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 first bonding step of bonding a wire inserted through a bonding tool to the first bonding point;

a wire looping step of looping the wire while paying out the wire;

a second bonding step of bonding the wire to the second bonding point;

a cut portion forming step of raising the bonding tool while paying out the wire and moving the bonding tool in a direction from the second bonding point toward the first bonding point to form a cut portion in the wire extending out of the tip of the bonding tool, the cut portion being bent in the vicinity of the second bonding point;

a bonding tool moving step of lowering the bonding tool and moving the tip of the bonding tool to the cut portion of the wire while being pressed against the wire;

a thin portion forming step of lowering the bonding tool vertically toward the second bonding point for compression to thin the cut portion of the wire;

a bonding tool raising step of raising the bonding tool while paying out the wire; and

a wire tail forming step of moving the bonding tool in a direction away from the first bonding point and the second bonding point and along a wire direction connecting the first bonding point and the second bonding point and then cutting the wire at the cut portion to form a wire tail at the tip of the bonding tool.

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

in the cut portion forming step, the bonding tool is raised to a first height;

in the bonding tool moving step, the bonding tool is lowered to a second height lower than the first height and, at the second height, the bonding tool is moved to the cut portion of the wire while the tip of the bonding tool is pressed against the wire; and

in the thin portion forming step, the bonding tool is used for compression to a third height lower than the second height.

3. The semiconductor device manufacturing method according to claim 1, wherein in the bonding tool moving step, the tip of the bonding tool is pressed against the wire at a point nearer the first bonding point than the second bonding point.

4. The semiconductor device manufacturing method according to claim 2, wherein in the thin portion forming step, the bonding tool is moved along the wire direction while being kept at the third height.

5. A semiconductor device comprising:

a first electrode at which a wire tail is bonded as a first bonding point;

a second electrode at which a wire is bonded as a second bonding point; and

a wire loop extended in a predetermined shape for connection between the first electrode and the second electrode, wherein

the wire loop has a first bonded portion with respect to the first electrode, and

a first tip portion of the wire loop on the side of the first bonded portion is arranged within a region of the first electrode in a plan view and formed to become integrated with the first bonded portion to form a thin portion thinner than the diameter of the wire.

6. The semiconductor device according to claim 5, wherein the portion of the wire loop rising from the first electrode is formed with a recessed portion.

7. The semiconductor device according to claim 6, wherein

the first electrode is provided on a semiconductor chip and the region of the first electrode is a region exposed through a passivation film formed on the semiconductor chip, and

the second electrode is provided on a substrate on which the semiconductor chip is mounted.

8. 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 freely in an XY plane and in a Z direction within a bonding region;

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

a bonding tool attached to one end of the ultrasonic horn and configured to press a wire inserted therethrough against the first bonding point and the second bonding point that serve as bonding targets; and

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

the control unit is configured to be capable of performing the steps of:

raising the bonding tool while paying out the wire and moving the bonding tool in a direction from the second bonding point toward the first bonding point to form a cut portion in the wire extending out of the tip of the bonding tool, the cut portion being bent in the vicinity of the second bonding point;

lowering the bonding tool and moving the tip of the bonding tool to the cut portion of the wire while being pressed against the wire;

using the bonding tool for compression to thin the cut portion of the wire;

raising the bonding tool while paying out the wire; and

moving the bonding tool in a direction away from the second bonding point and then cutting the wire at the cut portion to form a wire tail at the tip of the bonding tool.

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 first bonding step of bonding a wire inserted through a bonding tool to the first bonding point;

a wire looping step of looping the wire while paying out the wire;

a second bonding step of bonding the wire to the second bonding point;

a cut portion forming step of raising the bonding tool while paying out the wire and moving the bonding tool in a direction from the second bonding point toward the first bonding point to form a cut portion in the wire extending out of the tip of the bonding tool, the cut portion being bent in the vicinity of the second bonding point;

a bonding tool moving step of lowering the bonding tool and moving the tip of the bonding tool to the cut portion of the wire while being pressed against the wire;

a thin portion forming step of lowering the bonding tool vertically toward the second bonding point for compression to thin the cut portion of the wire;

a bonding tool raising step of raising the bonding tool while paying out the wire; and

a wire tail forming step of moving the bonding tool in a direction away from the first bonding point and the second bonding point and along a wire direction connecting the first bonding point and the second bonding point and then cutting the wire at the cut portion to form a wire tail at the tip of the bonding tool.

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

in the cut portion forming step, the bonding tool is raised to a first height;

in the bonding tool moving step, the bonding tool is lowered to a second height lower than the first height and, at the second height, the bonding tool is moved to the cut portion of the wire while the tip of the bonding tool is pressed against the wire; and

in the thin portion forming step, the bonding tool is used for compression to a third height lower than the second height.

3. The semiconductor device manufacturing method according to claim 1, wherein in the bonding tool moving step, the tip of the bonding tool is pressed against the wire at a point nearer the first bonding point than the second bonding point.

4. The semiconductor device manufacturing method according to claim 2, wherein in the thin portion forming step, the bonding tool is moved along the wire direction while being kept at the third height.

5. A semiconductor device comprising:

a wire;

a first electrode at which the wire is bonded first as a first bonding point; and

a second electrode at which the wire is bonded, which is bonded at the first electrode and extended in a predetermined shape from the first electrode, wherein

the wire has a thin portion bonded to the first electrode, and

the thin portion is formed to be thinner than the diameter of the wire within a region of the first electrode in a plan view by the bonding tool pressing an end portion of the wire on the side of the first electrode.

6. The semiconductor device according to claim 5, wherein the portion of the wire rising from the first electrode is formed with a recessed portion.

7. The semiconductor device according to claim 6, wherein

the first electrode is provided on a semiconductor chip and the region of the first electrode is a region exposed through a passivation film formed on the semiconductor chip, and

the second electrode is provided on a substrate on which the semiconductor chip is mounted.

8. 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 freely in an XY plane and in a Z direction within a bonding region;

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

a bonding tool attached to one end of the ultrasonic horn and configured to press a wire inserted therethrough against the first bonding point and the second bonding point that serve as bonding targets; and

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

the control unit is configured to be capable of performing the steps of:

raising the bonding tool while paying out the wire and moving the bonding tool in a direction from the second bonding point toward the first bonding point to form a cut portion in the wire extending out of the tip of the bonding tool, the cut portion being bent in the vicinity of the second bonding point;

lowering the bonding tool and moving the tip of the bonding tool to the cut portion of the wire while being pressed against the wire;

using the bonding tool for compression to thin the cut portion of the wire;

raising the bonding tool while paying out the wire; and

moving the bonding tool in a direction away from the second bonding point and then cutting the wire at the cut portion to form a wire tail at the tip of the bonding tool.

9. The semiconductor device according to any one of claims 5 to 7, wherein the wire is made of aluminum.