

height measuring step may include detecting whether the free air ball at the front end of the wire is grounded to the first electrode and the second electrode, respectively, based on an output change in a predetermined electric signal supplied to the wire inserted in the bonding tool when the free air ball at the front end of the wire contacts the first electrode and the second electrode, respectively.

[0010] In the above wire bonding method, the predetermined electric signal is a DC voltage signal or an AC voltage signal, and the first height measuring step and the second height measuring step may include detecting whether the free air ball at the front end of the wire is grounded to the first electrode and the second electrode based on a change in a potential difference between the wire and the first electrode and between the wire and the second electrode.

[0011] A wire bonding apparatus according to an aspect of the present invention includes: a bonding tool configured to allow a wire to be inserted, wherein a free air ball is formed at a front end of the wire; a bonding stage for fixing and holding a workpiece which includes a first electrode and a second electrode; a first height measuring part for measuring a height of the first electrode by detecting whether the free air ball is grounded to the first electrode; a second height measuring part for measuring a height of the second electrode by detecting whether the free air ball is grounded to the second electrode; a first bonding part for bonding the free air ball to the first electrode by controlling a height of the bonding tool based on a measurement result of the first height measuring part; and a second bonding part for bonding the wire to the second electrode by controlling a height of the bonding tool based on a measurement result of the second height measuring part to connect the first electrode and the second electrode.

[0012] In the above wire bonding apparatus, the first height measuring part and the second height measuring part may detect whether the free air ball at the front end of the wire is grounded to the first electrode and the second electrode, respectively, based on a change in a bonding load applied to the free air ball when the free air ball presses the first electrode or the second electrode.

[0013] In the above wire bonding apparatus, the first height measuring part and the second height measuring part may detect whether the free air ball at the front end of the wire is grounded to the first electrode and the second electrode, respectively, based on an output change in a predetermined electric signal supplied to the wire inserted in the bonding tool when the free
5 air ball contacts the first electrode or the second electrode.

[0014] In the above wire bonding apparatus, the predetermined electric signal is an AC voltage signal, and the first and the second height measuring parts may respectively detect whether the free air ball at the front end of the wire is grounded to the first electrode and the second electrode based on a change in a potential difference between the wire and the first electrode and between
10 the wire and the second electrode.

Effects

[0015] According to the present invention, a plurality of electrodes can be correctly bonded.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] [FIG. 1] FIG. 1 is a view showing a wire bonding apparatus according to the first
15 embodiment.

[FIG. 2] FIGs. 2(A) and 2(B) are a top view and a bottom view of a plane of the bonding arm of the wire bonding apparatus according to the first embodiment.

[FIG. 3] FIGs. 3(A) to 3(D) are views for explaining the operation of the wire bonding
20 according to the first embodiment.

[FIG. 4] FIG. 4 is a flow chart showing an example of the height measuring processing of the wire bonding according to the first embodiment.

[FIG. 5] FIGs. 5(A) to 5(C) are views for explaining the height measuring processing of the wire bonding according to the first embodiment.

[FIG. 6] FIG. 6 is a view for explaining the height measuring processing of the wire
25 bonding according to the first embodiment.

wire 42 presses the electrode 112. Specifically, the height measuring part 88 compares the speed change amount ($|b-c|$) from the speed b to the speed c in the movement of the bonding tool 40 when the free air ball 43 at the front end of the wire 42 presses the electrode 112 with the speed change amount recorded in the recording part 130 as the threshold value, and the height measuring part 88 determines that the free air ball 43 has been grounded to the electrode 112 when the speed change amount ($|b-c|$) is greater than the speed change amount recorded in the recording part 130. In addition, the height measuring part 88 may detect whether the free air ball 43 is grounded to the electrode 112 based on that the moving speed of the bonding tool 40 when the free air ball 43 at the front end of the wire 42 presses the electrode 112 reaches a predetermined set value (such as the speed c).

[0063] Here, when the height measuring part 88 has detected the grounding of the free air ball 43 to the electrode 112 (Yes in S5 of FIG. 4), the process proceeds to the Step S7, and when the height measuring part 88 has not detected the grounding of the free air ball 43 to the electrode 112 (No in S5 of FIG. 4), the process returns to the Step S3.

[0064] (Step S7)

As shown in FIG. 5, the height measuring part 88 measures the height of the electrode 112 by detecting whether the free air ball 43 is grounded to the electrode 112. The height measuring part 88 measures the height of the electrode 112 based on, for example, the height of the position P1 set in advance before the bonding tool 40 is lowered and the height H corresponding to the position Z2 of the bonding tool 40 when the free air ball 43 is grounded to the electrode 112. Further, the height of the position P1 and height H may include the height from the surface of the bonding stage 16 of the workpiece 100, the semiconductor chip 110, or the substrate 120.

