

TITLE OF THE INVENTION:

BONDING APPARATUS, BONDING SYSTEM, AND BONDING METHOD

TECHNICAL FIELD

[0001] The disclosures herein relate to bonding apparatuses, bonding systems, and bonding methods.

BACKGROUND

[0002] A chip mounting system disclosed in Patent Literature (PTL) 1 includes a chip supplying apparatus, a bonding apparatus, a surface treatment apparatus, a carry-in-and-out unit, and a conveyor (paragraph [0225] of PTL 1). The chip supplying apparatus supplies a plurality of chips individually. The chips are adhered to a tape covering an opening of a frame, and are individually pushed upward and individually inverted (paragraph [0251] of PTL 1). The bonding apparatus attaches the chip supplied from the chip supplying apparatus to a substrate.

CITATION LIST

PATENT LITERATURE

[0003]PTL 1: Japanese Patent No. 6337400

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0004] One aspect of the present disclosure provides a technology for reducing the installation area of a bonding apparatus for bonding a die to a substrate.

MEANS FOR SOLVING THE PROBLEM

[0005] A bonding apparatus configured to bond a plurality of dies to a substrate, wherein the substrate includes a plurality of first devices on a surface for bonding to the dies, each of the dies includes, on a surface for bonding to the substrate, a second device that is to be electrically connected to a corresponding one of the first devices, the bonding apparatus includes a carrier holder configured to hold horizontally a carrier on which the plurality of dies are mounted, a substrate holder configured to hold horizontally the substrate, a substrate moving unit configured to move the

substrate together with the substrate holder so as to change bonding positions of respective dies of the dies, a first conveyor configured to receive one of the dies from the carrier held by the carrier holder and convey the one of the dies, and a mounting unit configured to receive the one of the dies from the first conveyor and mount the received one of the dies onto the substrate held by the substrate holder, the carrier holder and the substrate holder are disposed apart from each other in a vertical direction, and when viewed from above, a center of the carrier held by the carrier holder is located within a movement range of the substrate held by the substrate holder.

EFFECT OF THE INVENTION

[0006] According to the aspect of the present disclosure, it is possible to reduce the installation area of the bonding apparatus for bonding a die to a substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] [FIG. 1] FIG. 1 is a plan view illustrating a bonding system according to an embodiment.

[FIG. 2] FIG. 2 is a flowchart illustrating a bonding method according to an embodiment.

[FIG. 3] FIG. 3 is a cross-sectional view illustrating an example of a carrier with dies attached.

[FIG. 4] FIG. 4 is a cross-sectional view illustrating an example of a substrate.

[FIG. 5] FIG. 5 is a cross-sectional view illustrating an example of the substrate with the dies.

[FIG. 6] FIG. 6 is a cross-sectional view illustrating an example of operation of a bonding apparatus.

[FIG. 7] FIG. 7 is a cross-sectional view illustrating an example of operation following FIG. 6.

[FIG. 8] FIG. 8 is a plan view illustrating an example of a positional relationship between the carrier and the substrate.

[FIG. 9] FIG. 9 is a cross-sectional view illustrating a bonding apparatus according to a first modification.

[FIG. 10] FIG. 10 is a cross-sectional view illustrating a bonding apparatus according to a second modification.

[FIG. 11] FIG. 11 is a cross-sectional view illustrating a bonding apparatus according to a third modification.

[FIG. 12] FIG. 12 is a cross-sectional view illustrating a bonding apparatus according to a fourth modification.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0008] In the following, embodiments of the present invention will be described with reference to the accompanying drawings. Since each of the drawings schematically shows embodiments of the present disclosure, the scale, spacing, positional relationship, or the like of each member may be exaggerated, or part of the members may be omitted from the drawings. An X-axis direction, a Y-axis direction, and a Z-axis direction are orthogonal to each other. The X-axis direction and the Y-axis direction are horizontal directions, and the Z-axis direction is a vertical direction. The X-axis direction includes an X-axis positive direction and an X-axis negative direction opposite to the X-axis positive direction. The Y-axis direction includes a Y-axis positive direction and a Y-axis negative direction opposite to the Y-axis positive direction. The Z-axis direction includes a Z-axis positive direction and a Z-axis negative direction opposite to the Z-axis positive direction.

[0009] Hereinafter, a bonding system 1 according to an embodiment will be described with reference mainly to FIGS. 1 to 5. As shown in FIG. 5, the bonding system 1 manufactures a substrate with dies DW by bonding a plurality of dies D to a substrate W. The substrate with dies DW includes a substrate W and a plurality of dies D bonded to the substrate W.

[0010] The substrate W includes a first base substrate W1 and a plurality of first devices W2 formed on the first base substrate W1. The first base substrate W1 is, for example, a silicon wafer, a compound semiconductor wafer, or a glass substrate. The first device W2 includes a semiconductor element, a circuit, a terminal, and the like. The substrate W has, on a surface for bonding Wa to the dies D, a plurality of first devices W2.

[0011] The die D includes a second base substrate D1 and a second device D2 formed on the second base substrate D1. The second base substrate D1 is, for example, a silicon wafer, a compound semiconductor wafer, or a glass substrate. The second device D2 includes a semiconductor element, a circuit, a terminal, and the like. The die D has, on a surface Da bonded to the substrate W, a second device D2 that is electrically connected to a first device W2 of the substrate W. Although one second

device D2 is electrically connected to one first device W2, a plurality of second devices D2 may be electrically connected.

[0012] Although not shown, a second die may be prepared in addition to the dies D. The second die has a third device electrically connected to the first device W2 of the substrate W on the surface Da bonded to the substrate W. The third device has a different function from the second device D2, that is, a different electric circuit. The second device D2 and the third device may be electrically connected to one first device W2. Although one third device is electrically connected to one first device W2, a plurality of third devices may be electrically connected.

[0013] As shown in FIG. 1, the bonding system 1 includes a carry-in-and-out station 2, a first processing station 3, a second processing station 5, and a control circuit 9. The carry-in-and-out station 2 and the first processing station 3 are aligned with the second processing station 5 in this order from the X-axis negative direction side to the X-axis positive direction side. Although not shown, a plurality of second processing stations 5 may be provided, and the plurality of second processing stations 5 may be aligned from the X-axis negative direction toward the X-axis positive direction.

[0014] The carry-in-and-out station 2 includes a mounting table 20. Cassettes C1 to C4 are mounted on the mounting table 20. The cassette C1 accommodates a carrier A on which dies D are attached. The cassette C2 accommodates the carrier A from which the dies D are removed. The cassette C3 accommodates the substrate W before bonding to the dies D. The cassette C4 accommodates the substrate with dies DW.

