

bonding tool 24 to move in the Z-direction which is a vertical direction, the second bonding tool 24 being a mounting tool for vacuum-attracting the semiconductor die 15 and bonding the semiconductor die 15 to the substrate 19. The reference sign 23z in FIG. 1 denotes a center line of the second bonding head 23 in the Z-direction. The second camera 26 captures an image of the substrate 19 from above and acquires the image. The reference sign 26z in FIG. 1 denotes an optical axis of the second camera 26. The second bonding head 23 and the second camera 26 are attached to the second base 20 in a manner that the center line 23z and the optical axis 26z are separated in the X-direction by the offset amount ΔH . The first base 10 and the second base 20 are transport mechanisms that transport the semiconductor die 15 attracted by the first bonding tool 14 and the second bonding tool 24 to the substrate 19.

[0023] A first encoder head 17 serving as a first detection unit is attached to the substantial center of the first base 10, and a second encoder head 27 serving as a second detection unit is attached to the substantial center of the second base 20. Reference signs 17a and 27a in FIG. 1 respectively denote a center line of the first encoder head 17 and a center line of the second encoder head 27.

[0024] At a position facing the first encoder head 17 and the second encoder head 27, the common linear scale 33 extending in the X-direction which is the moving direction of the first base 10 and the second base 20 is disposed. A plurality of graduations 34 is engraved in the linear scale 33 at predetermined pitches p. The first encoder head 17 and the second encoder head 27 optically read the graduations 34 to detect the graduation number on the linear scale 33.

[0025] The bonding stage 18 vacuum-attracts the substrate 19.

[0026] The laser distance detector 45 is disposed at a position separated from the

$$ka(n) = k(n) \times [NB \times p] / Lr \dots (\text{Equation 5})$$

[0061] As described above, similar to the operation described above, it is possible to improve the position detection precision of the first bonding head 13, the second bonding head 23, the first camera 16 and the second camera 26, and suppress reduction in the mounting precision of electronic components. Besides, in the above description, the graduation numbers of the linear scale 33 when the first base 10 is at the first position and the second position are detected by the first encoder head 17. However, it may be that the graduation numbers of the linear scale 33 when the second base 20 is at the first position and the second position are detected by the second encoder head 27.

[0062] This embodiment has the same effects as the embodiment described above.

[0063] In the description of the embodiment described above, the first base 10 and the second base 20 are moved by the reference distance Lr by aligning the optical axis 16z of the first camera 16 and the optical axis 26z of the second camera 26 with the position marks M_s and M_e , but the position correction coefficient $k(n)$ may be corrected by the following method.

[0064] The first base 10 is moved to a position where the position mark M_s enters the field of view of the first camera 16, the image of the position mark M_s is captured, and a distance d_1 (not shown) between the optical axis 16z of the first camera 16 and the position mark M_s is detected. In addition, the graduation number $B(s)$ of the linear scale 33 is detected by the first encoder head 17. Next, the first base 10 is moved to a position where the position mark M_e enters the field of view of the first camera 16, the image of the position mark M_e is detected by the first camera 16, and a distance d_2 between the optical axis 16z of the first camera 16 and the position mark M_e is detected. Then, a distance that takes the distances d_1 and d_2 (not shown) into consideration for the reference distance Lr is acquired

direction and the Y-direction are directions orthogonal to each other on the horizontal plane, and in the embodiment, as shown in FIG. 1, a direction in which the first gantry frame 120A and the second gantry frame 120B extend is described as the Y-direction, and a direction orthogonal to this direction is described as the X-direction. In addition,
5 the Z-direction is an up-down direction perpendicular to the XY plane.

[0068] As shown in FIG. 1, the main gantry 111 is a gantry having a rectangular plane, and the mounting stage 110 is attached to the upper surface of the main gantry 111. The mounting stage 110 vacuum-attracts the substrate 19 on which a semiconductor die is mounted. Two linear guides 112 are attached in parallel with each other near two
10 opposite sides of the upper surface of the main gantry 111. As shown in FIGS. 6-8, a first slider 126A and a second slider 126B are attached onto the linear guides 112 so as to be movable in the X-direction. Then, on the respective sliders 126A and 126B of the two linear guides 112, a first leg 123A of the first gantry frames 120A and a second leg 123B of the second gantry frame 120B are respectively attached. In other words, the
15 first gantry frame 120A and the second gantry frame 120B extend in the Y-direction so as to pass over the main gantry 111, and the legs 123A and 123B at both ends are attached to the respective sliders 126A and 126B and supported by the linear guides 112 attached to the gantry 111 so as to be movable in the X-direction.

