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High-Temperature Finish For Automotive Connector Applications

The automobile has undergone revolutionary changes during the last 10 years with the introduction of microprocessors and sensors to analyze and control various functions. One of the concerns of component manufacturers (*e.g.*, connectors) that supply the automotive industry is the increase in the operating temperatures.

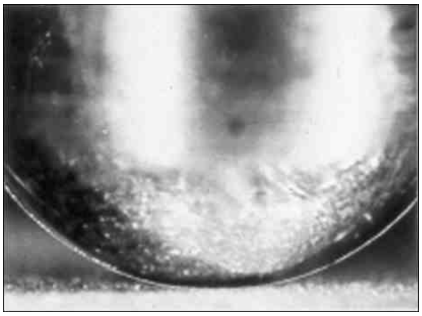

Fig. 1—Measurement of contact resistance.

Problem

An automotive manufacturer was designing a new high-reliability device for an under-hood application where operating temperatures could reach 175° C. Because it is known that temperatures exceeding 125° C can degrade many common types of electroplated finishes including hard gold (HG), this application required an extremely stable material that would not oxidize or allow diffusion of base metals to migrate toward the surface. Diffusion and porosity allow the transport of base metals to the surface, which subsequently will oxidize, leading to increases in contact resistance and ultimately, component failure. The contact finish of choice should exhibit stable contact resistance at 200° C for 2000 hours.

The Response

A program was developed to evaluate various metal finishes and configurations (layered structures) and their stability (resistance to oxidation and diffusion) under the high-temperature conditions of interest. The testing program involved thermal aging for the desired time and temperature, as well as measurement of changes in contact resistance.

The probe was constructed according to the specifications of ASTM B667, which defines the dry circuit conditions of measurement and the mechanical probing elements of the device.

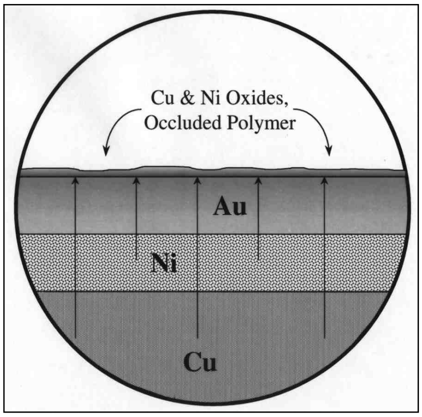

Fig. 2—Schematic of thermally deteriorated surface on typical plated connector. Cu & Ni diffuse to surface and oxidize. Occluded polymer in hard gold also contributes to increased contact resistance.

The Solution

As expected, the HG samples exhibited significant increases in contract resistance after exposure to 200° C for 2000 hours. Several other finishes survived to varying degrees of success, but one particular candidate displayed exceptional stability,

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demonstrating that a composite structure was required to obtain the desired results. A structure consisting of two pure materials and one alloy—all palladium-based—showed no change in contact resistance, even under the lowest load of 25 grams.

A summary of the HG and the layered structure results are illustrated in the two adjacent charts. As seen in Fig. 3, the HG samples, regardless of load, show an increase of contact resistance on the order of 100 milli-ohms. Alternatively, the layered composite exhibits exceptional stability and zero change in the contact resistance (Fig. 4).

This new information, coupled with other known properties of palladium-based finishes (excellent wear resistance, low porosity, lower cost than gold) provided the manufacturer with new choices for electroplated contact finish materials for use in high-reliability, high-temperature connectors. P&SF

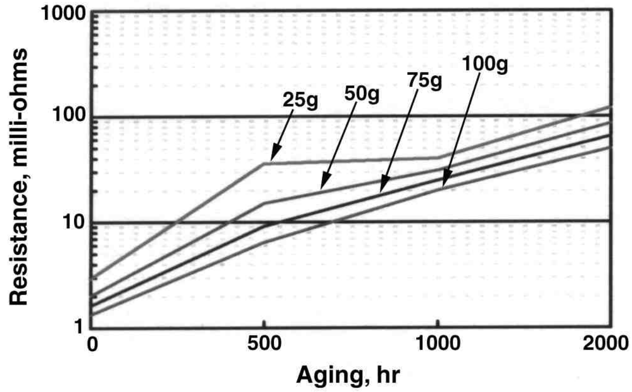

Fig. 3—Contact resistance data for hard gold after thermal aging at 200°C.

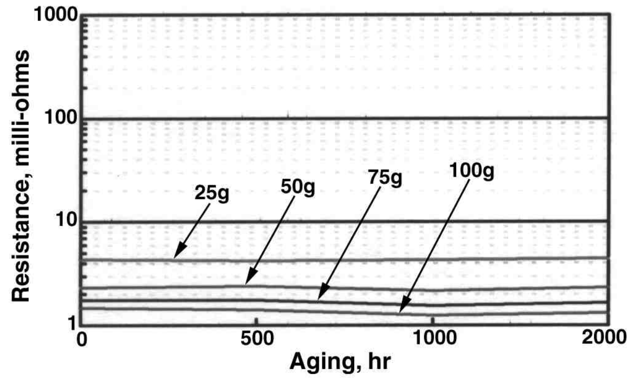

Fig. 4—Contact resistance data for layered structure after thermal aging at 200°C.

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