[0015] The carrier A holds a plurality of dies D as shown in FIG. 3. The carrier A is, for example, an electrostatic carrier. The electrostatic carrier electrostatically attracts the plurality of dies D. The electrostatic carrier may electrostatically attract and also attract by vacuum a plurality of dies D. Even after the electrostatic attraction force disappears, the plurality of dies D can remain held by the vacuum attraction force.

[0016] The carrier A is prepared for each substrate W, for example. In this embodiment, the carrier A holds only a plurality of dies D having the same function, but may further hold a plurality of second dies described above in addition to the plurality of dies D. Preferably, one carrier A holds all the dies bonded to one substrate W.

[0017] The carrier A has, for example, a conductive substrate A1 and an insulating film A2, and the dies D are attracted to the side opposite to the conductive substrate A1 with respect to the insulating film A2. A charge supply (not shown) applies a

voltage to the conductive substrate A1, thereby supplying charges of a first polarity (e.g., positive) to the conductive substrate A1. A charge elimination unit (not shown) removes charges of a first polarity from the dies D, thereby leaving charges of a second polarity (e.g., negative), which is opposite to the first polarity, in the dies D. [0018] While charges of a first polarity accumulate in the conductive substrate A1, charges of a second polarity accumulate in the dies D. As a result, a potential difference is generated between the conductive substrate A1 and the dies D across the insulating film A2, and electrostatic attraction force is generated. The generated electrostatic attraction force is maintained even after the voltage applied to the conductive substrate A1 is removed and the dies D are neutralized.

[0019] The conductive substrate A1 is made of, for example, silicon, aluminum, an aluminum alloy, stainless steel, or titanium. One or more through-holes A3 may be formed for each die D on the conductive substrate A1. The die D can be removed from the carrier A by supplying a gas to the through-holes A3 or inserting a pin (not shown) into the through-holes A3. The number and arrangement of the through-holes A3 are not particularly limited.

[0020] The insulating film A2 maintains electrostatic attraction by limiting the movement of charges between the second base substrate D1 of the die D and the conductive substrate A1. The insulating film A2 preferably has a breakdown voltage of 30 kV or more, more preferably 40 kV or more.

[0021] The insulating film A2 is preferably made of a material having flexibility, specifically, a material having an elastic modulus of 2 GPa or less, more preferably 0.5 GPa or less. When the die D is pressed against the insulating film A2 by the electrostatic attraction force, a vacuum attraction force is generated between the die D and the insulating film A2.

[0022] Even if charges leak from the conductive substrate A1 or the dies D and the electrostatic attraction force disappears, it is possible to continue to hold the plurality of dies D by the vacuum attraction force. One cause of charge leakage is that a processing liquid is supplied to the die D during removal of the protective film PF or during modification of the surface for bonding Da.

[0023] For example, polyimide or EVA (ethylene-vinyl acetate copolymer) is used for the insulating film A2 from the viewpoint of durability in modifying the surface for bonding Da. The thickness of the insulating film A2 is, for example, 10 μm .

[0024] A through-hole A4 communicating with the through-hole A3 of the conductive substrate A1 may be formed in the insulating film A2. The diameter of the through-

hole A4 of the insulating film A2 is preferably smaller than the diameter of the through-hole A3 of the conductive substrate A1. The through-hole A4 may be absent. Even if the through-hole A4 is absent, the insulating film A2 can be locally deformed by supplying a gas to the through-hole A3 or inserting a pin into the through-hole A3, and the die D can be removed from the carrier A.

[0025] Although not shown, the carrier A may have a carrier substrate corresponding to the conductive substrate A1 and a resin film corresponding to the insulating film A2, and a plurality of dies D may be mounted on the resin film. The carrier A preferably holds the dies D with the surfaces for bonding Da of the dies D oriented upward. The carrier A electrostatically attracts the dies D, for example. By pressing the dies D against the resin film, the resin film can be deformed to expel gas from between the dies D and the resin film, and can attract the dies D by vacuum.

[0026] The carrier substrate may be conductive or insulating. A through-hole penetrating the carrier substrate in the thickness direction is formed in the carrier substrate. The die D can be separated from the carrier A by supplying a gas to the through-hole or inserting a pin (not shown) into the through-hole. The number and arrangement of the through-holes are not particularly limited. One or more through-holes may be formed for each die D.

[0027] The carrier substrate is preferably made of a material having rigidity. For example, the carrier substrate is preferably made of, for example, silicon (Si), a ceramic, aluminum, an aluminum alloy, stainless steel, zirconia, silicon carbide (SiC), titanium, or glass. The carrier substrate may have a diameter similar to that of the substrate W. Further, the carrier substrate may have a thickness similar to that of the substrate W.

[0028] The resin film is preferably made of a material having flexibility, specifically, a material having an elastic modulus of 2 GPa or less, more preferably 0.5 GPa or less. The resin film is preferably made of, for example, polyimide or EVA (ethylene-vinyl acetate copolymer) from the viewpoint of durability when the surface for bonding of the die D is modified. The thickness of the resin film is, for example, 10 μm . The resin film is a single layer, and may be a plurality of layers. For example, the resin film may have a polyolefin layer and an acrylic adhesive layer.

[0029] The carrier A preferably has the same diameter as the substrate W. In this case, the same model number (i.e., the same dimensions and shape) can be used for a conveying arm for conveying the carrier A and a conveying arm for conveying the substrate W, thereby reducing the cost. Similarly, the same model number can be used

for the first activating apparatus 37 and the second activating apparatus 39, or the first hydrophilizing apparatus 38 and the second hydrophilizing apparatus 40, thereby reducing the cost. Further, increasing of the size of the apparatuses can be prevented. [0030] As shown in FIG. 1, the carry-in-and-out station 2 includes a third conveying region 21, a third carrier conveying arm 22, and a third substrate conveying arm 23. The third conveying region 21 is adjacent to the mounting table 20. The third conveying region 21 extends in the Y-axis direction. The third carrier conveying arm 22 holds and conveys the carrier A in the third conveying region 21. The third substrate conveying arm 23 holds and conveys the substrate W in the third conveying region 21.

[0031] The carry-in-and-out station 2 has a driver (not shown) for moving or rotating the third carrier conveying arm 22 and the third substrate conveying arm 23. The third carrier conveying arm 22 and the third substrate conveying arm 23 can move in the horizontal direction (both directions of the X-axis direction and the Y-axis direction) and the vertical direction, and can rotate about a vertical axis.

[0032] The third carrier conveying arm 22 and the third substrate conveying arm 23 may be mounted on the same Y-axis slider and moved in the Y-axis direction at the same time as shown in FIG. 1, or may be mounted on different Y-axis sliders and moved in the Y-axis direction independently. The third carrier conveying arm 22 and the third substrate conveying arm 23 are arranged at different heights.

