Spring 5-2008

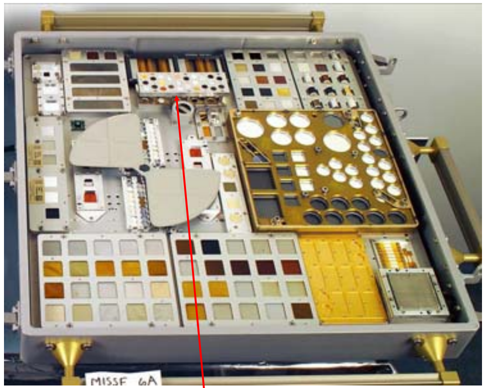
Launch and Deployment of the Misse-6 Payload: State of Utah Space Environment & Contamination Study

Joshua Hodges
Utah State University

Jeff Duce
Utah State University

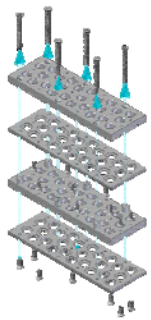
JR Dennison
Utah State University

Ram Side

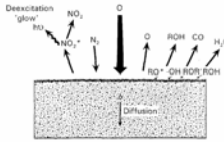


On the ram side of MISSE 6 Utah State has the Double Stack, a two tiered experiment with 75 samples being exposed to space atmosphere and 50 concealed samples experiencing the temperature cycles and pressures of space. The two tiered design allows for varying atomic oxygen (AO) and ultra violet radiation (UV) exposure.

Ram Sample Holder
SUSpECS Double Stack



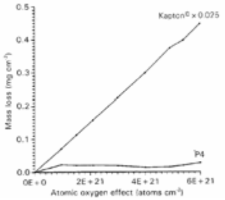
The Double Stack will also investigate oxidation by atomic oxygen and the effects that shadowing have on atomic oxygen exposure. (Below) Measuring the mass erosion rate of Kapton due to atomic oxygen radiation degradation has long been the standard in determining how much atomic oxygen a surface has been exposed to. (Above and Right) Double Stack Ag foils will be evaluated as an accurate AO fluence monitor sensor and calibrated against kapton sensors. This study will use high purity silver and measure the penetration depth of the oxide layers to determine the atomic oxygen exposure. This test will also study the effects caused by shadowing and the possibilities of ballistic scattering of atomic oxygen.



Interaction of atomic oxygen with organic materials

(Above) B.A. BANKS, S. K. RUTLEDGE, J. A. BRADY and J. E. MERROW, NASA/SDIO **Space Environmental Effects on Materials Workshop, Hampton,** VA, June July 1988. NASA **Conference Publication 3035, Part 1, pp.** 197-239.

(Right) J. KULIG, MS **thesis, Case Western Reserve University, Cleveland** (1991).



Mass loss of unprotected and P4 protected Kapton vs exposure to atomic oxygen

Rocky M … rtium

Launch and D … Misse-6 Payload: *S*tate of *U*tah *Spa* … *C*ontamination *S*tudy

Joshua Hodges[a], JR Dennison[a], Jeff Duce[b]

[a] Physics Department, Utah State University

[b] Get Away Special/ Microgravity Research Team

Email: joshual.hodges@gmail.com

Launch and Deployment Activities

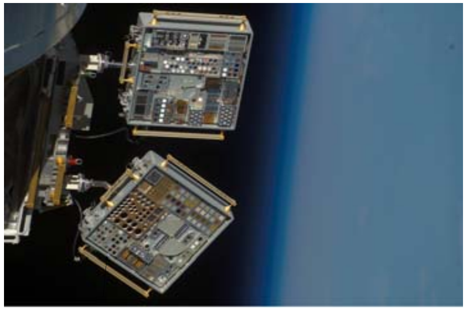
(Left) Shuttle Endeavour (STS-123) launched at 2:14 am on March 11th 2008. Aboard were two passive experiment containers (PEC) containing three experiments from students at Utah State University. (Right) Shuttle Endeavour on a pass by of the International Space Station (ISS) to check for damage to the shuttle that may have occurred during launch. With the shuttle bay open the PEC's can be seen in the top left corner. Each PEC weighs ~78 lbs and is the size of a large suitcase. The PEC's contain numerous experiments from a wide variety of contributors.

SUSpECS Objectives

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

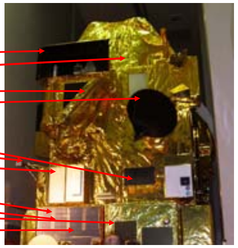
Integration of SUSpECS in to MISSE-6

SUSpECS I, II & III: Individual investigators prepared separate sample holders. Holders were integrated into Passive Experiment Containers (PECs). The PEC's were mounted on ISS for 6-12 months stay by astronauts Bob Bhenkin on EVA 5 March 22nd 2008 with the help of a hammer.

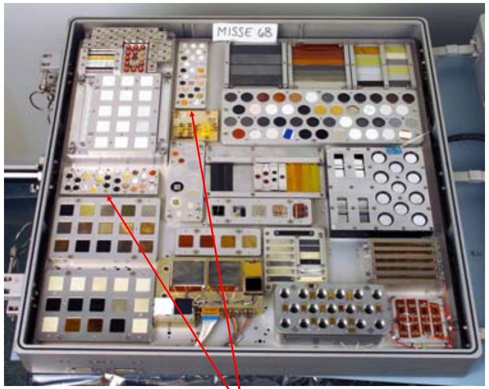


Approximately 125 samples are mounted on three 5 cm by 15 cm panels on both the ram (75) and wake (50) sides of the ISS. They have been carefully chosen to provide needed information for a broad cross section of prototypical materials used on the exteriors of spacecrafts. (See Below)The materials will be tested for electron-, ion-, and photon-induced electron emission yield curves and emission spectra. Characterization measurements include electron microscopy, reflection spectroscopy, resistivity and Auger electron spectroscopy.

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

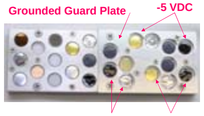


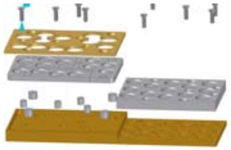
Wake Side



The SUSpECS sample holder on the wake side of the International Space Station will investigate the effects that spacecraft charging has on contamination of samples. Four sets of 4 samples (Ag, Al, graphitic carbon, and Kapton XC) are biased at +5 V, -5 V, and -18 V, in addition to the control set grounded to ISS. These samples will be examined to detemine the changes in contamination from the space environment that results from the sample charging.

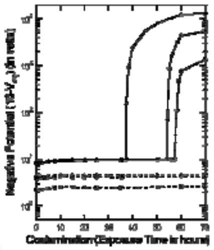
Wake Sample Holder
SUSpECS Electrical





(Right) 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 enhance contamination.

(Right) 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.



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 (99.777% 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	

Wake Side SUSpECS 3

Passive UV Exposure

25 Grounded Samples
10 Concealed samples

Scientific Solutions Inc has technology that uses nematic liquid crystal as the tuning medium in Fabry-Perot interferometers. The Liquid Crystal Fabry-Perot (LCFP) has passed temperature and vibration testing but the final test will be to see if it can withstand the atmosphere of lower earth orbit (LEO).