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Covering all the base (metal)s! – An overview of how plating materials can protect the base metal and the contact interface in electronic connectors.

- **Reasons**
- **Materials**
- **Methods**
- **Consider-ations**

The next issue of Technical Tidbits will discuss tin as a coating material.

Coating Electrical Contacts

Successful electrical connectors provide and maintain good electrical contact between the two halves of the contact interface. An ideal interface will be transparent to the current or signal passing through it. This transparency requires low contact resistance. Application of the appropriate normal force will initially help to provide this low resistance electrical interface. In order to maintain good electrical contact, one must prevent degradation of the contact interface by preventing loss of contact force, and by preventing corrosion.

With the exception of precious metals like gold and platinum, one will rarely find pure metals in nature. They will usually be found in their natural states as ores (compounds of the metal and some other nonmetal like oxygen, sulfur or chlorine). Significant energy and processing is required to convert ores into usable metal, such as iron oxide into iron and steel alloys, or copper sulfide into copper and copper alloys. Given time, most pure metals will corrode (recombine with corrosive agents in the environment like oxygen, chlorine, sulfur, fluorine, etc.), in an attempt to return to their natural state. Since these corrosion products interfere with the passage of electrical current across a contact interface, contact surfaces are usually coated to prevent (or at least minimize) the formation of corrosion products.

Although the primary reason for coating electrical contacts is for increased corrosion resistance, it is by no means the only reason. Some coatings are used to increase the contact surface hardness over that of the base metal for improved wear resistance. In sliding wear applications, lubricity and friction reduction of the contact surface are other key factors. Electrical conductivity is very important, especially in high power applications. Solderability is important for attaching a contact to a circuit board or a terminal to a wire. In automotive underhood applications, resistance to elevated temperature is paramount. The contact surfaces in switches and relays must be resistant to electrical arcing, especially at high voltage. In high frequency electronic circuits, contact interface materials must pass the signal without excessive reflective loss due to mismatched impedance, or the addition any nonlinear effects to the circuit, such as passive intermodulation distortion.

There are many metals that are used to coat contact electrical contacts. Tin and tin lead alloys are very common in automotive applications, or where solderability is important. Nickel is used most often as a corrosion barrier underplate for precious metals. Gold is used for its exceptional corrosion resistance. Platinum, palladium, and rhodium were widely used in the past, although recent increases in price are making them less attractive. Silver is used for high electrical conductivity. Some more advanced coatings like silver tin oxides are used in contacts where arcing may be present. In addition, many proprietary and nonproprietary alloys have been made utilizing the above materials, and other elements like carbon or cobalt.

There are several techniques that are used to apply a coating to a material. Electroplating uses an electric current and a galvanic reaction to apply the appropriate plating material to the base metal. Electroless plating uses an autocatalytic reaction to apply the coating to the metal in the plating bath, without the use of an electric current. Cladding is the mechanical bonding of the coating material to the base metal.

Coating Electrical Contacts (continued)

Hot dipping requires passing the base metal into a molten bath of the material to be coated, allowing the molten metal to adhere to and solidify on the surface.

To further complicate matters, there is also the question of when coatings can be applied during the contact fabrication process. All of the above processes can be used to coat the input strip material before stamping. However, this will produce coated scrap, which can be wasteful of precious metals and complicate scrap recycling. Furthermore, the stamped edges of the contact will be bare, which may lead to creep corrosion. In addition, some coatings may be less formable than the base metal, which may cause cracking during the forming process. This is significant, since bends are usually areas of high stress. Even if these cracks are small and do not extend into the base metal, they can still initiate fatigue failures, or allow for localized corrosion of the underlying base metal. This could reduce the service life of the contact.

Some other coating materials and methods allow one to blank the parts out of the strip material, and do reel-to-reel coatings on the carrier strip. This will prevent bare edges, and will keep the coating material out of the scrap. However, this may require a forming operation after the coating process, necessitating a second press and die. This also does not solve the potential cracking problem if the plating is not as formable as the base metal.

The third alternative is to plate after the entire stamping process. Selective plating of certain areas of the contacts is extremely difficult to achieve, if not impossible. Furthermore, there may be problems with uniformity of thickness, or with the ability of the plating bath to reach all areas of the contact, potentially leaving bare spots.

Pores in the coating material can allow corrosion of the base metal underneath. Electroplated materials are especially susceptible to porosity, whereas clad metals are generally immune. Some coating methods will allow for thicker or thinner coatings than others. For very thin strip, high-stress coatings can create problems with distortion of the contacts.

There are many considerations which go into selecting a coating material, the method used to apply it, and the proper time in the fabrication process to apply it. The details of these issues will be discussed in future editions of Technical Tidbits.

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