Multi-Functional Composites for Space Travel: Design Considerations and Early Concepts Using Reduced Graphene Oxide as a Polymer Reinforcer

Zach Seibers, Esther Beltran, Valeria La Saponara, Meisha Shofner, John Reynolds

There are numerous risks to space exploration including radiation exposure, static charge build-up, micrometeoroid impact, and extreme mechanical forces. Developing materials to address these risks remains a critical challenge to enable long-term space habitation and extended EVA operations. Polymers present a promising class of materials to address these needs in package that is lightweight and compatible with a variety of manufacturing techniques. Hydrocarbon polymers, such as high-density polyethylene (HDPE), are well known for their rich H content that is known to block specific types of radiation encountered during space expeditions. Due to their simple chemical structure that lacks larger heteroatoms, HDPE is resistant to numerous radiation-induced degradation pathways that often limit the applicability of more sophisticated polymers. One drawback of hydrocarbon polymers is their inferior mechanical properties, such as tensile strength and impact toughness, relative to metals and other high-performance polymer systems. Another issue specific to space travel is the fact that hydrocarbon polymers are electronic insulators and can therefore statically charge during flight, which can present hazards to astronauts and their equipment. This work seeks to address these shortcomings by incorporating chemically modified reduced graphene oxide (rGO) nanoparticles as a reinforcement material. This presentation will cover the design and synthesis of chemically modified rGOs and their incorporation into HDPE composites. The electrical properties of the composites are assessed before and after simulated galactic cosmic ray (GCR) and solar particle event (SPE) radiation treatments performed at the NASA Space Radiation Laboratory. Finally, a brief perspective will be given on how these experiments are used to formulate composites using other matrix polymers and/or fiber reinforcement to meet the needs of different applications encountered in orbital and lunar surface environments.