

“Cable Tray #1”

Zinc Whiskers Detected on Zinc-Coated Steel Cable Tray

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Analyses by: Lyudmyla Panashchenko/NASA Goddard

Executive Summary

- “**Cable Tray #1**” was examined at NASA Goddard Space Flight Center (GSFC) to determine if zinc whiskers are growing out of the zinc-coated iron-based wire used in its construction
- Methods of analysis included:
 - X-Ray Fluorescence (XRF) Spectroscopy
 - Determine composition of surface finish on cable tray from which whiskers are growing
 - Optical Microscopy - 1x to ~100x
 - Document filament/whisker shapes and dimensions
 - Scanning Electron Microscopy (SEM) - ~50x to 5000x
 - Document filament/whisker shapes and dimensions
- ***CONFIRMED: Zinc whiskers are growing from this cable tray***
 - Dimensions (i.e., lengths and thicknesses) and morphology of growths are consistent with zinc whiskers.
Whiskers in excess of 0.6 mm in length were observed
 - Composition analysis confirmed both the metal whiskers & surface finish are ZINC

Background

Contained herein is analysis performed on “Cable Tray #1” of 2 samples

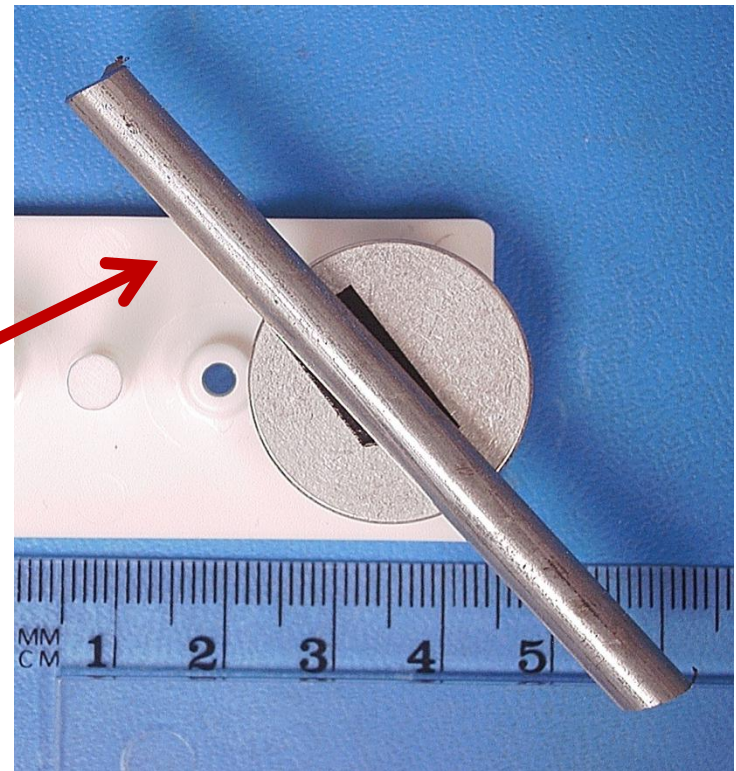
- Two distinctly different cable tray samples were provided by G. Camburn to J. Brusse in September 2012
 - Hereafter referred to as “Cable Tray #1” and “Cable Tray #2”
 - Based on naked eye inspection G. Camburn suspected each cable tray may exhibit zinc whisker growth, but he lacked access to analysis tools for confirmation
 - G. Camburn reports that each cable tray is made from “pre-galvanized” iron where a zinc coating has been applied to the iron-based wire by immersing the wire into molten zinc
 - G. Camburn suggests the following reference is representative of process used in making the wire:
<http://www.youtube.com/watch?v=J3aLT2B2m3Y>
- J. Brusse agreed to have the cable trays inspected to confirm and document any metal whiskers
- L. Panashchenko performed optical microscopy, scanning electron microscopy (SEM) and X-ray fluorescence (XRF) spectroscopy to confirm that this cable tray has developed zinc whisker growths

Cable Tray #1

Cable Tray #1 “As-Shipped”



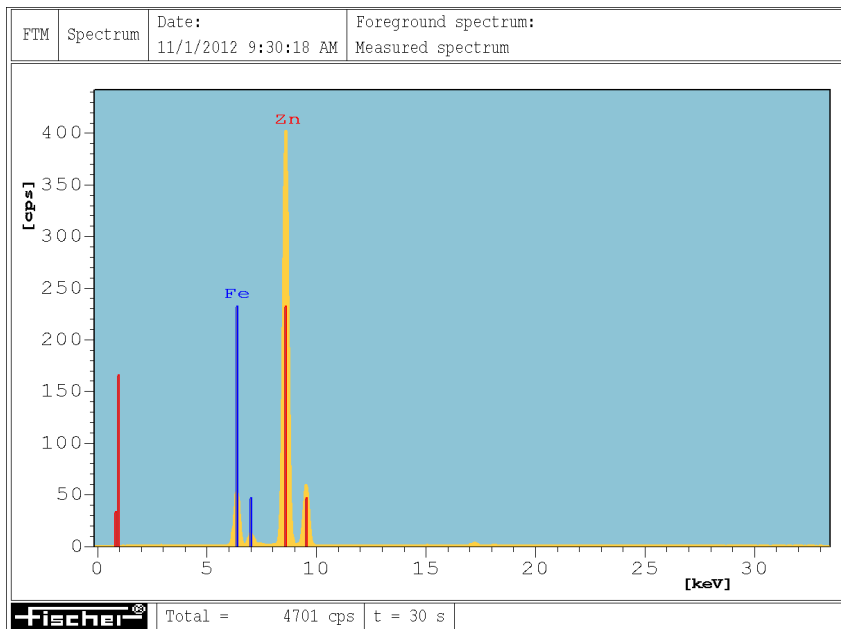
Piece of Cable Tray #1 Removed by J. Brusse for Detailed Analyses Documented Herein



X-ray Fluorescence (XRF) Spectroscopy Confirms Cable Tray is Zinc-Coated Iron Alloy Wire

**XRF Results Confirm Cable Tray is Made of
Zn-Coated Iron Alloy Wire**

Zinc Coating ~6.5 microns Thick



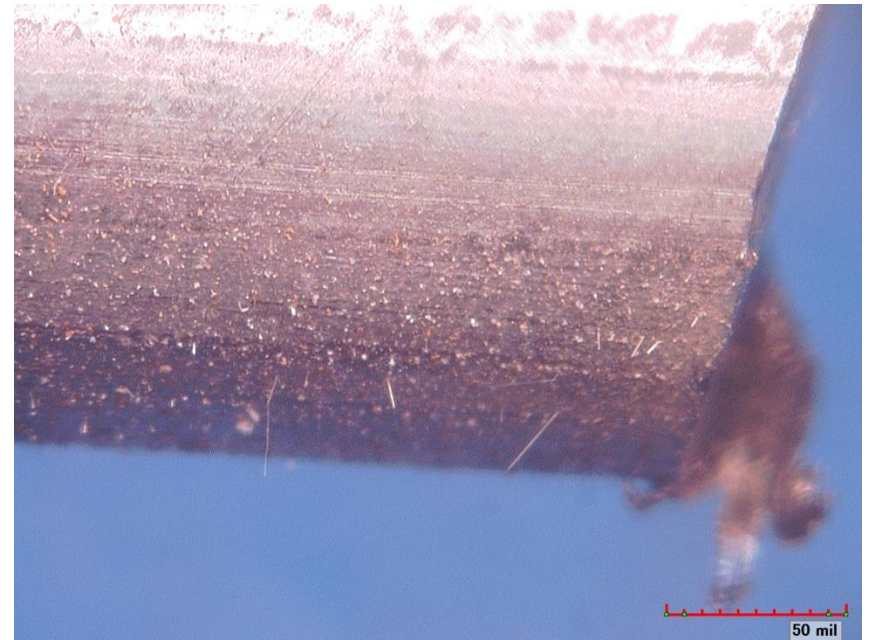
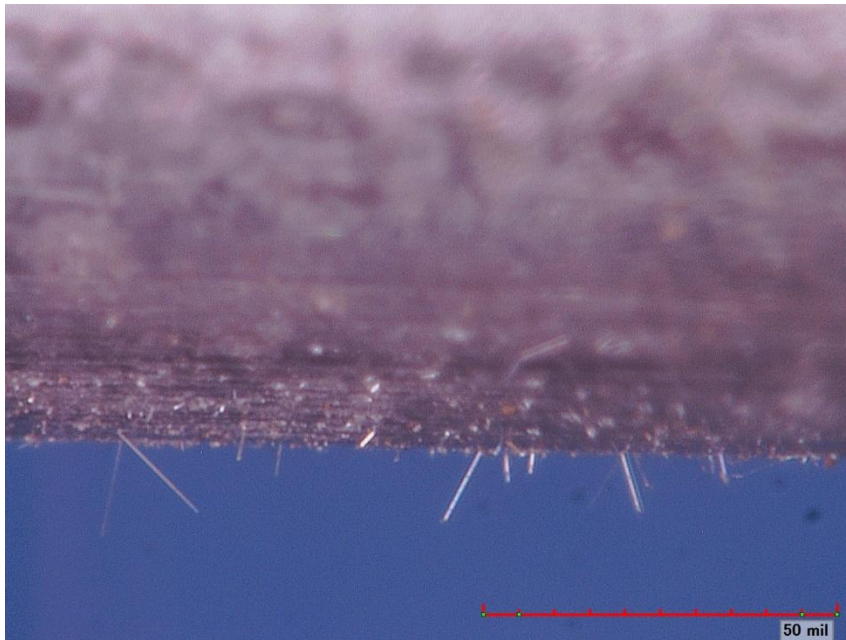
Meas. para. (foreground spectrum):
High voltage = 50 kV (875) Prim. Filter = Ni10
Collimator 2 = 0.30 Dm. Anode current 1000 uA
Meas. distance = 0.000 inch

