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High Force Connector for Telecommunications: An Analysis of Wear Resistance

Introduction

Friction and mechanical wear play critically important roles in the performance of contact finishes on electronic connectors. Adhesion and abrasion are the dominant wear mechanisms. Adhesive wear occurs when surfaces undergo metal transfer from one solid surface to another through cohesive bonding. Mechanical wear or abrasion involves a loss of material as loose particles from solid surfaces. Tribology of electronic connectors is important as plated contact coatings are relatively thin and it is necessary to maintain the integrity of the deposit during sliding to minimize the exposure of base underplatings and substrates. Gold electrodeposits are the most widely used contact material but are being steadily replaced by palladium alloys as they can withstand higher loads with less erosion.

Problem

Failure mode analysis of a telecommunication component that failed in the field pointed to the role of excessive wear of hard gold (HG) plated connectors. The failures were associated with high contact resistance.

The normal loading force on these contacts was, by design, very high at 330 grams. A need existed, therefore, for a finish that would withstand this aggressive wear condition.

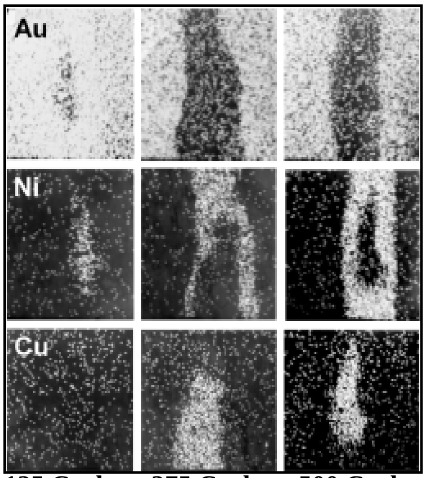
Analysis

Compare the wearing properties and life cycle of hard Au and gold-flashed palladium (GFPd) on the actual configuration of the telecommunication connector. Two finishes, HG and GFPd, were analyzed for their ability to resist wear during insertion/withdrawal cycles in actual service life at a thickness of 2.5 µm. Wear characteristics were evaluated after 60, 125, 250, 375, 500 insertion and withdrawal cycles.

Instrumental methods used were scanning electron microscopy (SEM) coupled with energy dispersive spectroscopy (EDS) for element mapping of exposed metallic layers, and X-ray fluorescence thickness profiling to quantify the wear after insertion/withdrawal cycling. These methods were adopted as comparative tools to determine the *location*, *size* and *depth* of the wear "scar."

The data indicate that GFPd finish is superior to HG under the high insertion force conditions (330 g. load, fully deflected) dictated by the convex geometry of this particular contact system.

This is evidenced in the fact that the copper substrate was exposed after 125 cycles in the case of HG while it remained protected (unexposed) for the GFPd systems. Examples can be seen in the SEM/EDS "dot" maps,



125 Cycles 375 Cycles 500 Cycles

Fig. 1—EDS element maps displaying erosion of the gold plating exposing nickel and eventually copper at 125, 375 and 500 cycles.

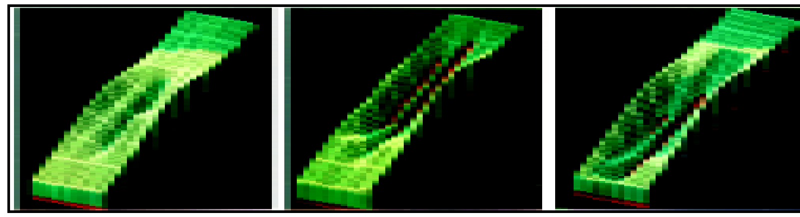


Fig. 2—XRF Thickness Profiles for 125, 375 and 500 Cycles showing reduced gold thickness in the wear area.

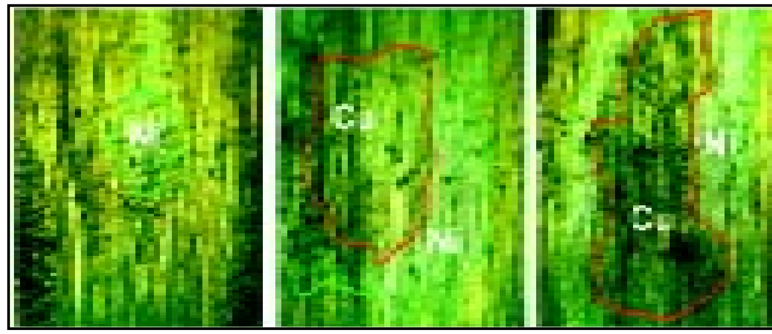
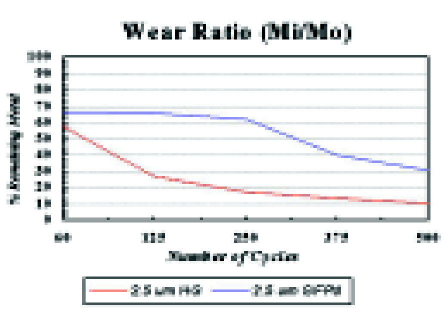


Fig. 3—Optical Microscopy visually illustrates removal of gold and nickel from the contact area after 125, 375 and 500 cycles.

Fig. 1, and XRF thickness profiles, Fig. 2.

Furthermore, the HG was observed to wear at a relatively steady rate and was removed quite rapidly relative to GFPd. This is supported by the SEM/EDS, and XRF data which show larger areas being worn through the hard gold to the substrate at lower insertion cycles. Optical microscopy provides visual confirmation of the wear as Cu is exposed in large areas after cycling. Overall, the following points have been established:

- At an equivalent number of insertions, the quantity of metal removed from the wear track area is less for GFPd than for HG.
- GFPd exposes a smaller area of substrate/underplate than the HG, thus offering better protection, Fig. 1.



The Wear Ratio of the worn contacts is defined as the thickness of metal remaining in the wear track area as a percentage of the original metal thickness.

It was intended to "quantify" the comparative wear of HG vs. GFPd. As can be seen in the case of gold only 0-5 percent of the metal remains.

The Solution

Adopting GFPd as the standard finish for this high reliability contact allowed the manufacturer to meet the goal of 500 wear cycles while maintaining adequate coverage of the underlying base metals and stable contact resistance. P&SF