[0033] The first processing station 3 includes a first conveying region 31, a first carrier conveying arm 32, and a first substrate conveying arm 33. The first conveying region 31 extends in the X-axis direction. The first carrier conveying arm 32 holds and conveys a carrier A in the first conveying region 31. The first substrate conveying arm 33 holds and conveys a substrate W in the first conveying region 31.

[0034] The first processing station 3 has a driver (not shown) for moving or rotating the first carrier conveying arm 32 and the first substrate conveying arm 33. The first carrier conveying arm 32 and the first substrate conveying arm 33 can move in the horizontal direction (both directions of the X-axis direction and the Y-axis direction) and the vertical direction, and can rotate about the vertical axis.

[0035] The first carrier conveying arm 32 and the first substrate conveying arm 33 may be mounted on the same X-axis slider and moved in the X-axis direction at the same time as shown in FIG. 1, or may be mounted on different X-axis sliders and moved in the X-axis direction independently. The first carrier conveying arm 32 and the first substrate conveying arm 33 are arranged at different heights.

[0036] The first processing station 3 includes a third transition apparatus 34, a fourth transition apparatus 35, a cleaning apparatus 36, a first activating apparatus 37, a first hydrophilizing apparatus 38, a second activating apparatus 39, a second hydrophilizing apparatus 40, an inspection apparatus 41, a peeling apparatus 42, and an annealing apparatus 43. The third transition apparatus 34, the fourth transition apparatus 35, the cleaning apparatus 36, the first activating apparatus 37, the first hydrophilizing apparatus 38, the second activating apparatus 39, the second hydrophilizing apparatus 40, the inspection apparatus 41, the peeling apparatus 42, and the annealing apparatus 43 are adjacent to the first conveying region 31.

[0037] The third transition apparatus 34 is provided between the third conveying region 21 and the first conveying region 31 and temporarily stores the carrier A. The third transition apparatus 34 relays the carrier A between the third carrier conveying arm 22 and the first carrier conveying arm 32. The carrier A to be relayed may be a carrier on which the dies D are attached or a carrier from which the dies D are removed.

[0038] The fourth transition apparatus 35 is provided between the third conveying region 21 and the first conveying region 31 and temporarily stores the substrate W. The fourth transition apparatus 35 relays the substrate W between the third substrate conveying arm 23 and the first substrate conveying arm 33. The substrate W to be relayed may be one before bonding the dies D or one after bonding the dies D (i.e., a substrate with dies DW).

[0039] The cleaning apparatus 36 removes the protective films PF from the dies D while the dies D are held by the carrier A. The protective films PF protect the surfaces for bonding Da of the dies D, for example, during dicing. When the protective films PF are water-soluble, the cleaning apparatus 36 supplies pure water to the protective films PF. The cleaning apparatus 36 may further clean the surfaces for bonding Da of the dies D after removing the protective films PF from the dies D. The processing quality of the surfaces for bonding Da of the dies D performed thereafter can be improved.

[0040] The first activating apparatus 37 activates the surfaces for bonding Da of the dies D while holding the dies D by the carrier A. The first activating apparatus 37 is, for example, a plasma processing device. In the first activating apparatus 37, oxygen gas, which is a processing gas, is excited under reduced pressure, for example, to be converted into plasma and ionized. By irradiating the surfaces for bonding Da of the dies D with oxygen ions, the surfaces for bonding Da of the dies D are activated. The

processing gas is not limited to oxygen gas, but may be, for example, nitrogen gas.

[0041] The first hydrophilizing apparatus 38 hydrophilizes the surfaces for bonding Da of the dies D while holding the dies D by the carrier A. For example, the first hydrophilizing apparatus 38 supplies pure water (for example, deionized water) onto the dies D while rotating the carrier A held by a spin chuck. The pure water imparts OH groups to the previously activated surfaces for bonding Da of the dies D. The dies D and the substrate W can be bonded by using hydrogen bonds between the OH groups.

[0042] The second activating apparatus 39 activates the surface for bonding Wa of the substrate W. The second activating apparatus 39 is, for example, a plasma treatment apparatus. In the second activating apparatus 39, oxygen gas, serving as the treatment gas, is excited under reduced pressure and thereby converted into plasma and ionized. By irradiating the surface for bonding Wa of the substrate W with oxygen ions, the surface for bonding Wa of the substrate W is activated. The treatment gas is not limited to oxygen gas, but may be, for example, nitrogen gas.

[0043] The second hydrophilizing apparatus 40 hydrophilizes the surface for bonding Wa of the substrate W. For example, the second hydrophilizing apparatus 40 supplies pure water (e.g., deionized water) onto the substrate W while rotating the substrate W held by the spin chuck. The pure water imparts OH groups to the previously activated surface for bonding Wa of the substrate W. The dies D and the substrate W can be bonded using the hydrogen bonding between the OH groups.

[0044] The inspection apparatus 41 inspects the bonding condition between the substrate W and each die D on the substrate with dies DW. The inspection is performed for each die D. The inspection includes checking for at least one of the following: the presence of foreign matter such as bubbles, and misalignment.

[0045] The peeling apparatus 42 removes from the substrate W any die D whose bonding condition has been determined to be defective by the inspection apparatus 41. The peeling apparatus 42 removes the die D before the annealing apparatus 43 heats the substrate with dies DW.

[0046] The annealing apparatus 43 heats the substrate with dies DW. Before the heat treatment, the dies D and the substrate W are bonded by hydrogen bonding between OH groups. By the heat treatment, a dehydration condensation reaction occurs, a covalent bond is generated, and the bonding strength between the dies D and the substrate W is improved.

[0047] The second processing station 5 includes a second conveying region 51, a second carrier conveying arm 52, and a second substrate conveying arm 53. The

second conveying region 51 extends in the X-axis direction. The second carrier conveying arm 52 holds and conveys the carrier A in the second conveying region 51. The second substrate conveying arm 53 holds and conveys the substrate W in the second conveying region 51.

[0048] The second processing station 5 has a driver (not shown) for moving or rotating the second carrier conveying arm 52 and the second substrate conveying arm 53. The second carrier conveying arm 52 and the second substrate conveying arm 53 can move in the horizontal direction (both directions of the X-axis direction and the Y-axis direction) and the vertical direction, and can rotate about a vertical axis.

[0049] The second carrier conveying arm 52 and the second substrate conveying arm 53 may be mounted on the same X-axis slider and moved in the X-axis direction at the same time as shown in FIG. 1, or may be mounted on different X-axis sliders and moved independently in the X-axis direction. The second carrier conveying arm 52 and the second substrate conveying arm 53 are arranged at different heights.

