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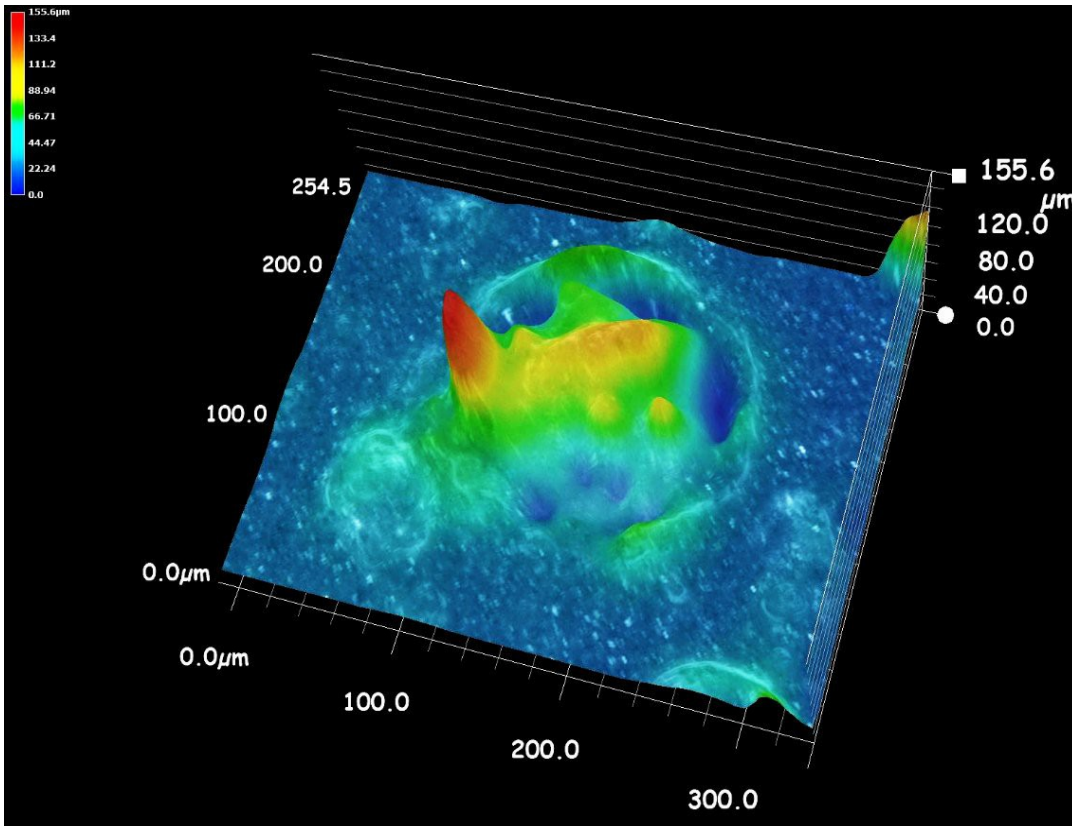
Whisker-Tough Magnum™

A conformal coating designed to meet the reliability requirements of military systems

You see here captivation of large and small whiskers. This is Whisker-Tough Magnum, the first-ever conformal coating purpose-designed to captivate tin whiskers.



Approved for Public Release 16-MDA-8582 (24 Feb 16)

The capabilities of the Whisker-Tough™ technology include:

- ✓ Qualification of the Whisker-Tough coating to the MIL-I-46058 Specification
- ✓ Qualification of the Whisker-Tough coating to the IPC-CC-830 Commercial Spec
- ✓ Full coverage over sharp edges on electronic component terminations
- ✓ Long term protection of fragile electronic components, shown by thousands of thermal cycles of the coating at the standard 3-mil thickness, and even 30 mils
- ✓ Multiple design mechanisms that captivate tin whiskers

