Hermetic Sealing Technologies Enable Reliable Welds and Protect Electronic Devices from Harsh Environments

Hermetic sealing is the encapsulation of electronic components into an airtight metal or ceramic housing using either parallel gap resistance seam welding or opposed electrode projection resistance welding. It is a key manufacturing process utilized in assembling micro-electronic packages for communication, aerospace and medical device manufacturing.

USES OF HERMETIC SEALING

Microelectronic devices are commonly used in industrial commercial communications, transportation, military and aerospace industries and include optical sensors, pressure sensors, communications devices, thermal and laser imaging and power amplifiers. By sealing these electronic packages, external contaminants – like moisture – are kept out preventing degradation of the electronic components inside and extending lifetime usefulness.

Implantable medical devices, like pacemakers and defibrillators, also require careful hermetic sealing to protect both the device and the patient.

MICROELECTRONIC PACKAGE TYPES

There are two primary types of packages: metallic tub and ceramic (figure 1).

The preferred material for metallic tub base packages is Kovar™, which has a similar Coefficient of Thermal Expansion (CTE) as glass; the use of this material prevents the metal-to-glass seals of the feedthrough connectors of the package from leaking due to material expansion from heat generated during the welding process.

Ceramic packages are made of a ceramic substrate with a brazed metal seal ring. Kovar is also used in ceramic packages; the Kovar is brazed onto the ceramic base as a seal ring to which the lid is welded.

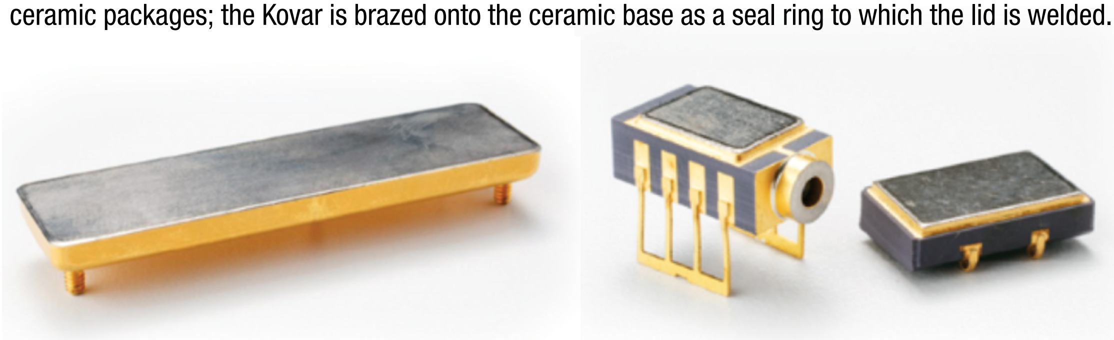

Figure 1: shows a metal tub package on the left and two types of ceramic packages on the right.

PARALLEL GAP RESISTANCE SEAM WELDING

Parallel gap seam welding is one way to execute a hermetic seal. A seam welder with rolling wheel electrodes is connected to a power supply, which is responsible for delivering electric current across the electrodes, through the lid and the package. The seam welder delivers multiple overlapping weld spots, thus creating a continuous weld (figure 2).

