Top Story

Center makes significant equipment upgrades

CCM faculty, staff, and students have access to a broad spectrum of composites characterization, manufacturing, processing, and computational equipment in the Center's 52,000-sq-ft, state-of-the-art facilities.

ATTL
Applications and Technology Transfer Laboratory

CMSL
Composites Manufacturing Science Laboratory

University of Delaware
Center for Composite Materials

COMPOSITES UPDATE
November 2012

CCM's equipment is continuously upgraded and augmented as needed to support basic research as well as applied programs carried out in collaboration with industrial and government sponsors.

Within the last year, the facilities underwent a significant expansion and upgrade in three areas: high-performance computing, materials processing, and materials characterization.

> *"We are very excited about our new equipment and capabilities that will enhance the quality, breadth and depth of our educational mission, the research conducted by our faculty, staff and students and the value we provide to our government and industrial sponsors."*
>
> *Professor Jack Gillespie*
> *Director, Center for Composite Materials*
> *Donald C. Phillips Professor of Civil and Environmental Engineering*
> *Department of Materials Science and Engineering*
> *Department of Civil and Environmental Engineering*

TOP STORY (Continued)

The following specific pieces of equipment have recently been added to CCM's labs:

High-Performance Computing
- SGI Shared Memory Supercomputer (Veyron)

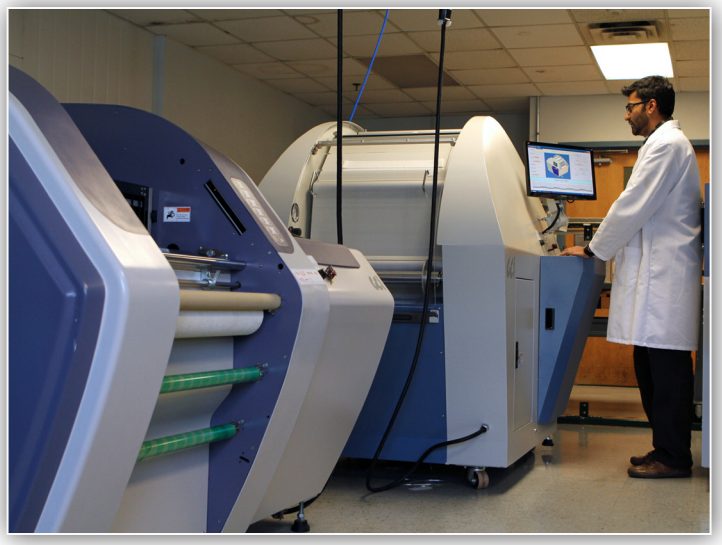
Composites Manufacturing
- Fabric Prototyping and Tow Sizing System
- Robotic Advanced Material Placement Head (AMP) for Thermoset and Thermoplastic Composites Processing
- AMP modules for Induction, Infrared and Hot-gas Heating and Real-time Sensing; Spray System for Films and Bagging
- Aqueous Bath Thermoplastic Prepreg Line
- Commercial Pultrusion Line

Materials Characterization
- Micro CT scanner
- High Capacity Impact Tower
- High Speed Infrared Cameras
- Instron Mechanical Test Machine (50 kip)
- T A Instruments Discovery Hybrid Rheometer
- Digital Image Correlation System
- Keyence Confocal Microscope
- Bruker X-Ray system
- Bruker Atomic Force Microcopy

SGI Shared Memory Supercomputer (Veyron)

The Altix UV1000 is the fastest shared-memory supercomputer in the world, according to its manufacturer, Silicon Graphics International. CCM researchers use Veyron to model fabric impact; model, at multiple length scales, the permeability, consolidation, and infusion of polymer composites; and simulate electromagnetic and thermal responses, impact, and wave propagation through heterogeneous materials and fluid-structure interactions. These functions are employed in support of various ongoing programs funded by the Department of Defense, the National Science Foundation, and industry.

