

## WORKING GROUP WRITTEN PRESENTATION

## SOLAR RADIATION

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CURRENT STATUS

Ultraviolet (UV) radiation testing of materials and coatings has been conducted for over 30 years. A substantial data base is available for laboratory exposure of thermal control coatings using simple UV sources such as mercury vapor or xenon arc lamps. These exposures typically cover a wavelength range down to 180 nm because of atmospheric absorption and the transmission of quartz windows. Limited data is available on the effects of lower wavelength UV radiation on materials and coatings. These laboratory data are also of short duration - typically 500 to 1,000 hours at one to two solar constants. Most testing laboratories have constructed their own UV simulation and testing systems, and little correlation can be established between exposure conditions, calibration techniques, and UV detectors. This difference in equipment leads to different test results on similar materials and coatings. There also are few facilities with extreme ultraviolet (EUV) (below 180 nm) exposure capability. Since these wavelengths are present at low flux levels in space solar radiation, the need for these wavelength sources in laboratory testing has not been established. Little laboratory data is available on synergistic effects of UV with thermal cycling or of UV, thermal cycling, and particulate radiation. These combined exposures are found in all space flights. The need for laboratory simulation of the combined space environment must be established to better predict material and coating performance in long-duration missions.

Most of the available flight data on coatings and materials was conducted prior to 1980. These data are confused by spacecraft contamination. Many coatings tended to degrade rapidly in the first few weeks of flight and then change the degradation rate. This rapid degradation was not experienced in most laboratory tests and was therefore attributed to spacecraft contamination. The effect of atomic oxygen in space on coatings and contamination has not been established in laboratory testing but is known to "bleach" UV degradation in some white paint coatings. This is another combined space environment parameter which is not available in current laboratory simulators.

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## TECHNOLOGY DRIVERS

The major technology drivers for solar radiation testing are the long design lifetimes of Space Station Freedom and other future space missions. All of these missions, whether in low Earth orbit or higher altitudes, will experience solar radiation exposure. The limitation of only 5-year duration flight data and less than 1-year laboratory exposure data requires extrapolation to an unacceptable degree. When the full environment of UV, atomic oxygen, and thermal cycling with a low dose of particulate radiation is considered for Space Station Freedom, then an understanding of each of these individual effects and their synergistic effects needs to be established.

## TECHNOLOGY NEEDS

The members of the Solar Radiation Working Group arrived at two major solar radiation technology needs: 1) generation of a long-term flight data base, and 2) development of a standardized UV testing methodology. The flight data base should include 1- to 5-year exposure of optical filters, windows, thermal control coatings, hardened coatings, polymeric films, and structural composites. The UV flux and wavelength distribution, as well as particulate radiation flux and energy, should be measured during this flight exposure. A standard testing methodology is needed to establish techniques for highly accelerated UV exposure which will correlate well with flight test data. Currently, UV can only be accelerated to about 3 solar constants and can correlate well with flight exposure data. With space missions to 30 years, acceleration rates of 30 to 100X are needed for efficient laboratory testing.

## UV TESTING RECOMMENDATIONS

The Working Group recommendations for solar UV testing follow the technology needs. A series of flight experiments with 1 year minimum duration should be conducted in the proposed service environments. These experiments should have radiometers for UV measurement and detectors for particulate radiation detectors for flux and energy. Provision should also be made for the specimens to be returned in vacuum. This information is necessary for correlation of laboratory simulation on Earth.

Since many materials are sensitive to UV radiation of specific wavelengths, the committee recommended that a continuum UV source be developed covering the range from the extreme ultraviolet to the visible. The continuum source would incorporate multiple lamps to cover this large UV spectrum.

The other major recommendation was the construction of a test facility to provide the data needed to standardize UV simulation sources, detectors for flux measurement, and testing procedures. Such a facility would be a national resource for evaluation of UV sources, detectors, and optical measuring equipment as well as conducting studies of UV effects on materials.