Manufacturing & Prototyping

Improved Assembly for Gas Shielding During Welding or Brazing

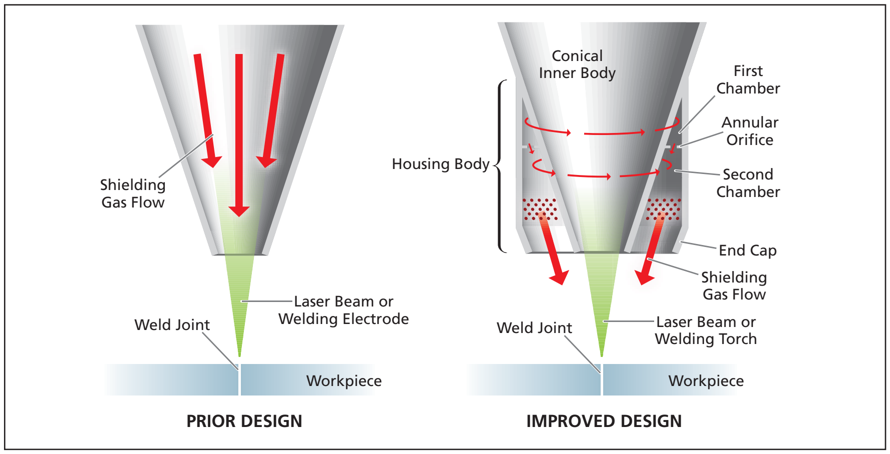
Inert gas is distributed evenly over the region surrounding the weld joint.

Marshall Space Flight Center, Alabama

An improved assembly for inert-gas shielding of a metallic joint is designed to be useable during any of a variety of both laser-based and traditional welding and brazing processes. The basic purpose of this assembly or of a typical prior related assembly is to channel the flow of a chemically inert gas to a joint to prevent environmental contamination of the joint during the welding or brazing process and, if required, to accelerate cooling upon completion of the process.

In a typical prior welding gas-shielding assembly, depicted in the left part of the figure, the inert gas is fed to the joint through a central nozzle in the welding torch. This arrangement does not always provide adequate protection against contaminants because the inert gas flows turbulently into the joint region and is not evenly distributed in the heated region surrounding the joint. The lack of inert gas in some places in the region surrounding the joint can result in oxidation, which, in turn, can lead to porosity and ultimately to cracking. Improper distribution of shielding gas can also lead to the formation of plasma and to insufficient cooling of portions of the region surrounding the joint that are meant to be protected against excessive heating.

The present improved welding gas-shielding assembly, depicted in the right part of the figure, provides a column of evenly distributed gas flow directly surrounding the pool of molten metal in the weld joint to prevent oxidation and formation of plasma.



These **Simplified Cross Sections** show the main differences between the present improved welding gas-shielding assembly and a typical prior such assembly.

The assembly includes a conical inner body and an outer shell comprising a housing body and an end cap. The outer shell contains chambers sized and shaped to act, along with the conical inner body, to distribute the inert gas evenly around the conical inner body and to encapsulate the flow of the gas and direct the flow onto the desired region surrounding the weld joint.

The gas enters the assembly through a supply tube from an external source. The passage through which the gas enters is tangential, so the gas flows in tangentially, creating a vortex flow in the chambers between the outer shell and the conical inner body. The gas circulates as it fills the first chamber, then flows through an annular orifice to fill a second chamber and then flows through a series of diffusing screens. After flowing through the screens, the gas is directed to the weld joint area by means of a nozzle. The combination of the vortex flow, chambers, and screens provides even columnar flow around the entire heated area.

This work was done by Paul Gradl and Kevin Baker of Marshall Space Flight Center and Jack Weeks of Pratt & Whitney. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32644-1.

Two-Step Plasma Process for Cleaning Indium Bonding Bumps

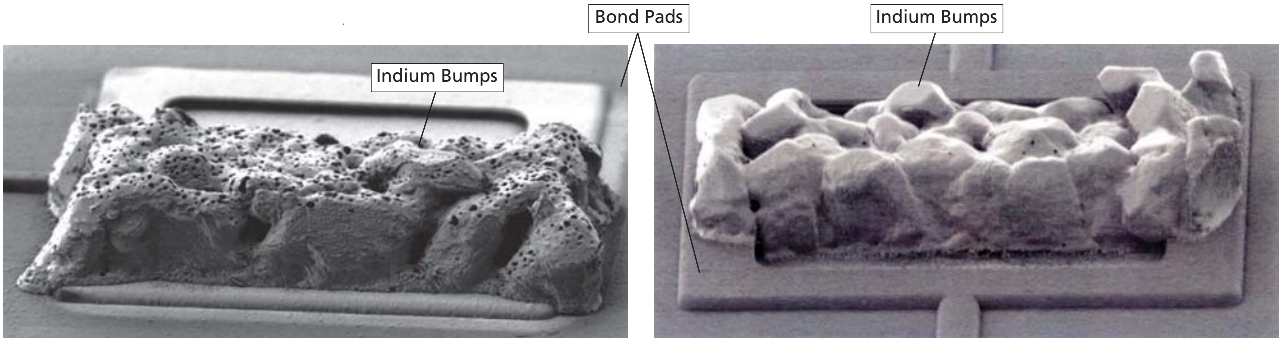
This process could increase yields in the manufacture of consumer electronic products.

