Metal-to-Metal Cladding

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Connection applications often require a combination of engineering properties not found in a single material. To meet these requirements, designers frequently combine metals with different, but complementary, engineering properties. In joining materials for high reliability interconnects, precious metal coatings are often required, which can increase costs significantly.

Traditionally, engineers have turned to electroplating as a means of applying these coatings; however, metal-to-metal cladding — as either an overall or a selective stripe coating — is a practical, cost-effective alternative to electroplating (figure 1). Besides providing unique property combinations, cladding reduces labor, simplifies assembly and improves product quality. More importantly, it provides designers with increased design flexibility.

A time-tested, metalworking technique, cladding is used successfully in a wide variety of industries, including the electrical, electronics, automotive, telecommunications, semiconductor and appliance industries. Typical applications include connector contacts, switch contacts, wirebond interconnects and semiconductor lead frames.

Bonding is Key
Metal-to-metal cladding joins dissimilar metals through the application of extremely high pressure without the use of brazing alloys or adhesives. This process “metallurgically” bonds the materials together, producing a continuous strip that can be coiled, annealed, rolled and slit to desired dimensions and mechanical properties.

The key to cladding is the metallurgical bond. Before bonding, the metals' surfaces must be free from contaminants that can interfere with the contact between the materials' atoms. Manufacturers achieve a contaminant-free surface by rigorously cleaning the metals, removing all foreign matter, such as oil, water and metal oxides.

Immediately following the cleaning, the metals are fed into a high pressure bonding mill where their atoms approach to within ten or twenty atom diameters of each other. This results in an interaction of electromagnetic forces and the formation of a physical bond.

To strengthen this bond, the bonded metals are subjected to a high-temperature heat treatment. This causes the atoms at the bond interface to diffuse and produces a permanent metallurgical bond. When the coating is a thin precious metal, such as gold or palladium (≤ 0.0001” thick), a nickel interliner between the precious and base metals is used. The interliner acts as a diffusion barrier preventing copper in the base metal from diffusing to the gold surface.

Skive Inlay Cladding
Skive inlay cladding is one of the most basic and cost-effective cladding techniques. It embeds a stripe or stripes of precious or other metal into a base metal with the top surface of the inlay flush with the base metal's surface (figure 2). Imbedding the stripe minimizes the risk of damage to the precious metal during stamping and assembly.

Because the process assures precise control of the dimensions, use of the precious metal can be minimized, with associated cost savings. These savings are increasingly important given the volatility and uncertainty of precious metal markets.

In addition, skive inlay cladding gives designers considerable freedom in locating the precious metal contact areas. Inlay stripes can be specified on either edge or on opposite sides of a base metal, and can be spaced as little as any spatial relation to each other. Clad inlays also offer formability equaling or exceeding that of the base metal, allowing stamping and forming of components in high-speed presses in a single die operation.

Parts can be stamped by automatic presses as easily and as quickly as with a monolithic metal.

Range of Materials
Cladding can join virtually any metal used in today’s connector applications, such as copper, brass, bronze, beryllium copper, steel and aluminum. Commonly used coatings are gold, palladium, platinum, silver and their alloys.

Non-precious metals, such as nickel, tin, lead, aluminum, copper, titanium and stainless steel are also used as coatings. They are selected to improve weldability, solderability and conductivity. Aluminum and stainless steel are also used for producing a solder resist area when necessary.

For low current connection applications, the preferred materials are gold,

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and is a much superior diffusion barrier to base metal copper diffusion to a precious metal surface, where it would be susceptible to oxidation at high temperatures.

Superior Formability/Increased Productivity/Reduced Costs
- Electrodeposited hard gold’s metallurgical structure makes it generally more brittle and harder to form than wrought gold. The clad nickel interliner also exhibits greater formability than electrodeposited nickel.
- Since most contact or connector parts require some forming, a three-step, stamp-plate-form process is required. This can be reduced to a single die operation with inlaid clad metals, providing what can often be significant savings in the cost of producing components.
- Selection of gold-alloys and less expensive palladium material can further reduce costs when compared to using pure gold.

Less Porosity
- Porosity is a discontinuity in a coating that exposes the substrate material to the potential of corrosion. Generally speaking, the thinner the coating, the higher the porosity. Since clad inlays are fully dense materials, their use minimizes concerns regarding porosity in thin metal films.

Typical Configurations
Typical configurations of clad metals are inlay, overlay and toplay. Inlays can be on the top or bottom of a base metal, any distance from the edge of the strip. Up to six inlays of the same or different materials on each surface can usually be applied.