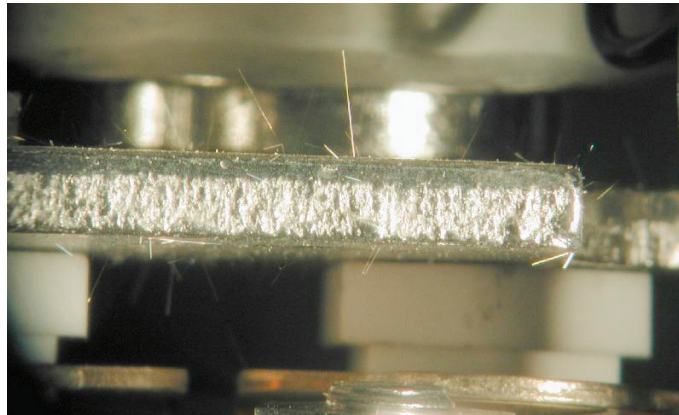


Mitigation of Tin Whiskers in VersaLogic Products

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Tin whiskers are electrically conductive, crystalline structures of tin that sometimes grow from surfaces where tin (especially very thin layers of electroplated tin) is used as a final finish. They may occur unpredictably after an incubation period as short as a few seconds, or as long as several years. Tin whisker problems were resolved with the addition of lead to tin in solder in the late 1950's. The ecologically-driven effort to remove lead from electronic products has resulted in renewed interest in tin whisker growth. These tin whiskers can grow to a length that can cause electrical shorting to adjacent conductors or may fracture and deposit themselves on other components leads. The whiskers could also deposit themselves on optical components, resulting in vision system defects or optical malfunctions.



Tin whiskers growing inside a hermetically-sealed relay. The tin-plated armature inside this relay showed whiskers over 3mm in length. (Photo from NASA GSFC Archives.)

Tin whiskers concerns have come about largely due to the electronics industry movement toward the use of pure tin and very high tin-content finishes for components, spurred on by lead-free legislation such as the European Union's RoHS initiative. Many different tin finishes exist, some with underplating, others alloyed with various metals, and still others with additional process steps (such as annealing). The exact mechanism for growth of whiskers has still not been identified despite many decades of research, but it is widely believed to be due to internal compressive stresses within the tin finish that create an environment for tin whiskers to grow. This compressive force can be due to mismatch in coefficients of expansion between the base metal and the tin finish, a very thin tin finish, or successive processes that induce a compressive force in the tin, e.g., bending, crimping, stamping, etc.

Comprehensive tests have been developed over the last few years to determine the potential of various tin finishes to "whisker", and to standardize them. The testing now proposed is a suite of tests that expose devices to:

1. Aging in a storage temperature environment (30°C, 60%RH) for at least 4000 hours,
2. Aging in a warm and humid environment (55°C, 85%RH) for at least 4000 hours, and
3. Temperature cycling between hot and cold temperatures (-55° or -40° to +85°C) for 1500 cycles.

Inspection intervals and number of samples required are identified in the standard for both optical and SEM inspection for whiskers during each of the tests. Length of tin whisker and additional acceptability criteria is defined for different manufacturing classes.

This testing suite was initially developed and recommended by iNEMI (International Electronics Manufacturing Initiative) and later modified and issued as a standard by the JEDEC Solid State Technology Association (formerly known as the Joint Electron Device Engineering Council) as JESD22A121. The result of this testing and measurement is to determine the extent to which a tin finish process will whisker

and whether the resultant whisker length is acceptable. For Class 2 products (high reliability industrial application), which is the standard to which VersaLogic products are built, a maximum whisker length of 40 microns (μm) is permissible with 45 microns permissible after temperature cycling. At this length the whiskers would not be able to electrically short to adjacent conductors on components with relatively high density interconnects.

As part of mitigation efforts, VersaLogic has included a new step in its existing component review process for qualifying components

based on their ability to resist whiskering. Comprehensive research is done on each part used in VersaLogic products to verify that the finish used is a recognized viable finish per "iNEMI Recommendations on Lead-Free Finishes for Components Used in High-Reliability Products" Version 4 updated December 2006 and that parts conform to tin whisker testing and measurement as defined in JESD22A121 "Measuring Tin Whisker Growth on Tin and Tin Alloy Surface Finishes" updated March 2006. The component review process includes identifying the finish of each part and ranking it, obtaining the tin whisker test results from the manufacturer for this finish (depending on finish ranking) and verifying that the testing conducted conforms to one of the standard tests for tin whiskering. Documents that contain additional detail that are to be used in conjunction with JESD22A121 are JESD201 "Environmental Acceptance Requirements for Tin Whisker Acceptability of Tin and Tin Alloy Surface Finishes", March 2006 and JP002 "Current Tin Whisker Theory and Mitigation Practices Guideline", March 2006

Using conformal coating on the final finish, a process which coats the PCB and protects it against environmental conditions such as moisture or extreme temperature changes, is another tin whisker mitigation technique that has been proposed and is still being evaluated. Some studies have shown that conformal coating has been shown to contain tin whiskers. It has not been shown to reduce tin whiskering. Studies have been conducted with conformal coating of varying types and thicknesses. The tests have shown that the type of conformal coating did not seem to be a factor, but that a thicker conformal coating is more effective than a thin coating in containing tin whiskers. Additional evaluation is required to determine the usefulness of conformal coating as a mitigation technique.

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