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How Spaceflight Affects the Detachment of Zinc Whiskers

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Introduction

Zinc whiskers are hair-like, microscopic protrusions that may form on zinc-galvanized or zinc-electroplated surfaces. If whiskers become airborne, they can land on and bridge electronic components, causing catastrophic electronic failures. Most whisker-induced failures, however, are left unreported due to lack of understanding and proper analytic methods. The scientific community has limited knowledge and understanding of the behavior of metal whiskers, especially of the detachment of zinc whiskers. This study focuses on the detachment rate of zinc whiskers on a zinc-whiskered floor tile sample through the rigors of spaceflight.

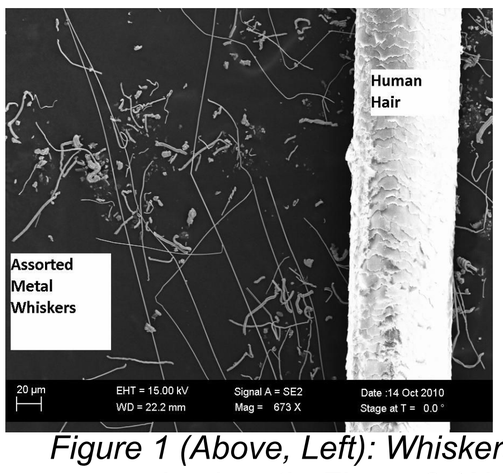


Figure 1 (Above, Left): Whiskers can be around 2 microns in width and of varying length. Figure 2 (Above, Right): Whiskers in field of view of microscope imager.

Method

Systematic photographic analysis of sample and double-sided carbon tape that surrounded the sample in its Fluid Mixing Enclosure (FME).

Preliminary Analysis:

- Images were obtained by using a Celestron microscope imager (4x zoom). Light was adjusted towards whiskers from the side of the sample in order to make whiskers more visible. 132 whiskers were identified during pre-launch analysis before securing the sample in Fluid Mixing Enclosure (FME).

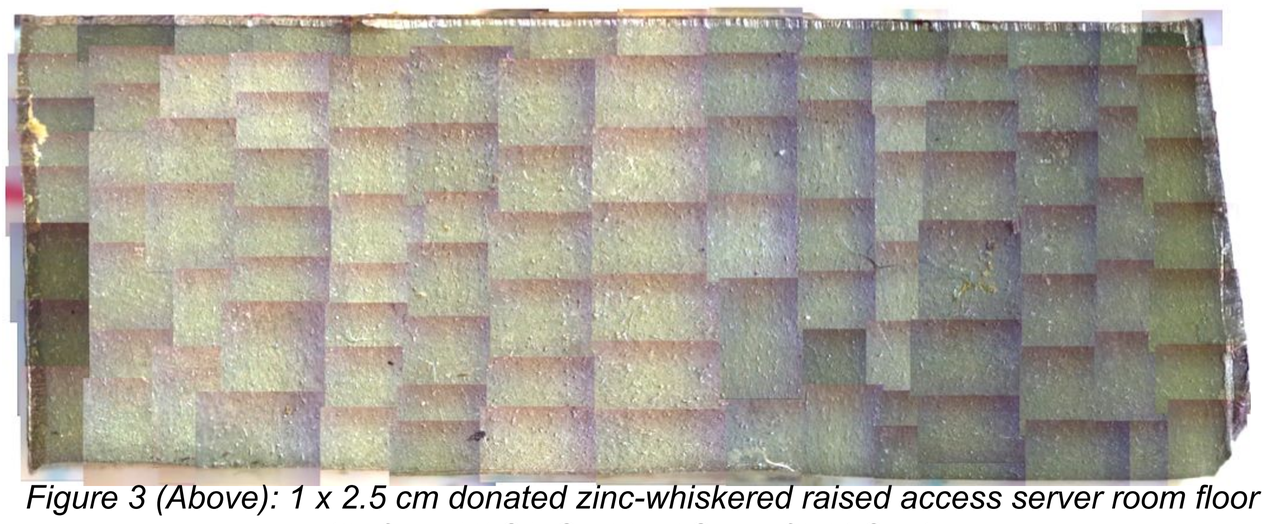


Figure 3 (Above): 1 x 2.5 cm donated zinc-whiskered raised access server room floor tile from NASA Goddard Spaceflight Center

