CONCLUSION

The vicinal illumination technique has been successfully used to detect cracks in many types of ceramic materials. The effect of inherent material properties on the suitability of the technique has been studied and discussed. Several case histories have shown the efficiency and effectiveness of both bright field and dark field techniques used for failure analysis, screening, and routine evaluation. This inspection method has become an important tool for inspection and analysis of many ceramic materials for space flight applications.

Effects of Conformal Coat on Tin Whisker Growth

Jong S. Kadesch
Unisys / NASA
e-mail: jkadesch@pop300.gsfc.nasa.gov
301-286-2785

This article provides a status report on an experiment to study the effects of a conformal coat on tin whisker growth initiated by NASA Goddard 13 months ago. Interim updates have been reported and documented on a regular basis on the Code 562 web site:

http://nepp.nasa.gov/whisker/

Tin whisker formation from pure tin plated surfaces is well known and documented. However, little research has been conducted to understand the benefits (if any) of using protective barriers such as conformal coat to prevent whisker formation or to inhibit growth. Although NASA prohibits the use of pure tin plating, there is still a possibility that some devices may still contain pure tin plated surfaces (i.e., Commercial Off-The-Shelf Components (COTS), hybrids, etc.). The presence of conformal coating is often used to mitigate the whisker concern. In these situations, projects need to understand the risks of continued use and potential benefits of using a protective coating over the tin surface.

Most published literature on tin whiskers agree that brass with a bright tin finish is a combination that promotes whisker formation. Whether conformal coating could provide enough protection against whisker growth is unknown and the literature search regarding the conformal coating associated with tin whiskers was unsuccessful. Therefore the experiment was dedicated to understanding the role of the conformal coating on tin whisker growth.

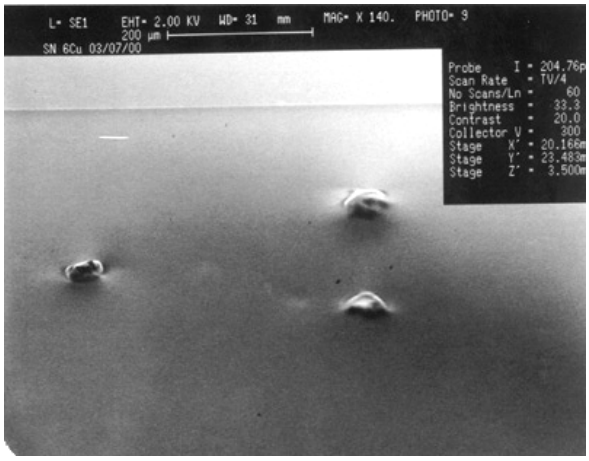
For this experiment several brass substrates (some with copper flash) have been plated using a "bright" tin finish. The literature suggests that the bright tin plating process is most susceptible to whisker formation due to residual stresses in the surface material. Introduction of scratches in the surface also creates localized stresses that may promote whisker formation. To further promote whisker formation some of the plated samples were scratched using a knife blade.

The samples were segregated into two test groups. Portions of each sample were coated with Uralane 5750 conformal coat material. Uralane 5750 was selected because of its widespread use in NASA systems. One test group has been placed in an oven at 50 °C because the literature suggests that whisker growth is greatest at this temperature. The other test group is being stored at room temperature. All samples are being visually examined periodically to determine;

- If conformal coat inhibits whisker formation
- If whiskers are capable of growing outward through the conformal coat
- Incubation period for whisker formation
- Rate of whisker growth

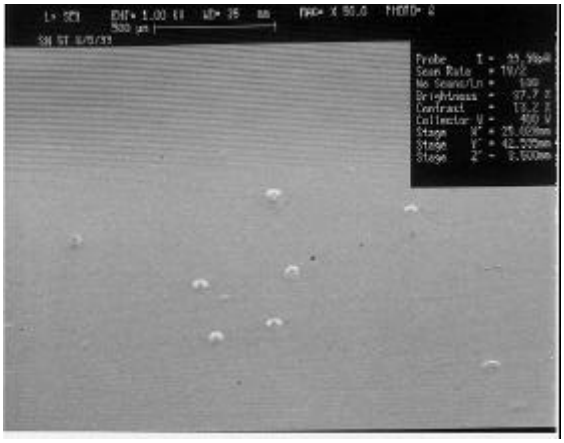
The latest observation indicates that tin whiskers under the conformal coat are pushing their way outward causing dome shapes in the coating. As time progresses, these dome shapes become larger and narrower at the top, which suggests that the whisker tips are beginning to penetrate the tough skin of the conformal coat. Figure 1A and 1B show whiskers at the same location taken a year apart. Similarly, Figures 2A and 2B are SEM photos taken at another site six months apart.