List of spectra:
Foreground: Measured spectrum

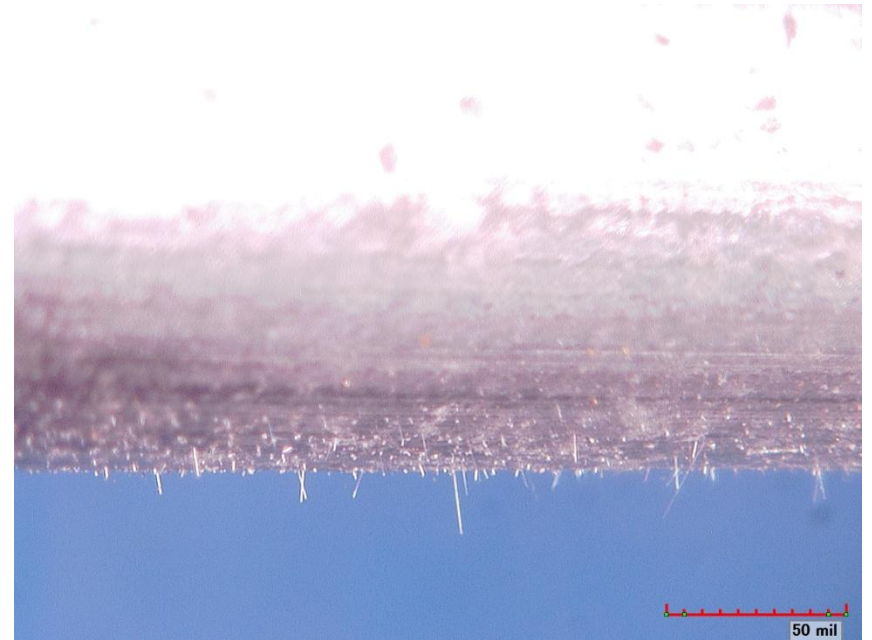
Zn/Fe	
Block No:2	Zn 1 (µm)
Mean value	6.562
Standard Dev.	0.933
C.O.V [%]	14.22
No of Readings	2

*Side note: the base metal here is referred to as iron, but other variations, such as steel, are likely.
XRF is not able to detect carbon which would further identify the material as steel*

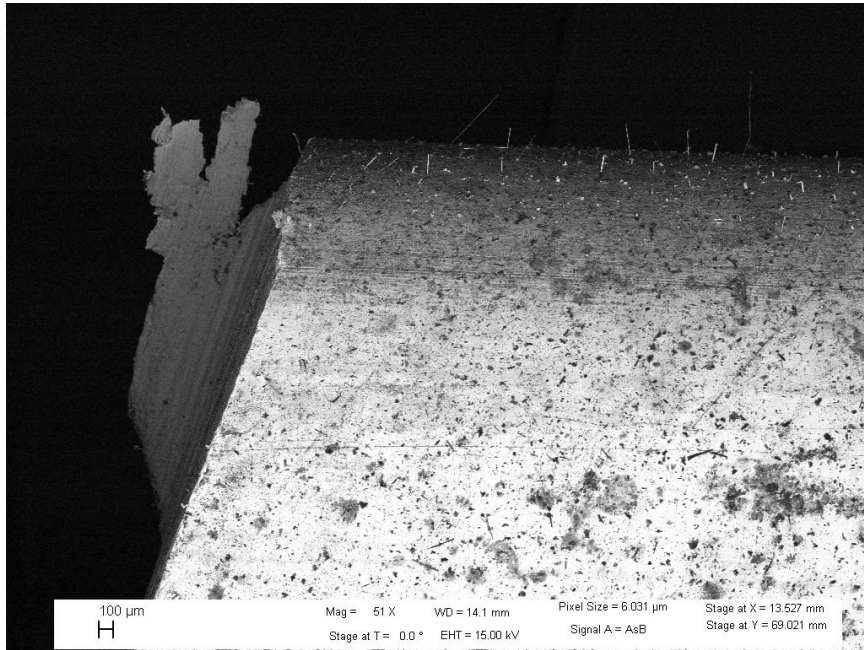
Optical Microscopy Identifies Filamentary Growths on Cable Tray Surface



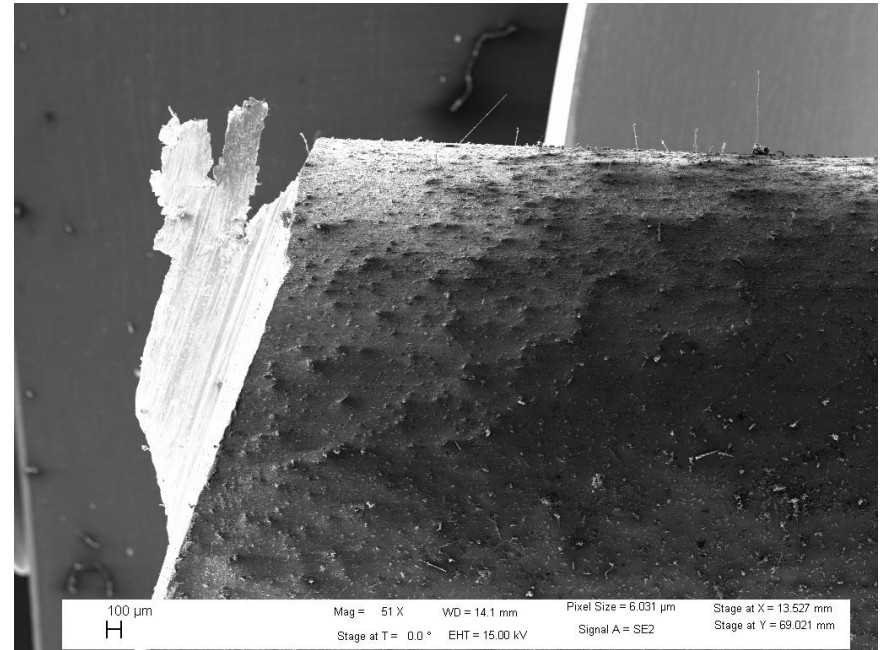
Optical Microscopy Identifies Filamentary Growths on Cable Tray Surface



Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #1*

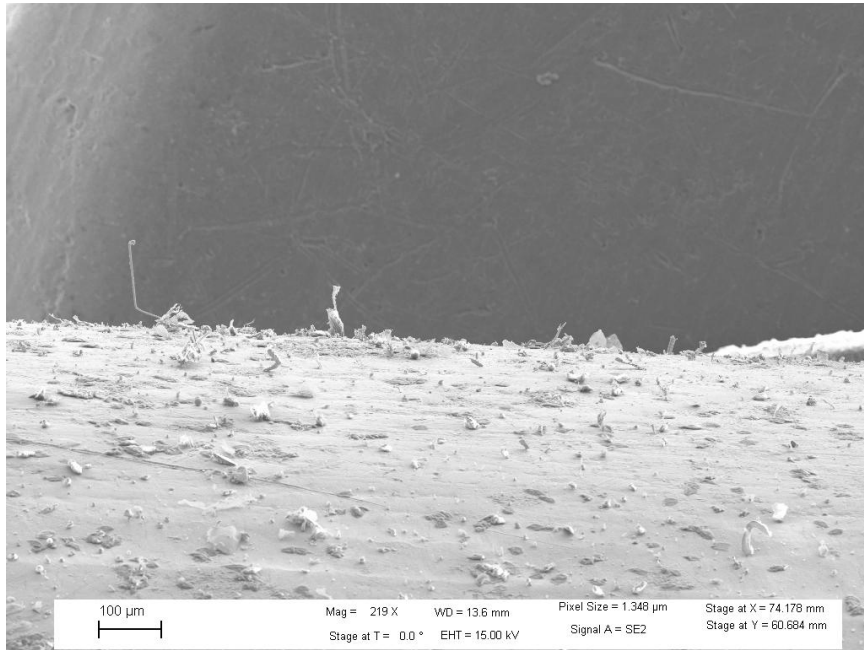


ThickTray-Sample1_37

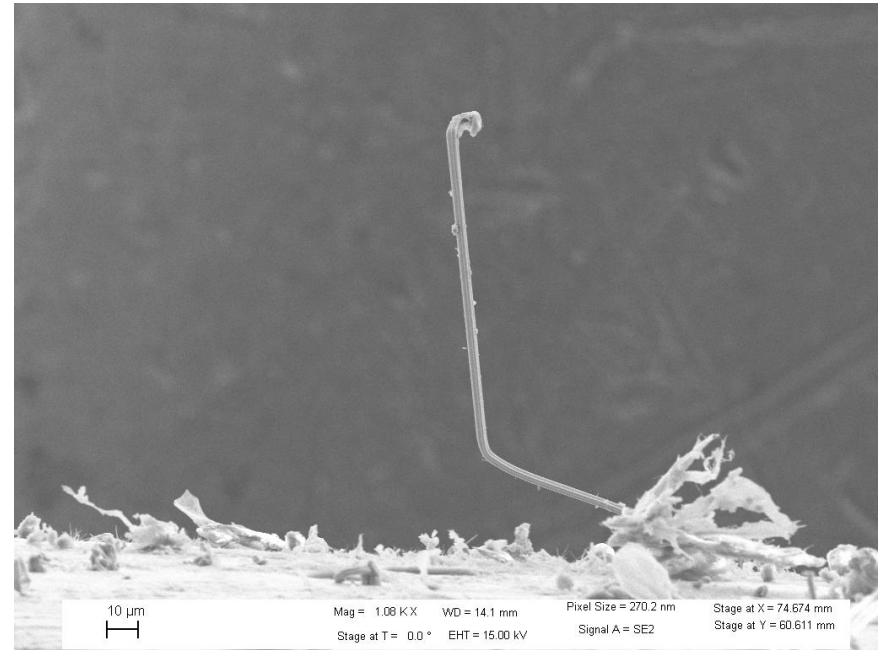


ThickTray-Sample1_36

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #1*

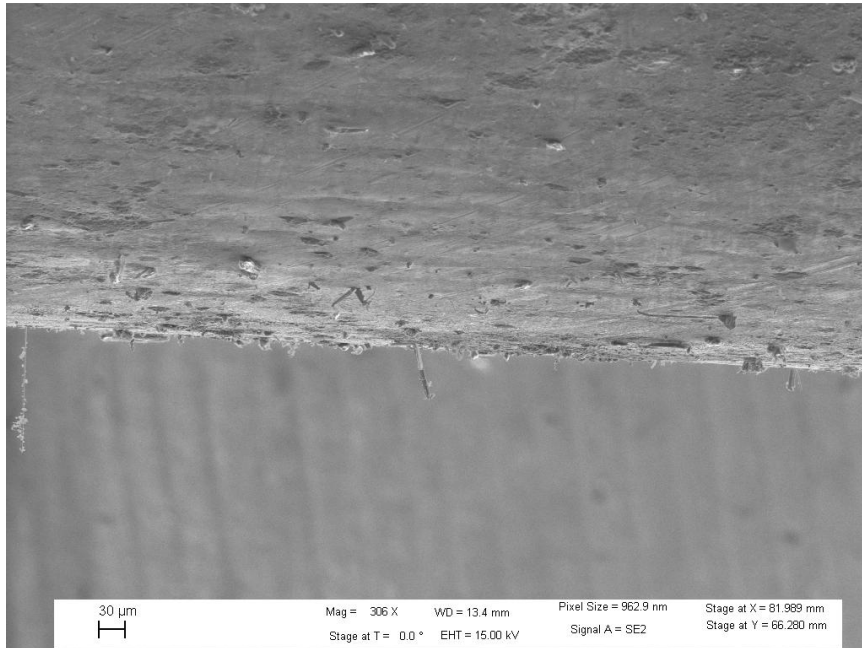


ThickTray-Sample1_09

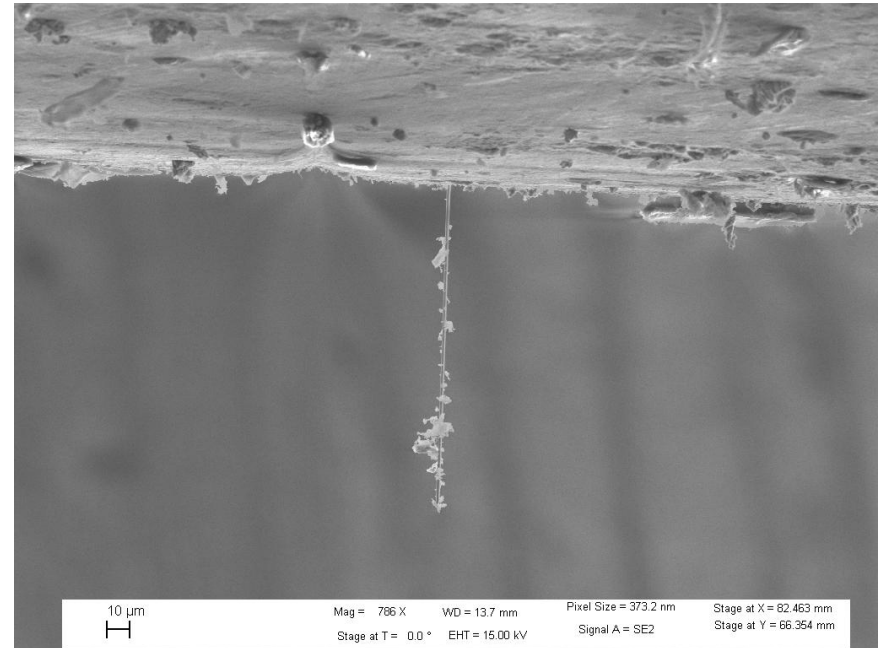


ThickTray-Sample1_10

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #1*



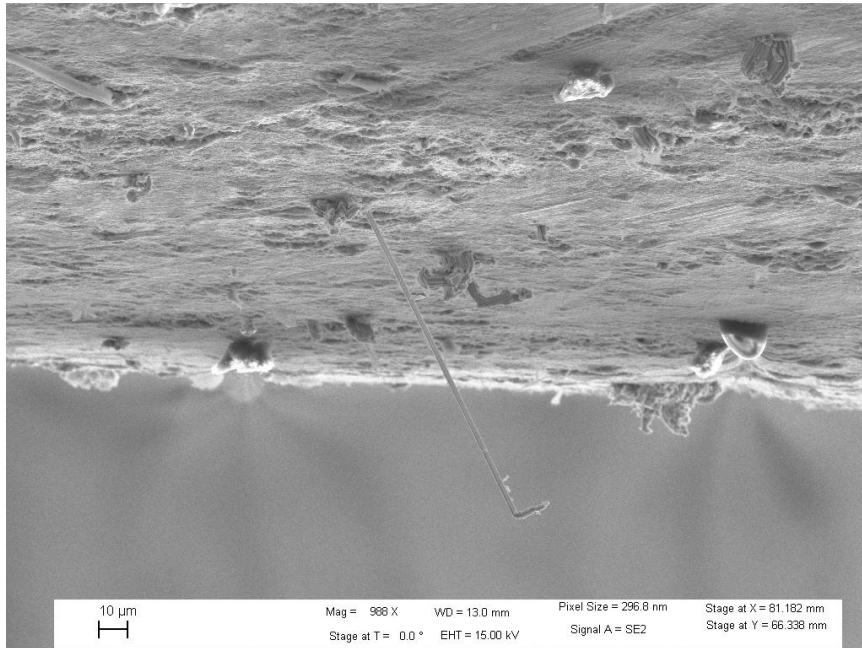
