Whiskers on Monitor PCBs

September 5, 2008

Abstract

Two (2) failed monitors were physically examined to assess potential failures. Long metal whiskers (> 900 microns) were observed on USB housings. Failure of monitors not directly linked to tin whiskers.

Background

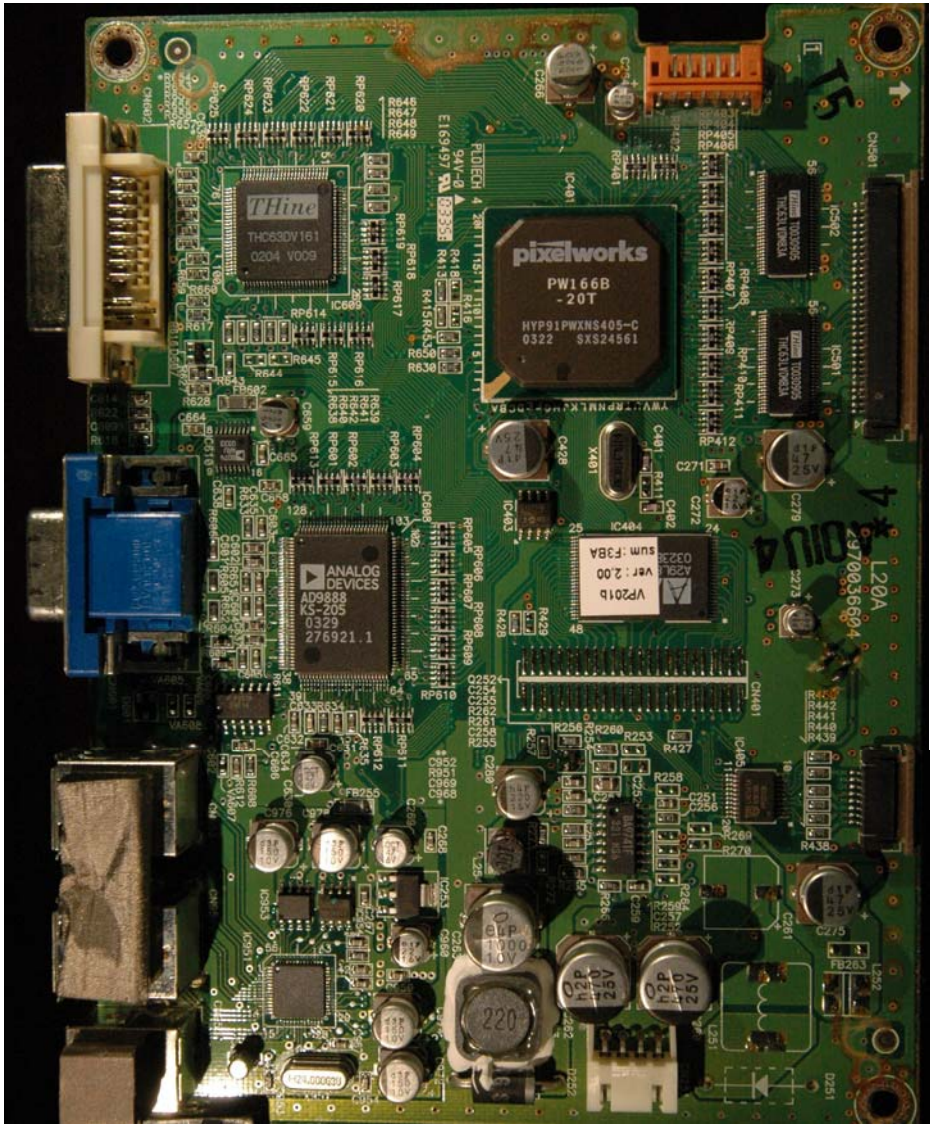
- Several failed LCD monitors purchased from Great Lakes Electronics Corp. www.recycleelectronics.com - a de-manufacturing and recycling company specializing in office computers. Reselling of some hardware is done through ebay: www.stores.ebay.com/Great-Lakes-Electronics-Corp
- Malfunction of the monitors was traced to the interruption of an electrical fuse. Replacement of a fuse returned function to normal
- Root cause of the current overload remains undetermined
- Physical examination of USB ports on the monitor video PCBs were found to have tin whiskers present on their surfaces.
- Observed whiskers were long enough to bridge fine pitched perimeter leaded packaged integrated circuits on the PWAs.

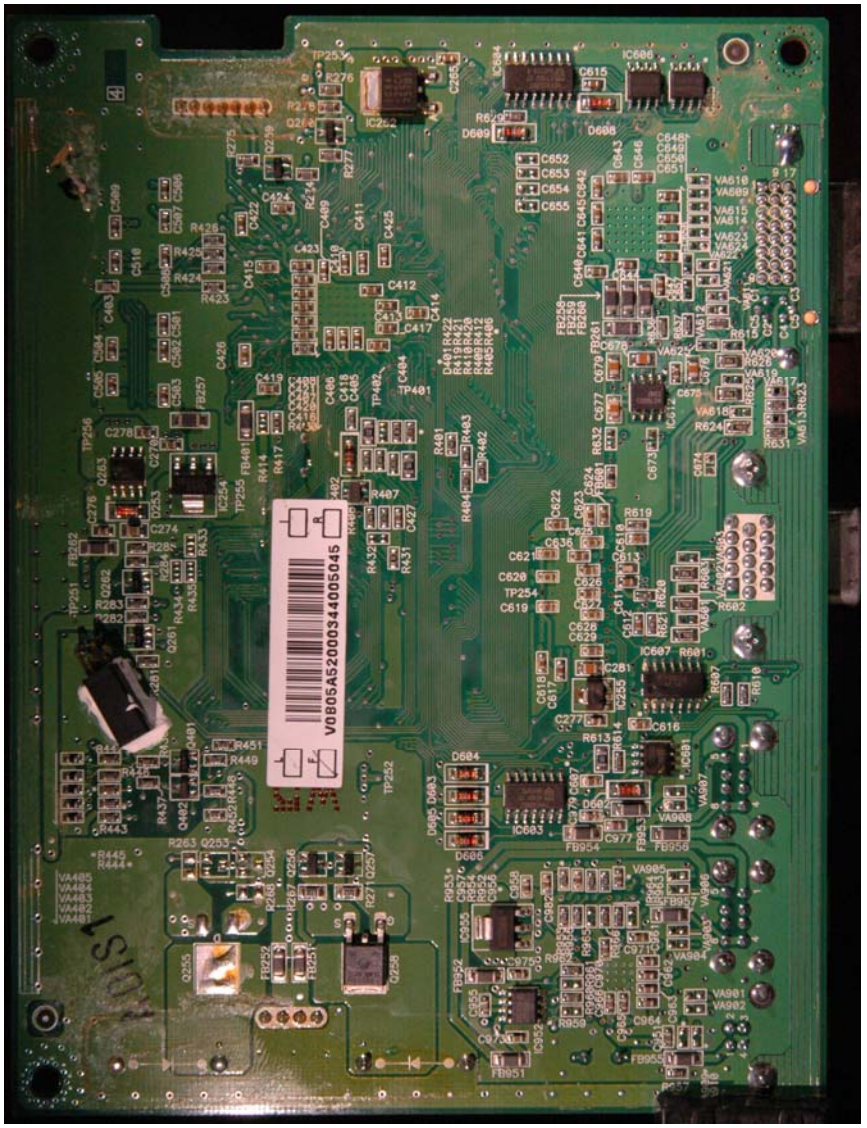
Printed Circuit Boards

- Both boards labeled by Plotech Co, LTD www.plotech.com – a PCB manufacturer originating in Taiwan, with LCD monitors listed as one of their specialties