[0050] The second processing station 5 includes a first transition apparatus 54, a second transition apparatus 55, and a bonding apparatus 56. The first transition apparatus 54, the second transition apparatus 55, and the bonding apparatus 56 are adjacent to the second conveying region 51.

[0051] The first transition apparatus 54 is provided between the first conveying region 31 and the second conveying region 51, and temporarily stores the carrier A. The first transition apparatus 54 relays the carrier A between the first carrier conveying arm 32 and the second carrier conveying arm 52. The carrier A to be relayed may be a carrier on which the dies D are attached or a carrier from which the dies D are removed.

[0052] The second transition apparatus 55 is provided between the first conveying region 31 and the second conveying region 51 and temporarily stores the substrate W. The second transition apparatus 55 relays the substrate W between the first substrate conveying arm 33 and the second substrate conveying arm 53. The substrate W to be relayed may be one before bonding the dies D or one after bonding the dies D (i.e., a substrate with dies DW).

[0053] As shown in FIGS. 6 and 7, the bonding apparatus 56 removes the die D from the carrier A and bonds the die D to the substrate W with the surface for bonding Da of the removed die D facing the surface for bonding Wa of the substrate W. A substrate with dies DW is obtained. The second device D2 of the die D and the first device W2 of the substrate W are electrically connected. The bonding apparatus 56

will be described in detail later.

[0054] The control circuit 9 is, for example, a computer, and includes an arithmetic unit 91 such as a CPU (Central Processing Unit) and a storage unit 92 such as a memory. The storage unit 92 stores a program for controlling various processes executed in the bonding system 1. The control circuit 9 controls the operation of the bonding system 1 by causing the arithmetic unit 91 to execute the program stored in the storage unit 92. A lower-order control circuit for controlling the operation of each device constituting the bonding system 1 may be provided, and a higher-order control circuit for controlling a plurality of lower-order control circuits may be provided. The lower-order control circuit and the higher-order control circuit may constitute the control circuit 9.

[0055] The control circuit 9 includes an electronic circuit such as a CPU, an FPGA (Field Programmable Gate Array), or an ASIC (Application Specific Integrated Circuit), and executes various control operations described herein by executing instruction codes stored in a memory or by being designed for special use.

[0056] Next, a bonding method according to an embodiment will be described with reference to FIG. 2. The process of FIG. 2 is performed through control by the control circuit 9.

[0057] First, the third carrier conveying arm 22 removes a plurality of dies D together with the carrier A from the cassette C1 and conveys them to the third transition apparatus 34. Next, the first carrier conveying arm 32 removes a plurality of dies D together with the carrier A from the third transition apparatus 34 and conveys them to the cleaning apparatus 36.

[0058] Next, the cleaning apparatus 36 removes the protective films PF from the dies D while the dies D are held by the carrier A (step S101). Then, the first carrier conveying arm 32 removes a plurality of dies D together with the carrier A from the cleaning apparatus 36 and conveys them to the first activating apparatus 37.

[0059] Next, the first activating apparatus 37 activates the surface for bonding Da of the dies D while the dies D are held by the carrier A (step S102). Thereafter, the first carrier conveying arm 32 removes the plurality of dies D together with the carrier A from the first activating apparatus 37 and conveys them to the first hydrophilizing apparatus 38.

[0060] Next, the first hydrophilizing apparatus 38 hydrophilizes the surface for bonding Da of the dies D while holding the dies D by the carrier A (step S103). Thereafter, the first carrier conveying arm 32 removes the plurality of dies D together

with the carrier A from the first hydrophilizing apparatus 38 and conveys them to the first transition apparatus 54. Subsequently, the second carrier conveying arm 52 removes the plurality of dies D together with the carrier A from the first transition apparatus 54 and conveys them to the bonding apparatus 56.

[0061] In parallel with the above-described steps S101 to S103, the following steps S104 to S105 are performed. First, the third substrate conveying arm 23 removes the substrate W from the cassette C3 and conveys it to the fourth transition apparatus 35. Then, the first substrate conveying arm 33 removes the substrate W from the fourth transition apparatus 35 and conveys it to the second activating apparatus 39.

[0062] Next, the second activating apparatus 39 activates the surface for bonding Wa of the substrate W (step S104). Then, the first substrate conveying arm 33 removes the substrate W from the second activating apparatus 39 and conveys it to the second hydrophilizing apparatus 40.

[0063] Next, the second hydrophilizing apparatus 40 hydrophilizes the surface for bonding Wa of the substrate W (step S105). Then, the first substrate conveying arm 33 removes the substrate W from the second hydrophilizing apparatus 40 and conveys it to the second transition apparatus 55. Subsequently, the second substrate conveying arm 53 removes the substrate W from the second transition apparatus 55 and conveys it to the bonding apparatus 56.

[0064] Next, the bonding apparatus 56 removes the die D from the carrier A and bonds the die D and the substrate W with the surface for bonding Da of the removed die D facing the surface for bonding Wa of the substrate W (step S106). Thus, the substrate with dies DW is obtained. Subsequently, the second substrate conveying arm 53 removes the substrate with dies DW from the bonding apparatus 56 and conveys it to the second transition apparatus 55. Subsequently, the first substrate conveying arm 33 removes the substrate with dies DW from the second transition apparatus 55 and conveys it to the inspection apparatus 41.

[0065] Next, the inspection apparatus 41 inspects whether the bonding condition between the substrate W and the die D is good or bad (step S107). The inspection apparatus 41 transmits the inspection result to the control circuit 9. The control circuit 9 checks whether the substrate with dies DW is defect-free (step S108). The control circuit 9 controls the routing of the substrate with dies DW, directing it to either the annealing apparatus 43 or the peeling apparatus 42 based on the inspection result from the inspection apparatus 41. The inspection need not be performed every time. For example, the inspection may be performed every lot, every predetermined number of

substrates, and every predetermined time. A lot is composed of a plurality of substrates W (e.g., 25 substrates) accommodated in one cassette C3. The inspection may be performed on the first substrate W of the lot.

[0066] When the die D has a defective bonding condition (step S108: NO), the substrate with dies DW is conveyed to the peeling apparatus 42. The first substrate conveying arm 33 removes the substrate with dies DW from the inspection apparatus 41 and conveys it to the peeling apparatus 42. Next, the peeling apparatus 42 removes a die D with a defective bonding condition from the substrate W (step S109). Then, the first substrate conveying arm 33 removes the substrate with dies DW from the peeling apparatus 42 and conveys it to the annealing apparatus 43. Then, step S110 and subsequent steps are performed.

