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Development and Evaluation of a Poly(2,5-benzimidazole)-Graphene Oxide Composite for LEO Coating Applications: A Comparative Experimental and Computational Study

The longevity of spacecraft materials is severely impacted by the radiation-rich environment of Low Earth Orbit (LEO), which has led to the development of lightweight, radiation-tolerant coatings. In this work, a composite material consisting of graphene oxide the (GO) and poly(2,5-benzimidazole) (ABPBI) was synthesised by in situ polymerisation and characterized by X-ray diffraction (XRD) and UV-visible spectroscopy (UV-Vis). The electrical and optical properties of the composite and its components were investigated computationally using Density Functional Theory (DFT).
In agreement with DFT results and much like investigations of ABPBI carbon nanotube (CNT), the ABPBI/GO samples UV-Vis data indicated significant absorption in the UV region. The electronic properties of ABPBI/GO are shown by the band structure and density of states (DOS, characteristic an indicative of a semiconducting nature.
ABPBI/CNTs have been successful in its resilience against atomic oxygen, proton and secondary neutron generation (Square et al., 2023a; Fourie et al., 2023). To evaluate ABPBI/GO, this work considers the plausibility of GO as an alternative nanofiller. The optical absorption, and electronic characteristics of the ABPBI/GO composite is compared to previously researched ABPBI/CNT systems. Recent results suggest enhanced structural flexibility under microgravity conditions (Swanepoel, unpublished manuscript). A large bandgap of ~4.12 eV was obtained for the pristine ABPBI, consistent with insulating behaviour, while the ABPBI/GO composite showed a reduced bandgap of ~2.01 eV. Both ABPBI/CNT and ABPBI/GO composites exhibit semiconducting behavior with DOS indicating bandgap narrowing and interfacial charge transfer. Optical absorption is strong in the deep-UV (~100–250 nm) for the GO composite and tunable between ~200–400 nm for the single-walled carbon nanotube (SWCNT) system, depending on nanotube loading.

References
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