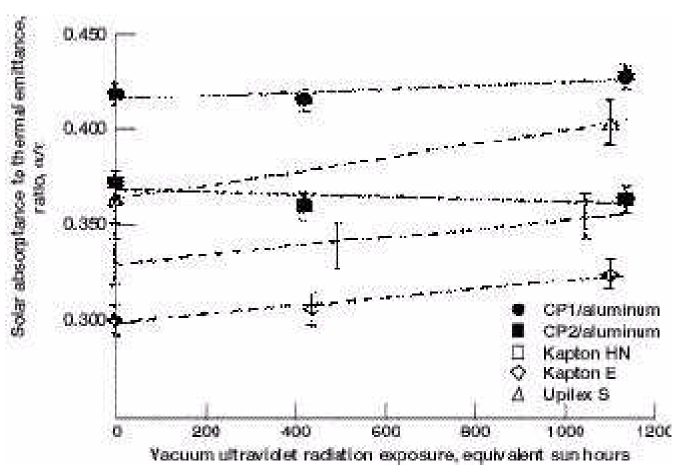
Effects of Vacuum Ultraviolet Radiation on Thin Polyimide Films Evaluated

NASA anticipates launching the Next Generation Space Telescope (NGST) mission--whose purpose is to examine the origins of our universe by making measurements in the infrared portion of the spectrum--in 2009. So that the telescope can operate at very low temperatures (less than 100 K), a halo orbit about the second Lagrangian point (L2) is being considered because it is far from Earth and its reflected sunlight. The Sun-Earth L2 point is located 1.53×10^6 km from the Earth in the direction away from the Sun (ref. 1).

This mission presents new challenges in many areas of technology, including the development of a multilayer insulation sunshield for the telescope. This sunshield is required to be large (proposed dimensions of approximately 33 by 14 m), storable, deployable, and lightweight (ref. 1). In addition, its polymer film layers must be seamable, foldable, and resistant to tearing and creep, with low outgassing (ref. 1). The sunshield must maintain its structural integrity and its Sun-facing side must maintain a low solar absorptance to thermal emittance ratio (α/ε) over the planned 10-yr mission duration including over 80,000 hr facing constant sunlight.

One possible configuration for the NGST sunshield uses a polymer film as thin as 12 μm, metalized on the backside, as the outermost (space-facing) layer. This outer layer will be most vulnerable to the effects of the space environment, which can degrade polymers (ref. 2). A program has been established by the NASA Goddard Space Flight Center to use ground testing to evaluate space environmental effects on candidate sunshield materials for NGST. The effects being evaluated include electron and proton radiation, vacuum ultraviolet (VUV) radiation, and micrometeoroid impacts.



Solar absorptance to thermal emittance ratio for polyimide films with exposure to VUV radiation.

The NASA Glenn Research Center is evaluating the VUV durability of the sunshield outer membrane candidate materials. Polyimide films (Kapton HN, Kapton E, and Upilex S) and fluorinated polyimide films (CP1 and CP2) being considered for the Sun-facing layer of the NGST sunshield were exposed to up to 1100 equivalent sun hours of VUV radiation. At various exposure levels, samples were measured for changes in optical and mechanical properties. Kapton HN, Kapton E, and Upilex S all showed increases in solar absorptance and the α/ε ratio (see the figure), although emittance changes were not significant. In addition, all samples tested showed decreases in spectral reflectance in the ultraviolet-to-visible wavelength range, indicative of changes to the polymer chemistry even at this low exposure level that represented only approximately 1 percent of the planned 10-year NGST mission. For exposures up to 1100 equivalent sun hours of VUV radiation, no significant changes were observed in ultimate tensile strength and elongation at failure for these materials. Longer-term VUV exposure testing being conducted at Glenn will help to validate these trends and to predict the long-term performance of these materials for the NGST sunshield.

Find out more from Glenn's Electro-Physics Branch (http://www.grc.nasa.gov/WWW/epbranch/ephome.htm**) and from NASA's Next Generation Space Telescope site (http://ngst.gsfc.nasa.gov/).**

References

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