EIA/ECA-CB19-A

EIA ENGINEERING BULLETIN

The Facts about Tin Whiskers

A Statement issued by members of EIA/ECA Steering Committee S-1

EIA/ECA-CB19-A

DRAFT of 22SEP05

Electronic Components, Assemblies & Materials Association

ELECTRONIC COMPONENTS, ASSEMBLIES & MATERIALS ASSOCIATION
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(From Project Number 5115, formulated under the cognizance of the ECA Steering Committee S-1)

Published by

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Technology Strategy & Standards Department
2500 Wilson Boulevard
Arlington, VA 22201

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Have You Seen Tin Whiskers? The Facts about Tin Whiskers

A Statement Issued by members of EIA/ECA Sub-Committee P-2.1

Due to environmental regulations the push towards lead free products has gained momentum in the past couple of years. However, with the shift towards lead free products, we have seen a re-emergence of the "***Fear of Tin Whiskers***". We use the word "FEAR" intentionally, because it is in the best interest for the whole Passive SMT component Industry **(Aluminum Capacitors, Ceramic Capacitors, Tantalum Capacitors, Circuit Protection Devices, Chip Beads, Inductors, and Resistor Products etc.)** and their users not over react, but to understand and evaluate any risks based on facts and data.

Over 30 years ago, when attempts were first made to plate electronic components with pure tin (mostly on copper or copper-alloy surfaces), there were reports of tin whisker growth. With that prior knowledge, the SMT component manufacturers conducted numerous studies (published and unpublished) on this subject and effective countermeasures were put in place to eliminate or mitigate the growth of tin whiskers. In fact, tin whiskers have not been a problem for the surface mount components ever since pure tin plating really took off (about 15 years ago). It is not possible to delve into all the publications and studies on this subject within the scope of this paper, however we shall highlight some very effective countermeasures taken by the whole industry. These include: using matte tin finish rather than bright (to reduce residual stresses), applying uniform nickel undercoating (which acts to suppress whisker growth besides acting as a solder barrier), and having parts with rounded corners (to avoid stress points). On the processing side too, care is taken to control grain size of tin, use high purity tin, annealing, use controlled current densities for deposition for both nickel and tin, high process control via SPC, control additives, stabilizers, etcetera. However, the above countermeasures may not be all inclusive, because every manufacturer may have their own process for tin whisker mitigation.

And what does the component industry have to show for it? Just for surface mount ceramic capacitors, in the past 5-7 years alone, over 2 TRILLION have been shipped worldwide. Most of them had pure tin terminations. To our knowledge, in commercial applications, there have been no documented cases to date of equipment malfunction, field failures or surface mount parts being returned because of tin whiskers. By any measure this is an impressive record.

However, two questions remain to be answered. Under what conditions and why do whiskers grow? It is easier to answer the first question, because some of our member companies have been able to reliably grow whiskers under specific accelerated conditions. As to the second question, there are some good hypotheses in literature to which many people subscribe to, but again for sake of brevity they are excluded from this paper. Controlled experiments have shown that whisker formation is initiated and accelerated by residual stresses. In practice, thermal cycling is the single biggest contributor to whisker growth. Maximum growth has been observed

when thermal cycling between –40C and 85C, BUT the maximum whisker length observed is about 50 um (some studies have shown maximum growth to approach 100 um) after 2500 cycles. Whisker growth is reported to reach a plateau after 2000 cycles. In fact some of us have done tests up to 8000 cycles with similar conclusions. Diffusion of nickel into the tin layer is hypothesized to prevent whisker formation (it is hypothesized to relieve stresses in tin layer). Humidity and long term room temperature storage by themselves have not been found to initiate whisker growth.

So is there an easy way to control this fear of whiskers? Yes, there is. If all your answers to the following checklist are "YES", you should stop worrying about whiskers. If the answer to one or more of the questions is "NO", please discuss the issue with your vendor, as a "NO" does not automatically mean whiskers.

1. Your products are ***not exposed*** to extreme thermal cycling conditions repeatedly and well beyond accepted industry standards.
2. Your products are ***surface mounted*** and do not use pure tin-plated metal lead frames. It should be noted that even for metal connections and lead frames, nickel under plating or normal re-flow/flow soldering leads to mitigation or elimination of tin whiskers.
3. Your products are ***not used in extremely dense circuits*** where the spacing between individual components becomes extremely critical.
4. You ***always use*** parts as specified. Example, you do not use tin-coated parts with epoxy or glue or other polymeric conductors. (These parts should use non-plated terminations.)
5. Your parts ***are not used*** in extreme conditions requiring very high reliability: applications like space, special military and medical applications.
6. You ***always buy parts*** from highly established and reputable component manufacturers (with a long history of providing high quality and reliable parts) and their authorized distribution and supply channels.

Note that despite the trend towards lead-free products and an impressive record of reliability for pure tin-plated parts, some manufacturers still offer options for providing tin-lead plated parts (in many cases at a premium). These parts are recommended for applications or conditions where the possibility of whisker growth is real and high. It should be emphasized that a switch to lead-free soldering does not lead to tin whisker formation. Under any circumstances please discuss your applications with your vendor of choice.

The passive component industry would once again like to emphasize that the safety, performance and reliability of your products is our main concern and we have developed technologies and processes to provide you very high quality parts at very competitive prices. And we all stand behind our products.

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