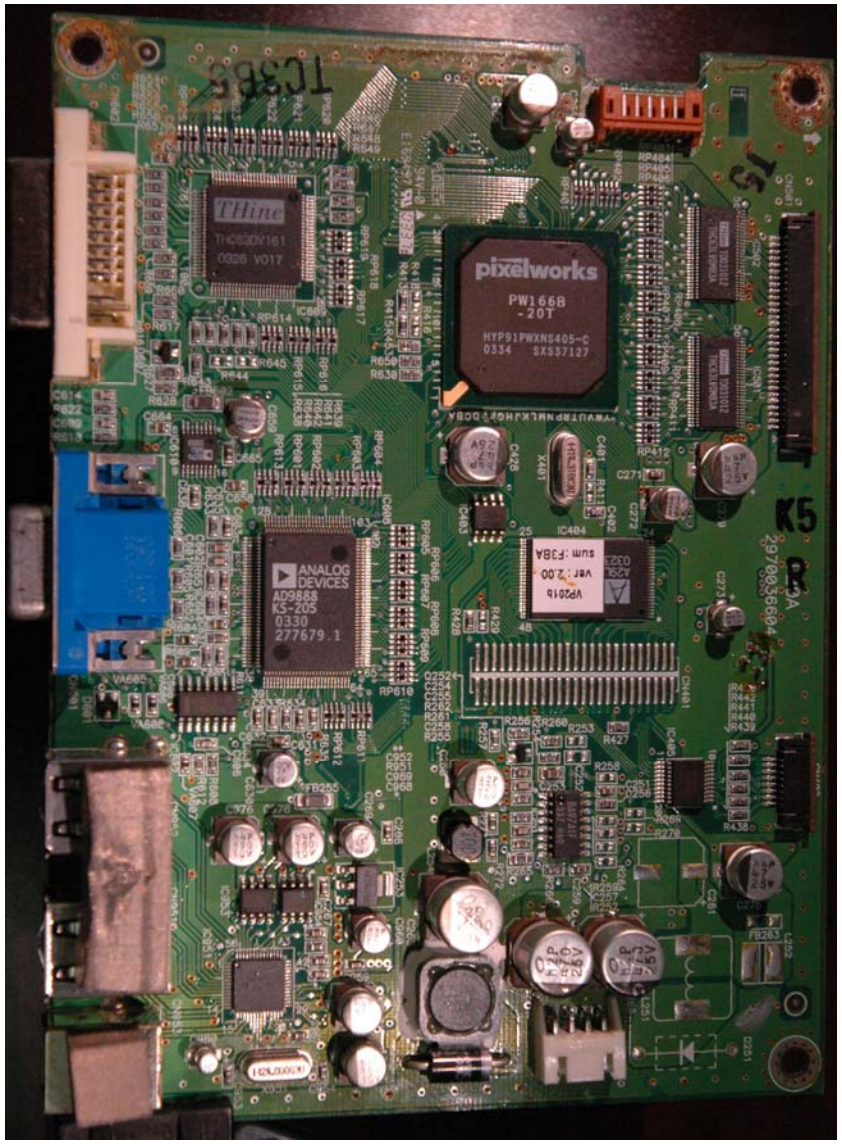
- The four digit markings 0335 and 0337 are suspected to be date codes of the form YYWW
- Date codes on some of the components are in mid-2003 year (possibly, the locations of the component manufactures are close to the PCB manufacturing, and a well-established supply exists, resulting in parts not stored for long periods of time)
- Boards contained a variety of electronic parts including relatively fine pitched quad flatpacks, AD9888 and THC63DV161

