Ground Testing of the MISSE-16 Materials

Elena A. Plis[1,2], Miles Bengtson[3], Daniel P. Engelhart[4], Ryan C. Hoffmann[5], Gregory P. Badura[1], Timothy S. Scott[6], Heather M. Cowardin[7], Jaqueline A. Reyes[8], Sydney Horne[2], Alexey Sokolovskiy[5]
Dale C. Ferguson[5]

1. Georgia Tech Research Institute (GTRI), Atlanta, GA, 30318, USA
2. Assurance Technology Corporation, Carlisle MA 017141 USA
3. National Research Council Research Associateship Program, 3550 Aberdeen Ave., Kirtland AFB, NM, 87117, USA
4. University of New Mexico, Albuquerque, NM, 87131, USA
5. Air Force Research Laboratory, Space Vehicles Directorate, USA, Kirtland AFB, Albuquerque, NM, 87117, USA
6. DuPont de Nemours, Inc, Durham, NC 27703, USA
7. NASA Johnson Space Center, Orbital Debris Program Office, Houston, TX, 77058, USA
8. University of Texas at El Paso, 500 W. University Ave., El Paso, TX, 79968, USA
8. Air Force Research Laboratory, Space Vehicles Directorate, USA, Kirtland AFB, Albuquerque, NM, 87117, USA

The harsh space environment imposes very stringent requirements upon spacecraft materials, especially those located on exterior surfaces of space objects in low Earth orbit (LEO). As humankind moves from space exploration to space commercialization, these materials may have to last for 15–20 years without considerable degradation of their optical, electrical, mechanical, and thermal properties. Operational requirements dictate that these materials continue to function according to expectations. Hence, we must understand the effects of the space environment on materials currently in use as well as on untested materials. For the years, the Materials International Space Station Experiment Flight Facility (MISSE-FF) have flown many different materials to investigate the effect of LEO space weather exposure on the performance and durability of materials and devices.

The MISSE-16 scientific team members plan to launch fifteen different novel and well-characterized spacecraft-relevant materials to the LEO environment for a duration of six months during the MISSE-16 mission. Changes in spectral reflectivity will be measured throughout the mission as the samples are exposed to the space environment. The same chemical damage the produces changes in optical reflectance also causes changes in numerous other physical properties such as electrical conductivity, mechanical strength, and chemical reactivity. Correlation of the changes in each of these properties as a function of radiation type, flux, and fluence allows various material properties to be inferred from one experimentally tractable measurement: color change. Flying identical test fixtures on the ram, zenith, and wake positions of the MISSE-FF, collecting spectrally resolved images of the materials, and concomitantly measuring the ambient space environment allows deconvolution of the material effects which occur as a result of exposure to neutral atomic oxygen (AO), unfiltered solar ultraviolet (UV) radiation, and electrons.

The flight experiment will function as a ground truth reference for our team's ongoing laboratory-based space weather-material interactions experiments. Comparison of the MISSE-16 data with extensive testing of "flight-duplicate" samples under simulated space weather conditions will enable development of chemical models for prediction of material degradation. This paper discusses preliminary results from the ground test campaign including measurements of UV/VIS/IR reflectance spectra, bidirectional reflectance distribution function (BRDF), surface potential decay, and surface morphology under electron and AO exposure.