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OPTICAL DEGRADATION AND RECOVERY OF MULTILAYER INSULATION IN A SIMULATED GEO ENVIRONMENT

Abstract

Ground- and space-based optical observations of space objects rely on knowledge about how spacecraft materials interact with light and how that interaction changes as a function of space weather exposure. In polymers, the changes in optical signature occur due to surface degradation, leading to altered reflectivity, and due to radiation induced chemical modification, leading to an alteration of a material's absorption/transmission properties. Electrons can be expected to primarily alter the bulk of the material with minimal effect on surface morphology due to the nature of energy deposition. The optical fingerprint of commonly used spacecraft surface materials changes continuously under exposure to high energy electrons, the primary damaging species in geostationary Earth orbit (GEO). Laboratory observations have also shown that these changes in a material's optical signature are to some degree transient. This work investigates the rate and degree of "optical healing" in vacuum for electron damaged polyimide (Kapton-H®), a major component in many variations of multilayer insulation (MLI). Characterization of optical damage as a function of electron exposure and optical healing as a function of time in vacuum represents a major step toward a predictive model for optical characterization of space objects. The results of this investigation will find use in the space environmental remediation community for characterization of high area to mass ratio (HAMR) objects as MLI fragments comprise a large portion of HAMR space debris.