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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 SuspenCasted AluminiuM (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 on MISSE-6.

Pre- and Post- Flight Comparisons

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

SUSpECS Objective

The purpose of SUSpECS is to characterize the performance of prospective spacecraft materials when exposed to the space environment, enabling more durable spacecraft assembly.

Future Work

Work on analysis of the effects of space environment exposure on the 168 samples has only begun. The students are working with official biomaterials for further analytical, FTIR, emissivity, mass loss, electron-, ion- and photon-induced electron emission, photodissociation, AES, photoemission, and variable angle UV/VIS/NIR reflectivity. This 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 changes in the space plasma. The direct UV light combined with the atomic oxygen creates the ISS environment highly reactive leading to chemical erosion and oxidation of the materials.

Applications

Material degradation in the space environment is a highly relevant study today. The most common application is the construction of spacecraft and satellites (see figure of communication satellite below that identifies many common spacecraft 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 system 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 USU 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 SUSpECS. 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 the theories of the origins of the universe.

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 future spacecraft.
- Composite and ceramic materials of the ATK Thermal Protection and Lightweight Structure Systems.
- Solar Probe Mission Heat Shield Insulator Samples tests.

Figure: (Above) Astronaut attaching MISSE-6 samples to the International Space Station. (Right) MISSE-6 samples, including SUSpECS, orbiting Earth suspended from the International Space Station.

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 bumer 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.

Figure: (Left) Layers of an astronaut’s spacesuit, designed to protect against micrometeoroid impact.

MISSE-6 SUSpECS Test Samples

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

Graphite Composite
- Aluminum
- Kapton
- Black Kapton
- Aquadag
- White Paint
- ITO
- RTV
- FEP
- Coverglass

Figure: Graph representing the probability of an impact vs. the mass of the impact events.

Figure: Graph representing the probability of an impact with a suspect sample vs the mass of the impact events.

Figure: Graph representing the probability of an impact with a suspect sample vs the mass of the impact events.