AN EVALUATION OF CANDIDATE OXIDATION RESISTANT MATERIALS FOR SPACE APPLICATIONS IN LEO

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ABSTRACT

Atomic oxygen has long been recognized as one of the main causes of degradation for materials such as polyimides and carbon on spacecraft in the low Earth orbital (LEO) environment. The degradation of components such as Kapton® solar array blankets and graphite epoxy structural members is of such magnitude that it could potentially jeopardize the long term durability of Space Station. Radiator surfaces must maintain emittances greater than ≈ .8 while in LEO in addition to maintaining resistance to attack by atomic oxygen at high temperatures. Ground based testing of materials considered for Kapton® array blanket protection, graphite epoxy structural member protection, and high temperature radiators was performed in an RF plasma asher. Ashing rates for Kapton® were correlated with rates measured on STS-8 to determine the exposure time equivalent to 1 year in LEO at a constant density Space Station orbital flux. Protective coatings on Kapton® from Tekmat, Andus Corporation and LeRC were evaluated in a plasma asher and mass loss rates per unit area were measured for each sample. All samples evaluated provided some protection to the underlying surface but ion beam sputter deposited samples of SiO_2 and SiO_2 with 8% polytetrafluoroethylene (PTFE) showed no evidence of degradation after 47 hours of exposure. Mica paint was evaluated as a protective coating for graphite epoxy structural members. Mica appears to be resistant to attack by atomic oxygen but only offers some limited protection as a paint because the paint vehicles evaluated to date were not resistant to atomic oxygen. Four materials were selected for evaluation as candidate radiator materials: stainless steel, copper, niobium-1% zirconium, and titanium-6% aluminum-4% vanadium. These materials were surface textured by various means to improve their emittance. Emittances as high as .93 at 2.5μm for stainless steel and .89 at 2.5 μm for Nb-1Zr were obtained from surface texturing. There were no significant changes in emittance after asher exposure. The protective coatings on Kapton® and candidate radiator materials evaluated so far are promising but further research on protection of graphite epoxy support structures is needed.