Microjoining

Meeting big challenges on a small scale

EWI®

We Manufacture Innovation

MICRO1-CIP14

Shrinking Technology

Rapidly advancing technology drives electronic and biomedical devices toward smaller sizes and increased complexity. Consumers desire sophisticated devices that are affordable, powerful, and aesthetically appealing. Biomedical devices need to be as small as possible, and safety and dependability are paramount. Achieving these goals necessitates joining processes that are able to meet the challenges of miniaturization.

Microjoining encompasses the processes that join extremely small parts, such as sheet and tubular materials that are often mere microns in thickness. These processes include welding, brazing, soldering, and adhesive bonding. Common microjoining welding techniques are wire bonding, laser welding, ultrasonic welding, and micro resistance welding.

World's Smallest Pacemaker

2013 saw the first human implant of the world's smallest pacemaker, a device one-tenth the size of a traditional pacemaker, or about the size of a large pill.

info@ewi.org

EWI microjoining lab

Challenges of Microjoining

There are many unique factors involved in microjoining, including heat input, repeatability, and production time. Working on a micro scale requires precise control to avoid damaging components.

The convergence of manifold technologies in electronic devices like smart phones means that a greater number of components are being packed into small spaces. This yields a high number of joints that must be reliable. These joints often bring together materials of different size, shape, and composition.

info@ewi.org

Micro Resistance Welding

Resistance welding on a micro scale has additional challenges due to the small size and composition of materials being joined.

Advantages of micro resistance welding:

- Fast
- Safe
- Reliable
- No consumables used
- Environmentally friendly

Micro Resistance Welding vs. Soldering

Soldering is frequently used in the assembly of electrical components, but micro resistance welding has many advantages for micro applications. It can be completed at a much faster rate, and does not use solder or flux.

info@ewi.org

Dissimilar Materials

Joining dissimilar materials presents opportunities to incorporate new functionalities and to reduce costs during manufacturing. Biomedical devices frequently require materials that possess unique properties, but can only be present in small amounts. These materials can be difficult to work with, and it is necessary to identify and employ the microjoining technique that best suits the task.

EWI's Patented NiTi Joining Process

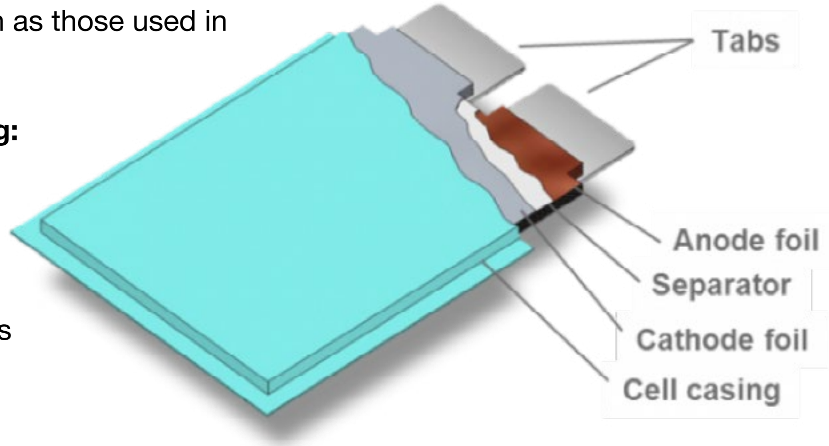
Nitinol (NiTi) is used in medical devices for its biocompatibility and superelastic properties. EWI patented a process that enables fusion welding of nitinol to stainless steel. This process has been licensed to end-users for specific product application.

Ultrasonic Metal Welding

Ultrasonic metal welding is a solid-state process that is ideal for joining dissimilar materials. Additionally, it is well suited for welding highly conductive materials, such as those used in batteries.

