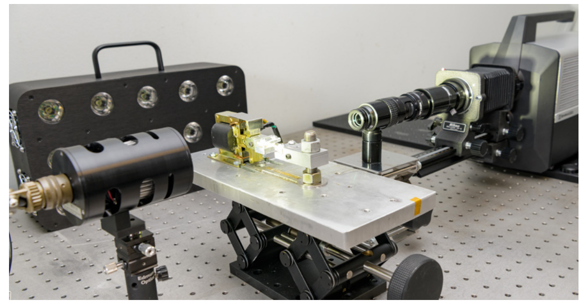
UNIVERSITY OF DELAWARE
CENTER FOR
COMPOSITE MATERIALS
Celebrating 50 Years

2025

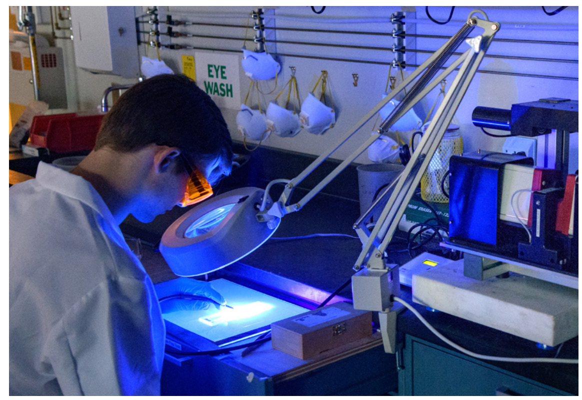
INTERFACE SCIENCE

The University of Delaware Center for Composite Materials' Interface Science facility, hosts a wide array of unique and specialized equipment dedicated to understanding the mechanisms of adhesion between fiber and resin and the role adhesion at the filament level length scale plays in determining macroscopic composite properties. Micromechanical testing capabilities include both quasi-static and dynamic (test rates up to~106 reciprocal seconds) microdroplet testing and In situ fiber fragmentation testing for evaluation of interfacial shear strengths (IFSS) for different combinations of fibers, sizing/surface treatments, and resins.



Shimadzu Ultra High-speed Camera

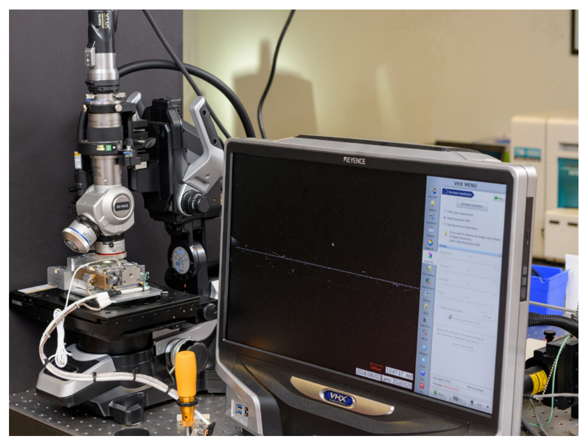
Recent acquisitions include a Shimadzu HPV-X2 ultra-high speed camera (50 ns minimum exposure), a Renishaw micro-Raman spectroscopy unit with measurement capability at three different wavelengths and Favimat Automated Fiber Test System with Firmabond fiber pull-out test fixture. The Shimadzu HPV-X2 camera will enable fiber fragmentation testing at high loading rates and enable monitoring in real time the propagation of filament breakage in multifilament model composites under quasi-static loading conditions. The Renishaw micro-Raman system will enable mapping of the localized strain along the length of a single filament during a fiber fragmentation test, while the Favimat fiber pull out system will enable IFSS determination for thermoplastics and viscous high temperature thermosetting resin systems.



Automated single filament tensile

In addition to these unique interface testing facilities, UD-CCM has a comprehensive suite of surface characterization and imaging capabilities including Atomic Force Microscopy, variable pressure SEM imaging, Laser confocal microscopy, ATR FTIR spectroscopy, high speed IR imaging and Dynamic Contact Angle measurements. Fiber Surface chemistry modification capabilities include Plasma treatment, Ozone treatment and a commercial laboratory scale fiber sizing application system.

