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Resistance Brazing

Resistance brazing is a type of material joining process that uses resistance welding equipment to produce a brazed metallurgical connection. Resistance brazing is a bit different than conventional brazing and it is important to understand the distinctions. Conventional brazing is a two-step process. In the first step, the flux, which is applied as a paste or as a reducing atmosphere surrounding the parts, becomes active as the parts are heated and removes any oxides or contaminants from the surfaces that will be brazed. For the fluxing process to work, the flux has to have access to mating surfaces and hence those surfaces cannot be in intimate contact. Once the flux has removed the oxides, the second step of brazing process commences as the braze alloy melts and flows between the parts to be joined and bonds to both parts as it cools. For both steps to work in conventional brazing, there has to be a gap between the parts to be brazed so that the flux and braze can do their job.

Resistance brazing is different from conventional brazing in the sense that the mating parts, during the heating and brazing process, are in intimate contact with each other with little chance for the flux or braze alloy getting in between from outside (Figure 1). Intimate contact is required for the resistance welding process to be able to heat the parts by sending current through the mating surfaces. So how does resistance brazing work? It works by not having a conventional flux and by placing the braze alloy at the interface in the form of a foil or sometimes the braze alloy is directly plated on the surface.

One method to eliminate the need for a flux is to use self-fluxing braze alloys such as Sil-Phos alloys which contain 5-8% Phosphorous; as the braze melts, the P in the alloy is able to reduce oxides on the surface of the copper parts. Sil-Phos, which is a trade name, is actually a family of Cu-Ag-P alloys with varying compositions to control melting behavior. Sil-Phos alloys are commonly used for brazing copper in conventional brazing processes as well. In resistance brazing with Sil-Phos alloys, a small piece of braze foil is sandwiched between the copper parts prior to brazing. The joint is then heated by passing current through the sandwich and allowing the braze alloy to melt and bond to the surfaces. Sil-Phos is limited to use on copper components and cannot be used with other copper alloys such as brass and bronzes or ferrous components.

Another way to avoid flux is to plate the components with a layer of braze alloy that resists oxidation. A common option used in resistance brazing of electronic packages is to plate Kovar components, both base and lid, with a layer of Ni; some customers prefer to have a flash on gold on top of the Ni layer. The lids are welded on specially designed machines that have rolling electrodes that travel along the length of the lid making overlapping spot welds/braze. After traversing along one direction, the assembly is rotated 90 degrees and the other two sides are welded (Figure 2). During resistance brazing, the Ni layer on both parts melts and forms an in-situ braze alloy that bonds both parts together to form a hermetic seal (Figure 3a.). If a lower bonding temperature is desired, a layer of electroless Ni can be used instead. Electroless Ni can have up to 15% Phosphorous which lowers the melting point of the Ni layer down to 850°C. Presence of phosphorous can cause the weld to be brittle and hence the percentage is usually controlled down to about 7%. Electroless Ni layer can be used as an in-situ plating for copper and ferrous alloys as well.

Resistance brazing can also be done the old fashioned way with braze foil/paste and flux, but such an operation is very rare. For conventional brazing using resistance welding equipment, the parts have to be specially designed to allow for channels along the mating surfaces from where the flux can escape and the braze alloy can collect and bond to both parts. Since flux is used, the flux residue will have to be removed and in most cases can be done by rinsing in warm DI water. Finally, just because you are trying to resistance braze does not mean you will get a brazed joint. You still have to section the joint to find out the location of the braze alloy. There are applications where metallurgical sections reveal that the braze alloy has been completely squeezed from between the mating surfaces and what you have is actually a good strong solid-state bond! (Figure 3b.). Of course, there is no way of knowing that by looking from the outside since the braze alloy does appear to have formed a nice external fillet.

