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# Downsizing Tin Whiskering in Microminiature Connector Design

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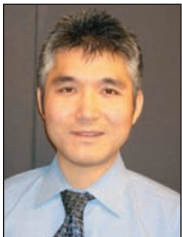

Goji Tanabe

Customers are continuing to drive market trends toward compact portable electronic devices that offer all-inclusive features such as support for high pixel photos, videos and other multimedia applications. To meet this demand, OEMs are developing the latest mobile phones, portable computers and other consumer electronic devices in increasingly smaller housings and with these enhanced capabilities. As a result, OEMs are relying on design leaders, including connector manufacturers, to develop new and innovative ways of creating internal components that offer a decreased pitch and profile size.

Microminiature interconnects, with a pitch less than 2.00 mm, accommodate today's smallest electronics. However, design issues like tin whiskering can increase signal interference as well as reduce overall device reliability and cost effectiveness. Connector manufactures are faced with challenges to not only accommodate shrinking overall design requirements, but to create components that are ultimately reliable despite their size.

Whisker growth occurs on a number of metallic surfaces, and it is commonly found in connector applications that use tin in the solder or final finish. Forming the shape of very thin, hair-like protrusions that emerge outward from a surface, tin whiskers have been known to cause complete system failures in electronic assemblies. They are a serious concern for designers working on products where long-term reliability is essential. Normally a few millimeters in length, there is evidence of tin whiskers growing up to lengths of 10 mm.

With their fine-pitch and low height, microminiature connector designs are especially sensitive to tin whiskering because even the smallest amount of metallic growth can interfere with data transmission and cause signal interference. Furthermore, continuing trends in the electronics market indicate that as products consistently reduce in size, even the tiniest of metal whiskers can short-circuit a number of conductive surfaces present in condensed electronic systems.

While the direct cause of whiskering is relatively unknown, stressful environments and temperature conditions have been recognized to promote the whiskering process. Electroplated finishes that generate greater residual stress in order to produce a brighter surface also appear to encourage whisker growth in tin. Other variables that may encourage tin whiskering include bending or stretching surfaces post-plating, scratches or nicks in the plating, or thermal expansion mismatching between materials.

**Plating gold over a palladium nickel underplate has been proven to minimize, and in some cases eliminate, metallic whisker growth.**

Until recently, adding lead to tin minimized the problem, but legislation enacted by the European Union in 2002 now prevents manufactures from incorporating potentially hazardous materials, like lead, into their systems. This progressive movement, known as the Restriction of Hazardous Substances (RoHS), has prompted electronic

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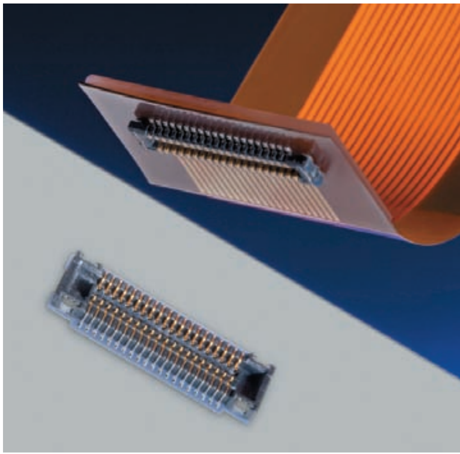

**Gold plating is used by companies (shown here in Molex's SlimStack™) to provide an RoHS-compliant solution in microminiature designs where there is an elevated risk of tin whiskering interference.**

designers to conceptualize new methods of production that minimize whisker growth.

As a result, some manufacturing companies are designing their microminiature products with gold instead of traditional tin. Gold plating, the process of depositing a thin layer of gold over a metal surface, is used by companies like Molex to provide an RoHS-compliant solution in microminiature designs where there is an elevated risk of tin whiskering interference.

Plating gold over a palladium nickel underplate has been proven to minimize, and in some cases eliminate, metallic whisker growth. The nickel base aids in improving wear resistance by inhibiting corrosion and providing a robust backing for the gold layer. This process also promotes higher mating and un-mating cycles in board-to-board and wire-to-board systems. Ideal for microminiature designs, gold plating provides a better pin-contact to increase reliability and produce higher connectivity.

Despite its cost compared to lower-priced options like silver and zinc, gold is recognized among manufacturers as a top replacement for tin-lead plating combinations in microminiature designs where even the slightest amount of whiskering can cause a system to short out. Over time, products using gold experience consistent performance reliability which can significantly improve the overall cost-effectiveness for systems that require a longer lifespan.

For cost-conscious buyers who are concerned about the cost of gold reaching $1,000 per troy ounce, less expensive gold plating techniques are also available. For example, some companies practice selective gold plating in their manufacturing process. This allows the connector manufacturer to accurately plate only the contact area of the connector interface, typically in the range of 1.0 µm minimum thickness levels. As a result, manufacturers can very accurately control the plating thickness to reach a desired level that meets customer requirements and minimizes plating costs.

As manufacturers and OEMs continue to move away from lead-based materials, the problems surrounding whiskering in microminiature systems continue to increase. So far, connector makers are meeting the challenge to minimize whisker growth present in pure tin and other metallic surfaces through the use of gold plating. As appeal for compact designs with increased reliability and performance continues to strengthen, even greater demands will be placed on incorporating effective methods of preventing whiskering into microminiature design.

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