Fundamental Soldering Technologies Volume 3: Ultrasonic Wave Soldering

Soldering on glass and ceramic materials is possible with ultrasonic wave soldering

The technique of ultrasonic soldering ignores conventional wisdom and actually uses it for applying oxide materials. With uses such as application of electrodes to glass surfaces for solar panels, this technology also can be applied to materials such as aluminum and ceramics.

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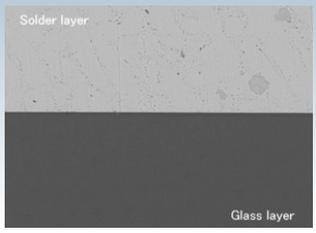
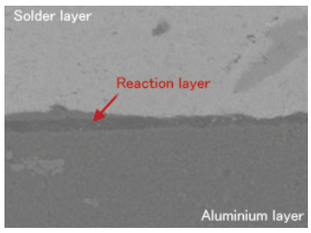
Until now, soldering was basically a process for joining solder and metals. Ultrasonic wave soldering is a technique that enables the soldering process to be used for joining solder to glass, ceramics and other non-metal materials. In recent years, as the movement toward natural energy sources has progressed worldwide, ultrasonic soldering is being used in many applications, such as for attaching electrodes to solar panels.

The technology of ultrasonic wave soldering enables the application of solder to materials such as glass, ceramics, and anodized aluminum, which cannot be used with conventional soldering. Typically when soldering, it is standard procedure to remove oxides from the surface of the material to be soldered. However, the materials used in ultrasonic soldering are themselves oxides. These materials are joined with solder using different principles than in traditional soldering. Also, the use of flux is required in traditional soldering, but ultrasonic soldering is possible even without the use of flux.

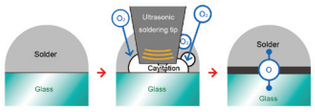
Soldering on glass



Soldering on aluminum



Ultrasonic soldering bonding mechanism



Ultrasonic "Cavitation" Effects

When ultrasonic vibrations are applied to a liquid, the differences in amplitude pressure create small cavities in the form of air bubbles. This phenomenon is called "cavitation," and at the time when these cavities are crushed by atmospheric pressure, a large amount of energy is released. An ultrasonic soldering system consists of a heater with an iron tip that supplies ultrasonic vibrations at 60 KHz during its soldering. The waves are transmitted to the iron tip through the ultrasonic waves produced by the oscillator's vibrations. In the boundary between the base material and the melting solder, a hollow cavity (foam) forms as a result of the cavitation effect.

Intermetallic Compound Formation

For aluminum, stainless steel and other metals, soldering is not impossible. In the traditional method, soldering is performed using special flux to remove the firm layer of oxidation. However, as a result of recent environmental regulations, the use of highly acidic flux materials must be avoided. This has led to a focus on new ultrasonic soldering techniques that can be performed flux-free. Ultrasonic soldering uses the energy released from the rupture of hollow spots through the process of cavitation to replace the function of the flux, removing the oxidation layer. After removing this oxidation layer, the result is the formation of a reaction layer, just as in traditional soldering.

Covalent Bonding with Oxygen

On the other hand, when the base materials themselves are oxides, the energy released from cavitation cannot remove the oxidation layer. In this case, using the energy from the cavitation rupturing, the layers of air, organic matter and other foreign materials are removed from the bonding surface. After that, the vacuum effect forms a hollow cavity, and through the intermediary of oxygen captured from the atmosphere, the oxide that is the base material and the metallic elements of the solder form a covalent bond. At this point, the soldering process is complete. This is why when working with non-metal base materials, there is no reaction layer forming a boundary between the base material and the solder. In this way, although the bonding principles differ, ultrasonic wave soldering has made previously impossible soldering applications a reality.

Expanding Applications of Ultrasonic Wave Soldering

Until recently, soldering was mainly performed using low-power tools. However, as a result of new technological developments, the scope of soldering has expanded to everything from small, detailed work to high-power, large-scale projects as well as materials that previously were unusable. At JAPAN UNIX, we possess a wealth of information regarding all kinds of soldering techniques encompassing the basics of iron soldering as well as laser and ultrasonic wave techniques, and also are carrying out streamlining and automation processes through the use of specialized robots.

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