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Development of Prepreg and Out-Of-Autoclave Process for Z-Aligned Carbon Nanofiber Toughened Lightweight Composites

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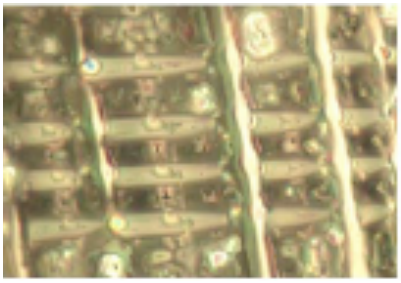

Microscopy picture of the fracture surface of the inplane shear tested sample.

Research: Carbon fiber (CF) reinforced polymer matrix composite laminates, comprising aligned continuous carbon micro-fibers embedded in polymer matrices, have superior tensile properties in the in-plane directions (x and y directions) but are weak in the matrix sensitive properties such as compressive strength, shear strength, and impact tolerance. The research team plans to utilize z-direction aligned carbon nanofibers (CNFs) to pin through the CF arrays thus improving the matrix sensitive properties. The manufacturing of such composites involves two major steps: the fabrication of the CF/(Z-aligned CNF/epoxy) prepreg and the out-of-autoclave (OOA) process to turn the prepreg into a solid composite laminate. An electrical field is used to align CNFs during the manufacturing process. The new composite materials will be evaluated for mechanical and thermal performance improvements.

Potential Impact: This research could benefit the aerospace, defense, energy, and transportation industries.

- Higher survival rate against impact damage, interlaminar crack growth, and fatigue failure
- Higher stability against varying environmental temperature (high/medium/low)
- Good affordability compared to the industrial state-of-the-art prepreg/autoclave processed composites, which are facing a significant challenge in scaling-up for today's composite structure needs
- The improved Z-direction thermal, electrical, and thermal-mechanical properties could be utilized in multifunctional composite structures

The team will actively seek opportunities for further developing the technology with aerospace companies and government agencies such as NASA, AFOSR, ONR, and NSF. Current collaborators include the Marshall Space Flight Center (MSFC), Langley Research Center (LaRC), and an aerospace company (Spirit AeroSystems). Material test data and evaluation samples may be shared with potential partners for further technology development.

The educational components include: (1) recruiting graduate and undergraduate researchers; (2) offering a new course; (3) recruiting and retaining students from underrepresented groups to engage in the research activities at USA, AU, and TU.

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