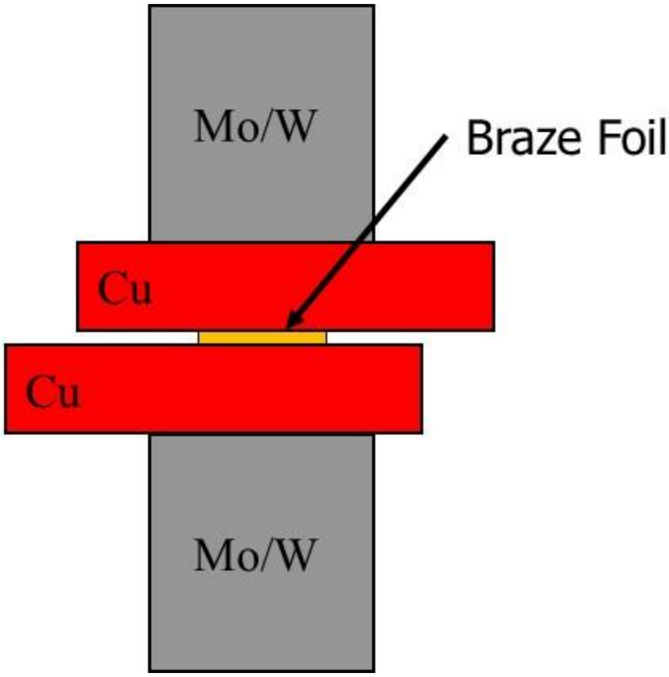


Figure 1. Schematic showing two copper pieces sandwiching a Sil-Phos foil and being resistance brazed by two molybdenum or tungsten electrodes.

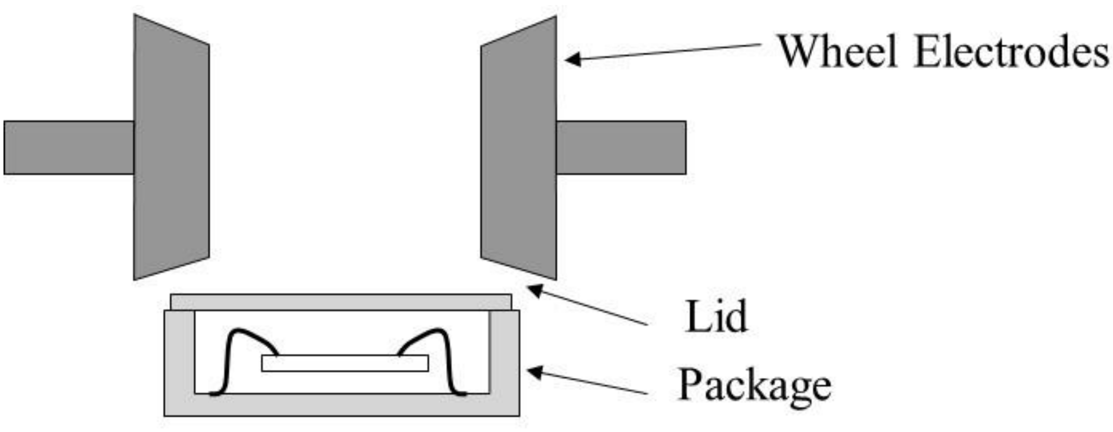
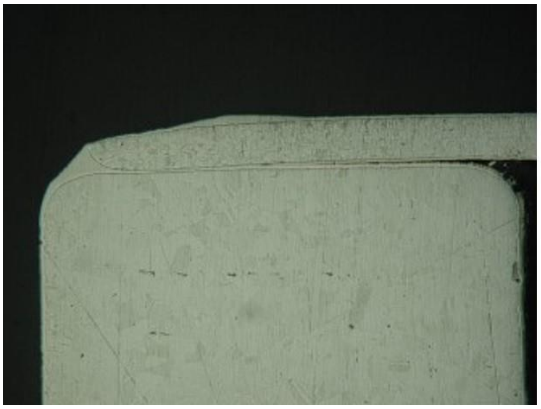


Figure 2. Schematic showing roll-spot welding used for sealing lids. The round wheel electrodes traverse along the length of the package making overlapping spots.



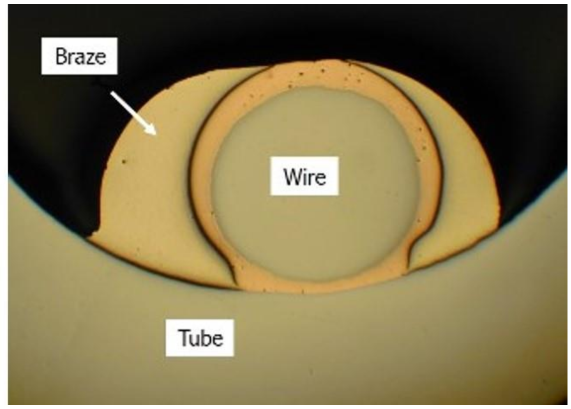


Figure 3. Section of braze joint on the left show a braze between kovar lid and base. Flow of Ni and Au plating to form a fillet is evident. Section on the right shows a braze joint that is actually a solid-state bond on the inside, even though a braze fillet is visible on the outside.

For additional questions or concerns, please contact
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