Spring 3-15-2014

Simulation of UV Induced Discoloration on Space Polymers

Kelby T. Peterson
Utah State University

JR Dennison
Utah State University

Simulation of UV Induced Discoloration on Space Polymers

Kelby Peterson
Utah State University

JR Dennison
Material Physics Group
Utah State University

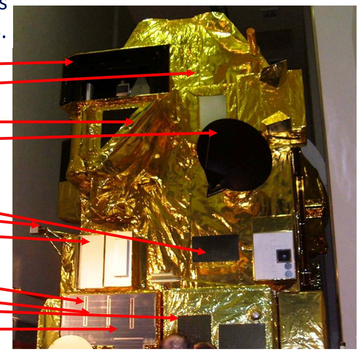
Abstract

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.

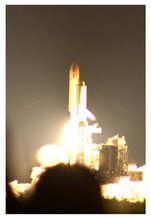
Experiment Timeline

1/2007 *Material Selection*

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



3/2008 *MISSE-6 Launch*

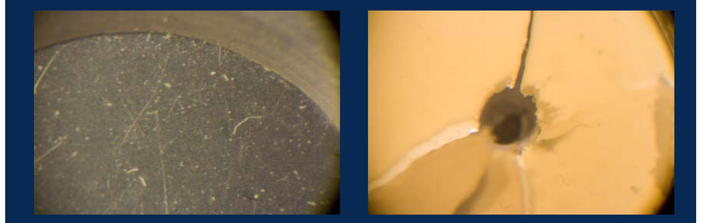


4/2008 *MISSE-6 Deployment*

9/2009 *MISSE-6 Returned to USU*

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

Atomic Oxygen Erosion



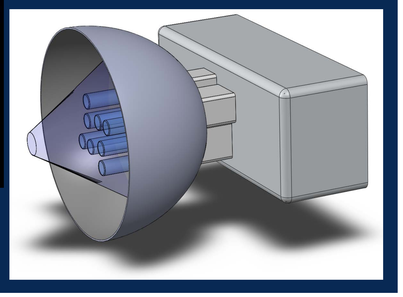
Before After

Vapor Deposited Aluminum (VDA) coated Mylar

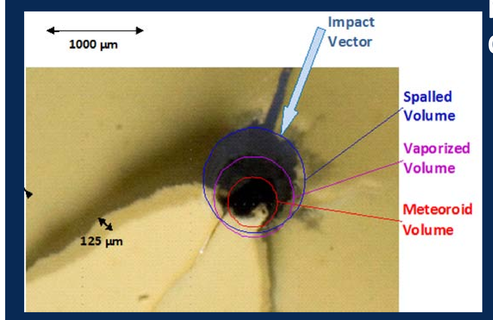
UV Radiation Yellowing

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



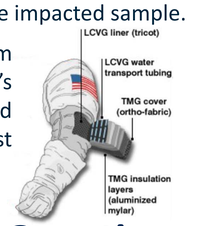
(Above) Approximate projections of the damage due to the micrometeoroid impact.

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?

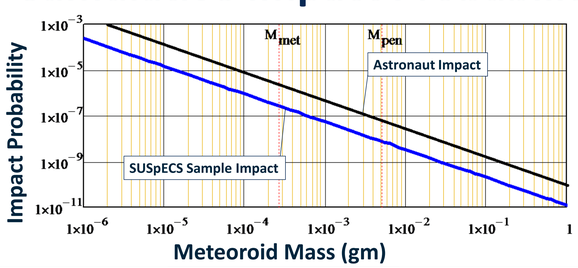
MISSE-6 Overview

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.

SUSpECS funding from USU Space Dynamics Laboratory, NASA Solar Probe Mission Program through Johns Hopkins Applied Physics Laboratory, and a USU Undergraduate Research Fellowship.

Kelby Peterson
Utah State University
Physics Department
Kelby.Peterson@aggiemail.usu.edu