

## CLAIMS

1. A semiconductor device manufacturing method of a semiconductor device having a wire loop for connection between a first bonding point and a second bonding point, the method comprising:

a wire tail contacting step of lowering a bonding tool with a wire tail extending out of the tip thereof to bring the tip of the wire tail into contact with a bonding surface of the semiconductor device;

a wire tail bending step of moving the bonding tool in a direction intersecting with the axial direction of the bonding tool to bend the wire tail with the tip of the wire tail in contact with the bonding surface;

a first bonding step of lowering the bonding tool to compress a portion of the wire tail at the first bonding point and to form the wire tail into a predetermined shape such that the tip of the wire tail points upward;

a wire looping step of moving the bonding tool while paying out the wire to cause the wire to extend in a predetermined shape;

a second bonding step of lowering the bonding tool to compress a portion of the wire at the second bonding point; and

a wire cutting step of cutting the wire to cause a portion of the wire to extend out of the tip of the bonding tool.

2. The semiconductor device manufacturing method according to claim 1, wherein in the wire tail bending step, the bonding tool is moved along a wire direction running between the first bonding point and the second bonding point.

3. The semiconductor device manufacturing method according to claim 2, wherein in the wire tail bending step, the bonding tool is moved along the wire direction and in a direction inclined with respect to the bonding surface.

4. The semiconductor device manufacturing method according to claim 2, wherein in the wire tail bending step, the bonding tool is moved along the wire direction and in a direction parallel to the bonding surface.

5. The semiconductor device manufacturing method according to claim 2, wherein in the wire tail bending step, the bonding tool is moved along the wire direction in a manner drawing a predetermined curved trajectory.

6. The semiconductor device manufacturing method according to claim 5, wherein in the wire tail bending step, the predetermined curve is concave toward the bonding surface.

7. The semiconductor device manufacturing method according to claim 5, wherein in the wire tail bending step, the predetermined curve is convex toward the bonding surface.

8. The semiconductor device manufacturing method according to claim 2, wherein in the first bonding step, the bonding tool is lowered in a direction perpendicular to the bonding surface.

9. The semiconductor device manufacturing method according to claim 2, wherein in the first bonding step, the bonding tool is lowered along the wire direction in a manner inclined with respect to the bonding surface.

10. The semiconductor device manufacturing method according to claim 2, wherein in the wire tail bending step, the bonding tool is moved along the wire direction by a distance equal to or greater than the length of the wire tail.

11. The semiconductor device manufacturing method according to claim 2, wherein

in the first bonding step, the portion of the wire tail is compressed at an electrode on a semiconductor chip as the first bonding point, and

in the second bonding step, the portion of the wire is compressed at an electrode on a substrate on which the semiconductor chip is mounted as the second bonding point.

12. A wire bonding apparatus for manufacturing a semiconductor device having a wire loop for wire-connection between a first bonding point and a second bonding point, the wire bonding apparatus comprising:

- a bonding arm movable in a plane parallel to and in a direction perpendicular to a bonding surface;

- an ultrasonic horn attached to the end of the bonding arm;

- a bonding tool attached to one end of the ultrasonic horn and inserted with a wire therethrough; and

- a control unit for controlling the operation of the bonding tool, wherein the control unit is configured to perform:

- a wire tail contacting step of lowering the bonding tool with a wire tail extending out of the tip thereof to bring the tip of the wire tail into contact with a bonding surface of the semiconductor device;

- a wire tail bending step of moving the bonding tool in a direction intersecting with the axial direction of the bonding tool to bend the wire tail with the tip of the wire tail in contact with the bonding surface;

- a first bonding step of lowering the bonding tool to compress a portion of the wire tail at the first bonding point and to form the wire tail into a predetermined shape such that the tip of the wire tail points upward;

- a wire looping step of moving the bonding tool toward the second bonding point while paying out the wire to cause the wire to extend in a predetermined shape;

- a second bonding step of lowering the bonding tool to compress a portion of the wire at the second bonding point; and

- a wire cutting step of cutting the wire to cause a portion of the wire to extend out of the tip of the bonding tool.

13. The wire bonding apparatus according to claim 12, wherein in the wire tail bending step, the bonding tool is moved along a wire direction running between the first bonding point and the second bonding point.

## CLAIMS

1. A semiconductor device manufacturing method of a semiconductor device having a wire loop for connection between a first bonding point and a second bonding point, the method comprising:

- a wire tail contacting step of lowering a bonding tool with a wire tail extending out of the tip thereof to bring the tip of the wire tail into contact with a bonding surface of the semiconductor device;

- a wire tail bending step of moving the bonding tool in a direction intersecting with the axial direction of the bonding tool to bend the wire tail with the tip of the wire tail in contact with the bonding surface;

- a first bonding step of lowering the bonding tool to compress a portion of the wire tail at the first bonding point and to form the wire tail into a predetermined shape such that the tip of the wire tail points upward;

- a wire looping step of moving the bonding tool while paying out the wire to cause the wire to extend in a predetermined shape;

- a second bonding step of lowering the bonding tool to compress a portion of the wire at the second bonding point; and

- a wire cutting step of cutting the wire to cause a portion of the wire to extend out of the tip of the bonding tool, wherein

- in the wire tail bending step, the bonding tool is moved along a wire direction running between the first bonding point and the second bonding point and in a direction parallel to the bonding surface.

