MATERION BRUSH PERFORMANCE ALLOYS
TECHNICAL TIDBITS

Issue No. 36 – December 2011 **Updated from Original June 2002 Publication**

Nickel as an Undercoating

Put in the nickel defense! -
An overview of how nickel undercoatings can protect plated surfaces from corrosion.

- **Wear Resistance**
- **Diffusion Barrier**

Although it is sometimes used as a contact material in electrical connectors, nickel is primarily used as an undercoating. It increases the overall hardness and wear resistance of the coating system. It functions as a diffusion barrier, preventing the diffusion of base metal through the coating. It can slow down creep corrosion from bare edges, and it can passivate pores in the overlying layers, minimizing pore corrosion.

If the electrical contact is to experience many mating and un-mating cycles, wear resistance becomes of paramount importance. The **wear resistance** of a surface is dependent upon the hardness of every layer, not just the outermost layer. Nickel is typically much harder than the base metals and the noble metal contact finishes commonly in use. This means that nickel increases the overall hardness of the contact surfaces. This will make the contact interface more durable.

Even if there are no pores in the plating and there are no bare edges, it is still possible for the base metal to corrode. Copper atoms can diffuse through precious metal plating, and will oxidize once they reach the surface. This diffusion is time and temperature dependent. Higher temperatures provide a greater number of atoms with the necessary energy to move through the lattice. Therefore, diffusion will occur more readily at higher temperatures. However, a nickel underplate provides a very effective **diffusion barrier**, preventing the copper from migrating to the surface.

A nickel underplate will also help to prevent copper-tin intermetallic formation in tin and tin-lead coated contacts. This increases the service life, unless the nickel underplate has high residual tensile stress. In that case, the nickel underplate may reduce the fatigue life of the contact.

Nickel can significantly reduce the likelihood of pore corrosion. Nickel is usually applied in a thicker layer than the overlying precious metal, so it will have fewer pores than the top layer. In order for the base metal to be exposed, the pores in every coating layer would have to coincide.

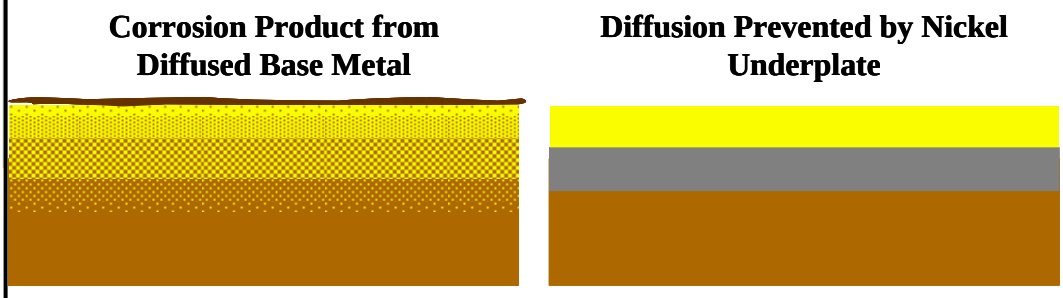

Figure 1. Representation of the use of a nickel underplate as a diffusion barrier.

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

Nickel as an Undercoating (continued)

If there are any pores in the precious metal layer, the odds are good that the nickel underplate would be exposed, and the base metal would not. A protective nickel oxide layer will form in any such pores. Since the oxide does not creep, the pores are effectively passivated, and the noble metal contact surface will remain unblemished. This is shown schematically in the left half of Figure 2.

The passive oxide formed by nickel will also help to limit the amount of creep corrosion from bare edges. The exposed copper at the bare edges will oxidize, and the corrosion product will tend to spread outward. However, the nickel underplate will oxidize as well. This passive layer of nickel oxide will inhibit the spread of the active copper corrosion product across the underplate, as shown in the right half of Figure 2. Unfortunately, it will not entirely prevent the eventual creep of corrosion product onto the precious metal, but it will significantly reduce the rate of spreading. This will increases the usable life of the contact. (However, for contacts that are to operate in aggressively corrosive environments, it is always best to eliminate bare edges.)

The last three issues of Technical Tidbits have demonstrated the usefulness of nickel as a coating material. It's hardness and corrosion resistance can greatly enhance the performance of the electrical interface, and will help to ensure low resistance for a long period of time.

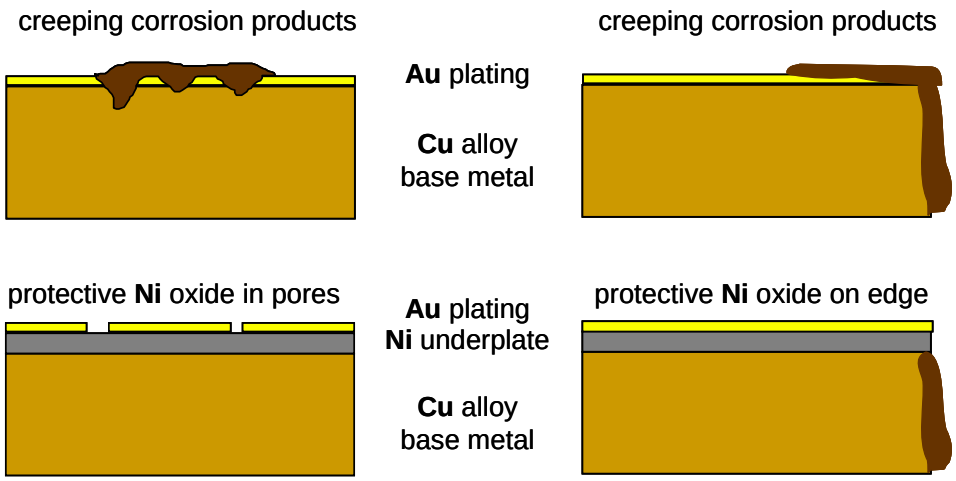

Figure 2. Passivation of pores and bare edges by the use of a nickel underplate.

Written by Mike Gedeon of Brush Performance Alloys Customer Technical Service Department. Mr. Gedeon's primary focus is on electronic strip for the telecommunications and computer markets with emphasis on Finite Element Analysis (FEA) and material selection.

TECHNICAL TIDBITS

Brush Performance Alloys
6070 Parkland Blvd.
Mayfield Heights, OH 44124
(216) 486-4200
(216) 383-4005 Fax
(800) 375-4205 Technical Service

MATERION

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

Please contact your local sales representative for further information on nickel undercoating or other questions pertaining to Brush Performance Alloys or our products.

Health and Safety

Handling copper beryllium in solid form poses no special health risk. Like many industrial materials, beryllium-containing materials may pose a health risk if recommended safe handling practices are not followed. Inhalation of airborne beryllium may cause a serious lung disorder in susceptible individuals. The Occupational Safety and Health Administration (OSHA) has set mandatory limits on occupational respiratory exposures. Read and follow the guidance in the Material Safety Data Sheet (MSDS) before working with this material. For additional information on safe handling practices or technical data on copper beryllium, contact Brush Performance Alloys.