[0067] Note that another operation may be performed after step S109. First, the first substrate conveying arm 33 removes the substrate W from the peeling apparatus 42 and conveys it to the second transition apparatus 55. Subsequently, the second substrate conveying arm 53 removes the substrate W from the second transition apparatus 55 and conveys it to the bonding apparatus 56. The bonding apparatus 56 re-bonds the die D to the position from which the die D was removed. Then, step S107 and subsequent steps may be performed again.

[0068] Conversely, if bonding conditions of all the dies D are defect-free (step S108: YES), the substrate with dies DW is conveyed to the annealing apparatus 43. The first substrate conveying arm 33 removes the substrate with dies DW from the inspection apparatus 41 and conveys it to the annealing apparatus 43. Next, the annealing apparatus 43 heats the substrate with dies DW (step S110). The bonding strength between the die D and the substrate W is improved by the heat treatment.

[0069] Thereafter, the first substrate conveying arm 33 removes the substrate with dies DW from the annealing apparatus 43 and conveys it to the fourth transition apparatus 35. Finally, the third substrate conveying arm 23 removes the substrate with dies DW from the fourth transition apparatus 35 and stores it in the cassette C4. The substrate with dies DW is carried out from the bonding system 1 in a state of being accommodated in the cassette C4.

[0070] After step S106, the second carrier conveying arm 52 removes the carrier A from the bonding apparatus 56 and conveys it to the first transition apparatus 54. Then, the first carrier conveying arm 32 removes the carrier A from the first transition apparatus 54 and conveys it to the third transition apparatus 34. Finally, the third carrier conveying arm 22 removes the carrier A from the third transition apparatus 34

and accommodates it in the cassette C2.

[0071] Next, the bonding apparatus 56 will be described in detail with reference mainly to FIGS. 6 to 7. The bonding apparatus 56 removes the die D from the carrier A and bonds the die D and the substrate W with the surface for bonding Da of the removed die D facing the surface for bonding Wa of the substrate W. A substrate DW with a die is obtained. The second device D2 of the die D and the first device W2 of the substrate W are electrically connected.

[0072] The bonding apparatus 56 includes, for example, a carrier holder 61, a substrate holder 62, a first conveyor 63, and a mounting unit 65. The carrier holder 61 holds a carrier A. The substrate holder 62 holds a substrate W. The first conveyor 63 receives and conveys a die D from the carrier A held by the carrier holder 61. The mounting unit 65 receives the die D from the first conveyor 63 and mounts the received die D on the substrate W held by the substrate holder 62.

[0073] The carrier holder 61 holds the carrier A horizontally from below with the surface for bonding Da of the die D oriented upward. The substrate holder 62 holds the substrate W horizontally from below with the surface for bonding Wa of the substrate W oriented upward. The first conveyor 63 orients the surface for bonding Da of the die D downward by inverting the die D while conveying the die D. The mounting unit 65 receives the die D from the first conveyor 63 and mounts the received die D onto the substrate W held by the substrate holder 62.

[0074] Although the carrier holder 61 of the present embodiment holds the carrier A horizontally from below with the surface for bonding Da of the die D oriented upward, the technology according to the present disclosure is not limited to this. For example, the carrier holder 61 may hold the carrier A horizontally from above with the surface for bonding Da of the die D oriented downward. In this case, the first conveyor 63 does not need to invert the die D while conveying the die D. By omitting the mechanism for individually inverting the die D, dust generation from the mechanism can be prevented.

[0075] The first conveyor 63 has, for example, a first suction head 63a and a first moving mechanism 63b. The first suction head 63a attracts the die D by vacuum. The first suction head 63a attracts the die D by vacuum in a state opposed to the surface for bonding Da of the die D. The first suction head 63a preferably attracts the die D by vacuum in a non-contact manner in order to prevent contamination of the surface for bonding Da of the die D. The first moving mechanism 63b moves the first suction head 63a.

[0076] The first moving mechanism 63b moves the first suction head 63a between a first receiving position and a first delivery position. The first receiving position is a position where the first suction head 63a receives the die D from the carrier A. The first delivery position is a position where the first suction head 63a delivers the die D to the mounting unit 65. The first moving mechanism 63b may invert the die D by inverting the first suction head 63a during conveyance of the die D.

[0077] The bonding apparatus 56 may include a pressing unit 66. The pressing unit 66 presses the die D upward to separate the die D from the carrier A held by the carrier holder 61. The pressing unit 66 presses the die D upward by, for example, supplying gas to the through-hole A3 of the conductive substrate A1 or inserting a pin (not shown) into the through-hole A3. When the carrier A is inverted, the pressing unit 66 presses the die D downward. The pressing unit 66 may press the die D in a direction to separate the die D from the carrier A. The first conveyor 63 receives the die D pressed by the pressing unit 66 from the carrier A at the first receiving position.

[0078] When the pressing unit 66 is provided, the carrier holder 61 may attract only part of the lower surface of the carrier A. The pressing unit 66 may press the die D upward at the remaining part of the lower surface of the carrier A. The carrier holder 61 is formed in a ring shape, for example, and attracts the outer periphery of the lower surface of the carrier A. The pressing unit 66 may press the die D upward at the center of the lower surface of the carrier A. If the die D can be separated from the carrier A only by raising the die D together with the first suction head 63a, the pressing unit 66 may be omitted.

[0079] The bonding apparatus 56 may include a carrier moving unit 67. The carrier moving unit 67 moves the carrier A together with the carrier holder 61. The carrier moving unit 67 moves the carrier A in the X-axis direction and the Y-axis direction, for example. Thus, even if the pressing unit 66 does not move in the X-axis direction and the Y-axis direction, the pressing unit 66 can press a plurality of dies D in a desired order. The first conveyor 63 can receive the die D at the same first receiving position every time. Therefore, the operation of the first conveyor 63 can be simplified. The carrier moving unit 67 may rotate the carrier A around the vertical axis instead of moving the carrier A in the X-axis direction. The carrier moving unit 67 may move the carrier A in the Z-axis direction.

[0080] The bonding apparatus 56 does not need to include the carrier moving unit 67. That is, the carrier holder 61 may be fixed. When the carrier holder 61 is provided above the substrate holder 62 and the mounting unit 65, the carrier holder 61 is

preferably fixed from the viewpoint of stability of the carrier holder 61. In this case, the first receiving position changes for each die D. Therefore, the pressing unit 66 is moved in the X- and Y-axis directions in accordance with changes in the first receiving position. The pressing unit 66 may be rotated around a vertical axis instead of being moved in the X-axis direction.

