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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. To do this the MISSE-6 samples were coated, launched into space, suspended off the side of the International Space Station. The Utah State University SUSpECS project was a unique student experiment on MISSE-6.

MISSE-6 Time Line
1/2005 Sample selection completed
12/2005 PEC’s completed and tested for flight
3/2008 Launch on Space Shuttle ISS-123
9/2009 Return of samples from space

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 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 analyses 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 samples 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 spacesuit.

SUSpECS Objective

The purpose of SUSpECS is to characterize the performance of prospective spacecraft materials when exposed to the space environment, allowing 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 and mechanical properties, such as FTIR, emissivity, mass loss, electron, ion- and photon-induced electron emission, photodiode, 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 effects of these quantities and their impacts.

References/Acknowledgements

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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 subject 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 Materials Physics Group 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 have included 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
- Au/Mylar
- Kapton
- Black Kapton
- Acquadad
- White Paint
- ITD
- RTV
- FrA
- Coverglass

SUSpECS Sample Sources

- Wide array of common spacecraft materials (see above).
- Basic materials and key components 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 satellite applications.
- Composite and ceramic materials of the ATK Thermal Protection and Lightweight Structure Systems.
- Solar Probe Mission Heat Shield Insulator Samples tests.