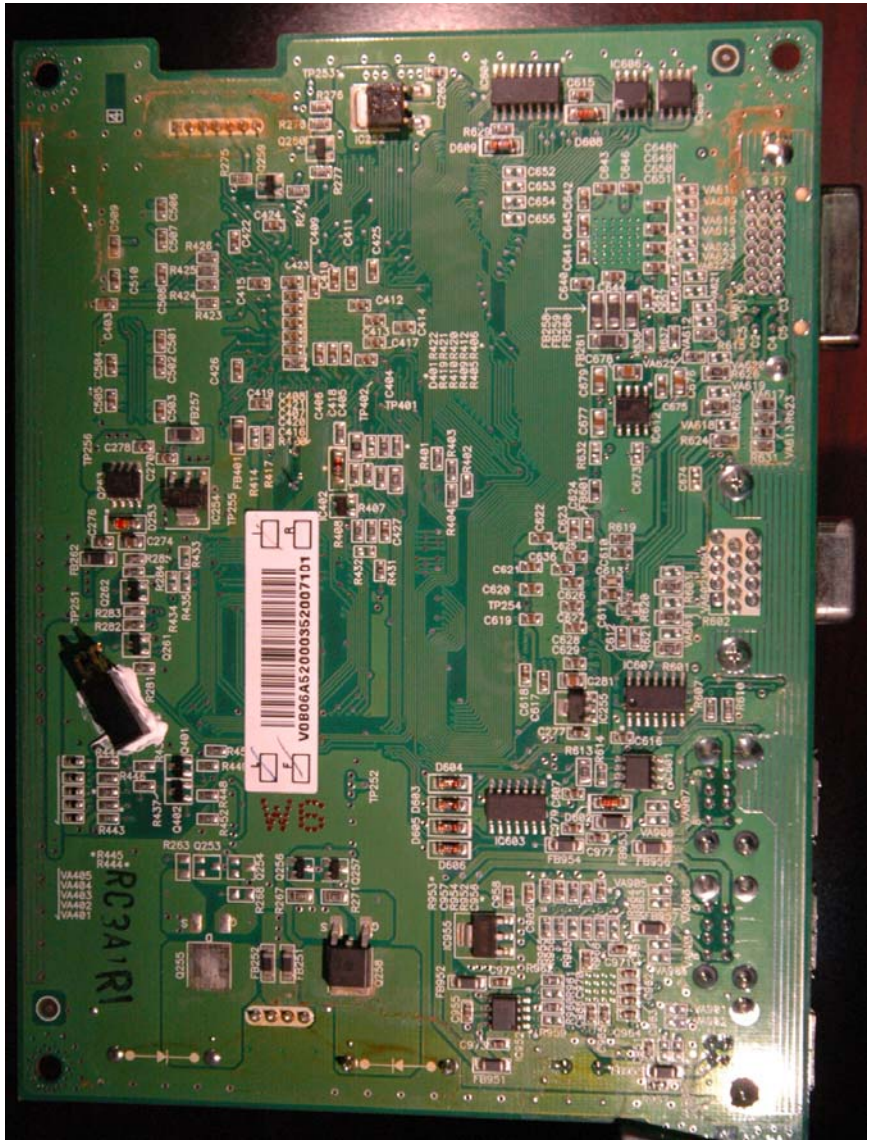
Video Board 0335 - Overview





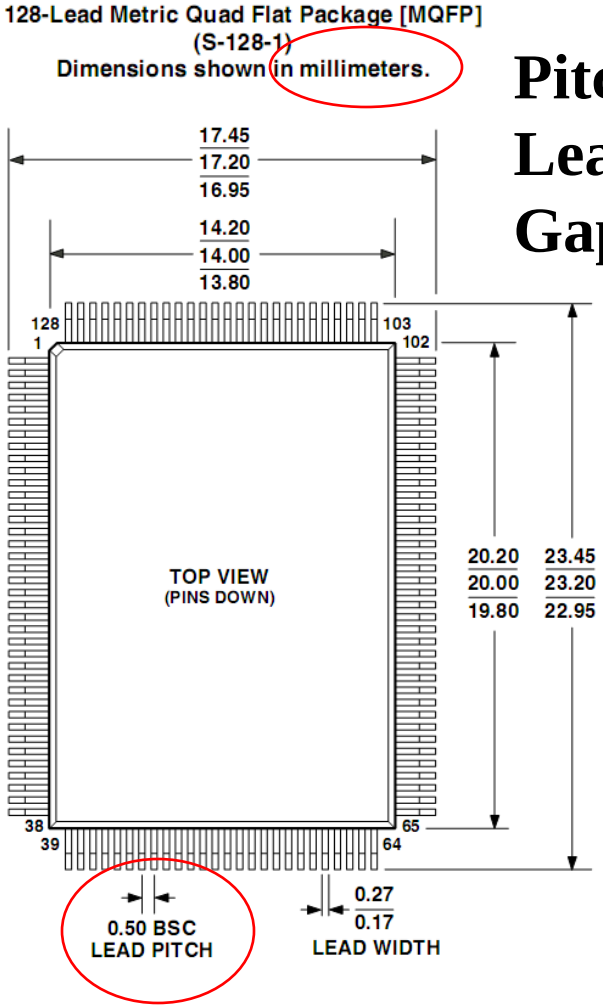
Video Board 0337 - Overview





Components on Board: AD9888

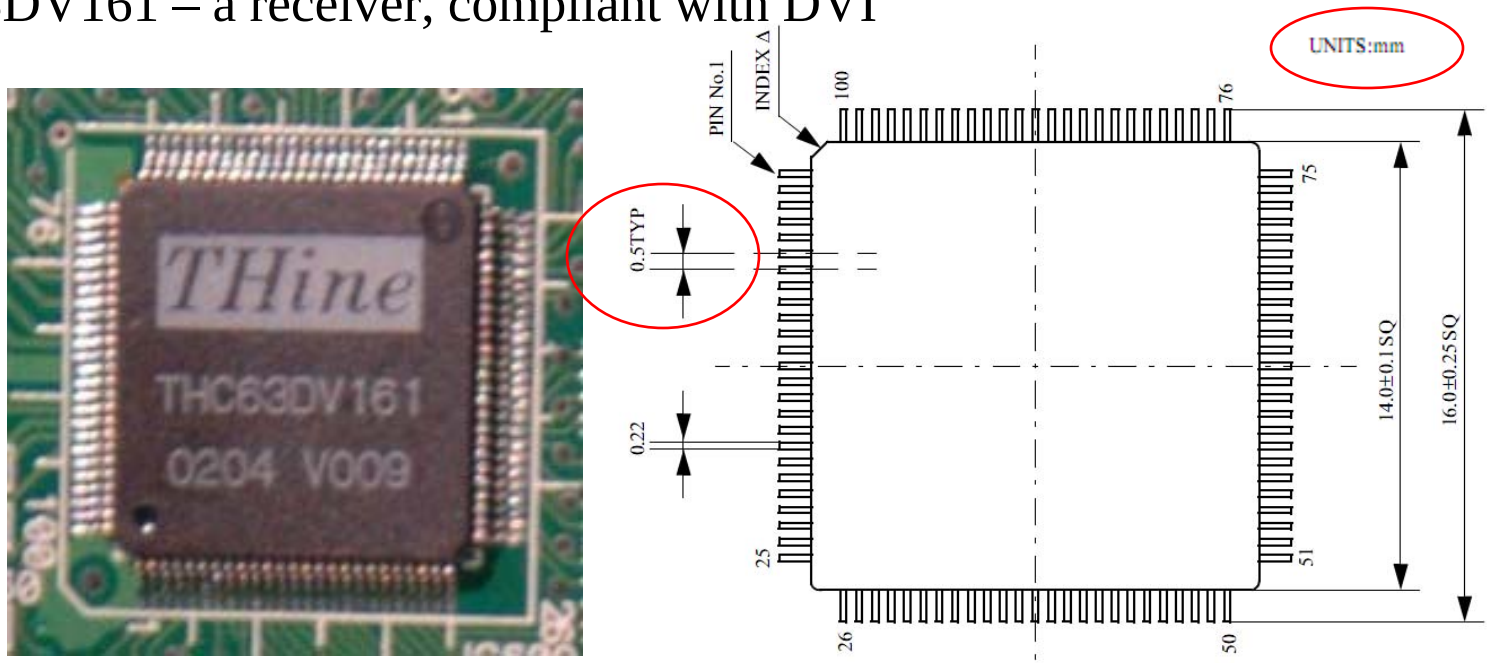
- AD9888: 205 MSPS Highly Integrated Graphics Digitizer for UXGA and HDTV Displays



Pitch: 500 microns
Lead Width: 170-270 microns
Gap: 330-220 microns

Components on Board: THC63DV161

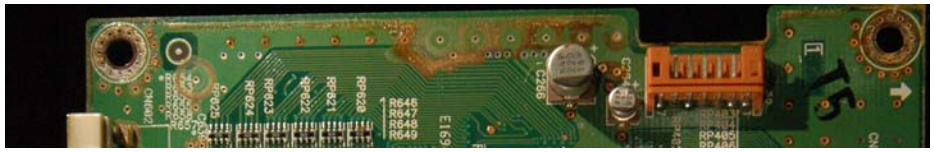
- THC63DV161 – a receiver, compliant with DVI



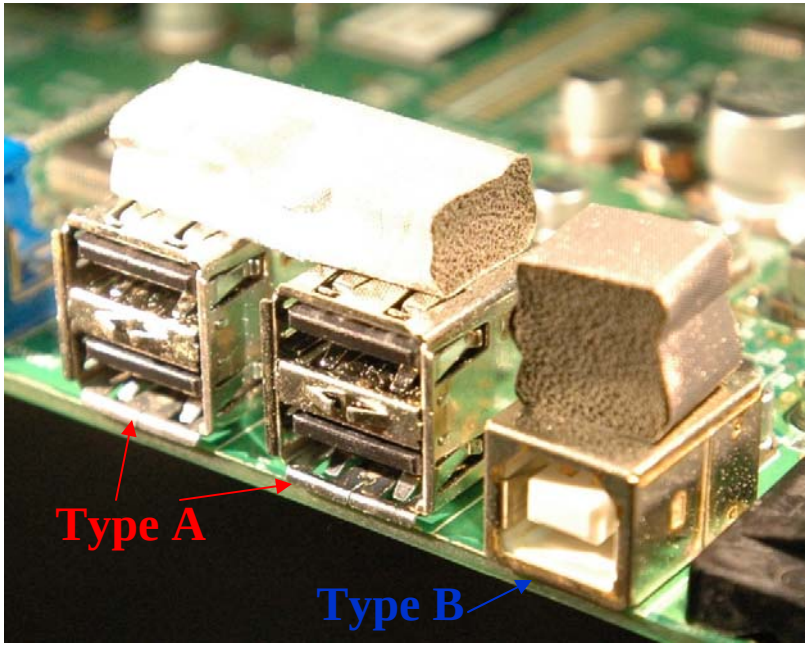
Pitch: 500 microns
Lead Width: 220 microns
Gap: 280 microns

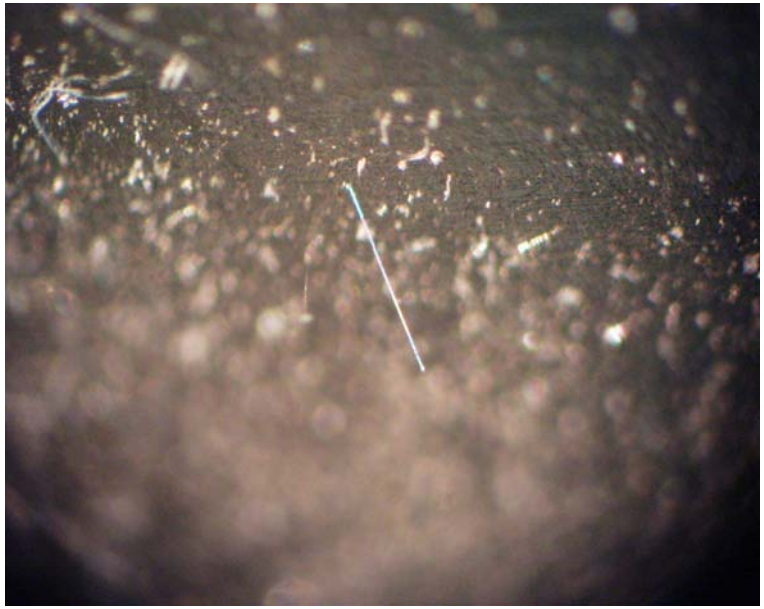
Observations on the Boards

- Corrosion observed around the perimeter of the PCB and in some vias



- Five USB ports: four of type “A” and one of type “B” – all unmarked
  - Whiskers found on the metal housings of the ports





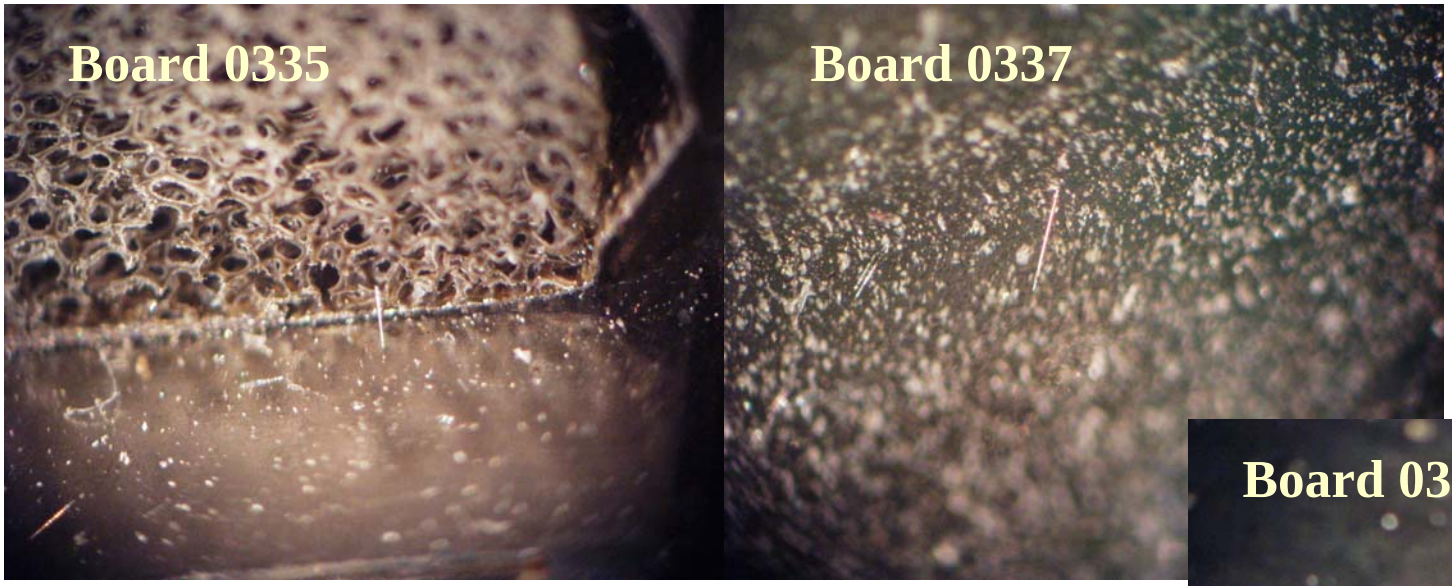
Example of a whisker on board 0335 (USB A) under optical microscope

