Aleaciones de Berilio S.L. Buen Suceso 13 - 28008 Madrid - tel. 915 488 187 - fax 915 489 307 - paco_aguirre@aleacionesdeberilio.com

Technical Tidbits

a publication by

BRUSHWELLMAN
ENGINEERED MATERIALS

VOL. 4 • No. 12 December 2002

IN THIS ISSUE

Auld Lange Syne! This issue of Technical Tidbits is a review of the coating systems discussed in 2002.

- Happy
- New
- Year

The next issue of Technical Tidbits will be in a brand new format.

TT0042

Summary of Electrical Contact Coatings

The year 2002 was a very challenging year for most everyone in the connector industry. 2003 offers hope for a better year, and many new challenges along the way. In the spirit of the changing times, Technical Tidbits will return 2003 with some format changes, as detailed in the accompanying letter from the editor. This issue will summarize all that was discussed in 2002 regarding contact coatings, and should make a handy reference.

Tin coatings are soft and easily solderable. They have the advantage of being much less expensive than all the other coatings. However, they are subject to fretting corrosion. This means that high contact forces are required (100-200 grams), and they must be used with lubricant. Wiping action is required during contact mating to disrupt any surface films. If the tin is applied by electroplating, it must be reflowed later to prevent tin whisker growth. Tin has a tendency to form a brittle intermetallic phase with copper, so a nickel underplate is recommended. Tin usually is limited to a maximum service temperature of 100 C. Tin-based coatings should not be mated to precious metal, and they should not be used in contacts where there is a potential for arcing.

Tin-lead coatings are usually used for areas that will be soldered. They are immune to whisker growth, so reflow is not necessary. There also are many other compositions of tin-based solders, and new lead-free solders always are being developed.

Nickel is usually used as an undercoating for other metals like gold, tin or palladium. It acts as a barrier layer to prevent diffusion of the base metal to the surface. In the case of tin-coated contacts, it prevents the formation of copper-tin intermetallics. It passivates pores and bare edges, reducing the potential of pore corrosion and creep corrosion. **Electroless nickel** is a very hard and wear resistant coating. When used without a precious metal overplate, nickel is susceptible to fretting corrosion and requires a minimum contact force of approximately 200 grams.

Gold is a soft, inert, low friction, high conductivity coating. It has exceptional corrosion resistance, and requires little more than 25-30 grams of contact force. However, it wears easily, and does not solder well. It is often used in low current or high reliability applications. Gold should be limited to cases where the temperature does not exceed 125 C. **Hard gold** is more lubricious and wear resistant, although it is less conductive. Contacts plated with hard gold require a little more normal force, usually 35-50 grams. Both types of gold require a nickel underplate to act as a diffusion barrier.

Silver is the highest conductivity contact metal. It is used in high current applications where there may be a potential for minor arcing to occur. Silver can be used in applications where the temperature can reach 200 C. Even though it does not oxidize readily, it can still tarnish easily in the presence of chlorine, sulfur, etc. A contact force of 100-200 grams should be sufficient to disrupt any such films.

Silver composites and silver metal oxides are used in higher current, higher voltage switches where there is a potential for severe damage from arcing. They are more

resistant to arc erosion than plain silver. Their higher melting temperatures also make them more resistant to contact welding during make and break operations.

Platinum and **palladium** are currently very expensive contact materials. They are resistant to most forms of corrosion, although their surfaces can readily adsorb organic material from the environment, which creates a brown, powdery organic film. Both platinum and palladium are more resistant to wear than gold. They are often used in high reliability contacts where gold would wear away too quickly. A thin gold flash may be placed on the surface, however, to reduce the potential for the formation of frictional polymer. A normal force of 50 to 100 grams is recommended for both platinum and palladium. It should be noted that these two metals also require a nickel underplate as a diffusion barrier.

Palladium nickel and **palladium cobalt** alloys are much more wear resistant than pure palladium. They may be used in sliding switch applications. **Palladium silver** is used in switching applications where arcing may be a concern.

The important point in all of this is that the individual application really drives the choice of coating method and material. The right choice of coating depends upon the ambient temperature, environmental contaminants present, current levels and number of mating cycles (not to mention cost.) The choice of plating material then dictates the normal force requirements.

In general, high normal force means more reliable contact. This does, however, mean that the insertion force will be high as well. Contacts are continually shrinking in size, requiring higher stress levels to achieve the required contact force. Furthermore, normal force tends to drop over time due to stress relaxation. In order to ensure adequate normal force at the end of life, the designed normal force will have to be increased above the bare minimum, which further increases both the stress and insertion force. These considerations will then go into the choice of the high performance base metal.

The optimal base material will be one that has high strength and good formability to allow for miniaturization. It will have good stress relaxation resistance to maximize normal force while minimizing insertion force. It will have good conductivity to minimize resistance. In highly cycled switch applications, it also will need to have good fatigue strength. Brush Wellman's copper beryllium alloys such as Alloy 25 (C17200) and Alloy Brush 60® (C17460) have the necessary properties to rise up to meet these challenges.

Written by Mike Gedeon of the Brush Wellman Customer Technical Service Department. Mr. Gedeon's focus is on the telecommunications and computer markets with emphasis on Finite Element Analysis and Material Selection.

References:

Colin, Dr. R.E. "Material Properties Affecting Electrical Switch Design."

Case Western Reserve University, Cleveland, OH 1977.

Please contact your sales representative for further information about contact physics or other questions pertaining to Brush Wellman and our products.

Technical Tidbits

Brush Wellman Inc.
17876 St. Clair Avenue
Cleveland, OH 44110
(216) 486-4200
(216) 383-4005 Fax
(800) 375-4205 Technical Service

BRUSHWELLMAN
ENGINEERED MATERIALS