Mohammad S Islam et al., Res. Rev. J Mat. Sci. 2018, Volume 6
DOI: 10.4172/2321-6212-C4-023

Toughening of nanocomposites for applications in cryogenic fuel tank

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Microcracks can occur in carbon fiber composite materials due to high thermal stresses induced by the large difference of the coefficient of thermal expansion between the polymer matrix and the carbon fibers. These micro-cracks can severely degrade the mechanical strength and gas permeability of composites, posing a significant challenge to the use of fiber composites in liquid fuel tanks of launch vehicles. The aim of the study was to develop a multi-scale toughening method to address the micro-cracking problem by incorporating hybrid nano-scale materials to enhance the fracture toughness and to reduce the coefficient of thermal expansion of the polymer matrix. Nanomaterials such as nanosilica, graphene and metal oxide were selected based on their thermal properties and toughening effect. Tensile and Single Edge Notch Bending (SENB) testing of the polymer and nanocomposites were carried out to study their tensile properties and bulk fracture toughness respectively, while Double Cantilever Beam (DCB) testing was carried out to determine the critical energy release rate (GIC values) of the fiber-polymer laminates. The results show that nanosilica improved the fracture toughness of the composites while metal oxide nanoparticles provided the best improvement in thermal conductivity, tensile strength, and fracture toughness.

Biography

Mohammad S Islam has obtained his PhD from the University of Waikato, New Zealand. Currently, he is a Research Fellow in the School of Mechanical and Manufacturing Engineering, University of New South Wales, Australia. Previously, he held Research Fellow positions at the University of Sydney in Australia, the University of Minho in Portugal, CSIRO Materials Science and Engineering in Australia and Materials Scientist position in Pultron Composites, New Zealand. He has published more than 25 papers in journals and has been serving as an Editorial Board Member of Composite Materials of Science Publishing Group.

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