Corrosion

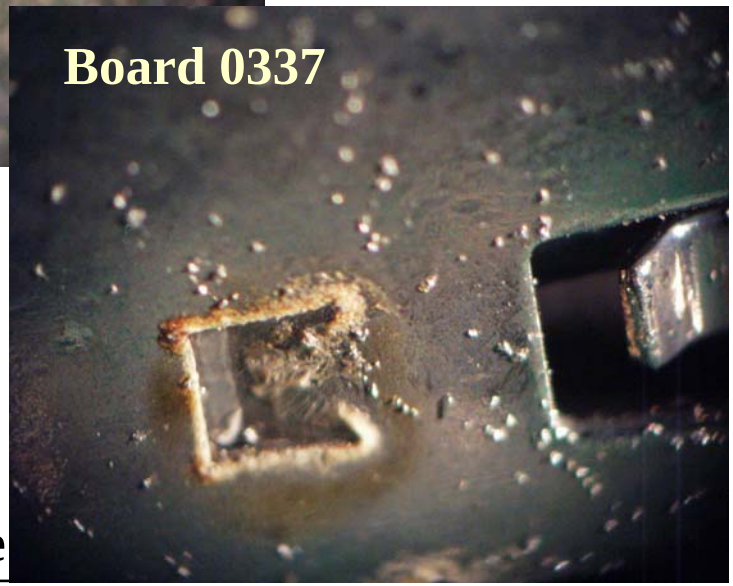
- Environment of the monitor in the prior 5 years is unknown
- Corrosion observed around the edges of the PCB may have been induced by the galvanic cell made up of the PCB and the frame it was mounted on
- Material analysis of the frame showed it to be Zn-coated Fe (Zn ~2.5µm thick)
- Optical inspection of the frame did not reveal presence of zinc whiskers
- Screws that mounted PCB on the frame are Fe-base with Zn coating, with Cr finish (Zn ~2µm, Cr <1µm) *[although the material composition is correct, thicknesses and order of layers may be wrong – XRF analysis leaves those for guessing. The outsides of the screw are yellow-hue]*
- The PCB material is suspected to be FR-4 material based on company's website

Whisker Observations

- Optical observations for whiskers and nodules made on both assembled boards
- Later, USB connectors were de-soldered for closer observation



Long Filament-type whiskers



Nodules on the surface

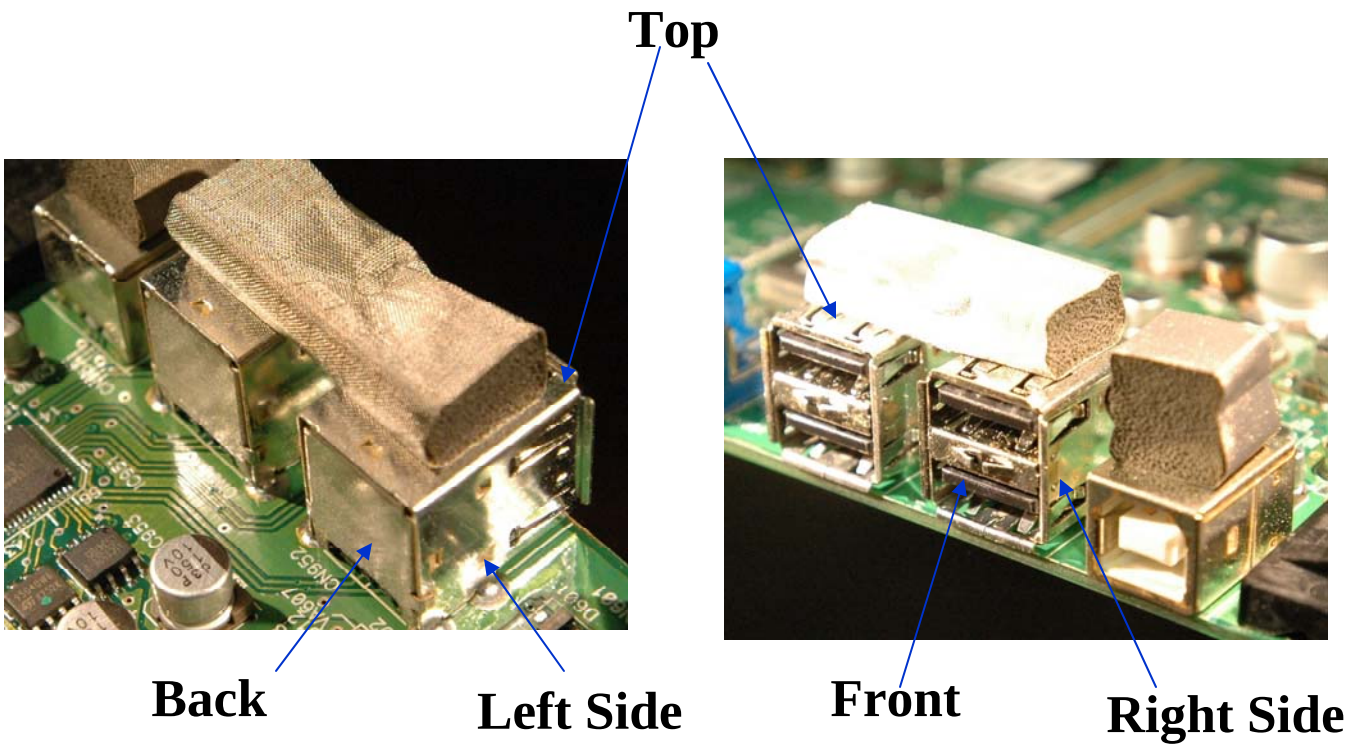
Material Analysis of the Connectors

- Material analysis of the connectors showed presence of Zn, Cu and Sn
- Assumed a Zn-Cu base (brass) plated with Sn
- Sn has measured to be ~5µm thick

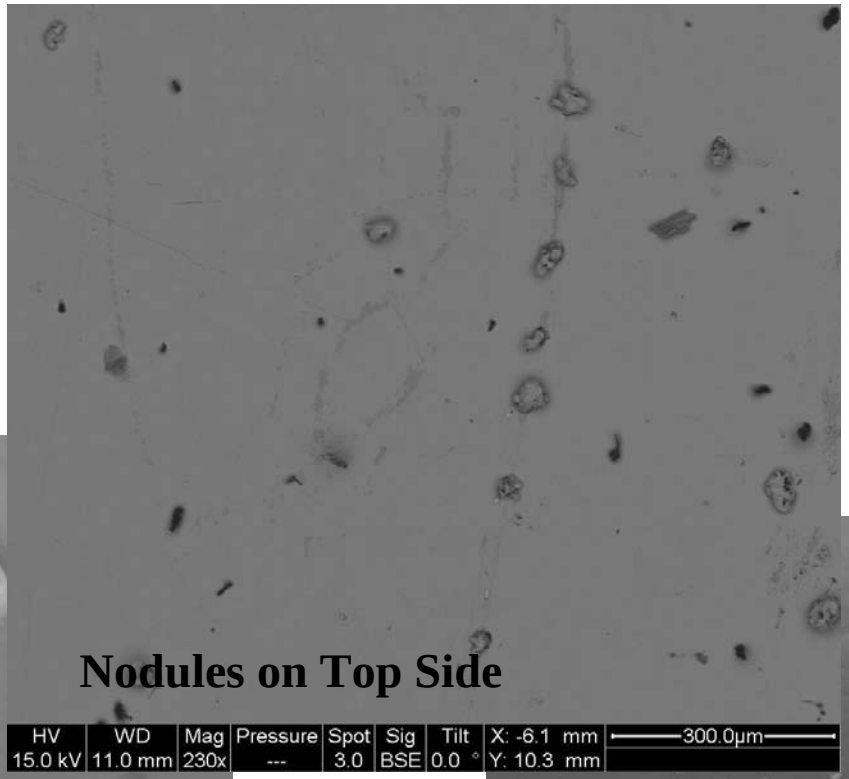
- Although any Sn surface has the potential to grow whiskers, Sn in 2-10µm thickness has been reportedly cited as more whisker-prone
- Brass reported as a good whisker-prone base material under Sn plating

