CLAIMS:

1. A wire bonding method for forming a wire interconnection including a wedge wire bond, the method comprising the steps of:

using a capillary to form the wedge wire bond;

using a wire holding device located above a wire clamp and the capillary to secure the wire while the wire clamp is open and not clamping onto the wire;

lifting the wire clamp and the capillary relative to the wire in a direction away from the wedge wire bond and towards the wire holding device so as to pay out a length of wire from the capillary;

at a predetermined height of the capillary, closing the wire clamp to clamp onto the wire; and thereafter

moving the capillary and wire clamp further away from the wedge wire bond to cause the wire to break away from the wedge wire bond so as to form the wire tail with a desired length extending from the capillary.

2. The wire bonding method as claimed in claim 1, further comprising the step of releasing the wire from being secured by the wire holding device after the wire clamp is closed.

3. The wire bonding method as claimed in claim 1, further comprising the steps of:

after the formation of the wire tail, positioning the capillary at a predetermined height and gradually lowering the wire tail towards an electrically-conductive surface;

determining a length of the wire tail extending from the capillary; and thereafter

creating a spark to melt an end of the wire tail to produce a molten ball so as to make a subsequent wire bond.

4. The wire bonding method as claimed in claim 3, wherein the step of determining the length of the wire tail extending from the capillary further comprises the step of using a contact detection device to detect a vertical position at which the wire tail contacts the electrically-conductive surface, and determining a length of the wire tail based upon the said vertical position at which the wire tail contacts the electrically-conductive surface.

5. The wire bonding method as claimed in claim 4, wherein the contact detection device comprises a first electrode which is electrically connected to the bonding wire and a second electrode which is electrically connected to the electrically-conductive surface.

6. The wire bonding method as claimed in claim 3, wherein the step of detecting the length of the wire tail extending from the capillary further comprises the steps of:

connecting an electrical sensor to the wire and to the electrically-conductive surface respectively to form a circuit loop, wherein the circuit loop is open when the wire is not in contact with the electrically-conductive surface and is closed with the wire is in contact with the electrically-conductive surface;

moving the capillary gradually towards the electrically-conductive surface until the wire contacts the electrically-conductive surface to close the circuit loop; and thereafter

determining the length of the wire tail extending from a tip of the capillary to the electrically-conductive surface at a vertical position of the capillary when the circuit loop is closed.

7. The wire bonding method as claimed in claim 1, further comprising the step of paying out an additional length of wire from the capillary, which comprises the steps of:

releasing the wire from being secured by the wire holding device;

pulling the wire with the wire clamp in a direction away from the wire holding device and towards the capillary;

using the wire holding device to secure the wire;

moving the capillary and wire clamp relative to the wire in a direction towards the wire holding device after the wire clamp is opened to pay out wire from the capillary; and thereafter

clamping the wire with the wire clamp and releasing the wire from being secured by the wire holding device.

8. Method as claimed in claim 1, wherein in the event the wire is stuck to the capillary, the method further comprises the steps of producing one or more electrical sparks onto the wire which is stuck on the capillary to melt the wire and then detaching the melted wire tail from the capillary.

9. Method as claimed in claim 1, wherein in the event the wire is stuck to the capillary, the method further comprises the steps of locating the stuck wire onto a ball which has been pre-bonded on a surface, attaching the stuck wire to the ball and separating the stuck wire from the capillary, then extending the wire from the capillary and thereafter breaking the wire from the ball.

10. Method as claimed in claim 1, wherein in the event the wire clamp is unable to pay out further wire from the capillary to lengthen a wire tail or the wire tail is not suitable to form a normal ball wire bond, the method further comprises the steps of forming a wire loop comprising a first wire bond and a second wire bond, and breaking the wire from the second wire bond to form a new wire tail of a desired length extending from the capillary.

11. Method as claimed in claim 1, wherein in the event the wire clamp is unable to pay out further wire from the capillary to lengthen a wire tail, the method further comprises the steps of forming a ball wire bond, extending a length of wire between the capillary and the ball wire bond, and then breaking the

wire from the ball wire bond to form a new wire tail of a desired length extending from the capillary.

12. Method as claimed in claim 1, wherein the wire holding device comprises a wire clamp.

13. An apparatus for wire bonding, comprising:

a capillary operative to form wire bonds at its tip;

a wire clamp located above the capillary for controlling wire being fed to the capillary; and

a wire holding device located above the wire clamp and the capillary, the wire holding device being operable separately from the wire clamp and being operative to secure the wire relative to the wire clamp and the capillary.

14. The apparatus for wire bonding as claimed in claim 12, further comprising a contact detection device operative to detect a moment when a wire tail extending from the capillary contacts an electrically-conductive surface.

15. The apparatus for wire bonding as claimed in claim 13, wherein the contact detection device comprises a first electrode which is configured to be electrically connected to a bonding wire and a second electrode which is configured to be electrically connected to the electrically-conductive surface.

