

shown by an arrow 83 shown in FIGS. 4 and 6B. Thereby, the center line 24 of the capillary 20 is located closer to the second bond point P2 than the center line 36 of the first bond point P1.

[0047] Next, as shown in FIG. 6C, the CPU 61 drives the XY-table 11 in the opposite direction of FIG. 6B while holding the height of the distal end 25 of the capillary 20 at the shear height h_2 , and horizontally moves the capillary 20 by a distance Δx_d to a point d in the reverse direction toward the first bond point P1 from the second bond point P2 as shown by an arrow 84 shown in FIGS. 4 and 6C. Because the Δx_d is larger than the Δx_c shown in FIG. 6B, the center line 24 of the capillary 20 is on the reverse side of the first bond point P1 as shown in FIG. 6C.

[0048] Furthermore, the CPU 61 drives the XY-table 11 while holding the height of the distal end 25 of the capillary 20 at the shear height h_2 , and horizontally moves the capillary 20 by a distance Δx_e to a point e in the forward direction toward the second bond point P2 as shown by an arrow 85 shown in FIGS. 4 and 6D. Because the Δx_e is smaller than the Δx_d shown in FIG. 6C, as shown in FIG. 6D, the center line 24 of the capillary 20 is on the reverse side of the first bond point P1, and is located to pass through an end portion 45 of the crimping ball 41 on the opposite side (reverse side) of the second bond point P2.

[0049] As shown in FIGS. 6B to 6D, when the height of the distal end 25 of the capillary 20 is held at the shear height h_2 , and the distal end 25 of the capillary 20 is reciprocated toward the forward side and the reverse side in the horizontal direction, as shown in FIGS. 6C and 6D, a part of the ball neck 42 is sheared and broken at the shear height h_2 by the distal end 25 of the capillary 20 and is scraped off in the horizontal direction. Thereby, a shear surface 44 on the forward side and a shear surface 43 on the reverse side are formed. Here, the shear surface 44 on the forward side appears near the upper end surface of the crimping ball 41. In addition, the shear surface 43 on the reverse side appears near a lower end surface of the ball neck 42. There is a slight gap between the shear surface 43 and an upper surface of the end portion 45 of the crimping ball 41 on the opposite side (reverse side) of the second bond point P2. A thin connection portion 46 connecting the ball neck 42 and the crimping ball 41 is formed between the shear surface 44 on

WHAT IS CLAIMED IS:

1. A method for manufacturing a semiconductor device in which a first bond point and a second bond point are connected by a wire, the method comprising:

a preparation step for preparing a wire bonding apparatus which comprises a capillary through which the wire is inserted and a movement mechanism for moving the capillary;

a ball bonding step in which after a free air ball is formed at a distal end of the wire inserted through the capillary, a distal end of the capillary is lowered to a crimping height, the free air ball is joined to the first bond point, and a crimping ball and a ball neck above the crimping ball are formed;

a thin-walled portion forming step in which the distal end of the capillary is moved in a horizontal direction, and a thin-walled portion having a reduced cross-sectional area is formed between the ball neck and the crimping ball;

a wire tail bending step in which after the thin-walled portion is formed, the capillary is reciprocated in an arc shape in the direction to the second bond point, and the wire is bent and deformed;

a wire tail separating step in which after the capillary is raised to unroll a wire tail, the capillary is moved in a direction to the second bond point, and the wire tail and the crimping ball are separated in the thin-walled portion; and

a wire tail joining step in which the capillary is lowered and a side surface of the separated wire tail is joined onto the crimping ball.

2. The method for manufacturing a semiconductor device according to claim 1, wherein

in the thin-walled portion forming step, the capillary is raised to a shear height higher than the crimping height, and the capillary is moved in the horizontal direction.

3. The method for manufacturing a semiconductor device according to claim 1 or 2,

wherein

in the thin-walled portion forming step, the capillary is reciprocated in the horizontal direction when forming the thin-walled portion.

4. The method for manufacturing a semiconductor device according to any one of claims 1 to 3, wherein

in the wire tail separating step, when the wire tail is separated from the crimping ball in the thin-walled portion,

the capillary is moved diagonally upward in the direction toward the second bond point.

5. The method for manufacturing a semiconductor device according to any one of claims 1 to 4, wherein

in the wire tail joining step, when the side surface of the wire tail is joined onto the crimping ball, a face portion of the capillary at the first bond point side is moved to the above of an end portion of the crimping ball opposite to the second bond point, and then the capillary is lowered to join the side surface of the bent and deformed wire tail onto the end portion of the crimping ball opposite to the second bond point by the face portion of the capillary.

6. A wire bonding apparatus which connects a first bond point and a second bond point by a wire, comprising:

a capillary through which the wire is inserted;

a movement mechanism which moves the capillary; and

a control portion which controls drive of the movement mechanism, wherein

by the control portion:

after a free air ball is formed at a distal end of the wire inserted through the capillary, a distal end of the capillary is lowered to a crimping height, the free air ball is joined to the first bond point, and a crimping ball and a ball neck above the crimping ball are formed;

the distal end of the capillary is moved in a horizontal direction, and a thin-walled portion having a reduced cross-sectional area is formed between the ball neck and the crimping ball;

after the thin-walled portion is formed, the capillary is reciprocated in an arc shape in the direction to the second bond point, and the wire is bent and deformed;

after the capillary is raised to unroll a wire tail, the capillary is moved in a direction to the second bond point, and the wire tail and the crimping ball are separated in the thin-walled portion; and

the capillary is lowered and a side surface of the separated wire tail is joined onto the crimping ball.

7. The wire bonding apparatus according to claim 6, wherein
by the control portion:

when forming the thin-walled portion, the capillary is raised to a shear height higher than the crimping height, the capillary is reciprocated in the horizontal direction;

when the wire tail is separated from the crimping ball in the thin-walled portion, the capillary is moved diagonally upward in the direction toward the second bond point; and

when the side surface of the wire tail is joined onto the crimping ball, a face portion of the capillary at the first bond point side is moved to the above of an end portion of the crimping ball opposite to the second bond point, and then the capillary is lowered to join the side surface of the bent and deformed wire tail onto the end portion of the crimping ball opposite to the second bond point by the face portion of the capillary.