[0081] The bonding apparatus 56 may include a substrate moving unit 68. The substrate moving unit 68 moves the substrate W together with the substrate holder 62. The substrate moving unit 68 moves the substrate W in the X-axis direction and the Y-axis direction, for example. Thus, the bonding positions of the dies D relative to the substrate W can be changed. As a result, the first conveyor 63 can deliver the die D to the mounting unit 65 at the same first delivery position every time. Thus, the operation of the first conveyor 63 can be simplified. The substrate moving unit 68 may rotate the substrate W about the vertical axis instead of moving the substrate W in the X-axis direction. The substrate moving unit 68 may also move the substrate W in the Z-axis direction.

[0082] The mounting unit 65 has, for example, a third suction head 65a and a third moving mechanism 65b. The third suction head 65a attracts the die D by vacuum from the side opposite to the first suction head 63a and the second suction head 64a described later. The die D has a surface for bonding Da and a back surface Db opposite to the surface for bonding Da. Since contamination of the back surface Db is not an issue, the third suction head 65a may contact the back surface Db of the die D.

[0083] The third moving mechanism 65b moves the third suction head 65a in the Z-axis direction to bond the die D to the substrate W. The third moving mechanism 65b may move the third suction head 65a in the X-axis and Y-axis directions or may rotate the third suction head 65a about the vertical axis in order to improve the bonding position accuracy of the die D to the substrate W. The amount of movement or rotation required to improve bonding position accuracy is small, and the third suction head 65a needs to move only minimally when viewed from above.

[0084] The bonding apparatus 56 may include at least one of the first imaging unit 71, the second imaging unit 72, and the third imaging unit 73 in order to improve the accuracy of the bonding position of the die D to the substrate W. Note that the first imaging unit 71, the second imaging unit 72, and the third imaging unit 73 do not need to capture an image every time the die D is bonded to the substrate W, but may capture an image periodically.

[0085] As shown in FIG. 6, the first imaging unit 71 captures an image of an alignment mark on the surface for bonding Da of the die D held by the third suction head 65a. The number of alignment marks to be captured is, for example, two, but is not particularly limited. The alignment mark may be a dedicated mark or part of an electric circuit constituting the second device D2.

[0086] The first imaging unit 71 is disposed below the third suction head 65a, for example. The first imaging unit 71 transmits the captured image to the control circuit 9. The control circuit 9 detects the position of the die D in the first coordinate system set in the third suction head 65a by performing image processing on the image captured by the first imaging unit 71.

[0087] As shown in FIG. 7, the second imaging unit 72 captures an image of an alignment mark on the surface for bonding Wa of the substrate W held by the substrate holder 62. The number of alignment marks to be captured is, for example, 2, but is not particularly limited. The alignment mark may be a dedicated mark or part of the electric circuit included in the first device W2.

[0088] The second imaging unit 72 is disposed, for example, above the substrate holder 62 and is provided, for example, in the third suction head 65a. The second imaging unit 72 transmits the captured image to the control circuit 9. The control circuit 9 performs image processing on the image captured by the second imaging unit 72 to detect the position of the first device W2 in the second coordinate system set in the substrate holder 62.

[0089] The control circuit 9 uses the image captured by at least one of the first imaging unit 71 and the second imaging unit 72 to align the die D held by the third suction head 65a and the substrate W held by the substrate holder 62. The alignment is performed by controlling at least one of the third moving mechanism 65b and the substrate moving unit 68. Before bonding the die D and the substrate W, the position of the die D or the substrate W can be corrected to improve the accuracy of the bonding position.

[0090] After bonding the die D and the substrate W, the third imaging unit 73 simultaneously captures images of both the alignment mark of the surface for bonding Da of the die D and the alignment mark of the surface for bonding Wa of the substrate W. The third imaging unit 73 captures the alignment mark of the die D and the substrate W by passing through the die D, for example. The third imaging unit 73 includes, for example, an infrared camera.

[0091] When capturing images of the alignment marks of the die D and the substrate

W through the die D, the third imaging unit 73 is disposed, for example, above the substrate holder 62 and is provided, for example, in the third suction head 65a. The third imaging unit 73 transmits the captured image to the control circuit 9. The control circuit 9 performs image processing on the image captured by the third imaging unit 73 to detect a deviation between the actual bonding position and the target bonding position.

[0092] The control circuit 9 uses the image captured by the third imaging unit 73 to align the die D held by the third suction head 65a and the substrate W held by the substrate holder 62 in the next and subsequent bonding between the die D and the substrate W. The position of the die D or the substrate W can be corrected in consideration of the characteristics of the bonding apparatus 56, which improves the accuracy of the bonding position.

[0093] Note that as shown in FIGS. 6 and 7, the carrier holder 61 and the substrate holder 62 are provided at an interval in the vertical direction. By arranging the substrate holder 62 and the carrier holder 61 in the vertical direction, it is possible to reduce the installation area (area when viewed from above) of the bonding apparatus 56 as compared with the case of arranging them in the horizontal direction.

[0094] The substrate holder 62 is preferably arranged below the carrier holder 61. By arranging the substrate holder 62 at a low position, the substrate holder 62 can be stably supported gravitationally, and bonding accuracy of the chip CP to the substrate W can be improved. The bonding accuracy is mainly determined by the positioning accuracy of the mounting unit 65 and the substrate holder 62. Compared with the above positioning accuracy, the positioning accuracy of the first conveyor 63 and the carrier holder 61 may be lower, and the carrier holder 61 may be arranged at a high position.

[0095] The mounting unit 65 is provided between the carrier holder 61 and the substrate holder 62. For example, the substrate holder 62, the mounting unit 65, and the carrier holder 61 are provided in this order from the lower side to the upper side. By arranging the substrate holder 62, the mounting unit 65, and the carrier holder 61 in the vertical direction, the installation area of the bonding apparatus 56 can be reduced as compared with arranging them in the horizontal direction.

[0096] Next, an example of the positional relationship between the carrier A and the substrate W when viewed from above will be described with reference to FIG. 8. When viewed from above, the center A0 of the carrier A held by the carrier holder 61 is preferably located within a movement range B of the substrate W held by the

substrate holder 62. When viewed from above, the carrier holder 61 and the substrate holder 62 can be arranged in a narrow range, and the installation area of the bonding apparatus 56 can be further reduced.

[0097] When the carrier A is movable, the center A0 of the carrier A is preferably always located within the movement range B of the substrate W when viewed from above. When the carrier A is fixed, the center A0 of the carrier A preferably coincides with the center B0 of the movement range B of the substrate W when viewed from above.

[0098] The center A0 of the carrier preferably coincides with the mounting unit 65 (more specifically, the third suction head 65a) when viewed from above. Thus, when viewed from above, the carrier holder 61, the substrate holder 62, and the mounting unit 65 can be arranged in a narrow range and the installation area of the bonding apparatus 56 can be further reduced.