[0065] Subsequently, as shown in FIGs. 5(C) and 6, after the time t_2 , when the bonding tool 40 is further lowered from the position Z2, the free air ball presses the first bonding point P2 at the speed c , and a free air ball 45 is deformed as shown and is slightly flattened, and the position

apparatus is required to include the grounding detection part 70; however, the speed detection part 86, the load sensor 50, and the bonding load detection part 150 are not necessarily required.

[0084] In the above-described embodiment, an aspect in which a plurality of bonding targets disposed at different positions are connected to each other by a wire is described as an example of the wire bonding method. However, the heights of the plurality of bonding targets may be different, or at least two of the plurality of bonding targets may have the same height.

[0085] Further, the present invention can also be applied to so-called reverse bonding in which the first bonding point P1 is set as the electrode 122 of the substrate 120.

[0086] FIG. 13 is a view for explaining another wire bonding method. As shown in FIG. 13, the present invention can also be applied to a so-called chain loop; that is, a wire loop 90 is formed by a single wire to connect a plurality of electrodes 112, 122, 162, 172, 182 and 192 respectively disposed on a plurality of chips (or substrates) 110, 120, 160, 170, 180 and 190.

Description of Reference Numerals

[0087]

1: wire bonding apparatus

30: ultrasonic horn

40: bonding tool

42: wire

43 (143): free air ball

70: grounding detection part

80: control part

150: bonding load detection part

WHAT IS CLAIMED IS:

1. A wire bonding method, comprising:

a step of preparing a wire bonding apparatus comprising a bonding tool and a bonding stage, wherein the bonding tool is configured to allow a wire to be inserted, and the bonding

5 stage fixes and holds a workpiece comprising a first electrode and a second electrode;

a ball forming step of forming a free air ball at a front end of a wire inserted in the bonding tool;

a first height measuring step of measuring a height of the first electrode by detecting whether the free air ball is grounded to the first electrode;

10 a second height measuring step of measuring a height of the second electrode by detecting whether the free air ball is grounded to the second electrode;

a first bonding step of bonding the free air ball to the first electrode by controlling a height of the bonding tool based on a measurement result of the first height measuring step; and

a second bonding step of bonding the wire to the second electrode by controlling a height of the bonding tool based on a measurement result of the second height measuring step to connect the first electrode and the second electrode.

2. The wire bonding method according to claim 1, wherein

the first height measuring step and the second height measuring step comprise: detecting whether the free air ball at the front end of the wire is grounded to the first electrode and the second electrode, respectively, based on a change in a bonding load applied to the free air ball when the free air ball at the front end of the wire presses the first electrode and the second electrode, respectively.

3. The wire bonding method according to claim 1 or claim 2, wherein

the first height measuring step and the second height measuring step comprise: detecting whether the free air ball at the front end of the wire is grounded to the first electrode and the second electrode, respectively, based on an output change in a predetermined electric

signal supplied to the wire inserted in the bonding tool when the free air ball at the front end of the wire contacts the first electrode and the second electrode, respectively.

4. The wire bonding method according to claim 3, wherein

the predetermined electric signal is a DC voltage signal or an AC voltage signal, and

5 the first height measuring step and the second height measuring step comprise:
detecting whether the free air ball at the front end of the wire is grounded to the first electrode and the second electrode based on a change in a potential difference between the wire and the first electrode and between the wire and the second electrode.

5. A wire bonding apparatus, comprising:

10 a bonding tool configured to allow a wire to be inserted, wherein a free air ball is formed at a front end of the wire;

a bonding stage for fixing and holding a workpiece which comprises a first electrode and a second electrode;

15 a first height measuring part for measuring a height of the first electrode by detecting whether the free air ball is grounded to the first electrode;

a second height measuring part for measuring a height of the second electrode by detecting whether the free air ball is grounded to the second electrode;

a first bonding part for bonding the free air ball to the first electrode by controlling a height of the bonding tool based on a measurement result of the first height measuring part; and

20 a second bonding part for bonding the wire to the second electrode by controlling a height of the bonding tool based on a measurement result of the second height measuring part to connect the first electrode and the second electrode.

6. The wire bonding apparatus according to claim 5, wherein

25 the first height measuring part and the second height measuring part detect whether the free air ball at the front end of the wire is grounded to the first electrode and the second electrode, respectively, based on a change in a bonding load applied to the free air ball when the

free air ball presses the first electrode or the second electrode.

7. The wire bonding apparatus according to claim 6 or claim 7, wherein

the first height measuring part and the second height measuring part detect whether the free air ball at the front end of the wire is grounded to the first electrode and the second electrode, respectively, based on an output change in a predetermined electric signal supplied to the wire inserted in the bonding tool when the free air ball contacts the first electrode or the second electrode, respectively.

8. The wire bonding apparatus according to claim 7, wherein

the predetermined electric signal is an AC voltage signal, and

the first and the second height measuring parts respectively detect whether the free air ball at the front end of the wire is grounded to the first electrode and the second electrode based on a change in a potential difference between the wire and the first electrode and between the wire and the second electrode.