Simulation of UV Induced Discoloration on Space Polymers

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Abstract

Materials International Space Station Experiment-6 (MISSE-6) was an experiment designed to examine the consequences of the space environment on various materials used in space-component design. MISSE-6 contained approximately 180 samples that were suspended from the side of the International Space Station (ISS) for 18 months and returned to allow for pre- and post-flight comparisons. The sample with the most evident changes was Mylar™ coated with Vapor Deposited Aluminum (VDA). The analysis shows evidence of atomic oxygen erosion of the VDA layer, UV-induced discoloration of the polymer, and a crater created by a micrometeoroid impact. This presentation focuses on the UV-induced discoloration and subsequent simulations. UV tests expose Mylar™ to varying intensities of UV radiation from deuterium lamps and quantify the discoloration. The results from the UV simulation are used to determine the approximate time period of the UV exposure for the sample and in turn the erosion rate of the VDA layer.

Experiment Timeline

**1/2007**

1/2007: Material Selection

**3/2008**

3/2008: MISSE-6 Launch

**4/2008**

4/2008: MISSE-6 Deployment

**9/2009**

9/2009: MISSE-6 Returned to USU

UV Onset? Experiment On ISS

**Pre-Flight**

Atomic Oxygen Erosion

- Before
- After

Vapor Deposited Aluminum (VDA) coated Mylar

UV Radiation Yellowing

- Elliptical reflector designed to direct the light to a focal point where the sample is placed for optimum exposure.

Deuterium lamp to simulate the UV solar radiation in a condensed time frame.

UV Radiation Simulation

Radiation from the sun, predominately in the UV spectrum causes Mylar to yellow over extended exposure. To determine the rate at which this yellowing occurs, a simulation of the space environment is being done using deuterium lamps to simulate the UV solar radiation. An elliptical reflector focuses the light on the samples to determine a time scale of the yellowing effect.

Micrometeoroid Impact

**Don Lind**, an astronaut from Logan, UT in his spacesuit made of the same material as the impacted sample.

Multilayer system of an astronaut’s spacesuit, designed to protect against micrometeoroid impact.

**The Basic Questions**

- What are the risks to an astronaut during extravehicular activity (EVA)?
- How can we design safer spacesuits?
- What’s the probability of an astronaut being struck by a micrometeoroid?

Cumulative Impact Probability

**Micrometeoroid Penetration**

Based on a 500 μm thick spacesuit, the minimum sized meteoroid required to penetrate a suit and ultimately harm an astronaut would be approximately 0.7 grams.

**MISSE-6 Overview**

The Materials International Space Station Experiment (MISSE) project aims to subject various materials to the space environment and document the effects in a controlled setting. The USU SUSpECS project was a unique student experiment on MISSE-6. The SUSpECS samples were selected, launched into space, suspended off of the International space station for 18 months, and then returned to Earth in pristine condition for analysis.

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