Space Environmental Effects (SEE) Testing Capability

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• Understanding the effects of the space environment on materials and systems is fundamental and essential for mission success.

• If not properly understood and designed for, the space environment can lead to materials degradation, reduction of functional lifetime, and system failure.

• Ground based testing is critical in predicting performance

• NASA/MSFC’s expertise and capabilities make up the most complete SEE testing capability available.
Capabilities Summary

- Ionizing Radiation –
  - Combined Space Environmental Effects
  - Solar Wind Facility
- Ultraviolet Radiation
- Atomic Oxygen (AO)
- Space Plasma Interaction – charging/arcing
- Hypervelocity Impact
- High Temperature Emissivity Measurement System (HiTEMS)
- Lunar Environments
- Analytical Capabilities
- Flight Experiments
Ionizing Radiation - Combined Space Environmental Effects

Pelletron Particle Accelerator System
- Low Energy Electrons
  • 1 keV – 100 keV
- High Energy Electrons
  • 100 keV – 2.5 MeV
- Protons
  • 40 keV – 700 keV
- Vacuum Ultraviolet Radiation (VUV)
  • 110nm – 160 nm
  • Deuterium Lamp
- In-Vacuum Reflectance Measurement
- 4-inch Diameter Exposure Area
Ionizing Radiation – Solar Wind Facility

- Low Energy Electrons
  - 1 keV – 100 keV
- Low Energy Protons
  - 1 keV – 30 keV
- Ultraviolet Radiation
  - Vacuum UV & Near UV
- 12-inch Diameter Exposure Area

Other systems are available with low-energy electrons and UV only.

Test chambers and exposure parameters can be customized to meet a wide range of customer requirements.
**Ultraviolet (UV) Radiation**
Combined Test Systems  
- Near UV (NUV) and/or Vacuum UV (VUV)  
System with NUV only  
Variable Intensity Range  
  (1-5 Suns)  
Thermally Controlled Sample Holder

**Atomic Oxygen (AO)**
Atomic Oxygen Beam Facility (AOBF)  
- 5 eV Neutral Beam  
- $10^{16}$ AO atoms/cm$^2$sec  
- Concurrent VUV Radiation (130 nm)  
AO Drift Tube System (AOTDS)  
- Thermal Energy  
- Neutral AO Atoms  
- NUV can be added
Space Plasma Interactions

- **LEO plasma** simulated using a magnetic filtered source
  - Electron Temperature Range (0.1 eV to 0.5 eV)
  - Plasma Density Range \((10^4 - 10^6)/\text{cm}^3\)
  - Monitored by Langmuir and emissive probes
- **GEO plasma** simulated using electron flood guns
  - Two flood guns exist to simulate high energy but low density environment.
  - Electron energies range from 1 to 100 keV.
- **Polar orbit conditions** are simulated using a combination of both the LEO and GEO sources discussed above
- Plasma Simulators are used to study:
  - Material conductivity
  - Arc characterization in both GEO and LEO
  - High voltage system interactions with plasma
- Test for Flight programs such as:
  - International Space Station Plasma Contactor Unit
  - ProSEDS tether and plasma contactor
  - Floating Potential Measurement Unit (FPMU)
  - National Polar Orbiting Environmental Satellite System (NPOESS)
Flight Instrumentation Qualification / Calibration

Floating Potential Measurement (FPMU) Wide Langmuir Probe (WLP)

- Conducted a series of tests on the Wide Langmuir Probe (WLP), which is one of three plasma probes on the FPMU, to determine effects of contamination on measured plasma properties.
- Placed WLP probe from FPMU qualification test article in MSFC plasma chamber, operated probe similar to on-orbit operation and measured plasma properties in the chamber.
- Found WLP was susceptible to contamination, helping produce contamination control requirements for FPMU.
Hypervelocity Impact Range

- Capability for testing to support materials, component, and subsystem development and performance characterization
- Model validation testing

Micro-light Gas Gun (MLGG)

- Bore size up to 3 mm (0.1 in.) diameter
- Velocity Range: 0.3 – 7.5 km/s
- Target chamber approx 1 m (3 ft.) dia. X 2 m (6 ft.) long
- Shot Frequency: 5-7 per day

Shuttle Flight 7 – window impact
High Temperature Emissivity Measurement System (HiTEMS)

- Emissivity is a measure of a material’s ability to transfer heat to the space vacuum.
- HiTEMS offers a unique capability for measuring material emissivity from 300 K (27°C) to 3000 K (2700°C).
- Capability consists of 2 test systems:
  - HiTEMS provides emissivity from 330K to 1600 K
  - Ultra-HiTEMS provides emissivity from 1600K to 3000K
Materials and Processes Supporting Capabilities

Analytical Capabilities
– Reflectance Measurements (AZ Tek LPSR)
– Transmission Measurements (PE UV/VIS/NIR Spectrometer)
– Infrared Reflectance Measurements (AZ Tek LPIR)
– Emittance Measurements (AZ Tek TEMP 2000)
– VUV Reflectance
– Fourier Transfer Infrared Spectroscopy (FTIR)
– Thin Films Tensile Testing

Other Materials and Processes Lab capabilities available:
• Materials and Processes Technical Information System (MAPTIS)
• Failure Analysis Laboratory
  – SEM, TEM, ESCA, Auger
• Mechanical Properties Testing
  – Metals and Non-Metals
• Chemistry
• Non-Destructive Evaluation (NDE)
• White Light Scanning
• Digital Manufacturing
• Composites development and manufacturing
Flight Materials Data

- MISSE data on MAPTIS
- Sample lists, presentations, papers, raw data, photos
- Searchable by material name, experiment, flight
- MISSE investigators are welcome to add their own data
Flight Materials Data

• For access to MAPTIS

• http://maptis.nasa.gov/Request.aspx
  – and fill out the form.

• To add MISSE data to MAPTIS
  – Contact ben.henrie@nasa.gov or miria.finckenor@nasa.gov
  – Miria – 256-544-9244
  – Be sure to specify whether your information is unlimited access or ITAR-restricted