ThickTray-Sample1_11



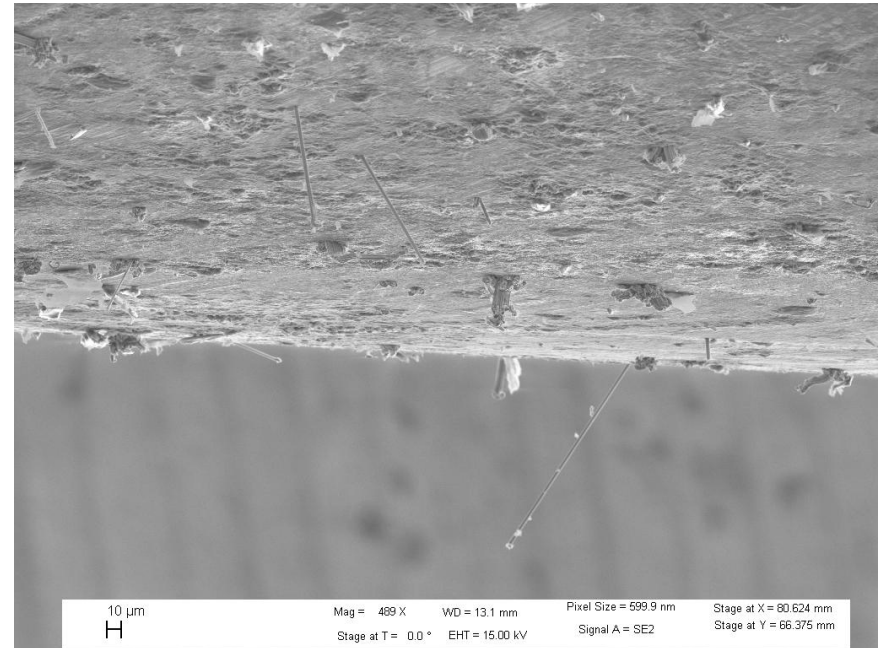
ThickTray-Sample1_12

*Debris on this whisker is not metal, but
dust collected on whisker*

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #1*

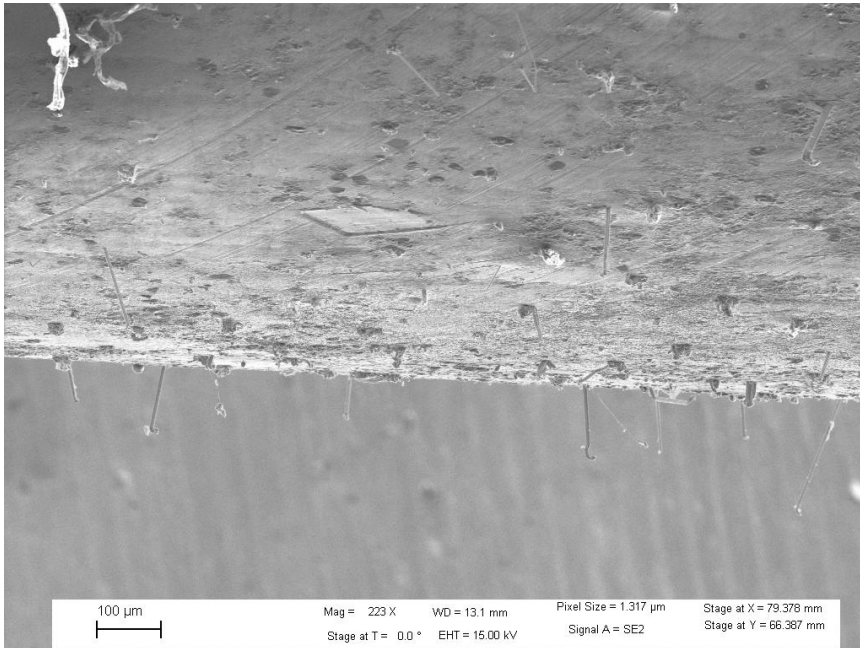


ThickTray-Sample1_13

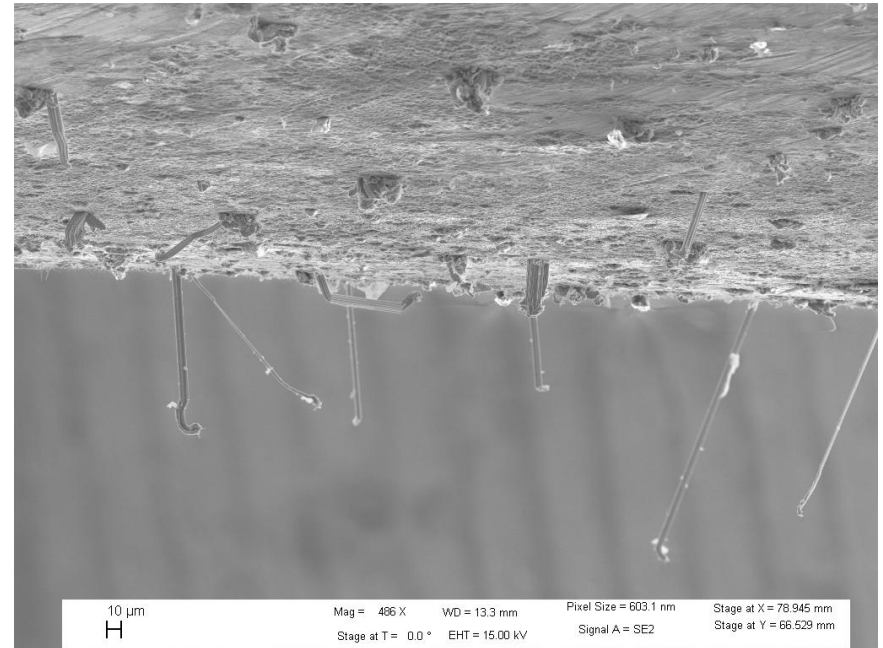


ThickTray-Sample1_14

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #1*

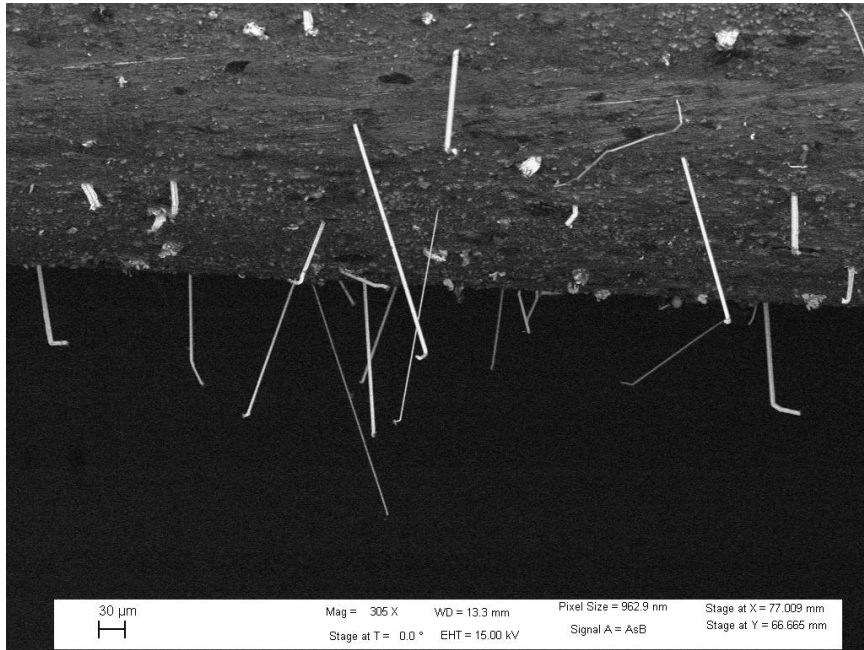


ThickTray-Sample1_15

