

Identification of Tin Whisker Growth on Tin Plated Copper Substrate

A. Knight¹, H. Aglan¹, D. Burdick²

¹ Tuskegee University, Tuskegee, AL

² The Boeing Company, St Lois, MO

Tin whiskers are single crystals of pure tin that grow spontaneously from the surface of mainly tin plated copper substrates. Tin whisker growth is a current problem arising from the replacement of lead (Pb) components in electronics with more health friendly alternatives like electroplated tin. Tin whiskers pose a serious risk to electronic devices and may cause failures by short circuiting the electronic components. Tin whiskers have the ability to grow several millimeters in length and there are several hypotheses about the mechanisms governing their growth [1-3].

In this study an attempt was made to create an environment that is conducive for the initiation and growth of tin whiskers. Tin plated copper coupons were used as substrates to grow the tin whiskers. The coupons were placed in a hygrothermal chamber with 90% relative humidity at 90°C. The test coupons were kept in the chamber for almost one year and were periodically examined using a Scanning Electron Microscope (SEM). Images were captured after 5 and 12 months and the effect of exposure time on hillock formation and whisker growth was observed.

SEM images were obtained showing different tin whisker growths. Energy Dispersive X-ray spectroscopy (EDS) was used to determine the composition of the tin whiskers. Figure 1A and 1B show images of the same field of whiskers taken after 5 and 12 months of exposure. Figure 1B (12 months exposure time) displays additional growth of the whiskers shown in Figure 1A. Figure 1C shows the root of the longer whisker which has multiple whisker initiating around the main whisker (yellow arrows). Figure 1D shows a magnified smaller whisker from 1B (blue arrow). Figure 2A shows a root at a different location, with two small whiskers (green arrows). Figure 2B shows the length of the longest whisker (375µm) that propagated from the root. Figure 3 captures the ability of the whisker to bend, change directions and come in contact with another whisker, which may cause a short circuit.

This investigation shows the ability of tin whiskers to grow spontaneously in a seemingly unpredictable manner. It was also observed that the whiskers have the ability to grow and come in contact with each other, which presents a hazard for electronic devices on which they may grow, because this would cause a short circuit.

References:

- [1] Sampson, Michael, and Henning Leidecker. N.p., n.d. Web. 1 Nov. 2016. <<https://nepp.nasa.gov/WHISKER/background/>>
- [2] Lee, B.-Z., and D.N. Lee. "Spontaneous Growth Mechanism of Tin Whiskers." *ActaMaterialia* **46.10** (1998): 3701. Web. <http://thor.inemi.org/webdownload/newsroom/Lee.pdf>
- [3] Fukuda, *et al.* *Microelectronics Reliability* **47.1** (2007): 88. Web.<<http://www.sciencedirect.com/science/article/pii/S002627140600117X>>

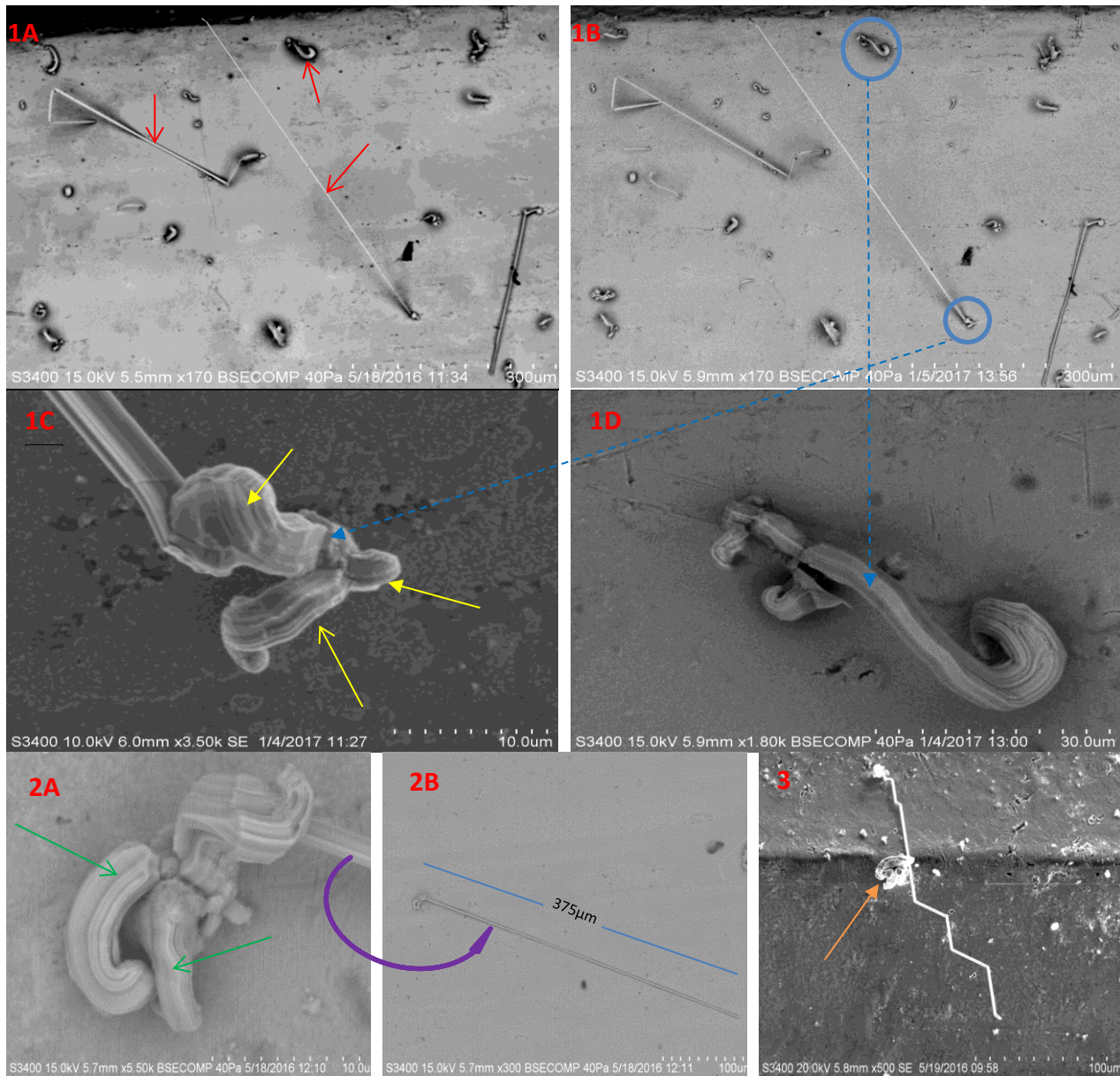


Figure 1A and 1B shows the same 'field' of tin whiskers taken at 5 and 12 months (whiskers-red arrows). **Figure 1C** shows the root of the longest whisker (multiple whisker growths-yellow arrows) and a magnified image of a smaller whisker in the region (magnified features-blue dashed arrows). **Figure 2A** shows a whisker root with multiple whisker growths from which the longer whisker in **2B** propagated (purple arrow). **Figure 3** shows a long whisker with multiple bends coming in contact with another smaller whisker (orange arrow).