Looking for Whiskers

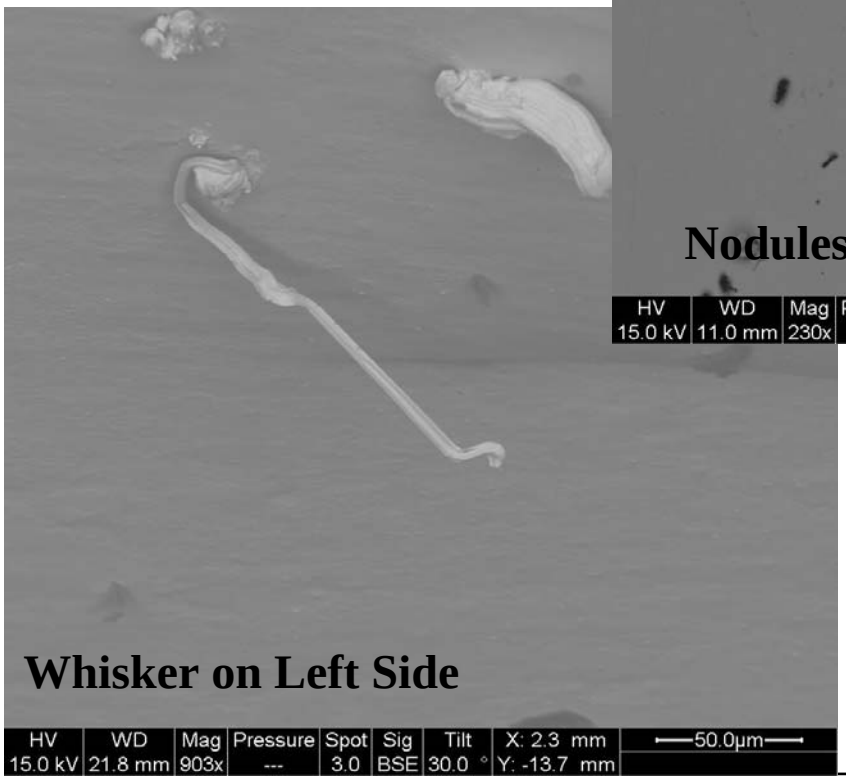
- Upon de-soldering and foam removal, 3 USB connectors observed:
  - USB type “A” from board 0335 (mostly nodulation, some whiskers 300µm)
  - USB type “B” from board 0337 (lots of nodulation, whiskers >500µm)
- Observations made on top, front, two sides, and back of each connector