1.0 OVERVIEW - The Whisker-Tough conformal-coating technology offers a new cost-efficient improvement for the manufacturing of high reliability electronic assemblies. The supply chain impact by the European ROHS legislation had resulted in many electronic components being only available with the whisker-growing tin-plated surface-finish. Initially, the technology evolved to replace the new tin plating with the legacy tin-lead surface finish on a piece-part basis. It was the 'low-hanging fruit" for the corrective action to prevent tin whiskers from impacting the reliability of military systems. But, it was expensive to refinish all those individual components. Consequently, a joint test was run by Boeing, Raytheon, and NSWC China Lake to test the acrylic, parylene, silicone, and urethane conformal coatings that were being used on circuit boards for environmental protection. If they would keep the tin whiskers from causing short circuits, then coating a whole circuit board to provide protection from tin whiskers would be a more economically attractive approach than refinishing each component before it got mounted on the circuit board. Within 3 years, all the test coatings had been punctured by the tin whiskers. Conformal coating manufacturers were contacted with a request to make a coating that would not get punctured. They were not interested, and that eventually led to a Government project supporting a ten-year-effort to develop a coating tougher than the whiskers, hence the name "Whisker-Tough™".

1.1 KEY DRIVER FOR THE WHISKER-TOUGH COATING PROJECT - The key driver for creating the Whisker-Tough coating has always been its economic advantage compared to current manufacturing options used to mitigate tin whisker risk in military systems, particularly those systems requiring high reliability while operating in harsh environments. Reducing costs on those programs is challenging.. Consequently, the research and development of the Whisker-Tough coatings has always been focused on its use in high-reliability system applications. The Whisker-Tough coating is a purpose-built coating.

Here are the requirements that have been built into the design of the Whisker-Tough coating created for military systems, and any other high-reliability severe-service application:

1.1.1 The Whisker-Tough coating must captivate the tin whiskers under the coating - This requirement applies to all whiskers, even if there is a large "swarm" of them. The coating can not be overwhelmed by sheer numbers. Three design mechanisms are involved to achieve this. First is the elastomer coating's strength in preventing puncture, 50 times better than the best commercial coating that was available. The second is the

coating's "controlled release" designed to allow the coating to create "containment-blisters" around whiskers before they could puncture the coating. The whiskers are trapped in the containment-blister and can not get out to cause a short circuit. A third is the extremely high elongation-capability, more than an order-of-magnitude above that of most coatings. These captivation-mechanisms are based on the mathematical equations-of-state of a point-stressed-elastomer, such that the material properties of the Whisker-Tough coating have been formulated specifically to captivate the tin whiskers. *In other words, the coating works by engineering-design.*

1.1.2 The Whisker-Tough coating must provide complete coverage over the tin-plated electronics, even over sharp edges. Liquid conformal coatings do not provide complete coverage over sharp edges because of the limitations of the Physics of Fluids that take place when the normal coatings are applied to the circuit board. Tin whiskers on circuit boards will grow on sharp edges such as those found on some microcircuit terminations. The new coating's multi-layer design does provide the complete coverage needed so that all tin-whisker-producing surfaces are controlled by the coating.

1.1.3 The Whisker-Tough coating must not cause any harm to fragile electronics over the service life of the military system - The Whisker-Tough elastomer was designed to be a soft, compliant, and stretchy coating because of this requirement and others. It has proven performance in long-term environmental testing for this, involving laboratory-testing of over 9000 thermal cycles from -50C to + 100C.

2.0 Military System Manufacturing Benefits Provided by Whisker-Tough - The Whisker-Tough coatings will replace the costly component-level tin whisker mitigation processes, and eliminate any component tracking escapes associated with that.

The Whisker-Tough coatings will reduce the needed Incoming-Receiving testing with X-Ray Fluorescence to find non-conforming (i.e., tin-plated) materials.

The Whisker-Tough coatings will replace many existing conformal coatings used to provide the circuit boards with environmental protection from condensation and conductive debris.

3.0 Benefits to a military customer- The Whisker-Tough coatings will reduce reliability problems that have occurred in recent years because of tin plating being found in vendor-supplied items, after they had entered the production line.

4.0 Engineering benefits: - The more abundant and often less-expensive lead-free (tin-plated) components can now be used in designs. Since the Whisker-Tough coating is applied to the whole circuit board, there is no concern if a particular component is tin-plated.

It will reduce the amount of supply-chain monitoring by Component-Engineering organizations for changes to component termination finish, from the legacy tin-lead to pure tin plating.

- This practice being added to parts and materials has not been approved by MDA and is not an endorsement by MDA/QS (Quality, Safety & Mission Assurance).