Paper ID: 79956
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IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Environmental Effects and Spacecraft Protection (6)

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CROSS-LINKED POLY(VINYL ALCOHOL)/BORIC ACID GELS FOR RADIATION SHIELDING APPLICATIONS

Abstract

Cross-linked gels are soft materials composed by hydrophilic polymer matrix cross-linked in water by physical or chemical bonds. Being lightweight and water-rich, these materials can be applied for protective purposes in different fields, including in space environment. Due to the high hydrogen content, these cross-linked gels show a significant radiation stopping power, thus less fragmentation of incident particles, suggesting their potential use for radiation shielding of electronic devices and protection of astronaut's health. In this work, cross-linked gels based on poly(vinyl alcohol) (PVA) and boric acid (BA) are fabricated and their properties investigated using different experimental techniques. The effect of parameters (time, temperature) used for fabricating the PVA/BA gels is evaluated. Fourier transform infrared spectroscopy (FTIR) is used to assess the ability of BA to form hydrogen bonds with the PVA macromolecules, at different BA concentrations. The gel thermo-mechanical properties and viscoelastic behavior are investigated by dynamic mechanical analysis (DMA) in compression mode. The shielding properties of the gels are evaluated in space environments influenced by galactic cosmic rays, solar particle events and low earth orbit radiation by the deterministic transport codes provided by NASA Langley Research Center, using as input water content and density values, which are experimentally determined. First, the High charge (Z) and Energy TRaNsport (HZETRN) code is employed to create different cross sections as first output for the selected materials, and then, propagate and transport the ionizing energy inside the materials. Second, the on-line tool for the assessment of radiation in space (OLTARIS) software, based on HZETRN transport code, is used to evaluate the shielding effectiveness on different Earth orbits. Results in terms of chemical, thermo-mechanical properties and simulated behavior against radiations show the potential application of these cross-linked PVA/BA gels as shielding materials in space environment.