NASA's Jet Propulsion Laboratory, Pasadena, California

A two-step plasma process has been developed as a means of removing surface oxide layers from indium bumps used in flip-chip hybridization (bump bonding) of integrated circuits. This process has considerable commercial potential in that flip-chip hybridization is used in the manufacture of cellular telephones and other compact, portable electronic products.

The need for this or another, similar cleaning process arises as follows: Indium bonding bumps tend to oxidize during exposure to air. As the duration of exposure and the level of oxidation increase, the electrical resistances of the bonds subsequently formed via the bumps also increase. In some cases, the resistances can become so large that the bump bonds may act as open circuits, preventing proper functioning of the bump-bonded devices.

There is a patented process for removal of surface indium oxide layers by



PROCESSED AT POWER GREATER THAN OPTIMUM

PROCESSED AT OPTIMUM POWER

These **Indium Bonding Bumps** were treated by two different versions of the two-step plasma process. The pockmarks on the left bump were caused by using greater-than-optimum plasma-generating power in the second step of the process. The right bump was processed at optimum power.

etching with hydrochloric acid. Unfortunately, once the oxide is removed, the acid can continue to attack the indium, reducing the size of the bumps and even undercutting them. The acid can also attack metal layers on and under the bond pads, potentially creating open circuits and thus negating the benefit of removing the oxide. In contrast, the two-step plasma process makes it possible to remove surface indium oxide, without incurring the adverse effects of the acid etching process.

In the first step of the plasma process, a device on which indium bonding bumps has been formed is exposed for a suitable amount of time (typically, 20 minutes) to a plasma generated in a gaseous mixture of 1/3 argon + 1/3 methane + 1/3 hydrogen. During this step, the oxygen in the indium oxide is removed through incorporation into CO and CO_2 gas molecules, while the indium in the indium oxide is removed through incorporation into $In(CH_3)$, which is volatile. Following this step, a carbonaceous surface film is also formed on device surfaces that are not covered by indium.

A second step for removing the carbonaceous film is as follows. The device is exposed to a plasma generated in a gaseous mixture comprising 72 percent of argon and 28 percent of hydrogen. This step greatly reduces the carbon content without exerting any significant adverse effect on the indium. The power used to generate the plasma in this step must be chosen carefully: the power should be high enough to ensure effective removal of the carbonaceous film, but not so high as to melt or otherwise damage the indium bumps (see figure).

This work was done by Harold F. Greer, Richard P. Vasquez, Todd J. Jones, Michael E. Hoenk, Matthew R. Dickie, and Shouleh Nikzad of Caltech for NASA's Jet Propulsion Laboratory.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to NPO-45911, volume and number of this NASA Tech Briefs *issue, and the page number.*

Tool for Crimping Flexible Circuit Leads

Lyndon B. Johnson Space Center, Houston, Texas

A hand tool has been developed for crimping leads in flexible tails that are parts of some electronic circuits — especially some sensor circuits. The tool is used to cut the tails to desired lengths and attach solder tabs to the leads. For tailoring small numbers of circuits for special applications, this hand tool is a less expensive alternative to a commercially available automated crimping tool. The crimping tool consists of an off-the-shelf hand crimping tool plus a specialized crimping insert designed specifically for the intended application.

The components of the insert and their roles include the following:

- A pin guide aligns pins on the solder tabs with the leads in a tail that is part of the flexible circuit.
- A punch pushes the pins through the pin guide and crimps them onto the tail.
- A forming plate aligns the tail over grooves that form the pins from the solder tabs.
- A spaceplate includes a surface that serves as a stop for positioning the tail when the tail is inserted in the forming plate.
- A dowel pin enables semi-permanent assembly and alignment of the punch, pin guide, and springs.
- A pin holder holds and helps to align the solder tabs before crimping.

This work was done by Aaron Hulse and Myron A. Diftler of Lockheed Martin Corp. for Johnson Space Center. Further information is contained in a TSP (see page 1). MSC-23461-1