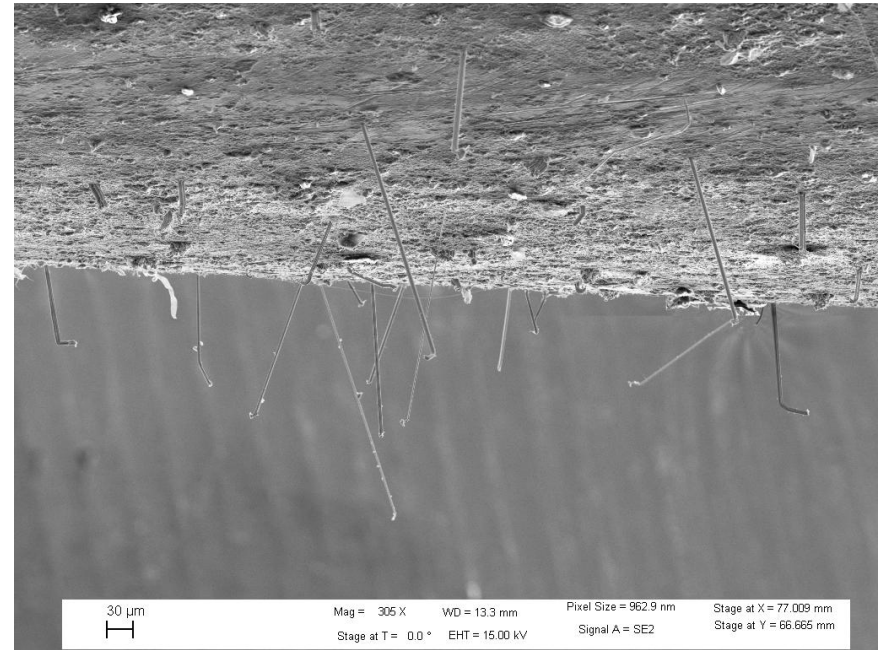


ThickTray-Sample1_16

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #1*

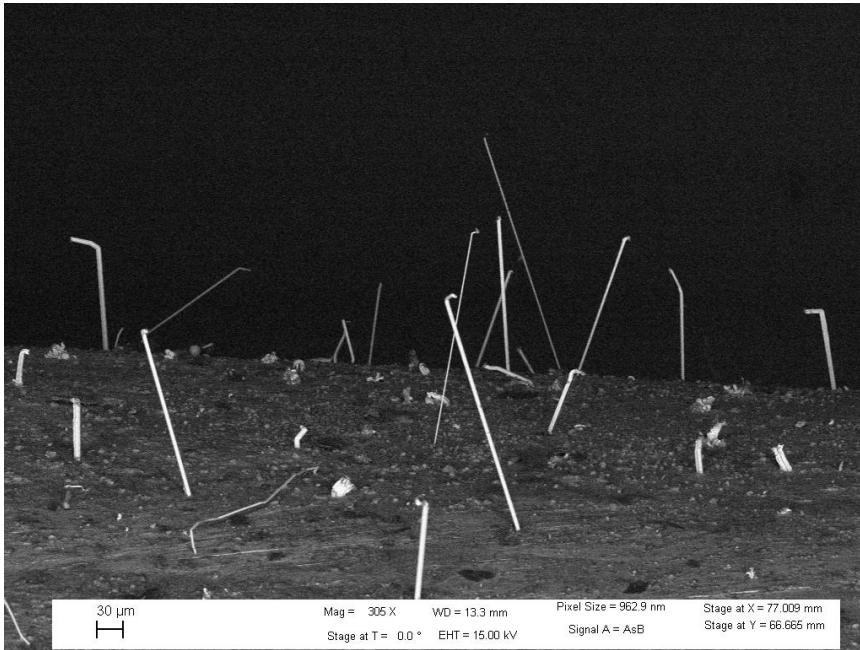


ThickTray-Sample1_20

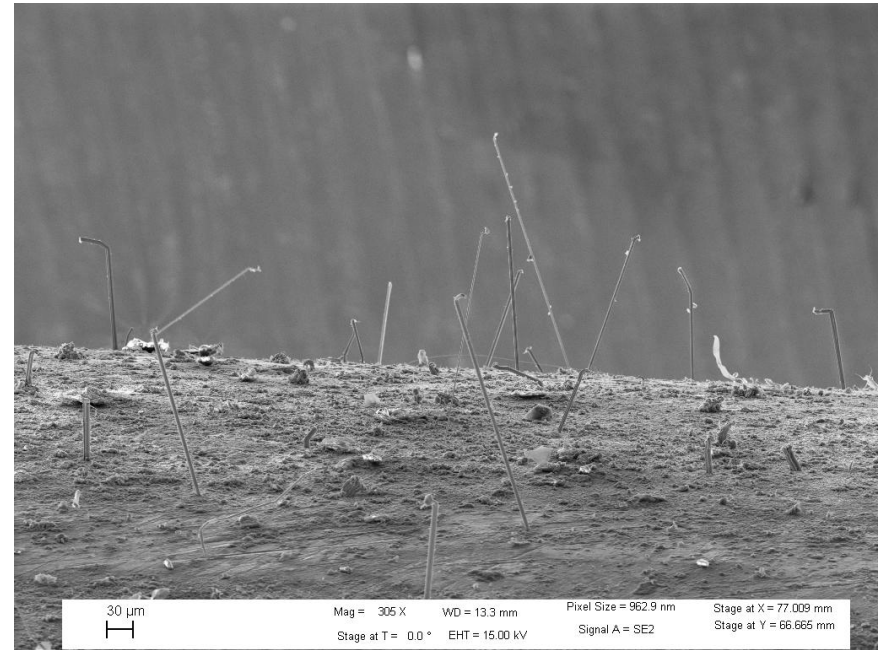


ThickTray-Sample1_19

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #1*

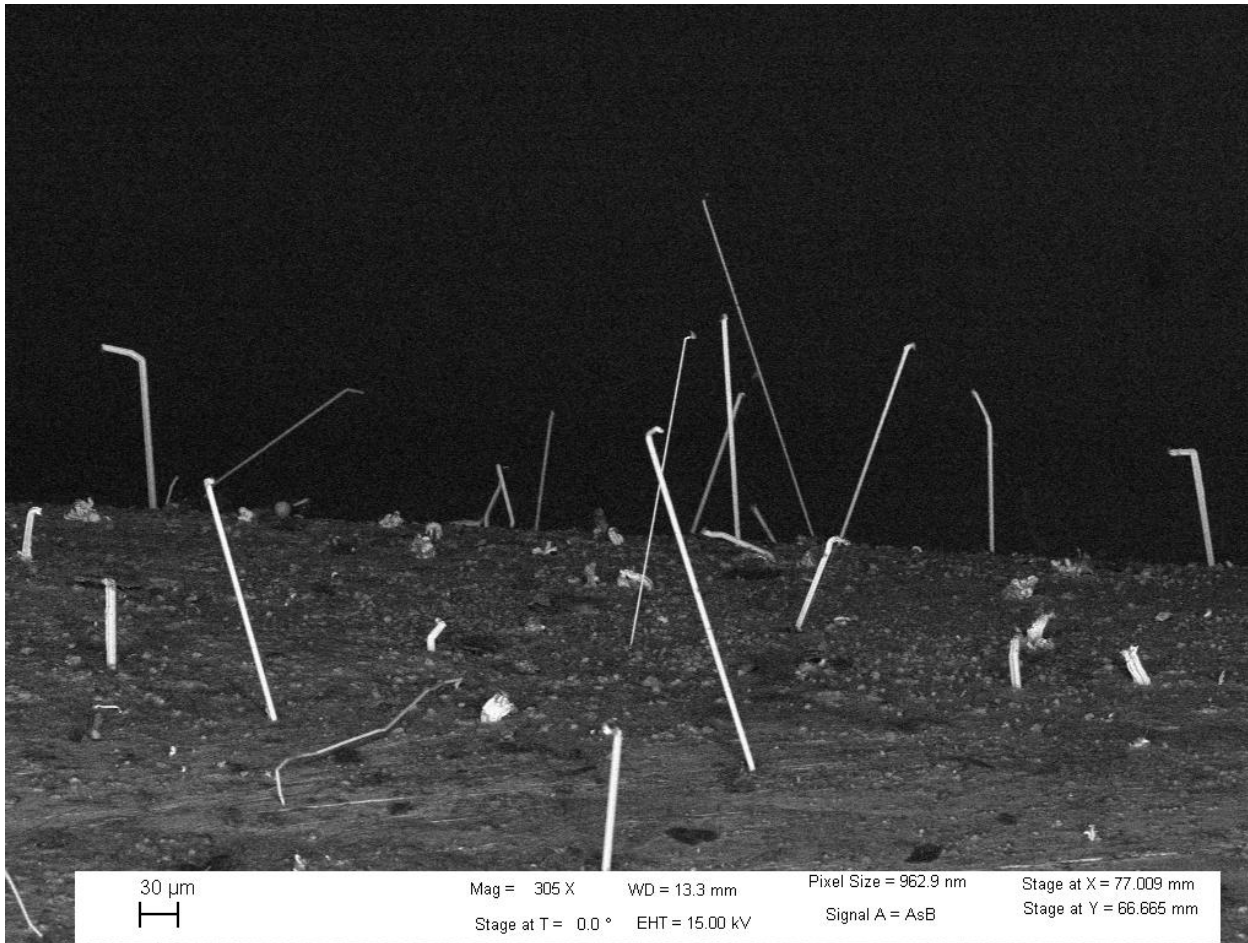


ThickTray-Sample1_22



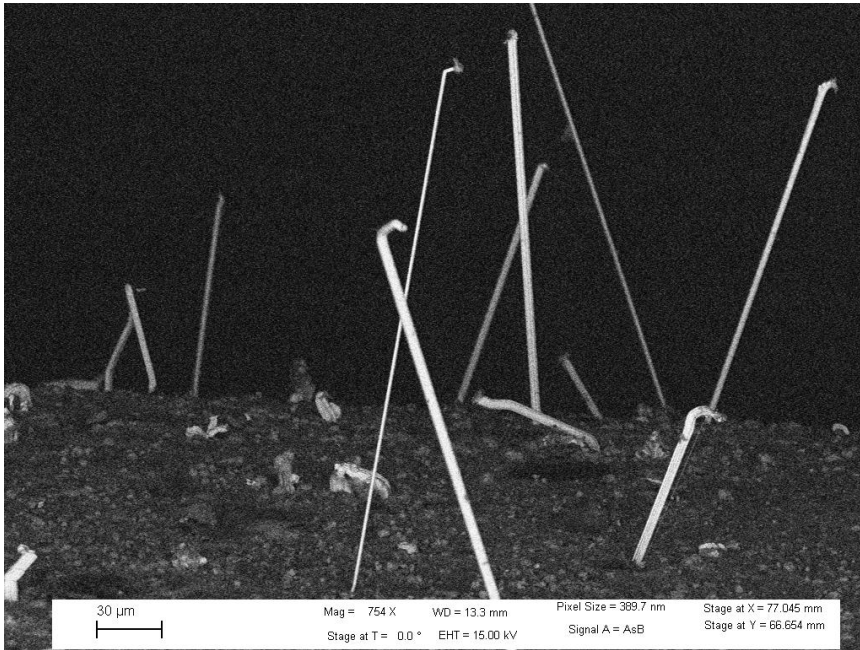
ThickTray-Sample1_21

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #1*

