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FABRICATION AND CHARACTERIZATION OF LAYERED UHMWPE COATINGS ON AEROSPACE-GRADE EPOXY RESIN FOR SPACE RADIATION SHIELDING

Abstract

Due to its high hydrogen content, ultra-high molecular weight polyethylene (UHMWPE) is one of the most effective materials in radiation shielding in space environment. UHMWPE is a chemically stable thermoplastic polymer, easily available and non-toxic, but it has poor mechanical and thermal properties, which make it difficult to use as an aerospace structural material. In this paper, we used UHMWPE to fabricate homogeneous coatings on the surface of an aerospace-grade epoxy resin (Cycom 823), in order to combine the superior mechanical and thermal properties of the selected thermosetting polymer with the radiation shielding capabilities of polyethylene. The coating was realized by mechanical mixing of UHMWPE microspheres in the epoxy, followed by phase segregation of the two polymers upon heating. Different microsphere sizes and loadings of UHMWPE were considered and coatings with different thickness and homogeneity were fabricated. The layered coatings were analyzed using optical microscopy, which showed an optimal degree of coverage of the underlying epoxy substrate. The thermal properties of the UHMWPE-coated epoxy resin were investigated by differential scanning calorimetry (DSC), whereas Izod and bending tests were performed to study the fracture toughness and the flexural properties. Results showed an increase of the absorbed impact energy of the coated epoxy resin, and therefore a higher impact strength with respect to the neat thermosetting resin. The vacuum outgassing characteristics of the UHMWPE-coated epoxy resin were also investigated, and all tested samples showed a total mass loss (TML) lower than 1%. Overall, the experimental results of the morphological, thermal and mechanical analyses showed the promising use of this layered UHMWPE coating in space radiation shields, for example for satellites structures to protect sensitive equipment from radiation.