TOP STORY (Continued)



Fabric Prototyping and Tow Sizing System

Funded through a DURIP grant, CCM recently acquired a CCITech SL8900 Sampling Loom System (2-D Loom, Warper, Sizing Unit) for research and development of composites with custom/hybrid fabric architectures and sizings. The Loom has a weaving width of 17", multiple weft yarns and programmable weave patterns. The Warper can produce warp beams for short runs (~3 yards) and the Sizing unit allows custom sizing runs for a single end of roving/yarn. The system enables rapid design, prototyping and evaluation of unique fabric architectures in short runs (~16" width by 3 yards in length) with all the standard high performance inorganic and organic fibers.

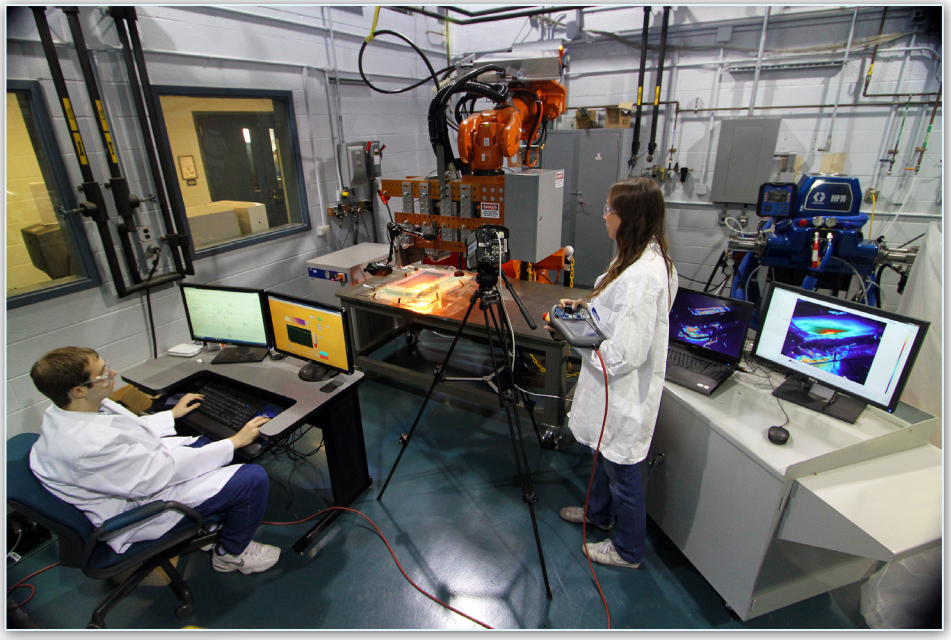
Robotic Advanced Material Placement Head (AMP)

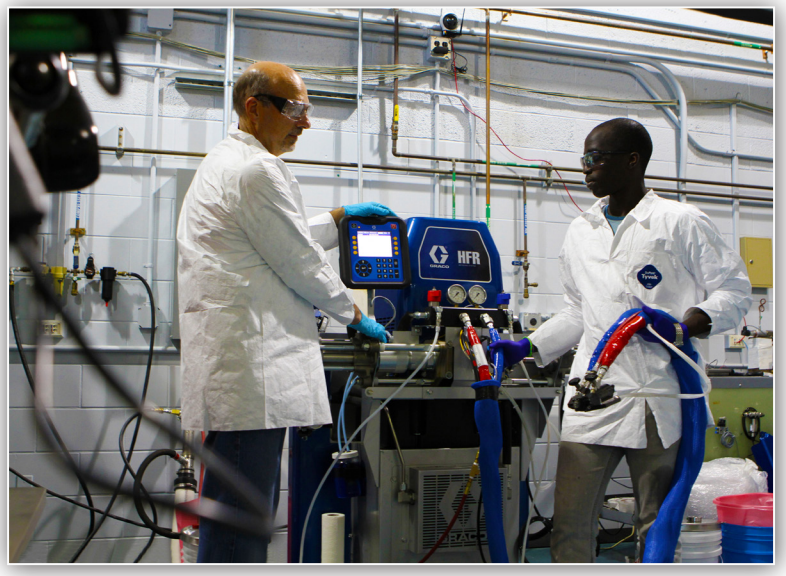
The AMP workcell is being used to conduct novel research on ATL/AFP processing. The system is designed to be flexible for research purposes, modular for multiple projects, and adaptive as new materials and processing techniques emerge. Current modules include two rollers, high-energy IR, induction and a spray bagging system. An IR camera mounted on the system is used for temperature measurement and process control. The system can be used to evaluate processing thermoplastic and thermoset (OOA) materials as well as dry fabric and metal-matrix composites.