[0099] Next, the bonding apparatus 56 according to the first modification will be described with reference to FIG. 9. Hereinafter, differences between this modification and the above embodiment will be mainly described. The bonding apparatus 56 according to this modification includes a housing 80 and a partition wall 85. The housing 80 accommodates the carrier holder 61, the substrate holder 62, and the mounting unit 65. The partition wall 85 partitions the interior of the housing 80 into an upper chamber R1 and a lower chamber R2.

[0100] The carrier holder 61 is provided in the upper chamber R1, and the substrate holder 62 and the mounting unit 65 are provided in the lower chamber R2. The partition wall 85 is provided with openings 85a through which the die D passes during the conveyance of the die D by the first conveyor 63. The partition wall 85 restricts particles from falling from the upper chamber R1 to the lower chamber R2. The particles are, for example, wear debris generated by friction in the machine.

[0101] When the first conveyor 63 inverts the die D while the die D is being conveyed, the operation is preferably performed while the die D is in the upper chamber R1. Even in a case of generating particles when the die D is inverted, soiling would only occur in the upper chamber R1, the lower chamber R2 can be kept clean, and particle entrapment can be prevented when the die D is bonded to the substrate W.

[0102] The housing 80 has a first lateral wall 81 and a second lateral wall 82 opposite each other. The bonding apparatus 56 may include a first airflow forming unit 87. The first airflow forming unit 87 forms an airflow moving from the first lateral wall 81 toward the second lateral wall 82 in the upper chamber R1. It is possible to restrict

particles from falling from the upper chamber R1 to the lower chamber R2. The first airflow forming unit 87 includes a first blowing unit 87a that blows airflow into the upper chamber R1 and a first suction unit 87b that draws airflow from the upper chamber R1. The first blowing unit 87a includes, for example, a fan and a filter. The first suction unit 87b includes, for example, a duct.

[0103] The housing 80 includes a lower wall 83. The lower wall 83 is provided below the partition wall 85. The bonding apparatus 56 may include a second airflow forming unit 88. The second airflow forming unit 88 forms an airflow moving from the partition wall 85 to the lower wall 83 in the lower chamber R2. By forming a downflow in the lower chamber R2, particle dispersion can be prevented. The second airflow forming unit 88 has a second blowing unit 88a for blowing an airflow into the lower chamber R2 and a second suction unit 88b for sucking the airflow from the lower chamber R2. The second blowing unit 88a has, for example, a fan and a filter. The second suction unit 88b has, for example, a duct.

[0104] Next, the bonding apparatus 56 according to the second modification will be described with reference to FIG. 10. Hereinafter, differences between this modification and the first modification will be mainly described. The bonding apparatus 56 according to this modification includes a second conveyor 64. The second conveyor 64 receives and conveys a die D from the carrier A separately from the first conveyor 63. The mounting unit 65 receives dies D from the first conveyor 63 and the second conveyor 64 in a desired order, and mounts the received dies D on the substrate W held by the substrate holder 62. After the mounting unit 65 mounts the n-th die D on the substrate W, the second conveyor 64 passes the (n+1)-th die D to the mounting unit 65 before the first conveyor 63 passes the (n+2)-th die D to the mounting unit 65, and the mounting unit 65 mounts the (n+1)-th die D on the substrate W. Therefore, the standby time of the mounting unit 65 can be shortened, the operation rate of the mounting unit 65 can be improved, and the bonding efficiency of the die D to the substrate W can be improved. Even in a case of the die D being thin and of some time being required to deliver the die D, the die D can be efficiently bonded to the substrate W. The n-th die D is the n-th die D bonded to one substrate W.

[0105] The second conveyor 64 has, for example, a second suction head 64a and a second moving mechanism 64b. The second suction head 64a attracts the die D by vacuum. The second suction head 64a attracts the die D by vacuum in a state facing the surface for bonding Da of the die D. The second suction head 64a preferably

attracts the die D by vacuum in a non-contact manner to prevent contamination of the surface for bonding Da of the die D. The second moving mechanism 64b moves the second suction head 64a.

[0106] The second moving mechanism 64b moves the second suction head 64a between a second receiving position and a second delivery position. The second receiving position is a position where the second suction head 64a receives the die D from the carrier A. From the viewpoint of stability of the carrier holder 61, when the carrier holder 61 is fixed, the second receiving position changes for each die D. The second delivery position is a position where the second suction head 64a delivers the die D to the mounting unit 65. The second delivery position does not need to change for each die D. Further, the second delivery position may be the same position as the first delivery position. The second moving mechanism 64b may invert the die D by inverting the second suction head 64a during the conveyance of the die D. Preferably, this operation is performed while the die D is in the upper chamber R1.

[0107] As shown in FIG. 10, while the first suction head 63a receives a die D from the carrier A at the first receiving position, the second suction head 64a delivers a die D to the mounting unit 65 at the second delivery position. Thereafter, while the first suction head 63a moves from the first receiving position to the first delivery position, the second suction head 64a moves from the second delivery position to the second receiving position. The first suction head 63a and the second suction head 64a pass through different openings 85a of the partition wall 85. The moving efficiency can be improved as compared with the case of sequentially passing through one opening 85a.

[0108] Next, while the first suction head 63a passes a die D to the mounting unit 65 at the first delivery position, the second suction head 64a receives a die D from the carrier A at the second receiving position. Thereafter, while the first suction head 63a moves from the first delivery position to the first receiving position, the second suction head 64a moves from the second receiving position to the second delivery position. The first suction head 63a and the second suction head 64a pass through different openings 85a of the partition wall 85. The moving efficiency can be improved as compared with the case of sequentially passing through one opening 85a.

[0109] The first conveyor 63 and the second conveyor 64 may alternately convey the dies D. For example, the first conveyor 63 conveys the odd-numbered dies D and the second conveyor 64 conveys the even-numbered dies D. The first conveyor 63 may convey the even-numbered dies D and the second conveyor 64 may convey the odd-numbered dies D. When viewed from above, the first delivery position and the second

delivery position may be the same position every time.

[0110] Next, a bonding apparatus 56 according to a third modification will be described with reference to FIG. 11. Hereinafter, differences between this modification and the first modification will be mainly described. In the bonding apparatus 56 of this modification, the carrier holder 61 is provided in the lower chamber R2, and the substrate holder 62 and the mounting unit 65 are provided in the upper chamber R1. In this case as well, the positional relationship between the carrier A and the substrate W when viewed from above is the same as that shown in FIG. 8. Therefore, the installation area of the bonding apparatus 56 can be reduced.

[0111] When the first conveyor 63 inverts the die D while the die D is being conveyed, the operation is preferably performed while the die D is in the lower chamber R2. Even in a case of generating particles when the die D is inverted, soiling would only occur in the upper chamber R2, the upper chamber R1 can be kept clean, and particle entrapment can be prevented when the die D is bonded to the substrate W.