Field of View: 3.5 mm
Whisker Length: 0.8 – 1.2 mm

Figure 4: Whiskers Visible On Sample

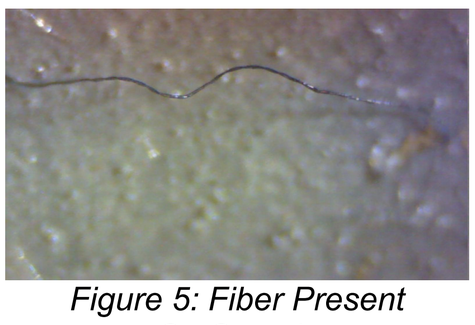
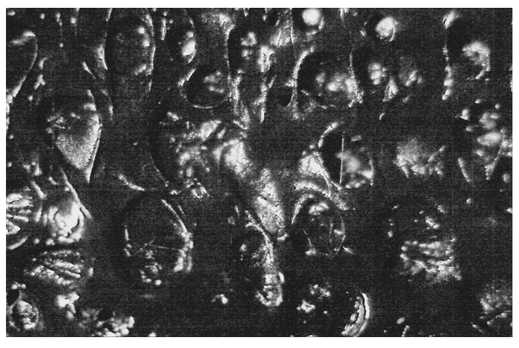


Figure 5: Fiber Present On Sample

Preliminary Discoveries

- Fragmenting of whiskers may have occurred due to stresses of spaceflight
- Greater fragmentation occurred near area of sample placement in middle of FME
- Air pockets, creases, and carbon fiber increased difficulty in lighting and analyzing



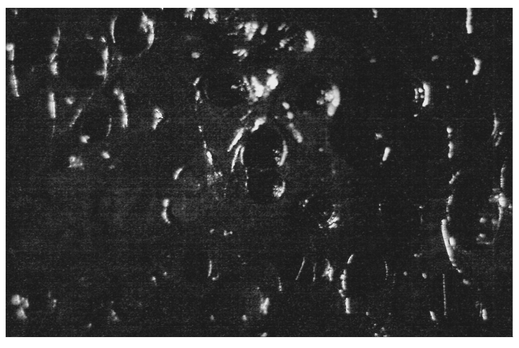


Figure 6 and 7 (Left, Right): Microscopic view (40x) of carbon fiber tape that surrounded the sample

Conclusion

In order to better understand “airborne” and detachment behaviors of whiskers, a zinc-whiskered floor tile sample was exposed to a microgravity environment. Through systematic photographic analysis of the sample and the double-sided carbon fiber tape that surrounded the sample in its Fluid Mixing Enclosure (FME), a significant number of detached whiskers were observed and analyzed. By surveying whiskers that detached from the sample and were captured by the carbon-fiber tape, preliminary results (using a Celestron Digital Microscope Imager) indicate that fragmentation of whiskers may have occurred due to the stresses of spaceflight conditions.

Future Work

- Complete systematic microscope imaging of post-flight sample for comparison.
- Use scanning electron microscope (SEM) for analysis of whiskers on carbon-fiber tape and floor-tile sample.
- Detailed write-up to Goddard scientists to disseminate results of experiment.

Figure 8 Right): Sample and double-sided carbon fiber tape secured in Fluid Mixing Enclosure (FME).

Figure 9 (Right): February 19, 2017 - Mission 9 experiment was delivered to the International Space Station (ISS) via SpaceX CRS-10

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