A. Picture taken on 3/11/99



B. Picture taken on 3/15/00

Figure 1. Whiskers forming under coating



A. Picture taken on 8/5/99

B. Picture taken on 3/15/00

Figure 2. Whiskers forming under coating

Among 14 samples, only 3 samples show these dome shapes. Two of these samples are kept at room temperature; one is copper flashed and the other is pure tin over a brass metal substrate. Figure 3 shows whiskers from a bare metal surface, without coating, and some whiskers are growing a lot faster than others. This one particular whisker is estimated to be 0.8 mm in length. This is, of course, relatively small to cause any short circuits. However, other experimenters have recorded tin whiskers on the order of 1 cm or more.

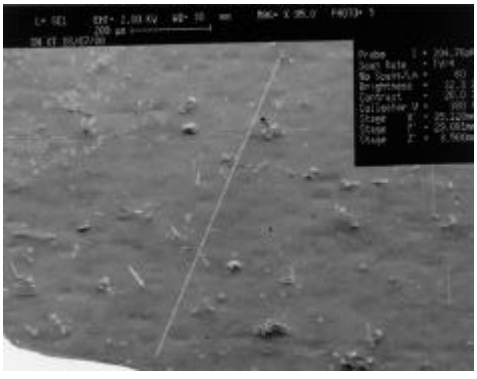


Figure3. Whiskers from uncoated side

Some general observations from our experiment to date include:

- Even though complete penetration of whiskers through coating is not yet observed, it is definite that the coating is slowing down the whisker growth.
- Despite of the optimal temperature for tin whisker growth at 50 °C, there are more whiskers and taller whiskers from the samples that are kept in room temperature.

The experiment is ongoing. Please visit our web site for further updates. This work is being done under the guidance of Dr. Henning Leidecker (NASA GSFC) with significant technical assistance provided by Scott Kniffin (Unisys Corporation).

Status of Military Specifications for Ceramic Switch Mode Power Supply (SMPS) Capacitors

Jay Brusse
Unisys Corporation at NASA Goddard
(301) 286-2019
Jay.A.Brusse.1@gsfc.nasa.gov

The US Military, NASA and the manufacturing community have worked diligently over the last few years to develop a Military procurement specification for ceramic Switch Mode Power Supply (SMPS) capacitors. This specification known as MIL-PRF-49470 [Capacitor, Fixed, Ceramic Dielectric, Switch Mode Power Supply (General Purpose and Temperature Stable), General Specification for] is accessible from the Defense Supply Center Columbus (DSCC) web site at:

http://www.dscccols.com/offices/doc_control/

MIL-PRF-49470 is intended to replace the DSCC drawing for similar capacitors, DSCC-DWG-87106. To date, two suppliers (AVX Olean Advanced Products and Presidio Components) have qualified a small portion of the available capacitance/voltage ratings available. Users are encouraged to start using the MIL-PRF-49470 parts in lieu of the DSCC drawing as soon as qualified sources become available.

Procuring parts through MIL-PRF-49470 instead of DSCC-DWG-87106 will provide users with a more reliable part. Some of the advantages of MIL-PRF-49470 over DSCC-DWG-87106 are:

Requirement	MIL-PRF-49470	DSCC-DWG-87106
Formal Qualification Process (QPL Established)	Yes	No
MIL-STD-790 Compliance	Yes	No
DSCC Audits	Yes	No
Routine Qualification Maintenance Testing (i.e., Life Testing)	Yes	No
Group A Percent Defective Allowed (PDA) Specified	Yes	No
Prohibits Mixing of Chips from Different Production Lots within a Single SMPS Stack Lot	Yes	No

DSCC's plan is to:

- Inactivate DSCC-DWG-87106 parts for new design when one supplier qualifies for the equivalent MIL-PRF-49470 part
- Cancel DSCC-DWG-87106 in its entirety when all parts on the drawing have two qualified sources for the equivalent MIL-PRF-49470 parts.

The QPL for MIL-PRF-49470 is available for download at DSCC's website.

http://www.dscccols.com/offices/sourcing_and_qualification/

As products are qualified, the associated MIL-PRF-49470 capacitors will be added to the NASA Parts Selection List www site at: http://nepp.nasa.gov/npsl

Recently, MIL-PRF-49470 was modified to include a "space level" product. However, at the time of this article, no sources have attained qualification for space level product. Some of the key additional requirements for the space level product include:

- Non-destructive internal examination (acoustic microscopy or other means)
- Chip Level DPA/Stack level DPA
- Humidity, Steady State, Low Voltage
- Extended Voltage Conditioning
- Lot Sample Thermal Shock plus Life Testing on all Lots