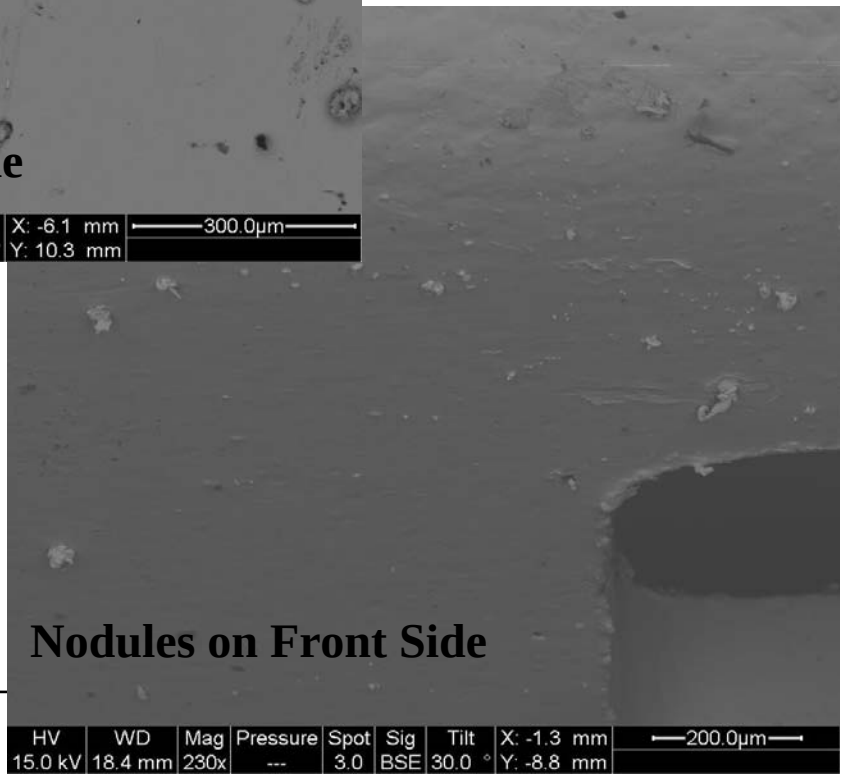
Board 0335 – USB “A” #1



Nodules on Top Side



Whisker on Left Side



Nodules on Front Side

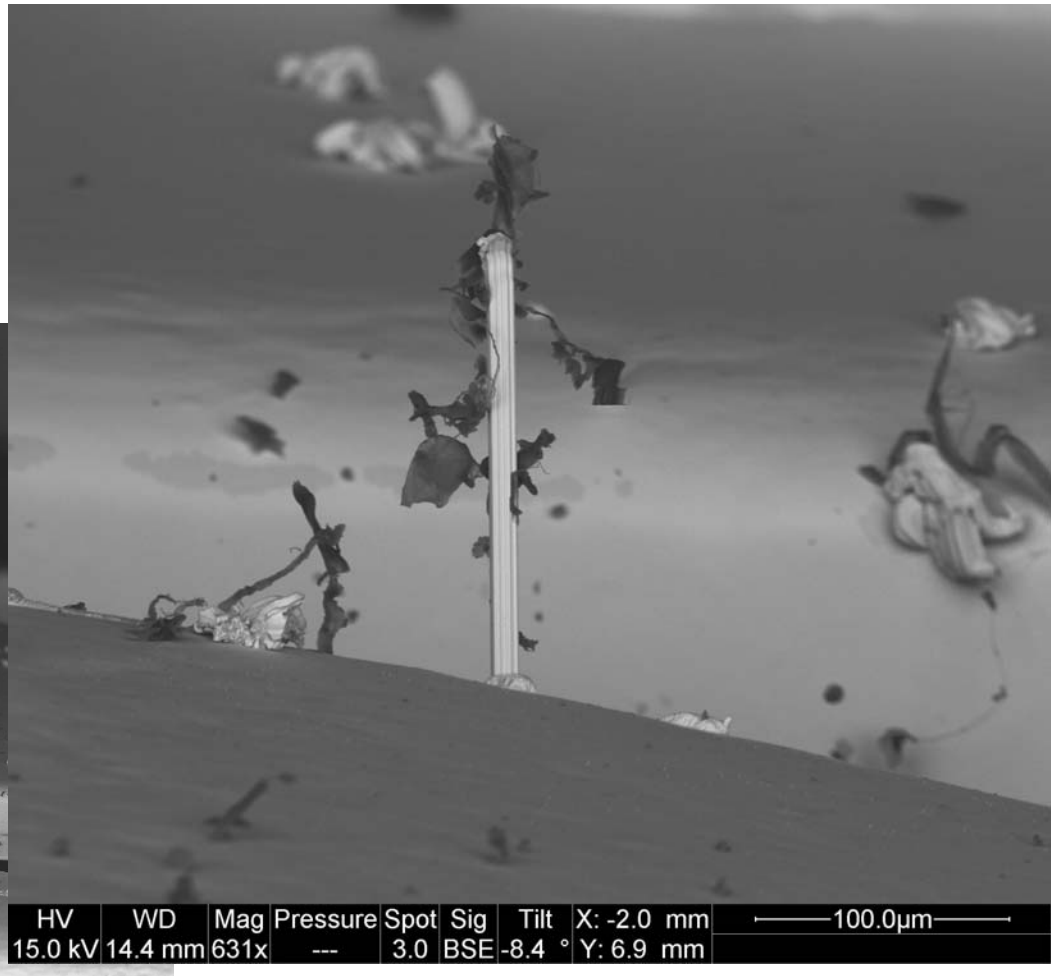
Board 0335 – USB “A” #2

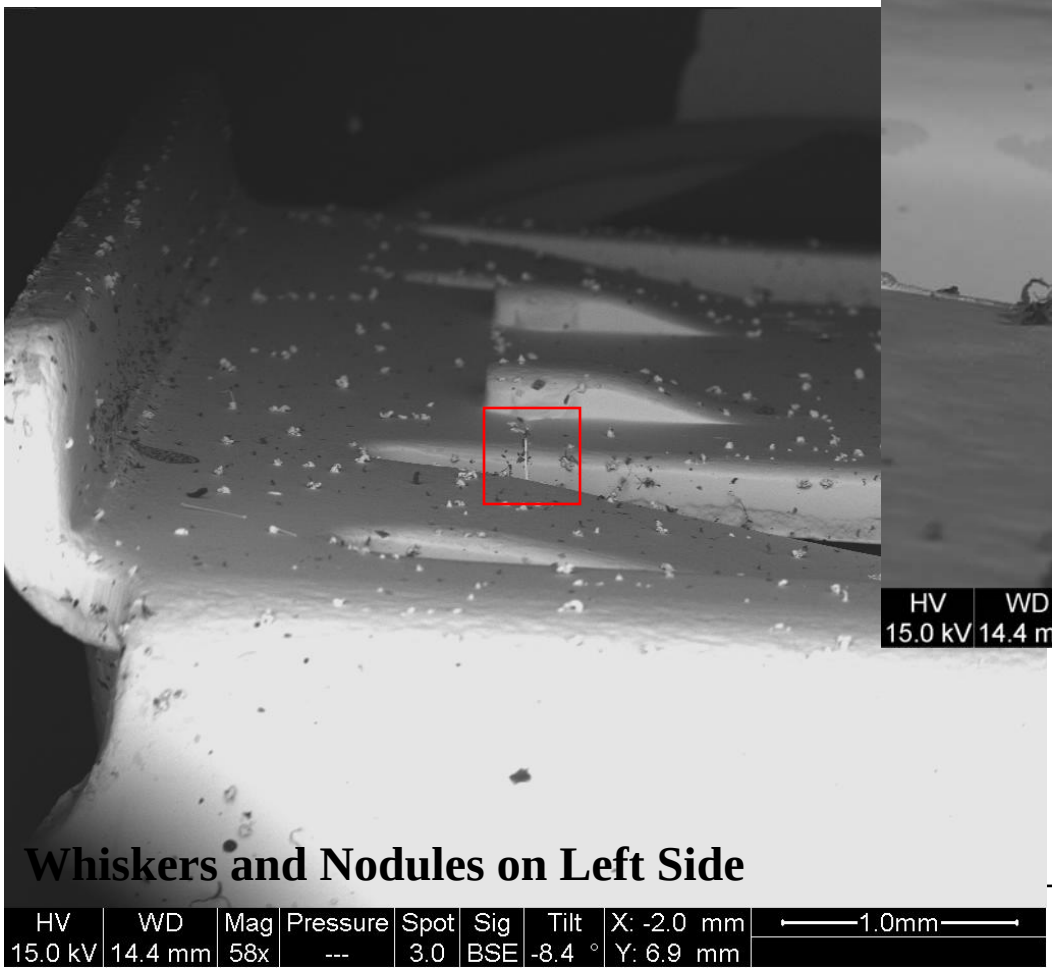
Whisker on Front Side

Whisker and Nodules on Right Side