Decades of research in the area of composite interface science have led to the development of sophisticated computational tools that enable modeling composite performance from the atomistic length scales to the continuum level. Today, UD-CCM has a dedicated SGI UV supercomputer used for multi-scale modeling of composite materials. Molecular dynamics simulations are being developed to study how processing conditions determine the composition of the fiber/sizing/resin interphase and ultimate the interphase performance under multi-axial loading.



In Situ fiber fragmentation testing station

PIONEERING INNOVATION EXCELLENCE

SINCE 1974

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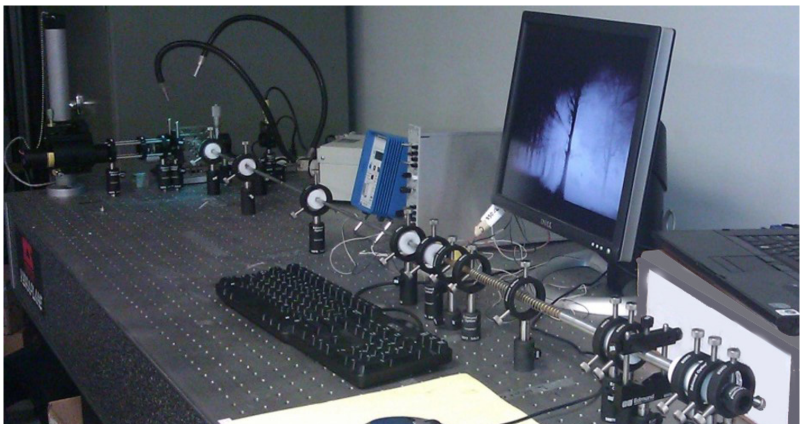
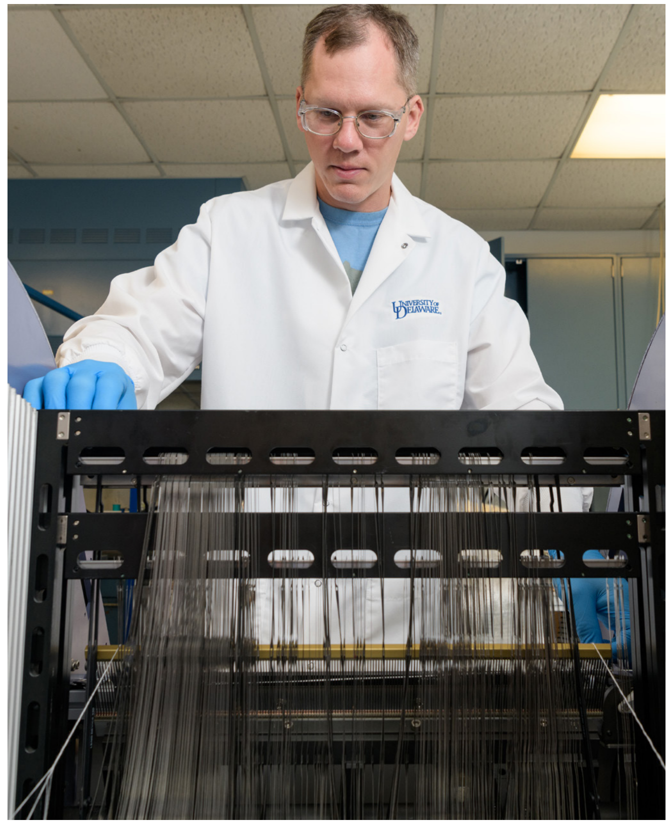
INTERFACE SCIENCE

