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Night of the living corrosion product? - An overview of creep corrosion and pore corrosion of coatings on electrical contact surfaces.

- **Passive Corrosion**
- **Active Corrosion**
- **Creep Corrosion**
- **Porosity**
- **Pore Corrosion**

The next issue of Technical Tidbits will discuss nickel as an undercoating layer.

Creep Corrosion and Pore Corrosion

Corrosion can be a very difficult problem to manage. Once it starts, it tends to grow and spread like fungus. Anyone who has seen a small dent in an automobile's paint job turn into an epidemic of rust can attest to this. If a designer creates a contact for use in a corrosive environment, such as a sensor in a car's exhaust system, corrosion is to be expected. The contact may therefore be designed with extra corrosion protection. It may be in cases where corrosion is least expected that it causes the biggest problems. For example, a cellular phone or pager would generally not be expected to be exposed to corrosive agent in service. However, such a device could very easily find itself dropped into a bucket of ammonia-based cleaning solution. It may continue to function after cleaning and drying, but some aggressive corrosion could be occurring in hidden areas.

Any place where a non-precious metal meets the atmosphere, corrosion may occur. Some metals undergo self-limiting corrosion, or **passive corrosion**. Once the oxide or sulfide layer forms, it will not grow any further. The layer of corrosion products effectively insulates the underlying base metal from the environment, and further corrosion is prevented. In **active corrosion**, the corrosion layer is not self-limiting. The base metal will continually corrode, and the corrosion product will tend to spread out from its point of origin.

Any pre-plated or clad contact (coated before stamping) will have bare edges. These edges are free to corrode, and the corrosion product can grow from the edges and slowly spread across the surface as shown in Figure 1. This is known as **creep corrosion**. Eventually, the corrosion product will interfere with the electrical connection by creating unacceptably high levels of contact resistance.

In an ideal world, surface platings would be uniformly thick, continuous, and stress-free. In the real world, there will always be some imperfections in the plating. In many cases, platings will have pores, through which the base metal will be exposed. The degree of **porosity** depends on the plating thickness, application method, base metal roughness, and base metal cleanliness. As plating thickness increases, there is less likelihood of a pore extending all the way to the base metal. In a very thin plating layer (on the order of those used for gold), the likelihood is high that many pores will extend all the way through this layer. Platings over base metals with rough surfaces will show more porosity those over smooth surfaces. Dirt or oxide on the surface of the base metal can also lead to the appearance of pores.

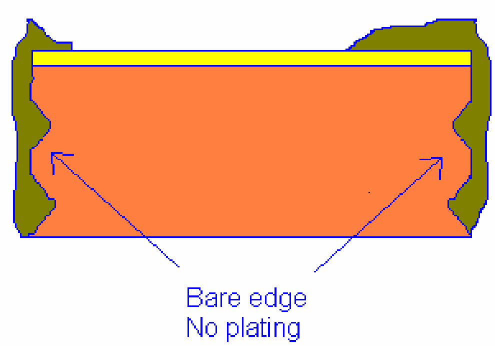

Figure 1. Representation of corrosion product creeping over gold plating from bare edges of spring contact.

Creep Corrosion & Pore Corrosion (continued)

If the base metal is exposed to a corrosive environment through these pores, **pore corrosion** can occur. Base metal corrosion can occur entirely in the pores, where it may be hidden from view, or the corrosion product may creep across the surface.

Figure 2 shows a striking example of the dangers of pore corrosion. This is an image of a metallographic cross section, taken by a scanning electron microscope. There are small cracks or pores in the plating that are visible in cross section, but the plating is mostly intact. The base metal is severely corroded underneath the plating. If the pores or cracks are too small to be seen with the unaided eye, there would be no way of knowing that this severe corrosion problem exists, until the contact suddenly fails.

The primary reasons to coat electrical contacts are to lower the contact resistance of the interface and to protect against corrosion. However, even plated surfaces are susceptible to corrosion, if the base metal is exposed through bare edges or pores. One solution to this problem would be to eliminate bare edges through plating after blanking, and to minimize porosity by using thicker coatings. Another solution is to use a nickel underplate. This will be the topic of the next edition of Technical Tidbits.

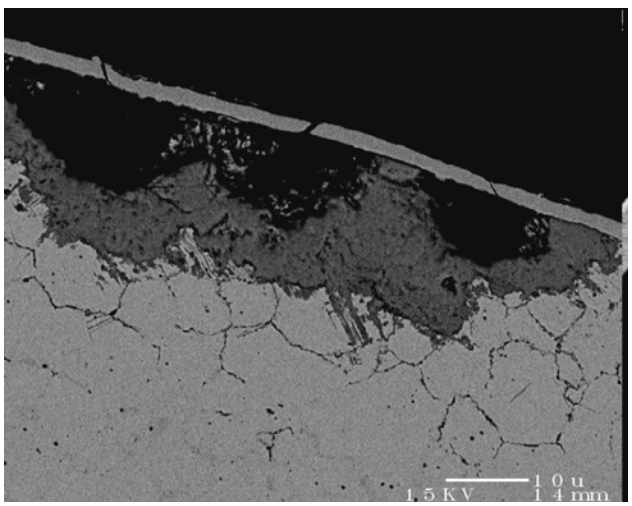

Figure 2. Corrosion of base metal under pores/cracks in the plating layer.

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References:

Slade, Paul G. Electrical Contacts Principles and Applications 1999 Marcell Dekker, Inc. New York

Mroczkowski, Robert S. Electronic Connector Handbook 1998 McGraw-Hill New York

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