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EXPERIMENTAL STUDY OF SOLAR RADIATION EFFECTS ON CARBON NANOCOMPOSITE SENSORS IN SIMULATED SPACE ENVIRONMENT

Abstract

Solar radiation, generally referring to the electromagnetic radiation emitted by the Sun, constitutes one of the most critical risks for human exploration in space. Whereas on Earth such radiation is filtered for the shorter and highly hazardous wavelengths by the atmosphere and its ozone layer, in space solar radiation has profound and adverse effects on the structural and electronic components of spacecrafts, as well as on biological systems, if they are not properly shielded. In this context, research on innovative radiation sensing materials and devices to measure the internal radiation environment of spacecrafts or to monitor the radiation exposure experienced by astronauts during extra-vehicular activities is constantly growing. In this paper, we report results on the design and experimental tests of lightweight carbon-based nanocomposite materials, which can be used for radiation sensing applications in space environment. The integration of carbon nanoparticles as sensing elements into a polymer matrix is not a trivial task, as the overall sensing properties of the material are highly affected by the amount and homogeneity of the filler dispersion. In a first step of the study, we investigated the fabrication process of functional nanocomposite sensors based on DNA-decorated graphene nanoplatelets embedded in a flexible and UV-transparent polymer matrix, such as polydimethylsiloxane. The sensing principle of such nanocomposites relies on the highly conductive nature of the graphene nanomaterial combined with the chemical sensitivity of the DNA strands to ionizing radiation. The surface properties of the nanocomposite films were investigated before and after testing in a thermo-vacuum chamber equipped with a solar lamp, in terms of morphology, electrical conductivity and wettability. Results show the potential applications of these nanocomposites as sensing materials for radiation monitoring in extreme environments characterized by high levels of biologically-damaging ionizing radiation, such as the space environment.