[0069] In addition, as shown in FIG. 6, the flip-chip bonding device 200 of the
20 embodiment includes the sub-gantry 180 separated from the main gantry 111 so as to surround the periphery of the main gantry 111. The sub-gantry 180 is a frame configured by columns 181 and 182 and a beam 184. As shown in FIGS. 6 and 8, a first X-direction stator 130A of the first X-direction linear motor 135A and a second X-direction stator 130B of the second X-direction linear motor 135B is attached onto the

beam 184 extending in the X-direction. As shown in FIG. 8, the first X-direction stator 130A and the second X-direction stator 130B are disposed opposite to a permanent magnet 132 with a space therebetween on a support plate 131. In the space between the permanent magnet 132 of the first X-direction stator 130A and the second X-direction stator 130B, a first coil 142A of a first X-direction mover 140A of the first X-direction linear motor 135A and a second coil 142B of a second X-direction mover 140B of the second X-direction linear motor 135B are disposed. The first coil 142A and the second coil 142B are fixed to a first base plate 141A and a second base plate 141B on the upper side, and the first base plate 141A and the second base plate 141B are fixed, by bolts or the like, to a first flat plate 125A and a second flat plate 125B attached to the front ends of a first arm 124A and a second arm 124B extending from the first leg 123A of the first gantry frames 120A and the second leg 123B of the second gantry frame 120B. Accordingly, the X-direction movers 140A and 140B of the X-direction linear motors 135A and 135B move in the X-direction together with the gantry frames 120A and 120B.

[0070] As shown in FIG. 8, the first X-direction mover 140A and the second X-direction mover 140B are attached to the first X-direction stator 130A and the second X-direction stator 130B. Parts of the first X-direction stator 130A and the second X-direction stator 130B to which the X-direction movers 140A and 140B are combined respectively form the first X-direction linear motor 135A and the second X-direction linear motor 135B.

[0071] In addition, as shown in FIG. 8, a linear scale 192 of a linear encoder 190 extending linearly toward the X-direction is attached to the side surfaces of the first X-direction mover 140A and the second X-direction mover 140B of the main frame 111, and a first encoder head 193A and a second encoder head 193B of the linear encoder 190 are

attached to the front ends of a first lug 191A and a second lug 191B being L-shaped and extending from the first X-direction mover 140A and the second X-direction mover 140B toward the main gantry 111 side. In this manner, the first encoder head 193A and the second encoder head 193B are attached to the ends of the first gantry frame 120A and the second gantry frame 120B on the linear scale 192 side.

[0072] As shown in FIGS. 6 and 9, the first mounting head 170A and the second mounting head 170B are supported by the first gantry frame 120A and the second gantry frame 120B. As shown in FIG. 9, the first mounting head 170A and the second mounting head 170B store a Z-direction moving mechanism for vertically moving, in the Z-direction, the first shaft 172A and the second shafts 172B to which a first mounting tool 173A and a second mounting tool 173B are attached at the front ends. The Z-direction moving mechanism moves the first mounting tool 173A and the second mounting tool 173B up and down and presses the semiconductor die 15 onto the substrate 19 which is attracted and fixed to the mounting stage 110. A space is arranged inside the first gantry frame 120A and the second gantry frame 120B, and two first linear guides 127A and two second linear guides 127B extending in the Y-direction are attached to both sides of the inner surfaces. First sliders 175A and second sliders 175B are respectively attached to the linear guides 127A and 127B, and suspension members 174A and 174B of the mounting heads 170A and 170B are attached to the sliders 175A and 175B.

[0073] <Calculation operation (calculation method) for position correction coefficient $k(n)$ of linear scale in mounting device>

Next, the calculation operation for the position correction coefficient $k(n)$ of the linear scale 192 is described with reference to FIG. 10 and FIGS. 2-3. If the linear scale 192 thermally expands, an error may be generated when the first gantry frame 120A and the

second gantry frame 120B are moved from the reference position of the flip-chip bonding device 200 to a predetermined position. Thus, the calculation operation (calculation method) for the position correction coefficient of the linear scale 192 is described below.

[0074] As shown in FIG. 10, the first gantry frame 120A is set at the initial position, and the second gantry frame 120B is moved in the X-direction to a position adjacent to the first gantry frame 120A. Then, the first gantry frame 120A and the second gantry frame 120B are connected by a connection member 122. Thereby, the interval between the center of the first encoder head 193A and the center of the second encoder head 193B becomes the predetermined interval a shown in FIG. 3. Then, the control unit 50 initially sets n to 1 as shown in step S101 of FIG. 2.

[0075] Next, the control unit 50 drives the first X-direction linear motor 135A to move the first gantry frame 120A and the second gantry frame 120B in the X-direction. At this time, because the first gantry frame 120A and the second gantry frame 120B are connected by the connection member 122, the interval between the center of the first encoder head 193A and the center of the second encoder head 193B is maintained at the predetermined interval a . Then, as shown in step S102 of FIG. 2 and in FIG. 3, the control unit 50 aligns the center of the first encoder head 193A with the first graduation number B1(1) of the linear scale 192. Next, in step S103 of FIG. 2, the control unit 50 detects, by the laser distance detector 45, the position of the first gantry frame 120A in the X-direction at this time as a reference position.

[0076] As described above with reference to FIGS. 2 and 3, the control unit 50 linearly moves the first gantry frame 120A and the second gantry frame 120B by the predetermined number of graduations ΔB of the linear scale 192, and sequentially detects, by the first encoder head 193A and the second encoder head 193B, the first graduation number B1(n) of the linear scale 192 at which the center of the first encoder head 193A