Effects of Multiwall Carbon Nanotubes on Electrical, Thermal, and Mechanical Properties of Carbon-reinforced Cyanate Ester Composites

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ABSTRACT

Current applications within areas such as electronics, military, and aerospace are demanding for lightweight and high-performing composite systems. More specifically, thermosetting formulations with minimal hazardous emissions that are used for high-temperature applications are in high demand. Cyanate ester resin (CE) has a high glass transition temperature (T_g, as high as 350ºC), excellent flammability, thermal stability, mechanical properties, and it does not release harmful volatiles during the cure process. Multiwall carbon nanotubes (MWCNT) can offer excellent electrical and thermal conductivity, structural strength and stiffness, and thermal stability. The enhancement of the resin's properties is highly dependent on the qualitative and quantitative dispersion of MWCNT. In this research, CE was blended with MWCNT (0.5%, 1%, and 1.5% by weight) using a combination of a Planetary Centrifugal Mixer (THINKY™) and a Stand Mixer. In order to improve dispersion, MWCNTs were processed with ceramic beads using the THINKY™ mixer to break-up the entangled nanoparticles. Transmission electron microscopy (TEM) was performed to evaluate separation of MWCNT entanglements. Carbon fiber-reinforced nanomodified cyanate ester composite panels were manufactured using a wet layup process followed by compression molding. Mechanical tests were then performed to evaluate tensile strength and modulus, flexural strength and modulus, compressive strength and modulus, and short-beam shear strength. Thermogravimetric analysis (TGA) was used to study

the four different formulations thermal stability in both air and nitrogen. Lastly, the flammability properties were also analyzed with micro combustion calorimetry (MCC). Results were compared with control samples showing a positive effect of MWCNT on the final properties of carbon-reinforced cyanate ester composites.