The MISSE 7 Flexural Stress Effects Experiment After 1.5 Years of Wake Space Exposure

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Abstract

Low Earth orbit space environment conditions, including ultraviolet radiation, thermal cycling, and atomic oxygen exposure, can cause degradation of exterior spacecraft materials over time. Radiation and thermal exposure often results in bond-breaking and embrittlement of polymers reducing mechanical strength and structural integrity. An experiment called the Flexural Stress Effects Experiment (FSEE) was flown with the objective of determining the role of space environmental exposures on various polymers under flexural stress. The FSEE samples were flown in the wake on the exterior of the International Space Station for 1.5 years. Twenty-four test samples were flown, 12 bent to a 0.375 in. mandrel and 12 were bent to a 0.425 in. mandrel. This was designed to simulate flight configurations of insulation blankets on spacecraft. The samples consisted of assorted polymer and fluorinated polymers with various coatings. Half the samples were designated for bend testing and the other half will be tensile tested. A non-standard bend test procedure was designed to determine the strain at which embedded polymers crack. All tensile samples designated for bending have been tested. None of the control samples’ polymers cracked, even under surface strain up to 15.7%, although one coating cracked. Of the ten flights samples tested, seven showed increased embrittlement through bend test induced cracking at surface strains from 0.70% to 11.73%. These results show that most of the tested polymers are embrittled due to space exposure, when compared to their control samples. Determination of the extent of space induced embrittlement of polymers is important for designing durable spacecraft.

Space Environment

Materials on the exterior of the spacecraft are exposed to many environmental threats that can be harmful to the spacecraft and its operation. These threats include:

- Solar radiation (ultraviolet, x-rays)
- Charged particle radiation (electrons, protons)
- Cosmic rays (energetic nuclei)
- Thermal cycling (hot & cold cycles)
- Micrometeoroids & debris impacts (space particles)

Atomic oxygen (AO, single oxygen atom)

FLEXURAL STRESS EFFECTS EXPERIMENT BACKGROUND

Objective: To examine the role of surface flexural stress (two different levels) on space environment induced polymer embrittlement.

- Samples were flown bent over a mandrel in the wake orientation, which imposed surface flexural stress, on the exterior of the ISS, and samples flown in the wake of the ISS were exposed to the space environment on the exterior of the International Space Station.

The Flexural Stress Effects Experiment (FSEE) samples were flown in the wake orientation on the ISS from November 28, 2009 to May 20, 2011 for 3.1 years, and received 2,000 equivalent sun hours (ESH) of solar radiation (Ref 2).

FSEE Materials

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<th>Sample ID</th>
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