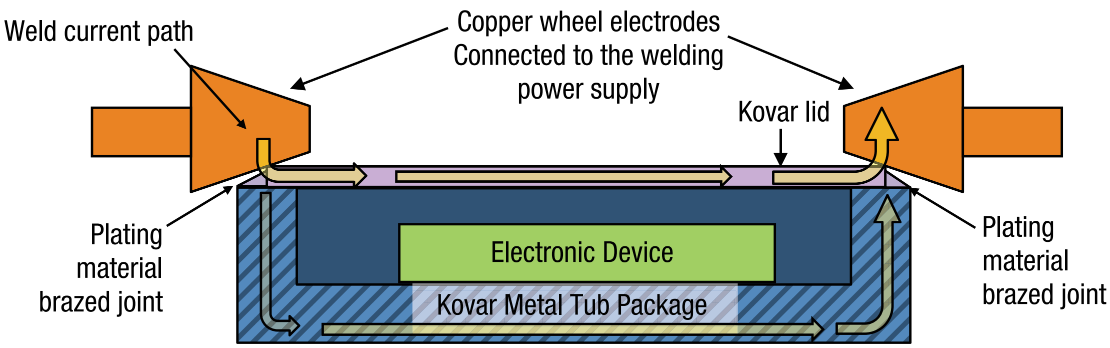

Figure 2: Schematic of parallel gap seam welding

OPPOSED ELECTRODE PROJECTION RESISTANCE SEAM WELDING

Another method used to execute hermetic seals is opposed electrode projection welding. This process utilizes opposing electrodes to join a header (containing the electronic device) to a cap designed with a ring or annular projection, by running current across the electrodes through both the cap and the header. The generated heat is directed through the projection in order to weld the parts together (figure 3). A successful weld should have at least a 50-90% projection collapse; linear displacement measuring device sensors (also known as Linear Variable Differential Transformer (LVDT)) can be added to the weld head to measure this collapse. Additionally, a fillet formation is typically seen at the perimeter of the cap indicating a successful weld.

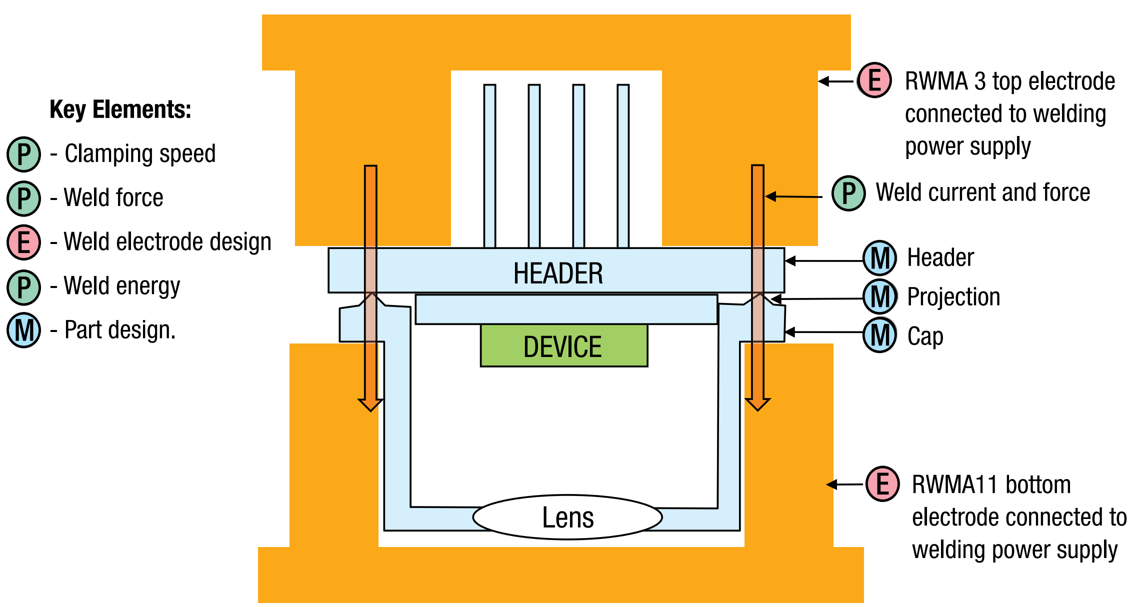

Figure 3: Projection welding schematic showing cross section of electrodes and example device.

As with parallel gap seam welding, the part design of the metal packages in opposed electrode projection seam welding is very important. The projection can be either on the cap or the header, but there must be a constraining feature between the two so that the parts self-align. The preferred material, again, is Kovar. For best results, the projection should be located in the middle of the flange, so that as the projection collapses, the displaced material is evenly distributed across the width of the flange.

TESTING AND TROUBLESHOOTING

Weld strength destructive testing can be performed in hermetic sealing applications to ensure that welds are secure. In destructive testing, seeing at least a 25% weld joint still intact after significant attempts to mechanically separate the lids or caps from the base is a good indicator that a strong weld was achieved. Other methods of testing hermetic reliability include helium fine leak and gross leak bubble testing, optical fine leak detection, internal gas analysis, particle impact noise detection and temperature cycling.

CONCLUSION

Hermetic seam sealing technology can be critical to success in a number of demanding applications such as industrial 5G commercial communications, aerospace, and military electronic devices. Ensuring an excellent seal through welding is extremely important, and only trusted weld device manufacturers who account for the demands explained above can ensure highly accurate and reliable welds. Manufacturers like AMADA WELD TECH are incorporating these standards into current controlled environment welding technology, and are also developing technology for the future that will enable even greater accuracy and weld success. The future of hermetic sealing is likely to be robot-assisted seam sealing pick-and-place with smart vision systems, which have the potential to eliminate current margins of error and lead to even greater success in hermetic sealing of sensitive electronic devices.