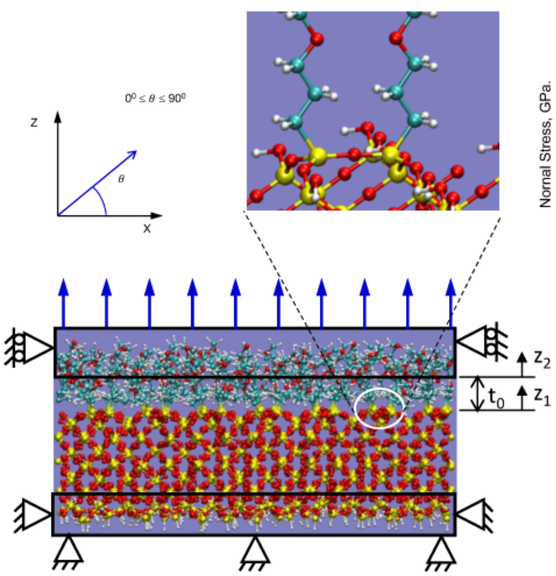
Predictions from these models are then validated experimentally, and used to provide critical inputs in to continuum level models at higher length scales. "Small changes in the composition of the fiber/resin interface, predictable by MD simulation, have a measurable impact on macroscopic performance of the composite", according to Dr. Joseph Deitzel, Senior Scientist at UD-CCM. "By developing novel experimental techniques that enable validation of model predictions at all length scales, we are able to achieve a true "Materials by Design" approach to composite materials."



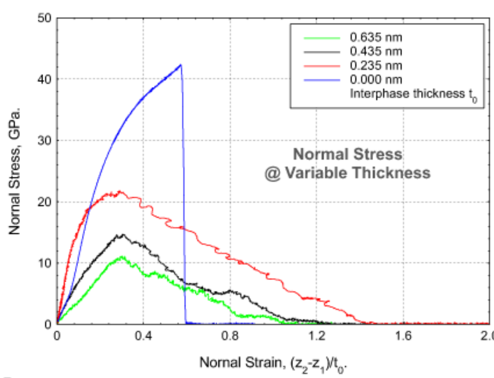


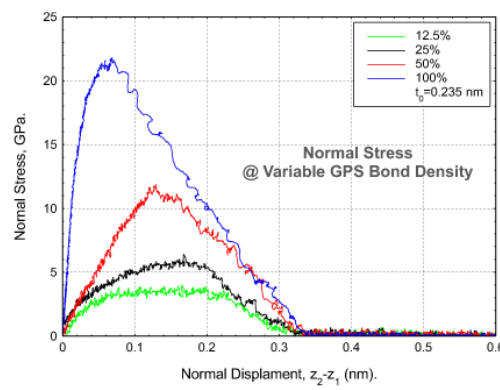
High strain rate dynamic microdroplet test

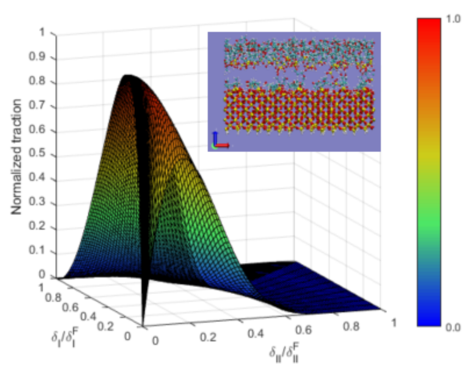
2D robotic loom and sizing facilities

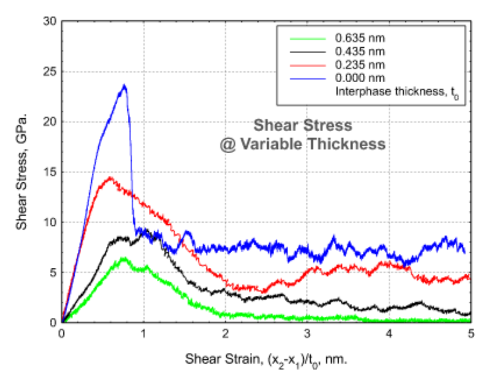


MD simulations of silica-sizing (mono-layer) shows that interphase properties can be improved significantly by increasing GPS bond density with the glass surface.









Chowdhury et. al, Silica-silane coupling agent interphase properties using molecular dynamics simulations, J Mater Sci 52 (2017):12981-12998

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