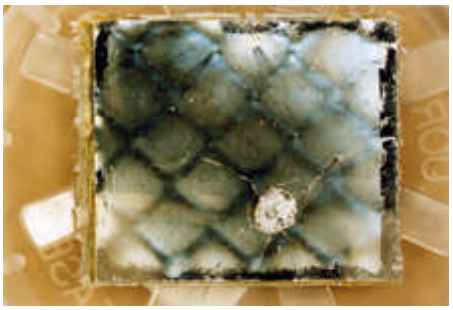
Retrieval of Mir Solar Array

A Russian solar array panel removed in November 1997 from the nonarticulating photovoltaic array on the Mir core module was returned to Earth on STS-89 in January 1998. The panel had been exposed to low Earth orbit (LEO) for 10 years prior to retrieval. The retrieval provided a unique opportunity to study the effects of the LEO environment on a functional solar array. To take advantage of this opportunity, a team composed of members from RSC-Energia (Russia), the Boeing Company, and the following NASA Centers--Johnson Space Center, Kennedy Space Center, Langley Research Center, Marshall Space Flight Center, and Lewis Research Center--was put together to analyze the array. After postretrieval inspections at the Spacehab Facility at Kennedy in Florida, the array was shipped to Lewis in Cleveland for electrical performance tests, closeup photodocumentation, and removal of selected solar cells and blanket material. With approval from RSC-Energia, five cell pairs and their accompanying blanket and mesh material, and samples of painted handrail materials were selected for removal on the basis of their ability to provide degradation information. Sites were selected that provided different sizes and shapes of micrometeoroid impacts and different levels of surface contamination. These materials were then distributed among the team for round robin testing.



Solar reflector on the back of one of the Mir solar cells, showing a micrometeoroid impact and contamination darkening in areas not shielded by the woven mesh on the back of the array (net pattern).

A preliminary examination of the solar array panel indicated significant darkening and diffuse light scattering on the surface of the panel and structural members. By their location and appearance, the darkened surfaces appear to be silicone contamination from adhesives used to assemble the solar array panel. NASA Lewis is performing tests to look at the contamination on the array and to determine the effect of atomic oxygen and vacuum ultraviolet radiation on contaminant fixation. Two samples have been evaluated to date--a handrail section (white-painted aluminum) and a woven polymer fabric used as an overwrap tape on a handrail. Both samples had visible dark-brown contamination. Optical microscopy revealed mud-tile-like crazing patterns in the contaminated areas. Field emission microscopy showed that the contaminant layer was very thick (approximately 1.6 μm in some areas) and had spalled off in some regions. Energy-dispersive spectroscopy confirmed that the contaminant layer on both the handrail and the overwrap tape was

silicon oxides (SiO_x) resulting from the oxidation of silicone.

Results are being shared with the other team members, who are each performing a different analysis, such as micrometeoroid and debris impact measurements and electrical measurements. Degradation mechanisms described through this analysis will provide valuable information that can be used in predicting the performance of solar arrays on the International Space Station and that could prevent contamination of the level observed on the Mir array.

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