction holes 22 shown in FIG. 4.

[0035] As shown in FIG. 10, when the large-sized semiconductor die 13c is placed on the surface 21a, the semiconductor die 13c covers surfaces of all the suction holes 22. Thereby, first, the first vacuum flow path 41 is evacuated, and the semiconductor die 13c is suctioned on the surface 21a. In the closed state, the first check valve 61 and the second check valve 62 have a minute leak of air. Therefore, similar to the above description, when the second vacuum flow path 42 and the third vacuum flow path 43 are covered with the semiconductor die 13c, the first check valve 61 and the second check valve 62 are opened.

[0036] Thereby, the second vacuum flow path 42 and the third vacuum flow path 43 are brought into the same vacuum state as the first vacuum flow path 41, and a

peripheral portion of the semiconductor die 13c is suctioned on the surface 21a. Because the suction holes 22 are evenly arranged, the entire semiconductor die 13c is vacuum-held on the surface 21a in a well-balanced manner by the suction holes 22 included in the first group A1 to the third group A3.

5 **[0037]** When the air that entered the first vacuum flow path 41, the second vacuum flow path 42, and the third vacuum flow path 43 is suctioned by the vacuum device 45, the pressure of the first vacuum flow path 41, the second vacuum flow path 42, and the third vacuum flow path 43 reaches -60 Pa to -70 Pa, which is the ultimate pressure when the semiconductor die 13c is suctioned on the surface 21a. Thereby, the pressure
10 sensor 46 arranged at the inlet pressure of the vacuum device 45 also detects a pressure of -60 Pa to -70 Pa, and a control device not shown detects that the semiconductor die 13c is suctioned and fixed. Then, the control device acquires an image of the semiconductor die 13c by the camera 48 and performs position detection.

[0038] As described above, in the suction stage 20 of the embodiment, the plurality
15 of suction holes 22 is divided into the first group A1 to the third group A3 corresponding to the sizes of the semiconductor dies 13, the first vacuum flow path 41 to the third vacuum flow path 43 are arranged which connect the plurality of suction holes 22 to the vacuum device 45 for each of the first group A1 to the third group A, and the first check valve 61 and the second check valve 62 are arranged in the second
20 vacuum flow path 42 and the third vacuum flow path 43, the first check valve 61 and the second check valve 62 being closed when the suction holes 22 are opened to the atmosphere and being opened when the suction holes 22 are blocked by the semiconductor die 13. In addition, the suction holes 22 are evenly arranged. Thereby, regardless of the size of the semiconductor die 13, the entire semiconductor die 13 can

be evenly suction-held in a well-balanced manner by the suction holes 22. Then, the position of the semiconductor die 13 can be suitably detected using the camera 48.

[0039] In addition, according to the above configuration, the suction stage 20 of the embodiment can evacuate the suction holes 22 blocked by the semiconductor die 13 corresponding to the size of the semiconductor die 13, and block the other suction holes 22 from the vacuum device 45. Therefore, the vacuum pressure when the semiconductor die 13 is vacuum-suctioned can be set to a pressure at which the semiconductor die 13 can be suctioned and held regardless of the size of the semiconductor die 13, and the suction holding of the semiconductor dies 13 can be confirmed by the control device.

[0040] As described above, the suction stage 20 of the embodiment can suitably suction and hold the semiconductor dies 13 of a plurality of sizes with one suction stage 20 without replacing the suction stage 20 according to the sizes of the semiconductor dies, a tact time of the bonding can be shortened, and efficient bonding can be performed.

[0041] Moreover, in the embodiment, the description is made on the premise that no check valve is arranged on the first vacuum flow path 41, but the present invention is not limited hereto, and a check valve having the same structure as the first check valve 61 may be arranged on the first vacuum flow path 41. In addition, the check valve may be arranged outside the suction stage 20 instead of being incorporated in the suction stage 20. In this case, for example, another type of check valve such as a swing type check valve may be used.

[Reference Signs List]

[0042] 10 pickup portion

5	11	wafer holder
	12	wafer
	13, 13a, 13b, 13c	semiconductor die
	14	pickup head
	15	collet
10	16	push-up mechanism
	17	substrate
	18	intermediate positioning portion
	20	suction stage
	21	upper plate
15	21a	surface
	21b	lower surface
	22	suction hole
	23	concave portion
	23a	bottom surface
20	24, 25	convex portion
	26	first cavity
	27	second cavity
	28	third cavity
	29, 30	step portion
	29a	upper packing
	30a	spacer
	31a	lower packing
	32-40, 52, 53a, 53b	through hole

	41	first vacuum flow path
	42	second vacuum flow path
	43	third vacuum flow path
	45	vacuum device
5	46	pressure sensor
	48	camera
	50	valve portion
	51	base
	54	pipe
10	55a, 55b	valve housing concave portion
	61	first check valve
	62	second check valve
	63	main body
	64	valve seat surface
15	65	valve body
	66, 69	hole
	67, 68	flow path
	70	bonding portion
	71	bonding stage
20	72	bonding head
	73	bonding tool
	100	die bonding apparatus

WHAT IS CLAIMED IS:

1. A suction stage which suctions and holds semiconductor dies having different sizes, comprising:

an upper plate in which a plurality of suction holes is arranged;

5 a plurality of vacuum flow paths which connects the plurality of suction holes arranged in the upper plate to a vacuum device for each of a plurality of groups corresponding to the sizes of the semiconductor dies; and

check valves arranged in at least one of the plurality of vacuum flow paths, wherein

10 the check valves are closed when the suction holes are opened to the atmosphere and are opened when the suction holes are blocked by a semiconductor die.

2. The suction stage according to claim 1, wherein

the check valves are valves in which a valve seat surface is rough and a minute leak of air is generated between a valve body and the valve seat surface in a
15 closed state.

3. The suction stage according to claim 2, wherein

the valve seat surface is an arc-shaped surface in which holes through which air flows are arranged, the valve body is a band-shaped body configured by an elastic body attached to one end of the valve seat surface, and the check valve is a valve in
20 which the valve body opens and closes the holes.

4. The suction stage according to any one claims 1 to 3, wherein

the suction holes are evenly arranged.