16. The apparatus for wire bonding as claimed in claim 13, wherein the wire holding device comprises a wire clamp.

Claims

1. A wire bonding method for forming a wire interconnection including a wedge wire bond, the method comprising the steps of:

using a capillary to form the wedge wire bond;

using a wire holding device located above a wire clamp and the capillary to secure the wire while the wire clamp is open and not clamping onto the wire;

lifting the wire clamp and the capillary relative to the wire in a direction away from the wedge wire bond and towards the wire holding device so as to pay out a length of wire from the capillary;

at a predetermined height of the capillary, closing the wire clamp to clamp onto the wire; and thereafter

moving the capillary and wire clamp further away from the wedge wire bond to cause the wire to break away from the wedge wire bond so as to form the wire tail with a desired length extending from the capillary,

wherein in the event that the wire is stuck to the capillary, the method further comprises the steps of:

moving the tip of the capillary adjacent to a device that is capable of producing electrical sparks;

producing one or more electrical sparks onto the wire which is stuck on the capillary using the device to melt the wire; and

detaching the wire tail from the capillary.

2. The wire bonding method as claimed in claim 1, further comprising the step of releasing the wire from being secured by the wire holding device after the wire clamp is closed.

3. The wire bonding method as claimed in claim 1 or claim 2, further comprising the steps of:

after the formation of the wire tail, positioning the capillary at a predetermined height and gradually lowering the wire tail towards an electrically conductive-surface;

determining a length of the wire tail extending from the capillary; and thereafter

creating a spark to melt an end of the wire tail to produce a molten ball so as to make a subsequent wire bond.

4. The wire bonding method as claimed in claim 3, wherein the step of determining the length of the wire tail extending from the capillary further comprises the step of using a contact detection device to detect a vertical position at which the wire tail contacts the electrically-conductive surface, and determining a length of the wire tail based upon the said vertical position at which the wire tail contacts the electrically-conductive surface.

5. The wire bonding method as claimed in claim 4, wherein the contact detection device comprises a first electrode which is electrically connected to the bonding wire and a second electrode which is electrically connected to the electrically-conductive surface.

6. The wire bonding method as claimed in any one of claims 3 to 5, wherein the step of detecting the length of the wire tail extending from the capillary further comprises the steps of:

connecting an electrical sensor to the wire and to the electrically-conductive surface respectively to form a circuit loop, wherein the circuit loop is open when the wire is not in contact with the electrically-conductive surface and is closed with the wire is in contact with the electrically-conductive surface;

moving the capillary gradually towards the electrically-conductive surface until the wire contacts the electrically-conductive surface to close the circuit loop; and thereafter

determining the length of the wire tail extending from a tip of the capillary to the electrically-conductive surface at a vertical position of the capillary when the circuit loop is closed.

7. The wire bonding method as claimed in any one of the preceding claims, further comprising the step of paying out an additional length of wire from the capillary, which comprises the steps of:

releasing the wire from being secured by the wire holding device;

pulling the wire with the wire clamp in a direction away from the wire holding device and towards the capillary;

using the wire holding device to secure the wire;

moving the capillary and wire clamp relative to the wire in a direction towards the wire holding device after the wire clamp is opened to pay out wire from the capillary; and thereafter

clamping the wire with the wire clamp and releasing the wire from being secured by the wire holding device.

8. Method as claimed in any one of the preceding claims, wherein in the event the wire is stuck to the capillary, the method further comprises the steps of locating the stuck wire onto a ball which has been pre-bonded on a surface, attaching the stuck wire to the ball and separating the stuck wire from the capillary, then extending the wire from the capillary and thereafter breaking the wire from the ball.

9. Method as claimed in any one of the preceding claims, wherein in the event the wire clamp is unable to pay out further wire from the capillary to lengthen a wire tail or the wire tail is not suitable to form a normal ball wire bond, the method further comprises the steps of forming a wire loop comprising a first wire bond and a second wire bond, and breaking the wire from the second wire bond to form a new wire tail of a desired length extending from the capillary.

10. Method as claimed in any one of the preceding claims, wherein in the event the wire clamp is unable to pay out further wire from the capillary to lengthen a wire tail, the method further comprises the steps of forming a ball wire bond, extending a length of wire between the capillary and the ball wire bond, and then breaking the wire from the ball wire bond to form a new wire tail of a desired length extending from the capillary.

11. Method as claimed in any one of the preceding claims, wherein the wire holding device comprises a wire clamp.

12. An apparatus for wire bonding, comprising:

a capillary operative to form wire bonds at its tip;

a wire clamp located above the capillary for controlling wire being fed to the capillary;

a wire holding device located above the wire clamp and the capillary, the wire holding device being operable separately from the wire clamp and being operative to secure the wire relative to the wire clamp and the capillary; and

a device that is capable of producing electrical sparks,

wherein in the event that the wire is stuck to the capillary, the tip of the capillary is operative to be moved adjacent to the device, which then produces one or more electrical sparks to melt the wire that is stuck to the capillary in order to detach the wire tail from the capillary.

13. The apparatus for wire bonding as claimed in claim 12, further comprising a contact detection device operative to detect a moment when a wire tail extending from the capillary contacts an electrically-conductive surface.

14. The apparatus for wire bonding as claimed in claim 13, wherein the contact detection device comprises a first electrode which is configured to be electrically connected to a bonding wire and a second electrode which is configured to be electrically connected to the electrically-conductive surface.

15. The apparatus for wire bonding as claimed in any one of claims 12 to 14, wherein the wire holding device comprises a wire clamp.