

Nano Composites for Lightweight Cryogenic Tanks for Crew Exploration Vehicles

A Letter of Intent for the Florida Space Research and Education Grants Program
(Category: Space Exploration and Spaceport Technology Development)

Submitted by

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The overall goal of this project is to develop a lightweight composite material system that can be used to build cryogenic storage systems for liquid hydrogen. Graphite/epoxy composites and their sandwich structures have been identified as potential material systems. The two problems associated with this material system are matrix cracking due to thermal stresses and degradation of fracture properties. Both give rise to increased gas permeability and lead to leakage. We approach this problem by looking at two methods to reduce matrix cracking and improve fracture toughness. First method is inclusion of nano particles and the second method is to use woven composites. Preliminary results indicate that both methods improve inter-laminar fracture toughness at cryogenic temperatures.

Nano ceramic particles such as zinc oxide will be mixed with epoxy resin to create nano polymer composite resin system, which will then be used in a Resin Transfer Molding process to impregnate graphite fiber performs. The resulting composite will be a hybrid system of nano particle/graphite fiber/epoxy composite. The fracture toughness, strength and gas permeability will be measured at cryogenic conditions. Multiscale modeling will be pursued to predict the experimental observations.

The analytical and experimental methods developed in this study will be useful to NASA and aerospace companies in designing composite cryogenic tanks for liquid hydrogen.