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Micrometeoroid from MISSE Examined to Understand the Effects of the Space Environment on Space Suit

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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 co-deposited, launched into space, suspended off 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.

MISSE-6 Time Line

1/2005 Sampling completed
12/2005 PEC’s completed and tested for flight
3/2008 Launch on Shuttle ISS-123
9/2009 Return of samples from space

SUSpECS Objective

The purpose of SUSpECS is to characterize the performance of prospective spacecraft materials when exposed to the space environment. This involves measuring 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.

Penetrating a Spacesuit

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 UV 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 kinematic and energy of the projectile to vaporize a hole of the observed size.

Future Work

Work on analysis of the effects of space environment exposure on the 188 samples has only begun. Examination of optical and AEDEP-DFTIR, emissivity, mass loss, electron, ion- and photon-induced electron emission, photomultiplier, AES, photoemission, 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


Space Environment Exposure

The ISS environment ranges in temperature from approximately 40 K to 300 K. It is also a high plasma environment that causes the gas atoms to become ionized that leads to charging of surfaces in space. The direct UV light exposure combined with the atomic oxygen makes the ISS environment highly reactive, leading to chemical erosion and oxidation of sample materials.

Applications

Material degradation in the space environment is a highly relevant study today. The most common application is the construction of spacecrafts and satellites (see figure of communication satellite below that identifies many common such materials that were flown on SUSpECS). An example of the application of such knowledge is the James Webb Space Telescope (JWST), shown below. The JWST is scheduled for launch in 2014 to replace the Hubble Telescope. This sensitive optical equipment on a massive platform the idea of a tennis court will be launched further into the vastly unknown space environment than any permanent equipment thus far with an operational lifetime measured in decades. It therefore requires careful consideration in choice of materials for maximum time before erosion renders it useless.

The Utah State University has worked on materials testing of JWST materials for the last 6 years. Tests were done with lab simulations of the space environment and with exposure on MISSE-6. SUSpECS samples include JWST heat shield materials, cable insulation, structural composites and optical materials. Our tests will determine if changes in these materials due to space environment interactions will lead to dramatic changes in the operating temperature of JWST and its ability to take state of the art images to test our theories of the universe.

MISSE-6 SUSpECS Test Samples

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

Graphite Composite
Al/Mylar
Kapton
Black Kapton
Aquadag
White Paint
ITO
RTV
FR4
Coverglass

SUSpECS Sample Sources

- Wide array of common spacecraft materials (see above).
- Basic materials and key contaminants of ISS solar arrays and structure.
- Materials from CRESUS 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 spacecraft.
- Composite and ceramic materials of the ATK Thermal Protection and Lightweight Structures System.
- Solar Probe Mission Heat Shield Insulator Samples tests.