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Simulation of UV Radiation Degradation of Polymers on MISSE-6 in the Low Earth Orbit Environment

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Abstract

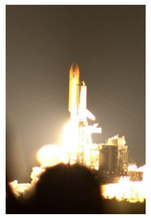
The State of Utah Space Environment & Contamination Study (SUSpECS) experiment flown on the Materials International Space Station Experiment 6 (MISSE-6) was an experiment designed to examine the consequences of the space environment on various materials used in space-component design. SUSpECS was comprised of 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 a thin film of polyethylene terephthalate (PET) Mylar™ coated with Vapor Deposited Aluminum (VDA). The post-flight analysis showed 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 laboratory tests to simulate these effects. The UV tests expose similar polymers to varying intensities of vacuum UV radiation from deuterium lamps over a condensed time span and quantify the discoloration of the polymers through comparison of the UV/Vis/NIR reflection spectra. The results from the UV simulation are used to determine the approximate time period of the UV exposure for the SUSpECS sample and in turn the erosion rate of the VDA layer.

Experiment Timeline

1/2007 *Material Selection*

This large communication satellite incorporates materials which are contained in SUSpECS.

3/2008 *MISSE-6 Launch*

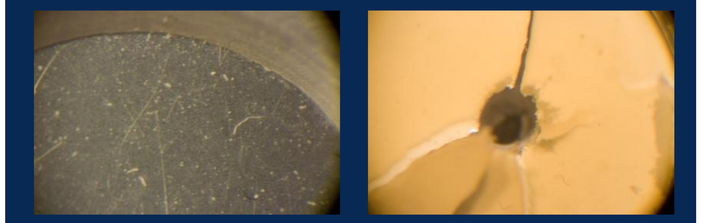


4/2008 *MISSE-6 Deployment*

9/2009 *MISSE-6 Returned to USU*

Pre-Flight | **UV Onset ? Experiment On ISS** | **Post-Flight Testing**

Atomic Oxygen Erosion



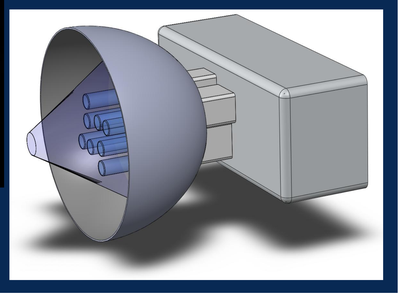
Before — After

Vapor Deposited Aluminum (VDA) coated Mylar

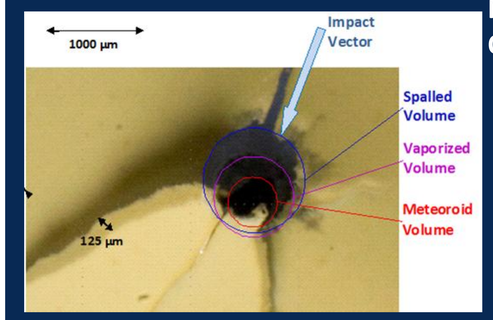
UV Radiation Yellowing

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

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



Micrometeoroid Impact



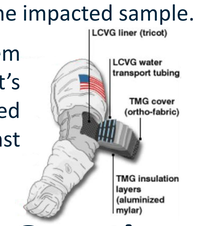
(Above) Approximate projections of the damage due to the micrometeoroid impact.

Micrometeoroid Questions:

- How large was it?
- What was the composition?
- Did impact occur before or after Al erosion?
- How far into the mission did impact occur?

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?

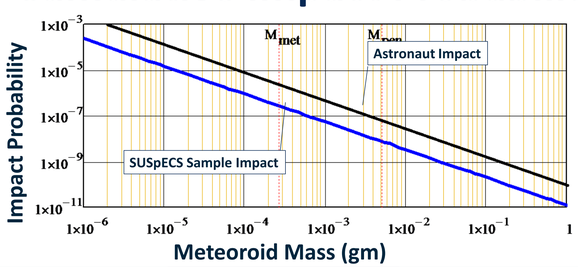
MISSE-6 Overview

The Materials International Space Station Experiment (MISSE) project that 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.

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.

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.

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