Title: “Post Flight Analysis of Optical Specimens from MISSE7”

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Abstract: More than 100 optical specimens were flown on the MISSE7 platform. These included bare substrates in addition to coatings designed to exhibit clearly defined or enhanced sensitivity to the accumulation of contamination. Measurements were performed using spectrophotometers operating from the UV through the IR as well as ellipsometry. Results will be presented in addition to discussion of the best options for design of samples for future exposure experiments.
Post Flight Analysis of Optical Specimens from MISSE 7

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Outline

M7 mission

Design

Samples

Performance

Summary
MISSE 7 Mission Objectives

PECs installed on the ISS Express Logistics Carrier
- space environment exposure experiments with power, control and telemetry
MISSE 7B PEC RAM Side Pre-flight
MISSE 7B PEC RAM Side Post-recovery

23.75" x 23.75"
MISSE 7B PEC Wake Side Post-recovery
MISSE 7B PEC Post Recovery

All spectrometer components and optical samples appeared to be in excellent condition.

Location of spectrometer carousels – there was a slight rotation from designated “0” index point.

After comparing 1. Images before and after flight
2. Data from the samples
   – spectrometer carousels probably were never activated during mission

Passive exposure was the fallback mission for these samples

Potential comm and control problems were apparent before launch
PEC 7B was powered down during the mission due to an increase in current load and some elevated temperatures.
Optical System Components

All spectrometer components were tested after de-integration and found to be in good working condition.

Optical fibers were all multimode fused silica, single and bifurcated
Spectrometers were Stellarnet “Blue Wave”

Calibration of system radiometric throughput was not performed before or after flight

Mission plan:
- Pre- and post-flight measurements on the ground
- Comparison to “standards” on the carousels in flight
Wake
Wake

Following Vibe test

Post-Flight

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RAM 1 Pre vs Post Flight

Pre-Flight

Post-Flight
PreFlight Transmission Spectra of Optical Coating Samples

Lambda 19, MSFC

Transmission vs. Wavelength (nm)
Sample Selection for M7

• Space environment includes many factors that can influence performance of optical coatings
  – Low level contamination or erosion is most common effect
    • Changes in R,T and A
    • Spectral changes are not dominant, but easiest to measure

• Specific designs may enhance sensitivity to low level contamination

• M7 samples selected for simple design, highest contrast
  – To evaluate effects of the environment
  – To facilitate data collection/analysis from spectrometers
Uncoated Fused Silica

Decrease in transmission approaching UV typical of contamination

preflight data normalized to 93.5 % at 600nm
Al$_2$O$_3$ Coating on Fused Silica

Increase in transmission to 94% may be attributed to 25nm of a polymer-like contaminant.
Al₂O₃ Coating on ZrO₂

Increase in transmission may be attributed to 25-35nm of a polymer-like contaminant.
AR Coating on $\text{SiO}_2$

Spectral shift of maximum transmission beyond 600nm consistent with 25-35nm of a polymer-like contaminant
Multilayer ZnSe/ThF$_4$ HR Coating on SiO$_2$

Spectral shift towards longer $\lambda$
- consistent with contamination layer on top of exposed ZnSe
- no evidence of AO erosion on wake side
Samples Obscured during the Flight – “Controls”

Good correlation between before and after data – consistent with protection from exposure
Summary

• The MISSE 7 spectrometers were a significant step forward but didn’t get to play
  – Miniaturization
  – Low power consumption
  – Speed

• Specific sample designs were chosen to enhance detection of low level contamination

• Data on the recovered optical samples from the wake carousel is completely consistent with the presence of a thin contamination layer
  – Some variation in amplitudes
    • Instrumentation
    • Sample size
    • Data is still reproducible
  – Measurement of samples that were shielded and never exposed show consistency in method