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EMBEDDED GRAPHENE-SILICON OXYCARBIDE POROUS CERAMICS FOR THERMOELECTRIC APPLICATIONS

Abstract

Thermoelectric devices have been an enabling technology for the exploration of deep space since the dawn of the space age. The ability to convert heat generated from the decay of radioactive plutonium-238 into electrical energy provides a constant source of solid-state energy to a spacecraft, eliminating the need for future maintenance or a reliance on an external energy source, such as the Sun. Without these devices, the expansive exploration of Mars and beyond would simply not have been possible. However, the current state-of-the-art thermoelectric technologies face many shortcomings that should be addressed in future design iterations to make the devices more efficient, less hazardous, and more feasible for the transfer into Earth-based applications. Such limitations include low efficiencies (8% in the new e-MMRTG) and fabrication from materials that are hazardous or expensive to manufacture (i.e lead tellurides). Over the last five years, fundamental work has been ongoing in exploring the use of polymer-derived ceramic nanocomposites for use in future thermoelectric applications. In particular, graphene networks have been introduced into a silicon oxycarbide (SiOC) ceramic matrix with the aim of creating an electrically percolated system while simultaneously creating a high concentration of phonon scattering sites – two properties that have been suggested to significantly improve thermoelectric performance. The current performance of these materials, along with their shortcomings and proposed future directions, will be explored in this presentation. A correlation will be drawn between the fabrication parameters and graphene content versus thermoelectric properties such as Seebeck coefficient, electrical conductivity, and thermal conductivity. In addition, a brief look into the nanostructure and mechanical performance of this system will be presented to further support the ongoing development of such a system for thermoelectric applications.