[0112] The first airflow forming unit 87 forms an airflow from the first lateral wall 81 to the second lateral wall 82 in the upper chamber R1. It is possible to restrict particles from falling from the upper chamber R1 to the lower chamber R2. The second airflow forming unit 88 forms an airflow from the partition wall 85 to the lower wall 83 in the lower chamber R2. By forming a downflow in the lower chamber R2, particle dispersion can be prevented.

[0113] Next, a bonding apparatus 56 according to a fourth modification will be described with reference to FIG. 12. Hereinafter, differences between this modification and the third modification will be mainly described. In this modification, as in the second modification, the bonding apparatus 56 includes a second conveyor 64. The mounting unit 65 receives dies D from the first conveyor 63 and the second conveyor 64 in a desired order, and mounts the received dies D on the substrate W held by the substrate holder 62. Therefore, the standby time of the mounting unit 65 can be shortened, the operation rate of the mounting unit 65 can be improved, and the bonding efficiency of the die D to the substrate W can be improved. Even in a case of the die D being thin and of some time being required to deliver the die D, the die D can be bonded to the substrate W efficiently.

[0114] The second conveyor 64 has, for example, a second suction head 64a and a second moving mechanism 64b. The second conveyor 64 may invert the die D by inverting the second suction head 64a while conveying the die D. This operation is preferably performed while the die D is in the lower chamber R2.

[0115] Further, the present invention is not limited to these embodiments, and various variations and modifications may be made without departing from the scope of the present invention.

[0116] The present application is based on and claims priority to Japanese patent application No. 2023-123445 filed on July 28, 2023, with the Japan Patent Office, the entire contents of which are hereby incorporated by reference.

EXPLANATION OF REFERENCE NUMERALS

[0117] 1	bonding system
56	bonding apparatus
D	die
Da	surface for bonding
D2	second device
W	substrate
Wa	surface for bonding
W2	first device

[Claim 1] A bonding apparatus configured to bond a plurality of dies to a substrate, wherein:

the substrate includes a plurality of first devices on a surface for bonding to the dies;

each of the dies includes, on a surface for bonding to the substrate, a second device that is to be electrically connected to a corresponding one of the first devices;

the bonding apparatus includes:

a carrier holder configured to hold horizontally a carrier on which the plurality of dies are mounted;

a substrate holder configured to hold horizontally the substrate;

a substrate moving unit configured to move the substrate together with the substrate holder so as to change bonding positions of respective dies of the dies;

a first conveyor configured to receive one of the dies from the carrier held by the carrier holder and convey the one of the dies; and

a mounting unit configured to receive the one of the dies from the first conveyor and mount the received one of the dies onto the substrate held by the substrate holder;

the carrier holder and the substrate holder are disposed apart from each other in a vertical direction; and

when viewed from above, a center of the carrier held by the carrier holder is located within a movement range of the substrate held by the substrate holder.

[Claim 2] The bonding apparatus according to claim 1, wherein:

the mounting unit is provided between the carrier holder and the substrate holder; and

when viewed from above, the center of the carrier held by the carrier holder coincides with the mounting unit.

[Claim 3] The bonding apparatus according to claim 1 or 2, comprising:

a housing configured to accommodate the carrier holder, the substrate holder, and the mounting unit therein; and

a partition wall configured to partition an interior of the housing into an upper chamber and a lower chamber, wherein:

the carrier holder is provided in the upper chamber;
the substrate holder and the mounting unit are provided in the lower chamber;
and
the partition wall is provided with one or more openings through which the one of the dies passes during conveyance of the one of the dies by the first conveyor.

[Claim 4] The bonding apparatus according to claim 3, wherein:
the housing includes a first lateral wall and a second lateral wall opposite each other; and
the bonding apparatus includes a first airflow forming unit configured to form an airflow moving from the first lateral wall toward the second lateral wall in the upper chamber.

[Claim 5] The bonding apparatus according to claim 3, wherein:
the housing includes a lower wall; and
the bonding apparatus includes a second airflow forming unit configured to form an airflow moving from the partition wall toward the lower wall in the lower chamber.

[Claim 6] The bonding apparatus according to claim 3, wherein the first conveyor is configured to invert the one of the dies while the one of the dies is being conveyed and the one of the dies is in the upper chamber.

[Claim 7] The bonding apparatus according to claim 1 or 2, comprising:
a housing configured to accommodate the carrier holder, the substrate holder, and the mounting unit therein; and
a partition wall configured to partition an interior of the housing into an upper chamber and a lower chamber, wherein:
the carrier holder is provided in the lower chamber;
the substrate holder and the mounting unit are provided in the upper chamber;
and
the partition wall is provided with one or more openings through which the one of the dies passes during conveyance of the one of the dies by the first conveyor.

[Claim 8] The bonding apparatus according to claim 1 or 2, comprising a second

conveyor other than the first conveyor, the second conveyor being configured to receive the one of the dies from the carrier held by the carrier holder and convey the one of the dies.

[Claim 9] A bonding system comprising:

- the bonding apparatus of claim 1 or 2;

- a first activating apparatus configured to activate surfaces for bonding of the dies in a state where the dies are mounted on the carrier;

- a first hydrophilizing apparatus configured to hydrophilize the surfaces for bonding of the dies in a state where the dies are mounted on the carrier;

- a first transition apparatus configured to temporarily store the carrier;

- a first conveying region adjacent to the first activating apparatus, the first hydrophilizing apparatus, and the first transition apparatus;

- a first carrier conveying arm configured to convey the carrier within the first conveying region;

- a second conveying region disposed on a side opposite to the first conveying region with respect to the first transition apparatus, the second conveying region being adjacent to the first transition apparatus and the bonding apparatus; and

- a second carrier conveying arm configured to convey the carrier within the second conveying region.

[Claim 10] A bonding system comprising:

- the bonding apparatus of claim 1 or 2;

- a second activating apparatus configured to activate a surface for bonding of the substrate;

- a second hydrophilizing apparatus configured to hydrophilize the surface for bonding of the substrate;

- a second transition apparatus configured to temporarily store the substrate;

- a first conveying region adjacent to the second activating apparatus, the second hydrophilizing apparatus, and the second transition apparatus;

- a first substrate conveying arm configured to convey the substrate within the first conveying region;

- a second conveying region disposed on a side opposite to the first conveying region with respect to the second transition apparatus, the second conveying region being adjacent to the second transition apparatus and the bonding apparatus; and

a second substrate conveying arm configured to convey the substrate within the second conveying region.

[Claim 11] A bonding method comprising bonding the dies to the substrate using the bonding apparatus of claim 1 or 2.