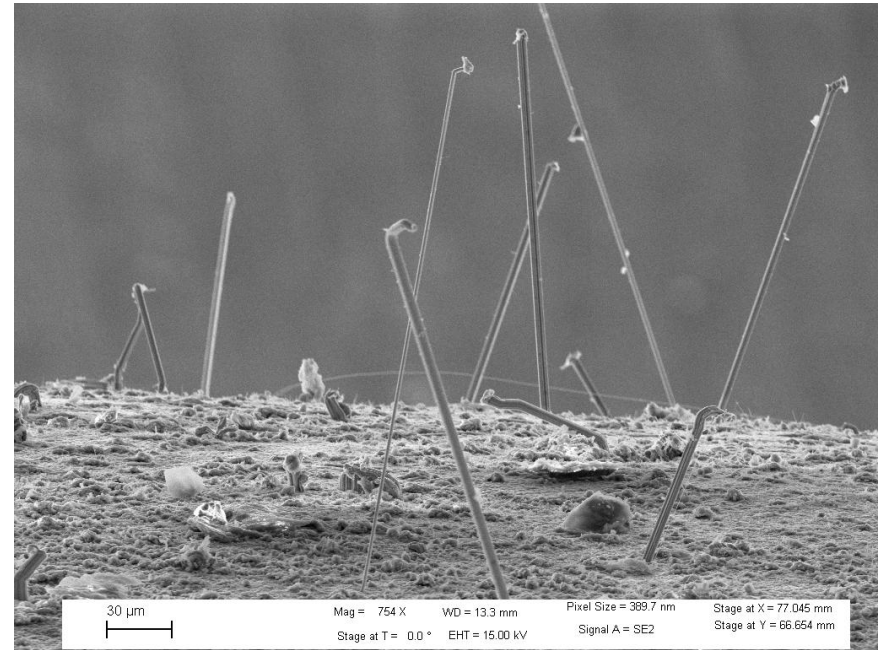


ThickTray-Sample1_22

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #1*

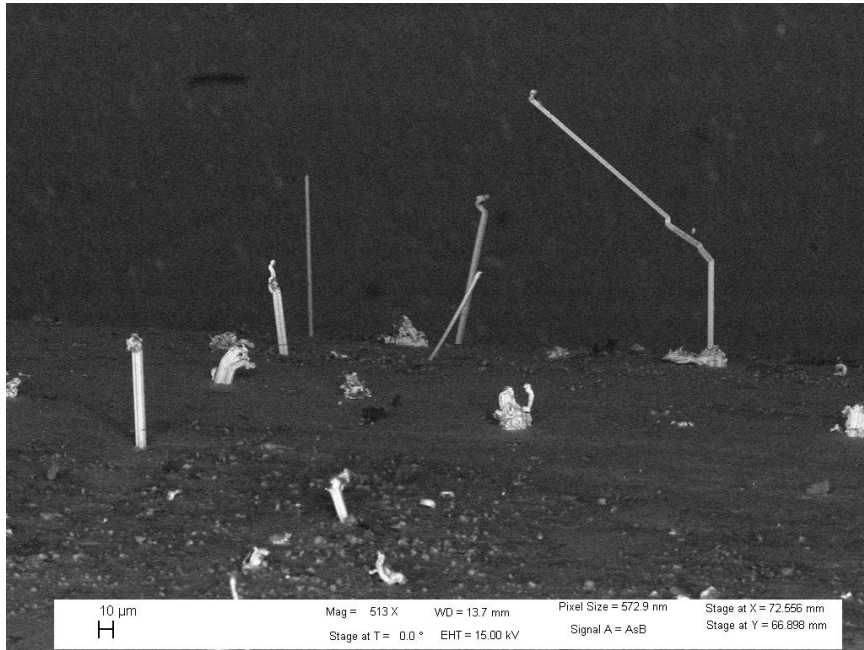


ThickTray-Sample1_24

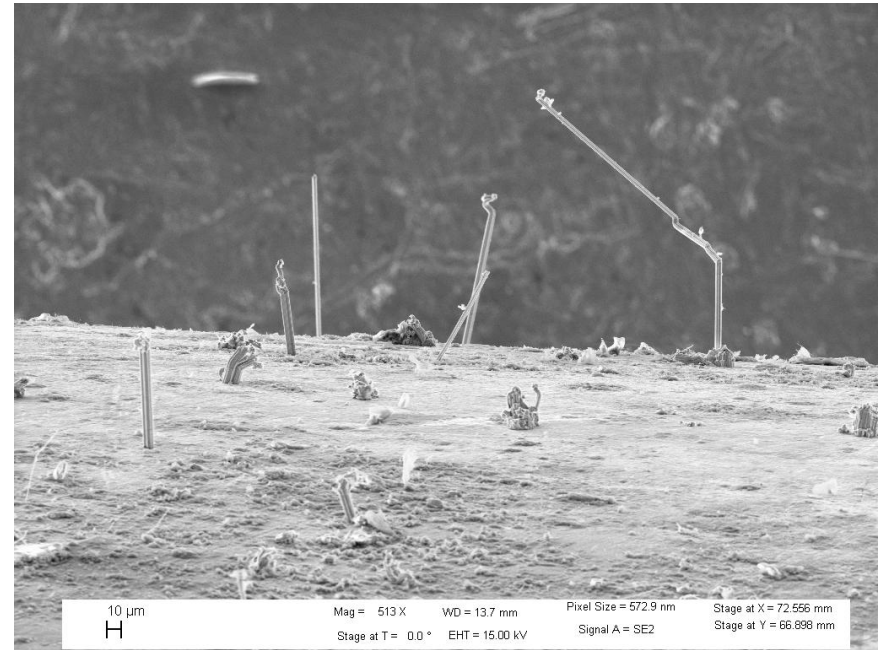


ThickTray-Sample1_23

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #1*

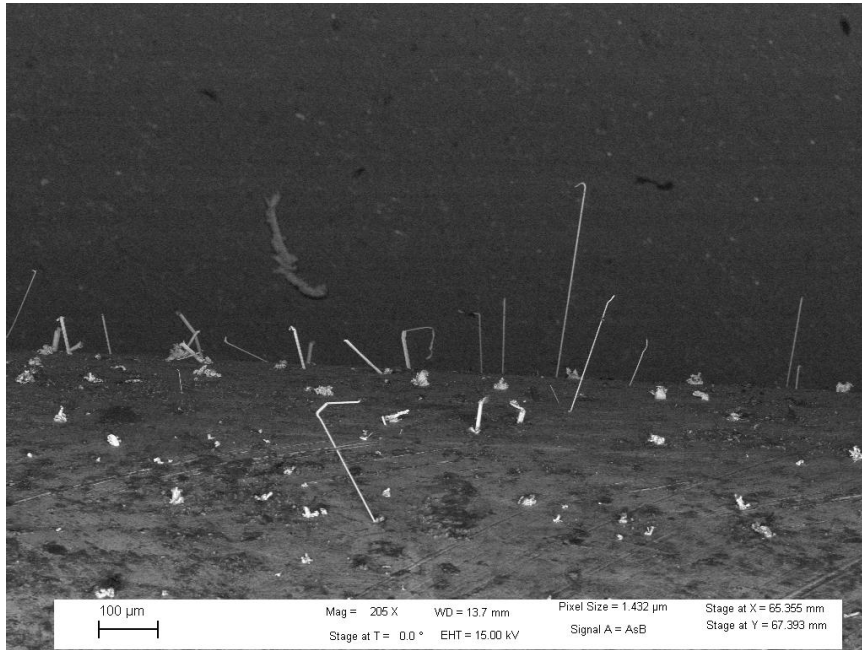


ThickTray-Sample1_26

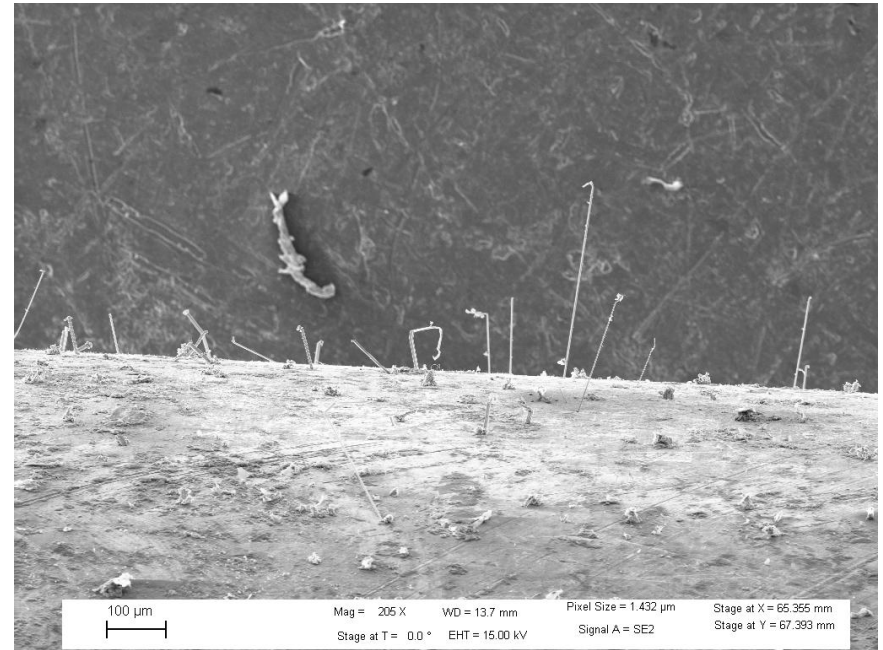


ThickTray-Sample1_25

