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SUSpECTS- State of Utah Space, Environment & Contamnation Study- MISSE VI

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microgravity research team

get away special

SUSpECTS-State of Utah Space Environment & Contamination Study-MISSE VI

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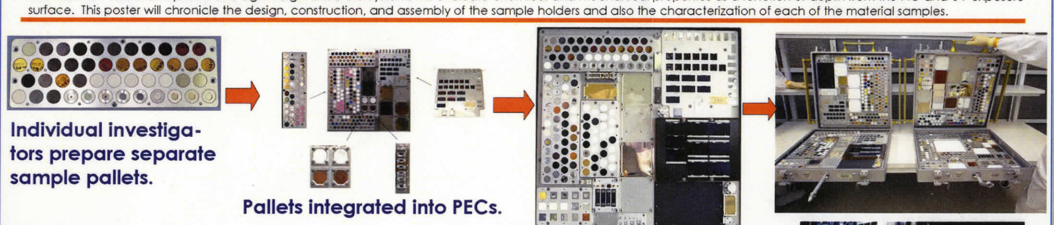
Abstract

A study of the effects of prolonged exposure to the space environment and of charge-enhanced contamination on the electron emission and resistivity of spacecraft materials, the **S**tate of **U**tah **Sp**ace **E**nvironment & **C**ontamination **S**tudy (***SUSpECTS***), is planned for flight aboard the MISSE-6 payload. The **M**aterials **I**nternational **S**pace **S**tation **E**xperiment (***MISSE VI***) program is designed to characterize the performance of candidate new space materials over the course of approximately four to eight month exposure periods on-orbit on the International Space Station, with a target flight date of mid-2006. The study is conducted by the Utah State University Materials Physics Group, in cooperation with the USU Get-Away Special Program, ATK Thiokol, and USU Space Dynamics Lab. While preliminary ground-based studies have shown that contamination can lead to catastrophic charging effects under certain circumstances, little direct information is presently available on the effects of sample deterioration and contamination on emission properties for materials flown in space.

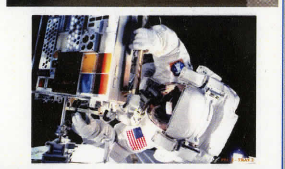
Approximately 145 samples will be mounted on panels on both the ram and wake sides of the ISS. They have been carefully chosen to provide needed information for different ongoing studies and a broad cross-section of prototypical materials used on the exteriors of spacecrafts. Characterization measurements include optical and electron microscopy, reflection spectroscopy, resistivity and Auger electron spectroscopy. In addition, studies of the service life of composite and ceramic materials of the ATK Thermal Protection Systems and Lightweight Structure Systems will evaluate chemical and mechanical properties as a function of depth from the AO and UV exposure surface. This poster will chronicle the design, construction, and assembly of the sample holders and also the characterization of each of the material samples.



Individual investigators prepare separate sample pallets.

Pallets integrated into PECs.

A fully integrated pallet (MISSE I)



MISSE VI Timeline

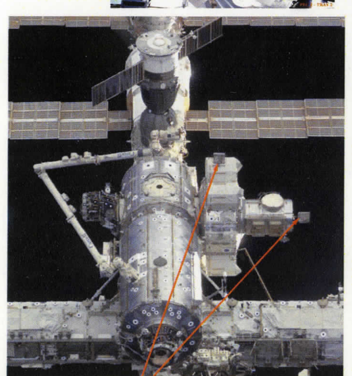
Aug 2005—Sample selection completed
Oct 2005—Preliminary design review of sample pallets
Dec 2005—Sample Pallets integrated into PEC's
Apr 2006—PEC's completed and tested for flight readiness
Late-2006—Launch on Space Shuttle for ISS deployment
6-9 months—Return of samples from space

MISSE VI OBJECTIVES:

The purpose of MISSE is to characterize the performance of new prospective spacecraft materials when subjected to the synergistic effects of the space environment.

SUSpECTS OBJECTIVES:

1. Basic research extends our understanding of the materials/space environment interactions.
2. Specific knowledge is gain for critical materials in several on-going projects of the team members.
3. Valuable collaborations between team members is fostered.
4. Analysis capabilities and flight experience are developed that will prove useful not only for follow-up funding for post-flight analysis of the SUSpECTS sample set, but for other joint ventures involving reliability and aging of materials in the space environment.

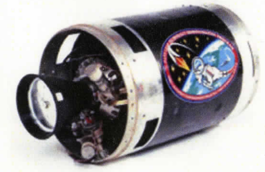


MISSE I and MISSE II are shown on the International Space Station. The actual Passive Experiment Containers shown here will be used to house our experiments on MISSE VI.

Above (L to R): Josh Hodges , Jeff Duce, and Sarah Burton, all USU students, preparing material samples
Below (L-R): Clean Table, a composite material sample, a gold sample

Sample Selection Objectives

- Ongoing seven-year study of the electron emission and resistivity properties of spacecraft materials.
- First extensive tests of space environment exposure and contamination on electron emission properties.
- Basic materials and key contaminants of ISS solar arrays and structure.
- Materials used in ISS Floating Potential Measurement Unit plasma probe for ISS.
- Critical thermal control and optical materials for SDL payloads.
- Composite and ceramic materials of the ATK Thermal Protection Systems (TPS) and the ATK Lightweight Structure Systems (LSS) .

