Ablative Performance of Carbon Fiber Reinforced Cyanate Ester Composites Filled with Nano-Ceramics

By

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Abstract

In this research work, a rayon-based carbon fiber reinforced nano-ceramics modified noble cyanate ester nanocomposite will be fabricated for the application on the field of Thermal Protection System(TPS) and the effect of using nano-silica as a filler element in cyanate ester will be evaluated. For the entire aerospace industry, ablative materials play a vital role. These materials are used in vehicles from atmospheric reentry, rocket nozzles, and ship hulls to protect their internal structure from hot combustion gases and as a heat shield for planetary entry also. Different loading levels of nano-ceramics will be dispersed onto the cyanate ester resin using high shear mixing and ultrasonication process. Hand layup followed by the compression molding will be used to fabricate rayon-based carbon fiber reinforced cyanate ester nanocomposite. Transmission electron microscopy (TEM) will be performed very effectively to microanalysis and failure analysis of the composites. Tension, flexure, and short beam shear tests will be conducted as per ASTM D 3039, ASTM D 7264, and ASTM D 2344, respectively. Differential scanning calorimetry (DSC), Thermal Gravimetric Analysis (TGA) and Thermomechanical analysis (TMA) will be performed to analyze the core characterization of the material, mass loss and the co-efficient of thermal expansion of different formulations, respectively. Aerothermal ablation testing will be conducted to evaluate the nanocomposites under a high heat flux of 1000 W/cm^2 by the Oxy-acetylene Test Bed (OTB) as per ASTM E285. The objective of this research is to determinate if a nanomodification of Cyanate ester with nano-ceramics will improve the ablation properties of carbon fiber reinforced cyanate ester nanocomposites, without declining its thermal and mechanical properties. The results will demonstrate the performance of this new material as an ablative material.