Whisker on Top Side

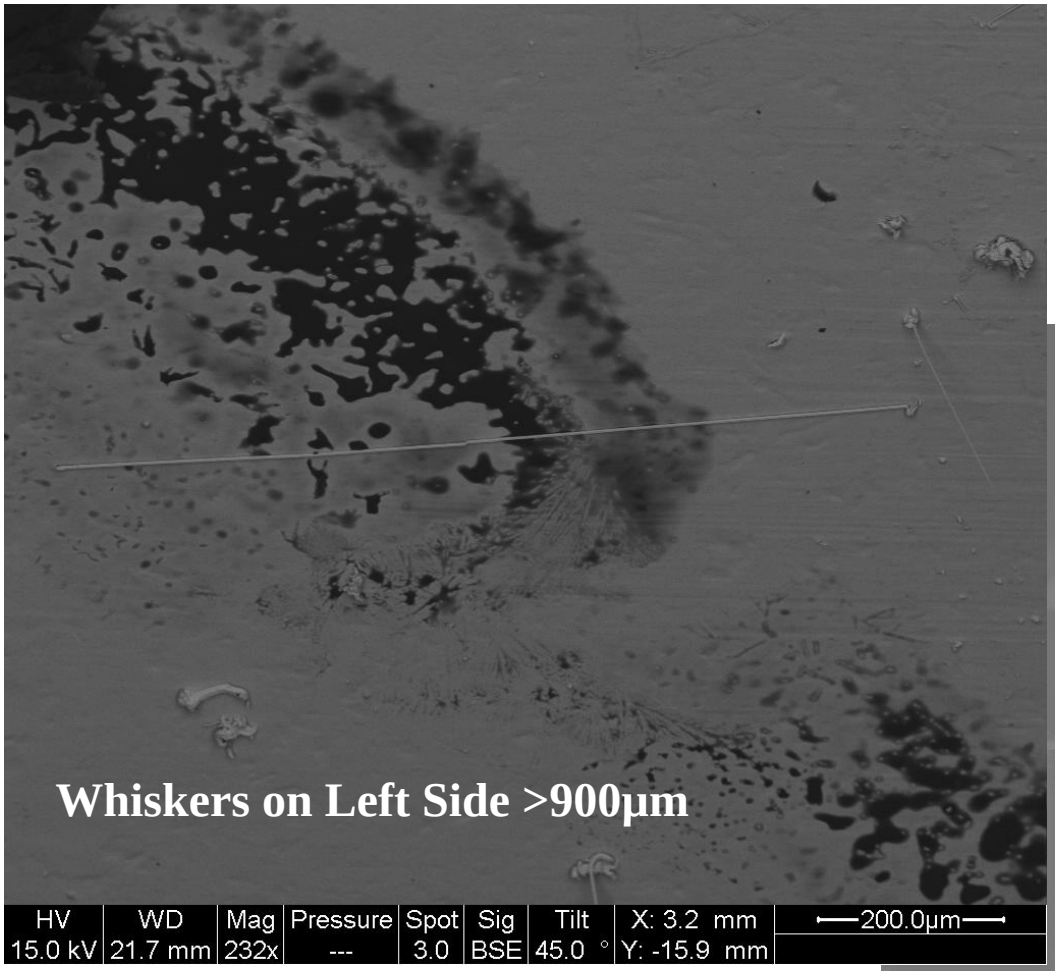
Board 0335 – USB “A” #2

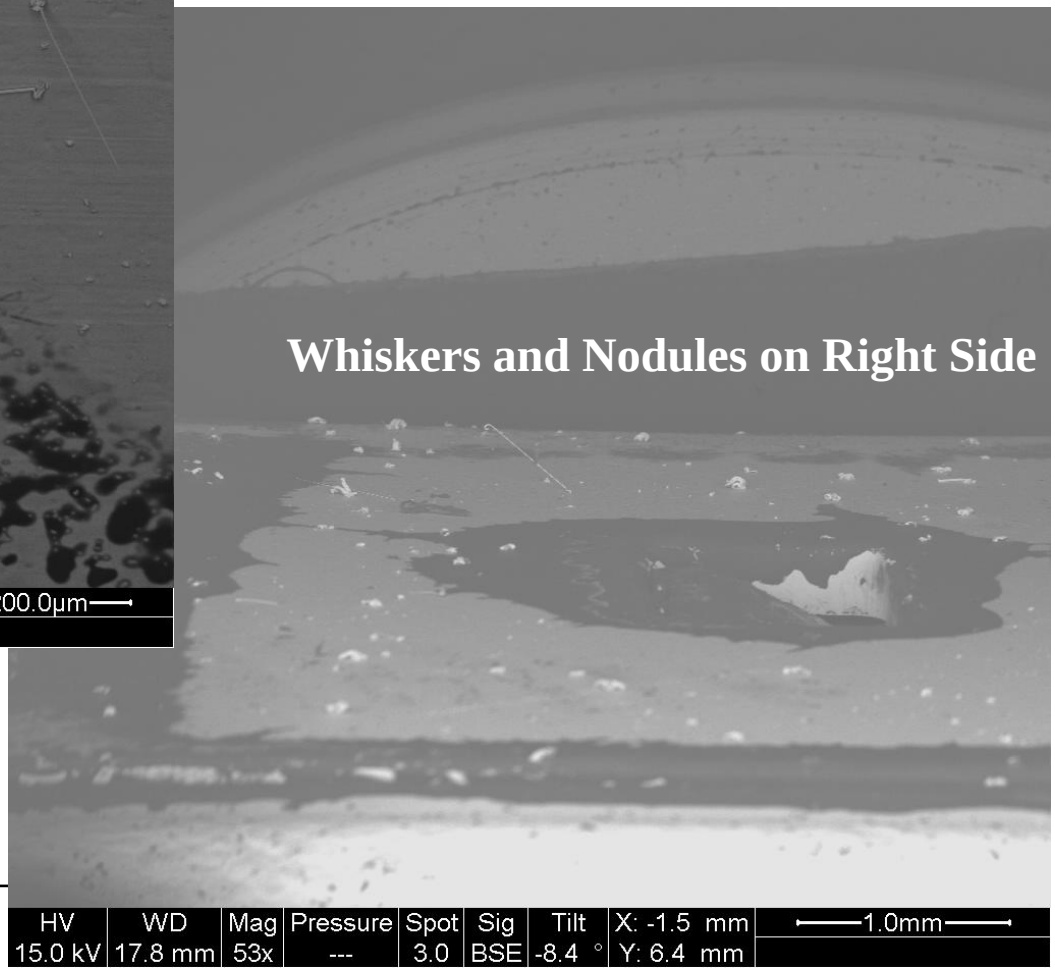




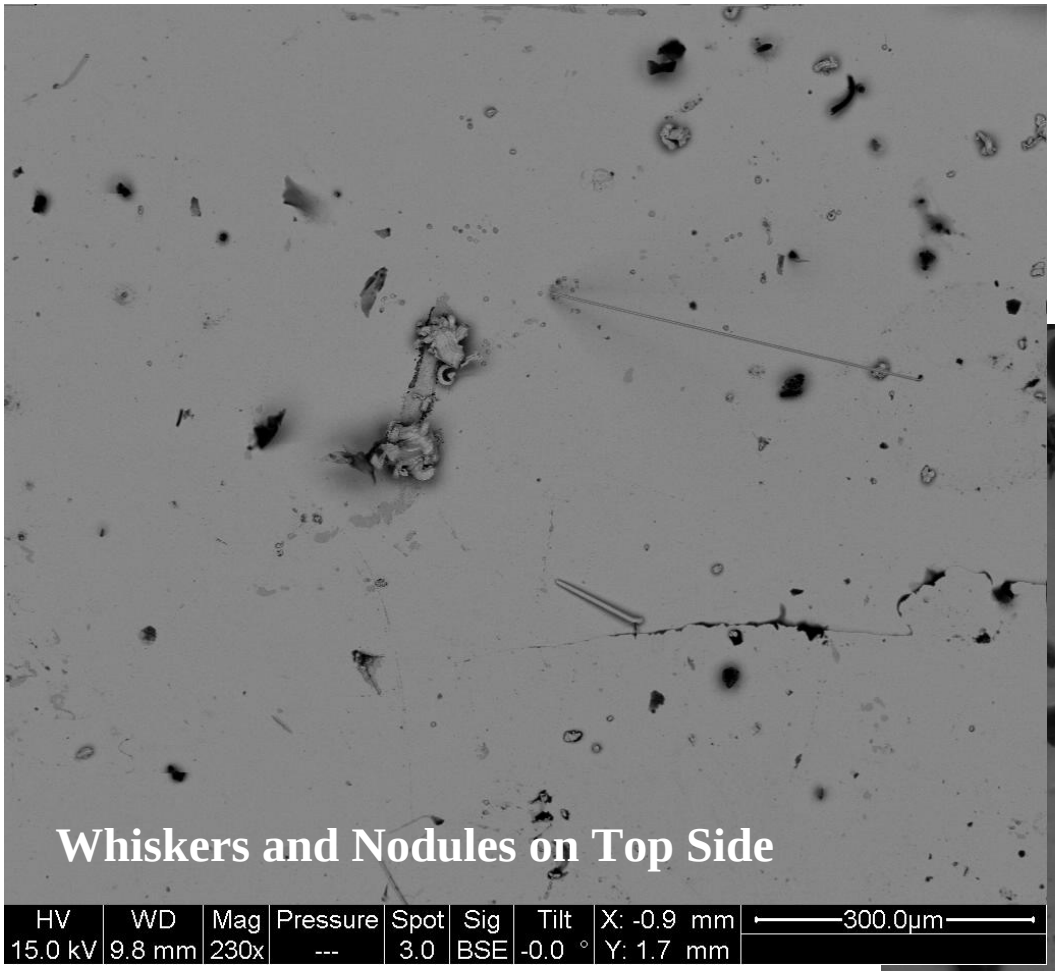
Whiskers and Nodules on Left Side

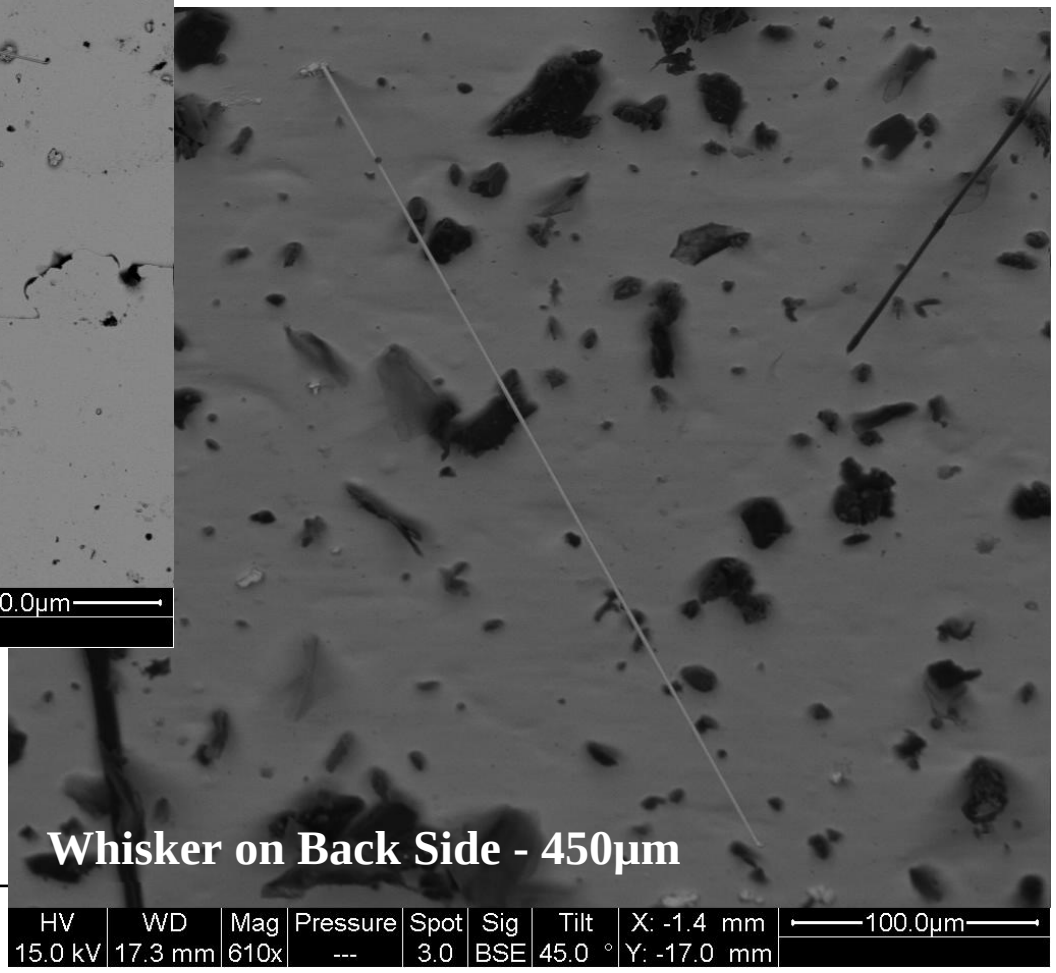
Board 0337 – USB “B”