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #1*

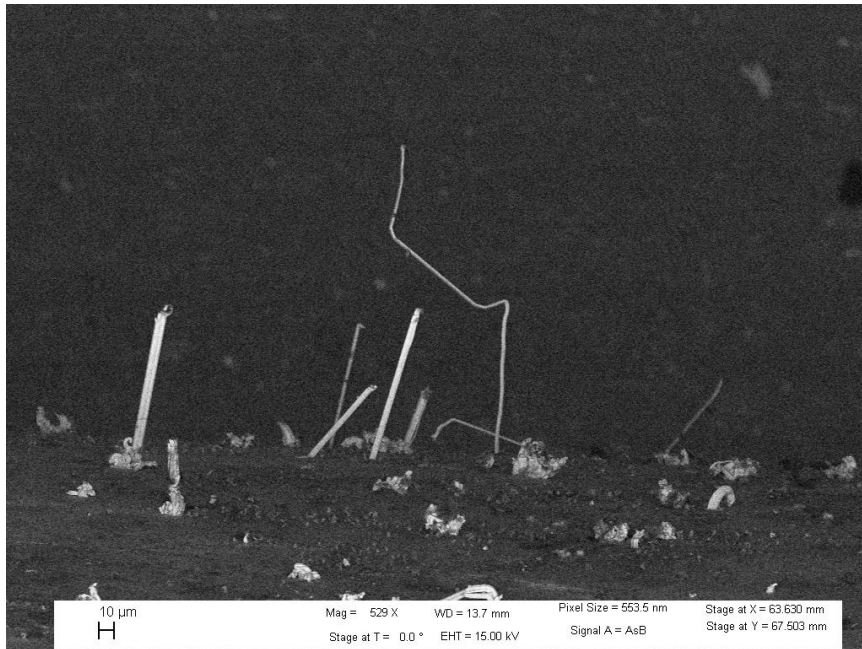


ThickTray-Sample1_28



ThickTray-Sample1_27

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #1*

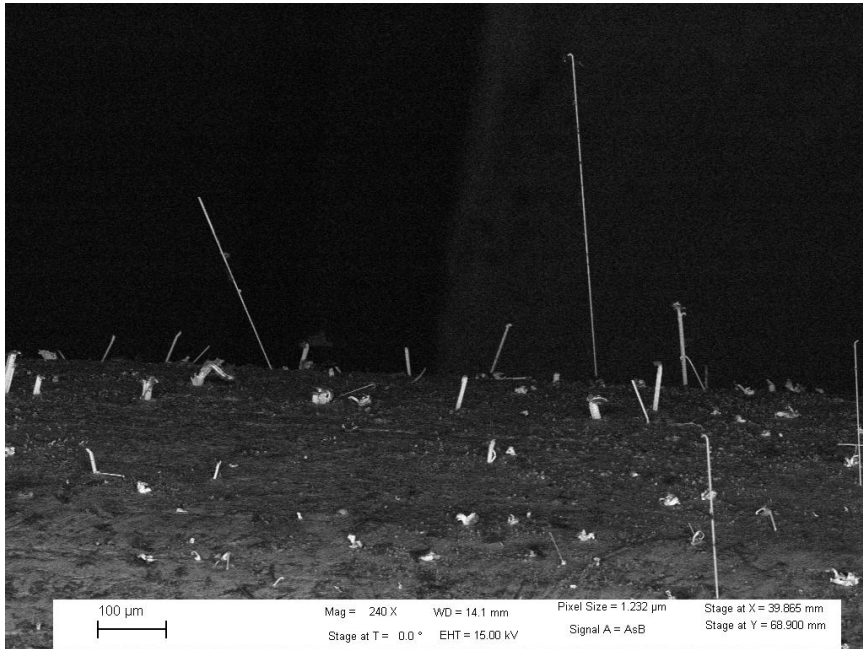


ThickTray-Sample1_30

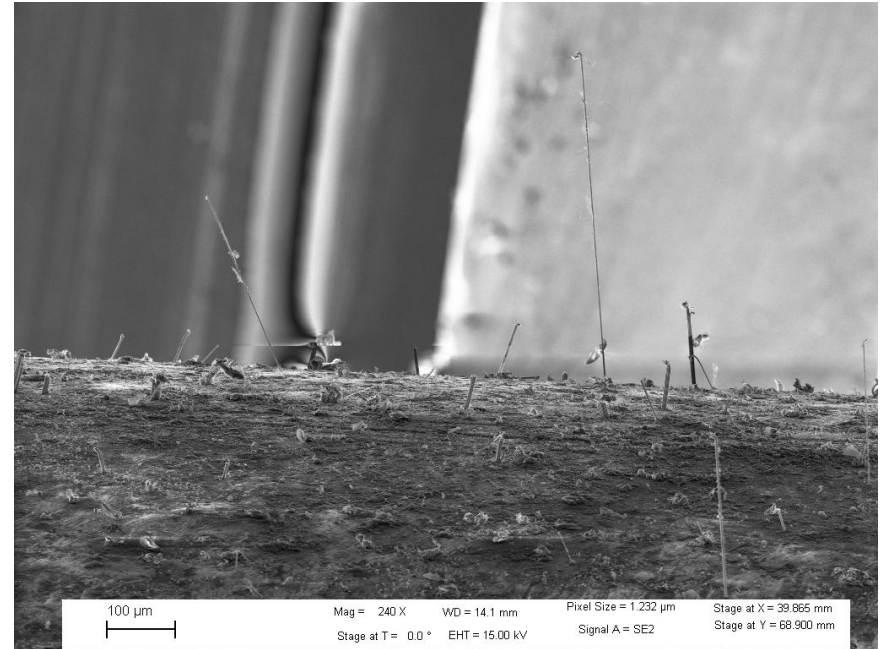


ThickTray-Sample1_29

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #1*

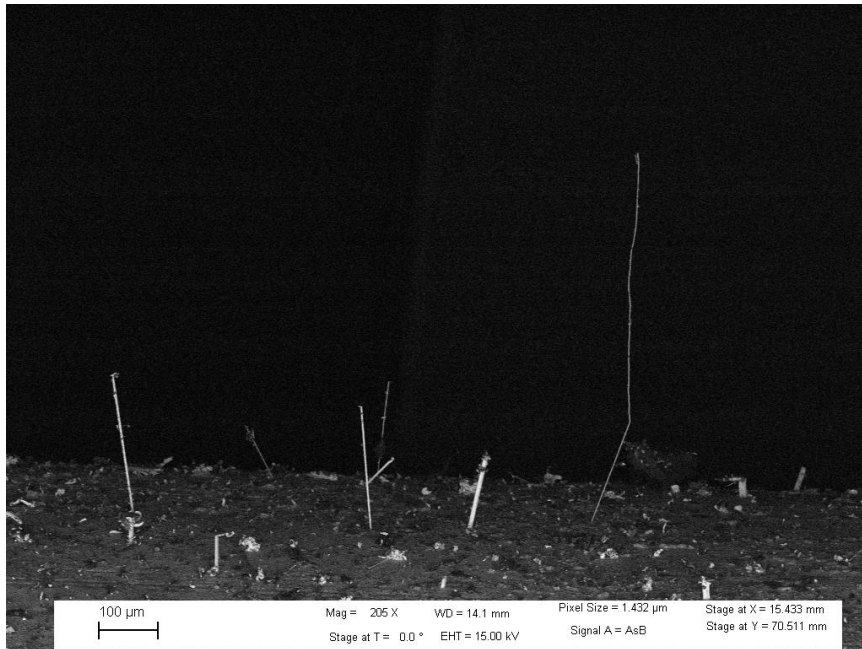


ThickTray-Sample1_34

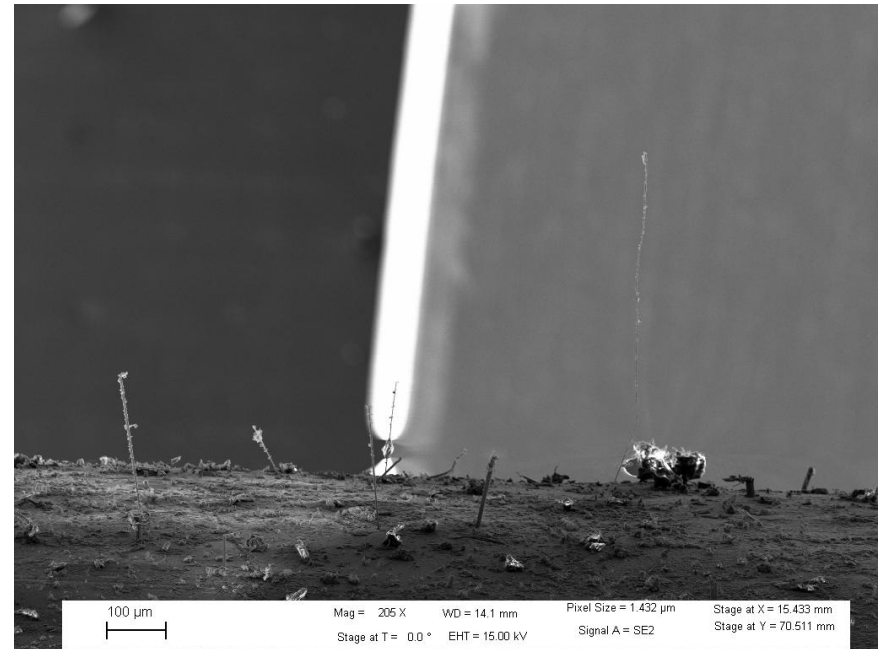


