CLAIMS

1. An automatic soldering method carried out using an automatic soldering device that includes a laser soldering device and a Z-axis drive device driving the laser soldering device in an up-down direction,

wherein the laser soldering device comprises:

a body having a lower opening, an image capturing hole in communication with the lower opening, and an irradiation hole in communication with the lower opening;

a mirror reflecting or transmitting laser light to guide the laser light to the lower opening, and reflecting or transmitting incident light through the lower opening;

an image capturing device capturing an image of a workpiece through the image capturing hole and the mirror;

a laser device constituted by a single laser light source; and

an optical fiber guiding the laser light from the laser device to enter the irradiation hole, and

wherein the automatic soldering method comprises:

a first height adjustment step of adjusting, by the Z-axis drive device, a height of the laser soldering device to a position at which the laser light has a preset irradiation diameter D1 larger than a diameter of a solder droplet S when viewed from above;

a preliminary heating step of sending an irradiation command to the laser device, and irradiating the solder droplet S with the laser light to heat the solder droplet S to a temperature at which a flux solvent component volatilizes and a solder powder does not melt;

a second height adjustment step of adjusting, by the Z-axis drive device, the height of the laser soldering device to a position at which the laser light has a preset irradiation diameter D2 smaller than the diameter of the solder droplet S when viewed from above; and

a main heating step of sending an irradiation command to the laser device, the irradiation command causing the laser device to emit the laser

light with a higher output than in the preliminary heating step, irradiating the solder droplet S with the laser light to heat the solder droplet S to a temperature at which the solder powder melts, and performing soldering.

2. The automatic soldering method according to Claim 1, wherein, in the second height adjustment step, the height of the laser soldering device is adjusted such that the laser light applied in the main heating step does not protrude from a region of an electrode pad.

3. The automatic soldering method according to Claim 2, wherein the solder droplet S is formed to protrude from the region of the electrode pad.

4. The automatic soldering method according to any one of Claims 1 to 3, wherein, in the first height adjustment step, the irradiation diameter D1 is set to fall within a range of 1.1 to 2 times the diameter of the solder droplet S.

5. The automatic soldering method according to Claim 4, wherein, in the second height adjustment step, the irradiation diameter D2 is set to fall within a range of 0.1 to 0.9 times the diameter of the solder droplet S.

6. The automatic soldering method according to any one of Claims 1 to 5, wherein the main heating step includes a step of gradually increasing the output of the laser light.

7. The automatic soldering method according to Claim 6, wherein, in the main heating step, the laser light is applied at a certain output for a preset time, and thereafter the output of the laser light is gradually increased.

8. The automatic soldering method according to any one of Claims 1 to 7, wherein plural patterns for relations among the diameter of the solder droplet S, combinations of the irradiation diameters D1 and D2

corresponding to the diameter of the solder droplet S, and the output of the laser light are stored, and the first height adjustment step and the second height adjustment step are performed in accordance with selected one of the patterns.

9. The automatic soldering method according to any one of Claims 1 to 8, wherein the image capturing device is constituted to be in focus in the second height adjustment step.

10. An automatic soldering device including a laser soldering device, a Z-axis drive device driving the laser soldering device in an up-down direction, and a control device controlling operations of the laser soldering device and the Z-axis drive device,

wherein the laser soldering device comprises:

a body having a lower opening, an image capturing hole in communication with the lower opening, and an irradiation hole in communication with the lower opening;

a mirror reflecting or transmitting laser light to guide the laser light to the lower opening, and reflecting or transmitting incident light through the lower opening;

an image capturing device capturing an image of a workpiece through the image capturing hole and the mirror;

a laser device constituted by a single laser light source; and

an optical fiber guiding the laser light from the laser device to enter the irradiation hole, and

wherein the control device executes:

a first height adjustment step of adjusting, by the Z-axis drive device, a height of the laser soldering device to a position at which the laser light has a preset irradiation diameter D1 larger than a diameter of a solder droplet S when viewed from above;

a preliminary heating step of sending an irradiation command to the

laser device, and irradiating the solder droplet S with the laser light to heat the solder droplet S to a temperature at which a flux solvent component volatilizes and a solder powder does not melt;

a second height adjustment step of adjusting, by the Z-axis drive device, the height of the laser soldering device to a position at which the laser light has a preset irradiation diameter D2 smaller than the diameter of the solder droplet S when viewed from above; and

a main heating step of sending an irradiation command to the laser device, the irradiation command causing the laser device to emit the laser light with a higher output than in the preliminary heating step, irradiating the solder droplet S with the laser light to heat the solder droplet S to a temperature at which the solder powder melts, and performing soldering.

11. The automatic soldering device according to Claim 10, wherein, in the second height adjustment step, the height of the laser soldering device is adjusted such that the laser light applied in the main heating step does not protrude from a region of an electrode pad.

12. The automatic soldering device according to Claim 10 or 11, wherein, in the first height adjustment step, the irradiation diameter D1 can be set to fall within a range of 1.1 to 2 times the diameter of the solder droplet S.

13. The automatic soldering device according to Claim 12, wherein, in the second height adjustment step, the irradiation diameter D2 can be set to fall within a range of 0.1 to 0.9 times the diameter of the solder droplet S.

14. The automatic soldering device according to any one of Claims 10 to 13, wherein the main heating step includes a step of gradually increasing the output of the laser light.

15. The automatic soldering device according to Claim 14, wherein, in the

main heating step, the laser light is applied at a certain output for a preset time, and thereafter the output of the laser light is gradually increased.

16. The automatic soldering device according to any one of Claims 10 to 15, wherein the image capturing hole is a vertical hole, and the laser light is applied through the lower opening that is a lower end opening of the image capturing hole, and

wherein the irradiation hole is a horizontal hole, and the mirror is disposed at a point at which the image capturing hole and the irradiation hole intersect.

17. The automatic soldering device according to any one of Claims 10 to 16, wherein an optical fiber lens is disposed between the mirror and the irradiation hole, and an image capturing lens is disposed between the mirror and the image capturing hole.

18. The automatic soldering device according to Claim 17, wherein the image capturing lens is a single-focus lens, and the automatic soldering device further comprises a position adjustment mechanism capable of adjusting a physical position of the image capturing device relative to the body, or wherein the optical fiber lens is a single-focus lens and the automatic soldering device further comprises a position adjustment mechanism capable of adjusting a position of the image capturing lens.

19. The automatic soldering device according to any one of Claims 10 to 18, wherein the image capturing device is constituted to be in focus in the second height adjustment step.

20. The automatic soldering device according to any one of Claims 10 to 19, further comprising:

a discharge device; and

an attachment member holding the laser soldering device and the discharge device and coupled to the Z-axis drive device.

21. The automatic soldering device according to Claim 20, further comprising an X-axis drive device to which the Z-axis drive device is mounted,

wherein the laser soldering device and the discharge device are simultaneously moved by the Z-axis drive device and the X-axis drive device.