Issue No. 33 – September 2011 **Updated from Original March 2002 Publication**

Don't fret about the fretting! - An overview of fretting corrosion on tin-coated electrical contact surfaces.

- **Oxide Disruption**
- **Wiping**
- **Fretting**
- **Lubricate**

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

Fretting Corrosion

Tin will naturally form a hard, brittle oxide on its surface. Since this oxide is an electrical insulator, it must be disrupted in order to achieve a good electrical path for the signal or current passing across the interface. Fortunately, the underlying tin is much softer and more ductile than the tin oxide on the surface. With sufficient normal force, the mating contact will break through the oxide film. Unoxidized tin will then extrude through the cracks in the oxide, making good electrical contact. To ensure that tin-coated contacts have enough contact pressure for **oxide disruption**, it is commonly recommended that such contacts provide a minimum of 100 grams of normal force. It is also recommended to design these contacts to have some **wiping** action during mating, in order to displace any debris or oxides adhering loosely to the surface. Following these recommendations, it is relatively easy to establish good electrical contact between the two halves of the contact interface. The real trick is in maintaining good electrical contact.

The characteristics listed in the last paragraph that make it easy to establish good electrical contact also make tin-coated surfaces susceptible to fretting corrosion. This occurs when the contact point oscillates on a microscopic scale (**fretting**). This can be caused by mechanical vibration of the contact, or thermal expansion and contraction if the ambient temperature experiences cycles through high and low values. When the contact point moves, the oxide film in the new location is disrupted, and more fresh tin flows to the contact point. However, the freshly exposed tin at the original contact point will then oxidize. If the contact returns to the original location, the cycle repeats. As fresh tin is continuously exposed and oxidized, the oxide layer will increase in thickness and the unoxidized tin will be depleted. This causes the contact resistance to oscillate while slowly increasing over time, as shown in figure 1. Gradually, the oxide will grow so thick that the contact cannot pierce through it. When this happens, the electrical interface is effectively insulated. Eventually, continued fretting will completely wear away the tin and underlying intermetallic layer, and expose the copper base metal. This will lower contact resistance again to stable amount, albeit higher than the original value, as shown in figure 2. However, the freshly exposed copper interface will then also be subject to corrosion.

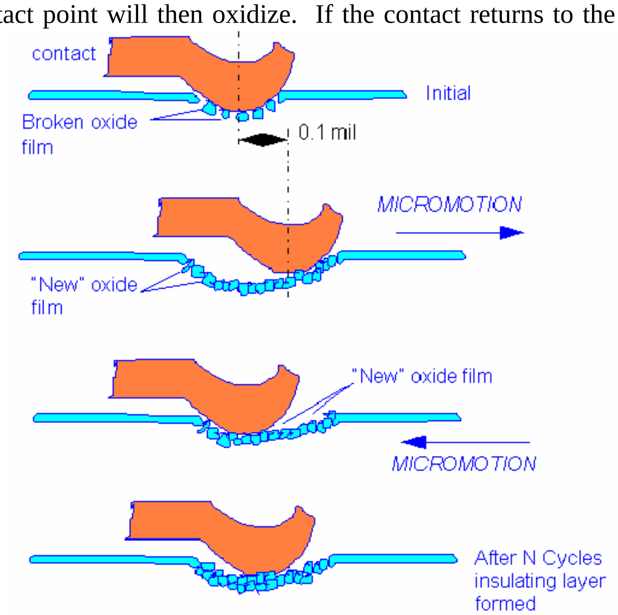

Figure 1. Disruption of tin oxide film and extrusion of fresh, ductile tin through cracks in the oxide during initial mating of the tin-plated contact interface.

Fretting Corrosion (continued)

Fortunately, there are ways to protect against fretting corrosion. One way is to use high normal force, to ensure that the contact is stable when mated. This will make it difficult for any micro-motion to occur. Perhaps the most effective method is to **lubricate** the contact interface. A good lubricant will significantly reduce the effects of fretting corrosion by inhibiting oxidation. It will also tend to minimize wear of the tin coating. Fretting corrosion may be a complex phenomenon, but the solution can be simple.

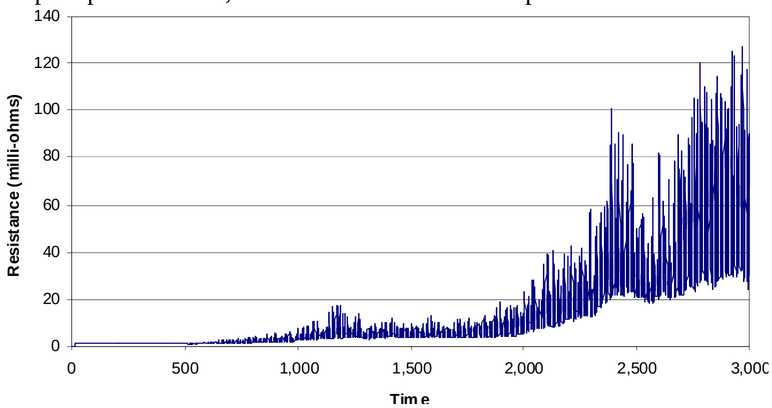

Figure 2. Measurement of contact resistance increasing over time due to fretting corrosion.

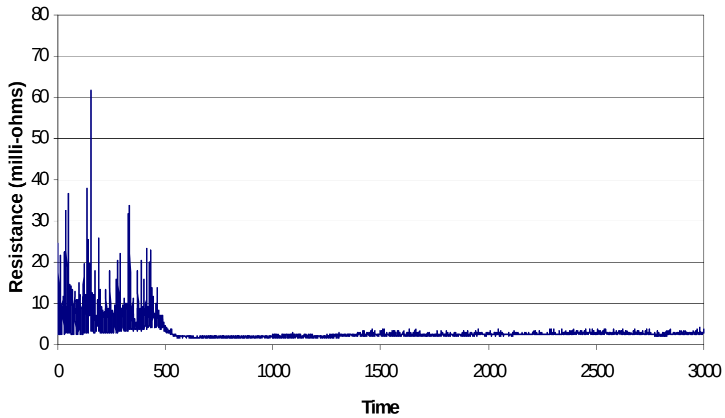

Figure 3. Measurement of contact resistance increasing and eventually decreasing and stabilizing due to fretting corrosion

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TECHNICAL TIDBITS

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References:

Whitley, J. H. "The Tin Commandments" Plating and Surface Finishing October 1981

Aukland, Dr. Neil R. & Hardee, Dr. Harry C. "Improving Fretting Performance of Tin-Lead Contacts" <u>Connector Specifier</u> March 1999

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

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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.