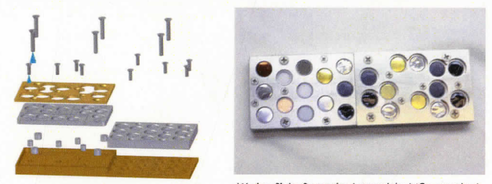


LEFT: The STAR 12GV rocket motor served as the third stage of the U.S. Navy/MDA Terrier Lightweight Exoatmospheric Projectile (LEAP) experiments. The motor first flew in March 1995. The stage has TVC capability, head-end flight destruct ordnance, and utilizes a graphite epoxy composite case. ATK developed the motor design and component technology between 1992-1995 .

ATK Thiokol will test materials degradation in the space environment for key materials for their flight Thermal Protection System and ATK Lightweight Structures System. The Samples will be microtomed to evaluate the depth gradients of chemical and mechanical changes due to environments with atomic oxygen, ultraviolet light (UV), vacuum conditions and thermal conditions.

USU Space Dynamics Lab (SDL) will test contamination, charging and degradation of key materials for the GIFTS satellite that contains optical elements sensitive to contamination and charging.

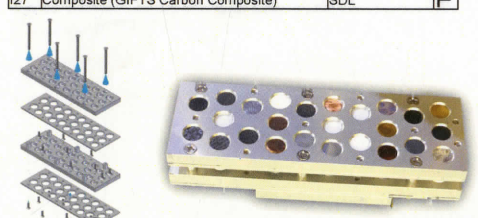
Above: USU SDL's Geosynchronous Imaging Fourier Transform Spectrometer (GIFTS).



Wake Side Sample Assembly (45 samples)

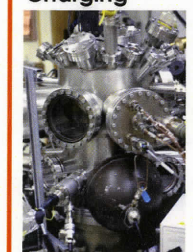
SUSpECTS Material Samples List

	Material	Source	
C01	COIC AS/N720 Oxide Ceramic Matrix Composite (CMC)	ATK	Provided By ATK
C02	COIC S200 Nonoxide CMC	ATK	
C03	Thiokol Carbon-Carbon Composite #1	ATK	
C04	Thiokol Carbon-Carbon Composite #2	ATK	
C05	Thiokol Fiber Filled Carbon-Carbon Composite	ATK	
C06	Thiokol Carbon-Phenolic Composite	ATK	
C07	Thiokol Graphite Epoxy Foil - No Hole	ATK	
C08	Thiokol Graphite Epoxy Foil - With Hole	ATK	
C09	COIC S400 Nonoxide CMC	ATK	
C10	COIC S200H Nonoxide CMC	ATK	
C11	COIC S300 Nonoxide CMC	ATK	
I01	Kapton on Aluminum	Sheldahl	Provided By Utah State University
I02	Teflon on Aluminum	Sheldahl	
I03	Mylar on Aluminum	Sheldahl	
I04	Nylon 6/6	McMaster-Carr	
I06	SiO_2 (Fused Quartz)	UQG Optics	
I07	Al_2O_3 (Sapphire)	UQG Optics	
I11	Germanium on Kapton	Sheldahl	
I12	Anodized Aluminum (Chromic Acid Etch)	NASA / MSFC	
I13	Anodized Aluminum (Sulferic Acid Etch)	NASA / MSFC	
I15	UV Ce-doped Cover Glass	OCLI	
I17	FR4 Printed Circuit Board Material	CRRES NASA	
I18	CV-1147 RTV on Copper	Boeing	
I19	DC93-500 RTV on Copper	Boeing	
I28	Borosilicate Glass	UQG Optics	
T01	Gold (99.99% Purity)	ESPI	
T02	Aluminum (99.999% Purity)	ESPI	
T03	316 Stainless Steel	McMaster	
T04	Gold(2um)/Nickel(2um) on 316 Stainless Steel	Gold Plating	
T05	OFHC Copper (99.9% Purity)	McMaster	
T06	Silver (99.???% Purity)	United Material	
T07	Inconnel on Silver on Teflon on ITO	Sheldahl	
T10	g-C (Graphitic Amorphous Carbon) on Copper	Arizona Carbon	
T11	Aquadag on Copper	LADD Research	
T12	100XC Black Kapton	Sheldahl	
T13	Thick Film Black	Sheldahl	
T14	ITO on Teflon on Silver on Inconel	Sheldahl	
I26	White Paint (Zinc Oxide Thermal Control Paint)	SDL	SDL
I27	Composite (GIFTS Carbon Composite)	SDL	



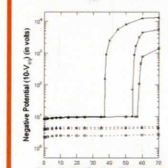
Ram Side Sample Stack (95 samples)

Ground-Based Studies of Electron Emission & Spacecraft Charging



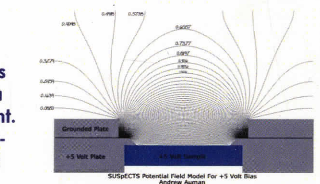
- Knowledge of satellite-plasma environment interactions are used to design experiments.
- Ground-based measurements then provide materials database and understanding of fundamental interactions
- Enhanced database and understanding aid in simulation of spacecraft charging by incorporation into NASCAP 2K

Charge Enhanced Contamination



Left: Studies at USU have shown that very thin layers of contamination—even a few monolayers—can potentially cause significant changes in electron emission properties that can dramatically affect the charging of satellites. The graph shows the differential charging of clean Au and 2-3 monolayers carbon-contaminated Au surfaces on a hypothetical satellite in GEO orbit.

Left: A solar panel that was damaged in a charging event. 1/3 of all damage is caused by the space environment



Above: GAS students are modeling electronic fields and particle trajectories of the biased wake-side samples. A side view shows the equipotential lines on a single sample charged to +5 volts. This charging attracts ions that can damage materials, and spread contamination

Above: SDL's Floating Potential Measurement Unit (FPMU) is a tool to study how the International Space Station charges as it flies through space.

Right: This satellite contains the following materials which are contained in MISSE VI

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