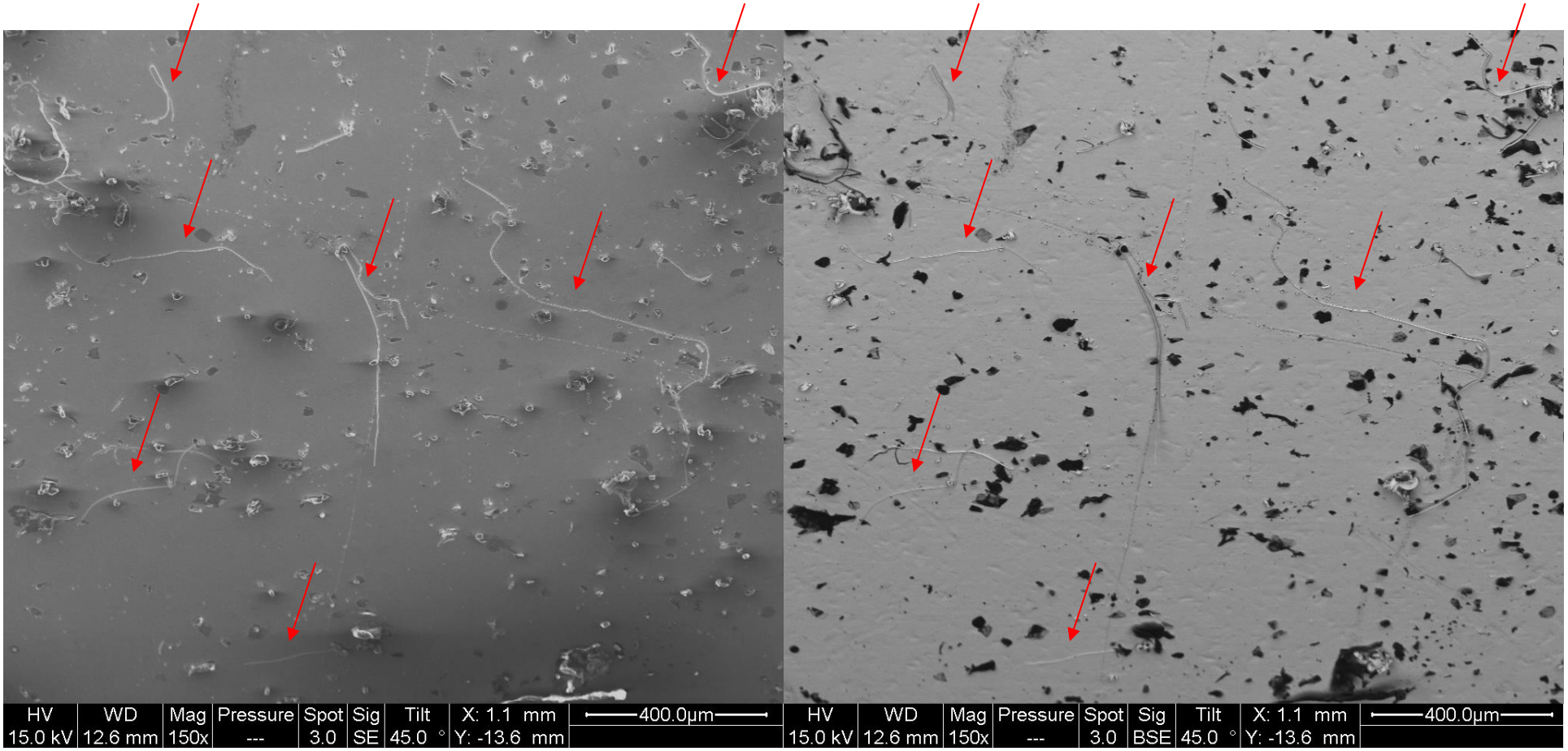
Board 0337 – USB “B”



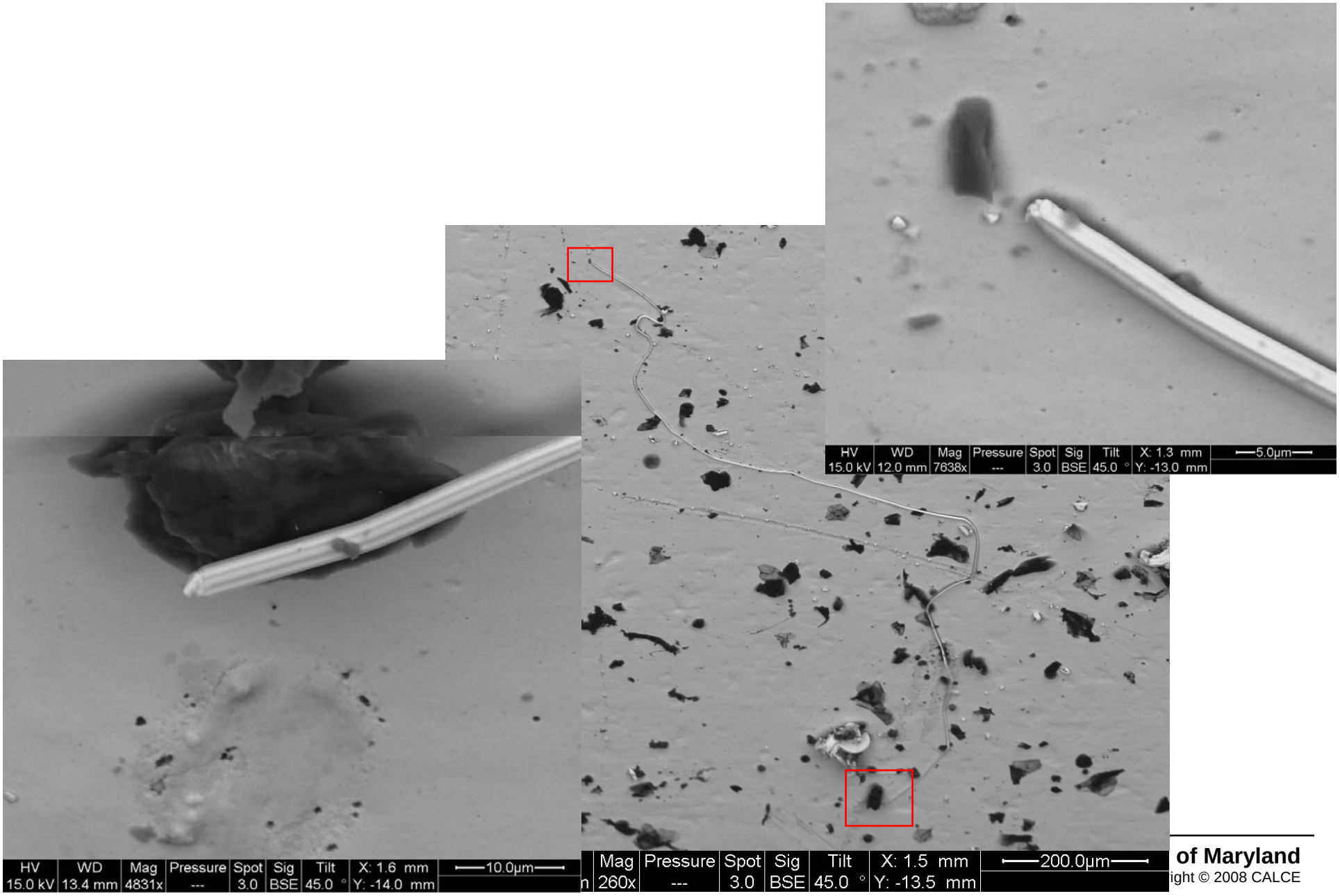


Board 0337 – USB “B” Back Side

- Lots of debris, and a variety of long broken and bent whiskers



Board 0337 – USB “B” Back Side



Summary

- Failure of monitor boards traced to blown fuse.
- The cause of fuse failures is unknown.
- Tin whiskers were observed on USB housings.
- While tin whiskers may not be the source of failure in this case, their presence is a concern.

Contact:

- For information on tin whiskers and assistance with tin whisker related issues, please contact

- Dr. Michael Osterman (osterman@calce.umd.edu)

- Investigation and images conducted by Research Associate Lyudmyla Panashchenko