Strategic Environmental Research and Development Program (SERDP) Tin Whisker Testing and Modeling: Thermal Cycling Testing

Authors: Stephan Meschter, Polina Snugovsky, Jeff Kennedy, Zohreh Bagheri, and Eva Kosiba
Company: Celestica Inc. and BAE Systems
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Abstract: Driven in part by European Union directives, most commercial electronics manufacturers began a global movement away from using lead (Pb). Component manufacturers are increasingly applying tin-rich finishes to the leads of their devices and soldering with lead (Pb)- free solders. Unfortunately, this can create a risk of tin whisker formation that can result in electrical failures. Because of its unique requirements such as long service lifetimes, rugged operating environments, and high consequences of failure, the aerospace and defense industries must mitigate the detrimental effects that tin whiskers. The present paper provides a status on the effort associated with a multi-year testing and modeling program that aims to assess tin whisker growth on leadfree manufactured assemblies and utilizes whisker short circuit statistical modeling to enable improved reliability assessments. The tin whisker growth of tin finished parts soldered with SAC305 (Sn-3.0Ag-0.5Cu) solder alloy under -55 to +85 °C thermal shock cycling conditions in accordance with JESD-201 for over 2000 cycles was evaluated. Significant whisker nucleation and growth from the SAC305 solder alloy occurred where the solder was less than 25 microns thick with alloy 42 lead terminations. Whisker angular rotation during growth was also observed. Several competing stress relaxation mechanisms in addition to whisker growth were found including excessive deformation, volume recrystallization with massive eruptions of the recrystallized grains. This type of microstructure is not typical for most field conditions. Therefore, the JESD-201 -55 to 85 °C three cycles per hour thermal shock profile does not provide an optimal lead-free assembly whisker assessment test. Also, this test causes cracking of harder conformal coatings not observed in service and may not allow whisker mitigation evaluation of certain conformal coatings.

Key Words:

Tin Whiskers, Lead Free, Assembly, Testing, Thermal Cycling, Statistics

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