2. A semiconductor device manufacturing method for a semiconductor device having a wire loop for connection between a first bonding point and a second bonding point, the method comprising:

- a wire tail contacting step of lowering a bonding tool with a wire tail extending out of the tip thereof to bring the tip of the wire tail into contact with a bonding surface of the semiconductor device;

- a wire tail bending step of moving the bonding tool in a direction intersecting with the axial direction of the bonding tool to bend the wire tail with the tip of the wire

tail in contact with the bonding surface;

a first bonding step of lowering the bonding tool to compress a portion of the wire tail at the first bonding point and to form the wire tail into a predetermined shape such that the tip of the wire tail points upward;

a wire looping step of moving the bonding tool while paying out the wire to cause the wire to extend in a predetermined shape;

a second bonding step of lowering the bonding tool to compress a portion of the wire at the second bonding point; and

a wire cutting step of cutting the wire to cause a portion of the wire to extend out of the tip of the bonding tool, wherein

in the wire tail bending step, the bonding tool is moved along a wire direction running between the first bonding point and the second bonding point in a manner drawing a predetermined curved trajectory.

3. The semiconductor device manufacturing method according to claim 2, wherein in the wire tail bending step, the predetermined curve is concave toward the bonding surface.

4. The semiconductor device manufacturing method according to claim 2, wherein in the wire tail bending step, the predetermined curve is convex toward the bonding surface.

5. A wire bonding apparatus for manufacturing a semiconductor device having a wire loop for wire-connection between a first bonding point and a second bonding point, the wire bonding apparatus comprising:

a bonding arm movable in a plane parallel to and in a direction perpendicular to a bonding surface;

an ultrasonic horn attached to the end of the bonding arm;

a bonding tool attached to one end of the ultrasonic horn and inserted with a wire therethrough; and

a control unit for controlling the operation of the bonding tool, wherein

the control unit is configured to perform:

- a wire tail contacting step of lowering the bonding tool with a wire tail extending out of the tip thereof to bring the tip of the wire tail into contact with a bonding surface of the semiconductor device;

- a wire tail bending step of moving the bonding tool in a direction intersecting with the axial direction of the bonding tool to bend the wire tail with the tip of the wire tail in contact with the bonding surface;

- a first bonding step of lowering the bonding tool to compress a portion of the wire tail at the first bonding point and to form the wire tail into a predetermined shape such that the tip of the wire tail points upward;

- a wire looping step of moving the bonding tool toward the second bonding point while paying out the wire to cause the wire to extend in a predetermined shape;

- a second bonding step of lowering the bonding tool to compress a portion of the wire at the second bonding point; and

- a wire cutting step of cutting the wire to cause a portion of the wire to extend out of the tip of the bonding tool, wherein

- in the wire tail bending step, the bonding tool is moved along a wire direction running between the first bonding point and the second bonding point and in a direction parallel to the bonding surface.

6. A wire bonding apparatus for manufacturing a semiconductor device having a wire loop for wire-connection between a first bonding point and a second bonding point, the wire bonding apparatus comprising:

- a bonding arm movable in a plane parallel to and in a direction perpendicular to a bonding surface;

- an ultrasonic horn attached to the end of the bonding arm;

- a bonding tool attached to one end of the ultrasonic horn and inserted with a wire therethrough; and

- a control unit for controlling the operation of the bonding tool, wherein

- the control unit is configured to perform:

- a wire tail contacting step of lowering the bonding tool with a wire tail extending out of the tip thereof to bring the tip of the wire tail into contact with a

bonding surface of the semiconductor device;

a wire tail bending step of moving the bonding tool in a direction intersecting with the axial direction of the bonding tool to bend the wire tail with the tip of the wire tail in contact with the bonding surface;

a first bonding step of lowering the bonding tool to compress a portion of the wire tail at the first bonding point and to form the wire tail into a predetermined shape such that the tip of the wire tail points upward;

a wire looping step of moving the bonding tool toward the second bonding point while paying out the wire to cause the wire to extend in a predetermined shape;

a second bonding step of lowering the bonding tool to compress a portion of the wire at the second bonding point; and

a wire cutting step of cutting the wire to cause a portion of the wire to extend out of the tip of the bonding tool, wherein

in the wire tail bending step, the bonding tool is moved along a wire direction running between the first bonding point and the second bonding point in a manner drawing a predetermined curved trajectory.