ABSTRACT

Materials and devices used on the exterior of spacecraft in low Earth orbit (LEO) are subjected to environmental threats that can cause degradation in material properties, possibly threatening spacecraft mission success. These threats include atomic oxygen, photon radiation, charged particle radiation, temperature effects and thermal cycling, impacts from micrometeoroids and debris, and contamination. The Materials International Space Station Experiment (MISSE) program, which includes participants from government, industry and universities, addresses the long duration environmental durability of spacecraft materials and devices in the LEO environment through a series of flight experiments. Experiments developed by principal investigators are loaded onto suitcase-like trays, called Passive Experiment Containers (PECs), and are exposed to the space environment on the exterior of the International Space Station (ISS). The MISSE trays are retrieved and returned to Earth enabling post-flight experiment evaluation. The trays are positioned in either a ram/wake orientation with one surface facing the ram direction (receiving atomic oxygen & solar radiation) and the other surface facing the wake direction (receiving solar radiation with no atomic oxygen exposure), or in a zenith/nadir orientation with one surface facing the zenith direction (receiving solar radiation with little atomic oxygen) and the other surface facing the nadir direction (receiving no direct solar radiation and little atomic oxygen). Five MISSE PECs have been flown and retrieved successfully to date (MISSE 1-5). MISSE 6A & 6B were delivered to ISS during the STS-123 mission, and were placed outside of the Columbus Module in ram/wake orientations. MISSE 7A & 7B have been developed, flight readiness tested, and are manifested for delivery to ISS during shuttle mission STS-129 currently scheduled for late 2009. Table 1 provides a summary of the MISSE 1-7 launch and retrieval missions, their locations on ISS, and the space exposure durations. This paper provides an overview of the MISSE program and includes examples of individual experiments and flight data, along with examples of how the MISSE flight data has been used for ground-facility calibration and for improved LEO environmental durability prediction.

Table 1. MISSE 1-7 Mission Exposure Summary

<table>
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<tr>
<th>MISSE PEC</th>
<th>Launch Mission</th>
<th>Date Placed Outside ISS</th>
<th>Location on ISS</th>
<th>Tray Orientation</th>
<th>Retrieval Mission</th>
<th>Date Retrieved from ISS</th>
<th>LEO Exposure Duration (years)</th>
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| 1 & 2     | STS-105        | 8/16/2001               | PEC 1: High Pressure Gas Tank (HPGT)  
PEC 2: Quest Airlock | Ram & Wake       | STS-114          | 7/30/2005             | 3.95             |
| 3 & 4     | STS-121        | 8/3/2006                | PEC 3: HPGT  
PEC 4: Quest Airlock | Ram & Wake       | STS-118          | 8/18/2007             | 1                      |
| 6A & 6B   | STS-123        | 3/22/2008               | Columbus Module  | Ram & Wake       | STS-128          | -                       | >1.4                  |
| 7A & 7B   | STS-129        | -                       | EXPRESS Logistics Carrier 2 (ELC 2) on the S3 Truss | 7A: Zenith & Nadir  
7B: Ram & Wake | TBD             | -                       | -              |

Key Words: Space experiment, International Space Station, low Earth orbit, environmental degradation, atomic oxygen, radiation, materials