



Maxim Integrated Products  
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## **Position Paper on Lead Free Product Use with Soldering Temperatures <235C**

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### **Introduction:**

The drive to eliminate lead from electronics has pushed semiconductor component manufacturers to consider alternative lead plating materials versus the widespread and highly accepted usage of Sn/Pb plating finish for the past 30-40 years. 100% matte tin (Sn) has emerged as the dominant Pb-free plating solution due to both economic and manufacturing reasons. However, the potential formation of “tin whiskers” on 100% tin plated surfaces, a widely known reliability issue initially reported in the 1940’s, has remained the dominant concern for the electronics industry. Decades of research conducted with regard to tin whiskers formation on pure tin plated surfaces led to the industry adoption of tin/lead (Sn/Pb) lead plating as the standard lead finish due to the known ability of lead to suppress the formation of tin whiskers, thus eliminating the potential for application failures resulting from tin whisker formation.

### **What is Tin Whiskering:**

A tin whisker is a single crystal of tin that grows spontaneously from the surface of a pure tin plated lead (See Figure 1). These whiskers can grow to lengths sufficient to bridge external leads, or break and fall off bridging across board traces or other electronic components, thus resulting in shorts and electrical failure of the boards and electronic systems.

### **Testing for Tin Whiskering**

Despite decades of research done on tin whisker growth, there remains a lack of methodology to accelerate and model tin whisker growth. However, due to the emerging growth of Pb-free manufacturing utilizing 100% matte tin (Sn) lead plating, industry standards have recently emerged including “Tin Whisker Acceptance Test Requirements”, NEMI Tin Whisker Users Group (July 28, 2004), and more recently “Measuring Whisker Growth on Tin and Tin Alloy Surface Finishes”, JEDEC STANDARD JESD22A121. Both publications provide recommendations based on storage, aging, and temperature cycling tests to measure and monitor tin whisker formation in tin plated lead plating of surface mount integrated circuits. Maxim/Dallas has adopted these recommendations as the basis for our collection of data on tin whisker formation on Maxim/Dallas products.

From the internal testing conducted at Maxim/Dallas, we have observed tin whiskers on material produced by our assembly subcontractors which utilized 100% matte tin (Sn) lead plating. The tin whiskers occurred in units subjected to IR Reflow soldering conditions less than the fusing temperature of the Sn plating material (~232C). Whisker formation was not been observed on units subject to IR Reflow conditions in excess of this temperature. It should be noted that this is consistent with industry research and publications on methods to mitigate the formation of tin whiskers in tin (Sn) plated lead finishes which suggest exposure to fusing temperatures, i.e. temperatures above the melting point of the pure tin or ~232C, minimize the potential for tin whisker formation (Dunn 1987, McDowell 1993). Based on these initial test results Maxim/Dallas recommends the use of a peak soldering temperature  $\geq 235C$  for our Pb-free products utilizing 100% matte tin plating.



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### **Summary of Issues:**

In summary:

- The use of 100% matte tin has emerged as the industry standard Pb-free lead plating due to manufacturing and economic factors.
- Maxim has observed the formation of tin whiskers in the 100% matte tin plating finish which has been provided by subcontract assembly vendors. These whiskers have ranged as high as 50um in length which is generally considered acceptable for consumers products, but may be considered a concern for high reliability business applications per NEMI classifications. For applications which do not require the a Pb-free material, the application may be better served using the existing Sn/Pb lead finish.
- Tin whiskering on 100% matte Sn lead plating is an industry known phenomena since the 1940's, and has historically been eliminated through the addition of lead (Pb) which is known to suppress the formation of tin whiskers.
- Maxim recommends the use of 100% matte Sn plated products where the reflow temperature is  $\geq 235\text{C}$ . This includes mixed and Pb-free manufacturing usage.

Maxim will continue to closely monitor the Pb-free material provided by our assembly subcontractors, and provide updates as information becomes available.

### **Contact Information:**

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Figure 1:

