The University of Delaware Center for Composite Materials (UD-CCM) has a wide variety of materials characterization capabilities available for both basic and applied research projects. These include a Thermal Analysis test lab, a Micromechanical testing facility, a Microscopy suite, a Surface Characterization facility and a High Speed Imaging facility. These capabilities together with our traditional mechanical testing facilities enable complete characterization of composites and their constituent materials from the atomic level to full scale prototypes. By using these diverse experiment techniques in concert, it is possible to obtain insight into the role that molecular architecture and constituent material (resins, fibers, fillers, etc.) microstructure plays in determining macroscopic properties (mechanical, thermal, optical, electronic). A brief description of each facility and their capabilities follows.

**Thermal Analysis Laboratory**
The University of Delaware Center for Composite Materials has state of the art Thermal Analysis laboratory for characterization of composite materials and their constituents. The equipment list includes a Mettler Toledo thermal Analysis Suite consisting of a DSC-1 Differential Scanning calorimeter, a TGA/DSC-1 Thermogravimetric Analyzer, and a DMA-STDA861e Dynamic Mechanical Analyzer. These capabilities enable the determination of basic thermal properties of resins such as glass transition temperature, Tg, crystal melting Temperature, Tm, heat capacity, material degradation temperatures, and frequency dependent mechanical properties such as Storage, E’ and Loss E” modulus as a function of temperature. The facility also includes a TA instruments AR 2000 Rheometer, and a Nicolet 820 FTIR. Used in conjunction, these systems can be used to measure a wide variety of physical parameters, including processing windows for thermosetting resins (Cure rate, viscosity changes as a function of time, temperature and Cure), high strain rate behavior of resins through Time-Temperature Superposition experiments (E’, E”), and environmental stability (degradation temperature, moisture sorption/desorption measurements, effect of environment on Tg, and Modulus).

**Micromechanical Testing Facility**
The UD-CCM micromechanical testing facility enables detailed characterization of fibers, resins and fiber/resin interfaces on the micro scale. The Instron Microtester can measure loads as small as a milliNewton up to 2 KiloNewtons and displacements with submicron precision. This system can be used to carry out a wide variety of testing including Single filament tension tests, adhesion testing, compression testing, fiber fragmentation testing and fiber pull out for evaluation of interface properties.
The system is equipped with an environmental chamber that allows testing to be done at subambient (LN2 cooled) and elevated temperatures. The facility also has specialized equipment, built and designed by UD-CCM specifically for the testing and evaluation of fiber/resin interphase properties. These include a state of the art microdroplet test apparatus and a Dynamic Interphase Loading Aparatus (DILA). The microdroplet test fixture permits the determination of effective interfacial shear strengths, debonding energy, and energy associated with fiber pull-out under quasi-static test conditions. The DILA apparatus is essentially a fiber push out test that provides data similar to that of the microdroplet test, but the experiments can be carried out under a wide range of loading rates, which allows examination of the rate dependent properties of the fiber/resin interphase. These techniques, coupled with our extensive FEA modeling capabilities can be used to provide a comprehensive picture of the mechanisms at work at the fiber/resin interface under axial loading conditions.

**Microscopy and Surface characterization Facilities**

UD-CCM has at its disposal a number of techniques for evaluation the chemistry, roughness and tribology of material surfaces. Chemical characterization of surfaces can be carried out through Attenuated Total Reflectance (ATR) FTIR and FTIR microscopy, and Contact angle measurement through both Sessile Drop and Wilhelmy methods. These techniques can be used to determine the chemical composition and reactivity of surfaces as well as their wetting properties. For characterization of surface roughness, UD-CCM has a Zygo Scanning White Light Interferometer and a Veeco Nanoscope 3A Atomic force microscope capable of nano-indentation and nanoscratching experiments. Surface morphology can be studied using our state of the art Nikon optical microscopy and image analysis suite, and/or out Hitachi TM1000 Table top Scanning Electron Microscope. Additionally, UD-CCM researchers have access to University capitol equipment including SIMS, EDAX, and XPS for detailed chemical analysis of surfaces.

**High-Speed Imaging Suite**

UD-CCM has developed a range of capabilities for the imaging of real-time testing ranging from Nano-second to days in duration. The facilities include a Redlake HG 100 high speed video camera capable of frame rates up to 100,000 frames a second, and a DRS Ultra 8 Range Framing camera that can collect 8 full frame images at exposure times as low as 10 nanoseconds, as well as a variety of high resolution CCD video cameras for use in monitoring testing procedures and processes at standard video rates. This imaging can be carried out at high magnifications using an Infinity K2 Video microscope.