Tailored Interfaces in Frontally Cured Carbon Fiber Composites

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Project Description:

Frontal curing is a rapid energy-efficient alternative to autoclave/oven curing for manufacturing high-performance fiber-reinforced polymer composites (FRPCs). Frontal curing leverages the exothermic heat of polymerization to propagate a self-sustaining reaction wave through the matrix after initiation with a small triggering stimulus (e.g. heat). Frontally cured carbon-fiber/poly(dicyclopentadiene) (CF/pDCPD) woven composites have been fabricated with mechanical properties (E ~ 55 GPa, F_{tu} ~ 600 MPa) similar to traditional carbon-fiber/BPA-epoxy composites. However, the non-polar nature of pDCPD contributes to a comparatively weak fiber-matrix interface in CF/pDCPD composites compared to a strong CF/epoxy interface, compromising in-plane shear and compression performance.

We evaluate the interfacial shear strength in CF/pDCPD composites using the single fiber fragmentation (SFF). In SFF, a tensile specimen with a carbon fiber parallel to the loading axis is incrementally loaded to repeatedly fracture the fiber until the number of fragments saturates. The length of fragments at saturation is related to the interfacial shear strength through a shear lag analysis coupled with single filament tensile (SFT) data. Ongoing work seeks to improve the interfacial adhesion in frontally cured carbon/pDCPD composites to match the performance of traditional high-performance carbon/epoxy composites.

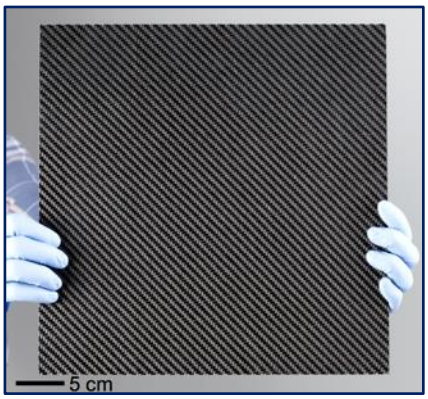

Figure 1. A 30cm × 30cm composite panel fabricated in <5min.

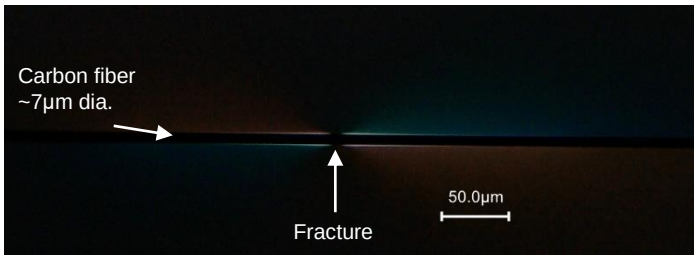

Figure 2. A cross-polarized micrograph of a fracture in carbon fiber during SFF. The light regions indicate local distortions to the stress field due to the fracture.

As an undergraduate research assistant, you will participate in the design, manufacturing, and micromechanical characterization (SFT/SFF) of CF/pDCPD composites. You will observe how engineering (e.g. pre-tension, pre/post-cure cycles) and chemical (e.g. comonomers, fiber treatment) approaches impact the manufacturability and interfacial strength of CF/pDCPD composites. In addition, you will

characterize properties of the composite that are influenced by interfacial adhesion such as short beam interlaminar shear strength.

Student Background and Expected Research Activities:

We are seeking a student who is interested in learning about composite interfaces, mechanical characterization, and polymer composite manufacturing. A background in polymer science is preferred, but not required. The student should be comfortable handling chemicals and operating mechanical testing equipment and optical microscopes.

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