ThickTray-Sample1_33

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #1*

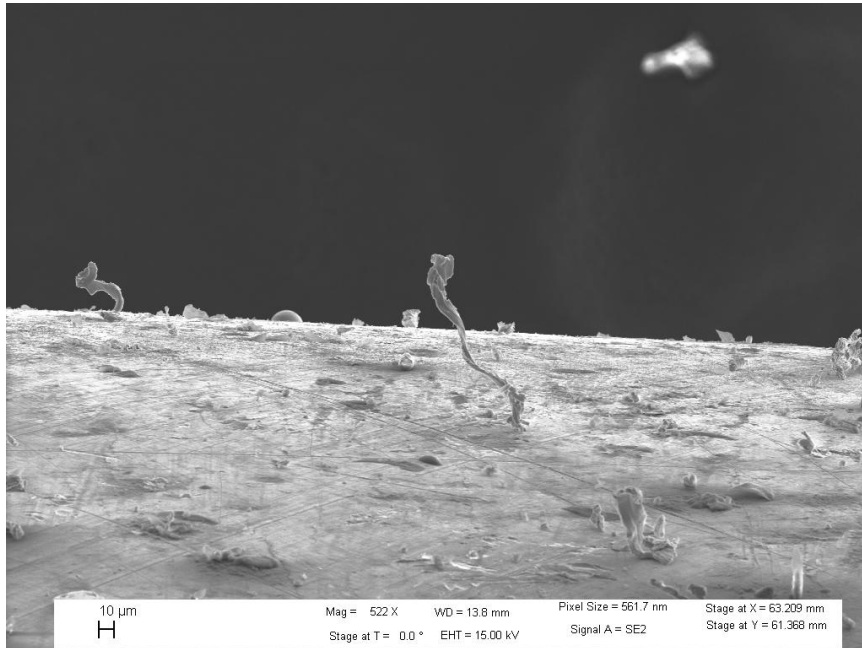


ThickTray-Sample1_39

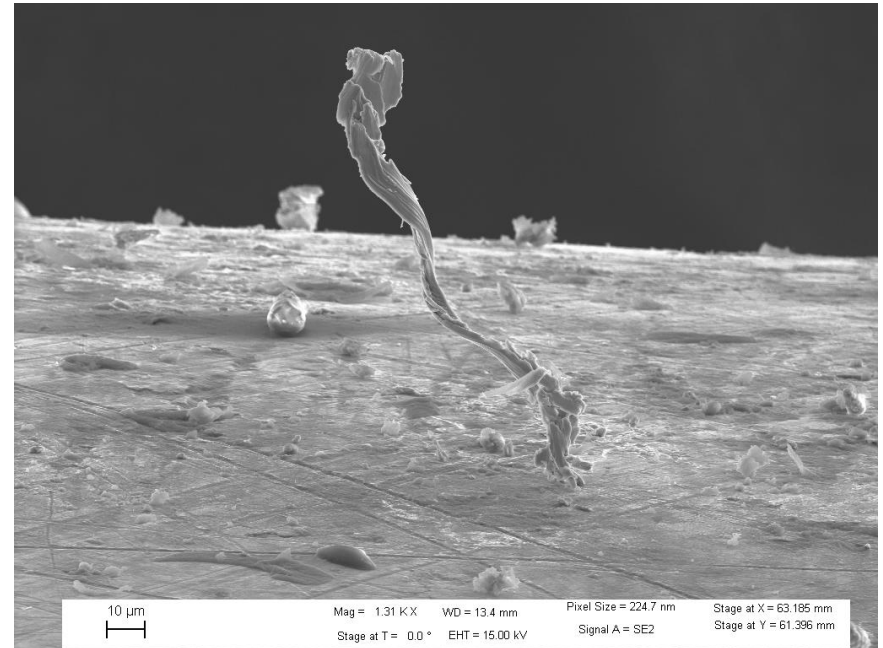


ThickTray-Sample1_38

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #1*



ThickTray-Sample1_05



ThickTray-Sample1_06

Scanning Electron Microscopy (SEM) of ZINC WHISKERS on *Cable Tray #1*



ThickTray-Sample1_07

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