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Overview of SUSpECS on MISSE-6

MISSE-6 is just one part of the MISSE project that aims to subject various materials to the space environment and document the effects in a controlled setting. In order to do this the MISSE-6 samples were coated, launched into space, suspended off of the International Space Station, and then returned to Earth in pristine condition for analysis. The Utah State University SUSpECS project was a unique student experiment on MISSE-6.

SUSpECS Objective

The purpose of SUSpECS is to characterize the performance of prospective spacecraft materials when subjected to various forms of degradation. The objective is to understand the synergistic effects of the space environment, enabling more durable spacecraft assembly.

Pre- and Post-Flight Comparisons

Optical microscopy and normal specular reflectance of pre- and post-flight samples are compared to assess on-flight degradation.

Future Work

Work on analysis of the effects of space environment exposure on the 168 samples has only begun. Measurements of optical properties, thermal properties (PTIR, emissivity, mass loss, electron, ion- and photon-induced electron emission, photomission, AES, photomission, and variable angle UV/VIS/NIR reflectivity) will continue. Work will also progress in collaboration with the AEDC space simulation facility to understand the origins of these effects and quantify their impacts.

References/Acknowledgements


Research on SUSpECS was supported by funding from JPL Space Dynamics Lab (SDT), the Utah State Solar Probe Mission Program through Johns Hopkins Applied Physics Laboratory, and a Utah State University Undergraduate Research Fellowship from the Office of Research and Graduate Studies.

Abstract

Samples that were part of the Materials International Space Station Experiment (MISSE) experienced varying effects whilst exposed to the space environment; perhaps the most intriguing effect was the crater created by a micrometeoroid impact into a thin film of Vapor Deposited Aluminum (VDA) coated Mylar. Approximately 160 samples of various materials used in space-component design were flown on MISSE-6 and spent 18 months suspended off of the side of the International Space Station. The Utah State University SUSpECS project was a unique student experiment that allowed for pre- and post-flight analysis of these material samples which were returned in pristine condition after exposure to the space environment. Despite micrometeoroids being a common occurrence, there is a significant lack of data pertaining to the effects of micrometeoroids on space components. Further examination of the micrometeoroid impact sample will allow us to determine the impact velocity, mass, and composition of the micrometeoroid and its influence on materials in space. Micrometeoroids pose a serious threat to space operations and in turn require constant observation. It is of particular interest to note that Mylar is a major component in the construction of astronaut suits; the knowledge gained from our evaluation of this meteoroid will allow us to determine the mass required to penetrate through a space suit.

Mylar with Micrometeoroid Impact

The VDA coated Mylar sample underwent vast changes in composition whilst in the ISS environment, beyond just the impact of the micrometeoroid. The most obvious would be the removal of VDA by Atomic Oxygen, exposing the underlying Mylar. Another is the yellowing of the initially white Mylar due to extensive UV exposure. Also evident is the degradation of the Mylar, again, due to Atomic Oxygen.

The estimated size of the micrometeoroid is found by matching the kinetic energy and the energy required to vaporize a hole of the observed size.

Penetrating a Spacesuit

Mass of a Penetrating Micrometeoroid:

Based on a 500 μm thick spacesuit, on typical meteoroid density and an observed relation for crater diameter and depth the minimum mass required to penetrate and ultimately kill an astronaut would be approximately 0.7 g.

Spacesuit Thickness:

A typical spacesuit has approximately seven 50 μm Mylar layers, one 50 μm Beta Cloth layer, and two other 50 μm layers totaling the suit’s thickness at 500 μm.

Modern astronaut spacesuits are designed with a dual-layer system containing bumber plates to protect the wearer from supervelocity impact by foreign objects. This additional space allows for the compression of the space suits to lessen the force of the impact.

References/Acknowledgements


Research on SUSpECS was supported by funding from JPL Space Dynamics Lab (SDT), the Utah State Solar Probe Mission Program through Johns Hopkins Applied Physics Laboratory, and a Utah State University Undergraduate Research Fellowship from the Office of Research and Graduate Studies.

SUSpECS Sample Sources

- Wide array of common spacecraft materials (see above).
- Basic materials and key contaminants of ISS solar arrays and structure.
- Materials from CRRES satellite designed to study environment-induced charging.
- Materials used in Floating Potential Measurement Unit plasma probe for ISS.
- Critical thermal control and optical materials for SOFTS.
- Composite and ceramic materials of the ATK Thermal Protection and Lightweight Structure Systems.
- Solar Probe Mission Heat Shield Insulator Samples tests.