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Optimization of Bonding Performance in CF/Epoxy Composites through Nanoparticle-Reinforced adhesive

Abstract: Fiber reinforced thermoset plastic composites are essential in the various industry due to its high strength and heat resistance. Recently, most of the industries require to store a large amount of composite structures for a certain time. Further, these thin panels need to be joined together to achieve the required thickness for their intended applications, applied to build large structures or detailed components. Therefore, adhesive bonding is essential in the thermoset composite industry. Thus, this research aims to improve the bonding performance of thermoset composites by providing new insights into bonding methods through using nanotechnology and advanced composite adhesion abilities. Using toughened epoxy as an adhesive aims to improve the bonding performance of Carbon Fiber/Epoxy composites (CF/Epoxy), providing significant advantages over traditional adhesives. Adding nanoparticles, such as Multi-Walled Carbon Nanotubes (MWCNTs), can significantly improve adhesive performance. These nanoparticles increase the strength and hardness of the adhesive joints, making them more durable and better able to handle. The CF/Epoxy composite was made through Vacuum assisted Resin Transfer Molding(VaRTM) with nanoparticles mixed under the ultrasonic system. The mechanical abrasion was conducted to improve the surface energy of composites, enhancing adhesive strength. Adhesive performance was evaluated through lap shear strength and interlaminar shear strength tests according to ASTM standards D1002 and D2344. Different amounts of MWCNTs 0.1%, 0.3%, and 0.5% by weight were incorporated in adhesive to find the best performance. These tests are also conducted at -60℃ to simulate the environmental conditions which the aircraft is actually operating. Optical microscopy and scanning electron microscopy were used to analyze the fracture surface.

Keywords: Thermoset composites, Adhesive bonding, Toughened epoxy, MWCNTs

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