Advantages of ultrasonic metal welding:

- Does not require high power
- Weld cycles are very short
- Joins multiple layers of thin materials in one operation



Lithium Ion Battery Cells

EWI evaluated ultrasonic metal welding for joining multiple layers of foils to a tab in a lithium-ion battery pack. One failure in a foil-to-tab joint would compromise the output of the entire pack, thus a robust joining process was needed. Results concluded that not only did the process provide high quality welds, it had several advantages over resistance spot welding and laser beam welding.

info@ewi.org

Ensuring Reliability

For any microjoining process, the greatest concern during the development of a joint is reliability. Determining reliability requires the use of welding equipment with closed-loop control for repeatability, in-process monitoring of key factors, and post-process inspection with non-destructive evaluation (NDE).

EWI process development projects determine which factors to monitor in-process, support the validity of the process with data, and develop criteria for proper post-weld NDE or inspection.

Magnified photo of edge welds on copper

Application of weld data technology to Micro–TIG

An edge weld was produced on two layers of 0.008” copper plate. As a result of accurate, high-speed data collection, process variables such as torch-to-work offset could be observed in the weld voltage waveforms.

info@ewi.org

Biomedical Sensor Mini Case Study

EWI's microjoining group was asked to join a platinum wire to a titanium film for a highly specialized medical device. The application was very limited in selection of materials, and soldering was not an option, as it would add non-biocompatible material and increase the overall size of the assembly. Due to these factors, parallel-gap resistance welding was chosen.

The parallel–gap resistance welding process:

- Welding electrodes were placed on the platinum wire with a small gap in between
- A current was passed between the electrodes for a few milliseconds
- The platinum wire heated and conducted energy to the titanium film
- The materials brazed together at specific locations

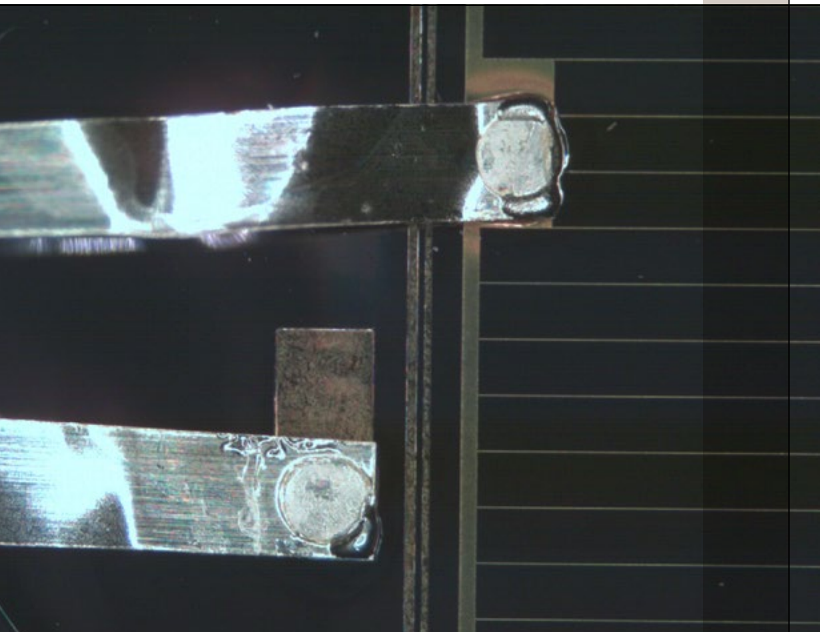
On–board data collection equipment ensured consistent and precise energy delivery to each joint.

Platinum wire parallel–gap welded to a titanium film on glass

info@ewi.org

Solar Cell Mini Case Study

EWI was tasked with applying microjoining capabilities to solar cell production. Project requirements called for a thin silver foil lead, Pb-free solder, and solder joint size less than 0.5mm. As production volume increased, it became necessary to transition to a semi-automated process. EWI developed a process to utilize a semi-automatic resistance reflow soldering machine. Following successful process development and functional testing, the client purchased the system and integrated it into its production process.



Silver foil leads resistance reflow soldered to solar cell pads

info@ewi.org

Conclusion

Applications of microjoining are diverse and ever expanding. EWI develops, tests, and implements new microjoining processes that align closely with industry needs and provide solutions for the present and future.