TOP STORY (Continued)

SC6100 and A615 IR Cameras

CCM recently purchased two FLIR cameras for temperature measurement and control: the science grade SC6100 IR camera and the industrial grade A615 system. The SC6100 camera with microscope attachment provides high-speed (35kHz) and high-resolution (640x512) MWIR imagery and can also be used for IR thermography. The system features a 50-megapixel clock that streams 14-bit digital data at up to 126 Hz in full resolution. The A615 camera is used for process monitoring, automation, and control.





Hydraulic Meter Mixer

The recently acquired hydraulic meter mixer from Graco is part of a system that allows the development of automated new manufacturing composites such as spray-on bagging. This significant acquisition allows CCM to showcase its goal of adapting and developing the newest composites processing methods.

TOP STORY (Continued)

SkyScan 1172 Micro CT Scanner

This scanner features µm–resolution 3D images, allowing nondestructive evaluation of composite materials. The system is currently used to evaluate microstructural changes during composite processing, locate fiber in complex 3D fabrics, and detect internal damage such as cracks and fiber breakage. The system also allows the integration of a heat and mechanical stage to actuate the sample. It offers a novel tool for students, staff and industrial partners to provide insight into the composite microstructure without the time-consuming effort needed for standard microscopy.

High Capacity Impact Tower

A custom-built high-energy drop tower system is being used to test thick composite panels, fastener assemblies, and other components of vehicle structures. The tower provides up to 37kJ of impact energy over an open (10ftx12ft) test floor and has a movable test fixture for multi-impact (durability) and damage tolerance testing. The system also has built-in lighting and isolated camera extension cranes for full-field DIC (Digital Image Correlation) analysis.

TOP STORY (Continued)

T A Instruments Discovery Hybrid Rheometer

This new rheometer utilizes magnetic bearings, which greatly increases the sensitivity in measurement of torque, compared to the traditional air bearing design. The system can measure viscosities at temperatures in excess of 300°C and at sub-ambient conditions down to liquid nitrogen temperatures. The system can currently carry out cone-and-plate and parallel plate viscosity measurements and can be adapted to other forms of viscosity measurement. The main research application for this instrument is the measurement of polymer resin viscosity as a function of time, temperature, and filler content.temperature, and filler content.

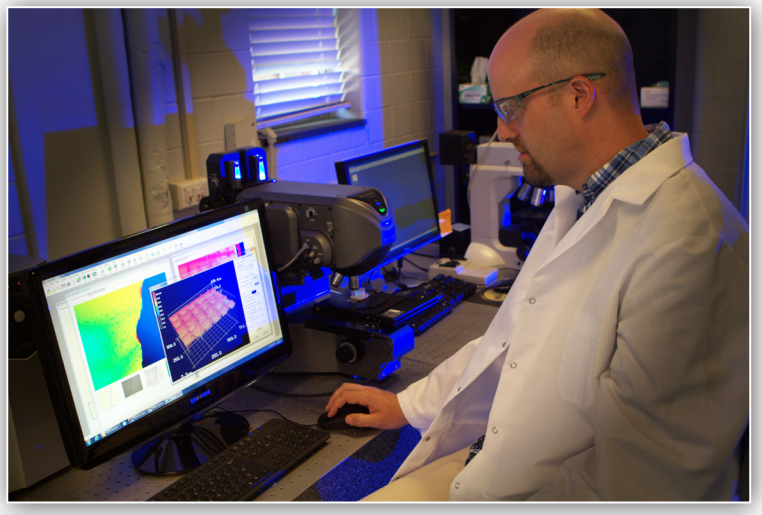
Instron 5985 Testing System

Outfitted with the full ensemble of fixtures, grips and T-slot base, this system has a capacity of 250kN.

TOP STORY (Continued)

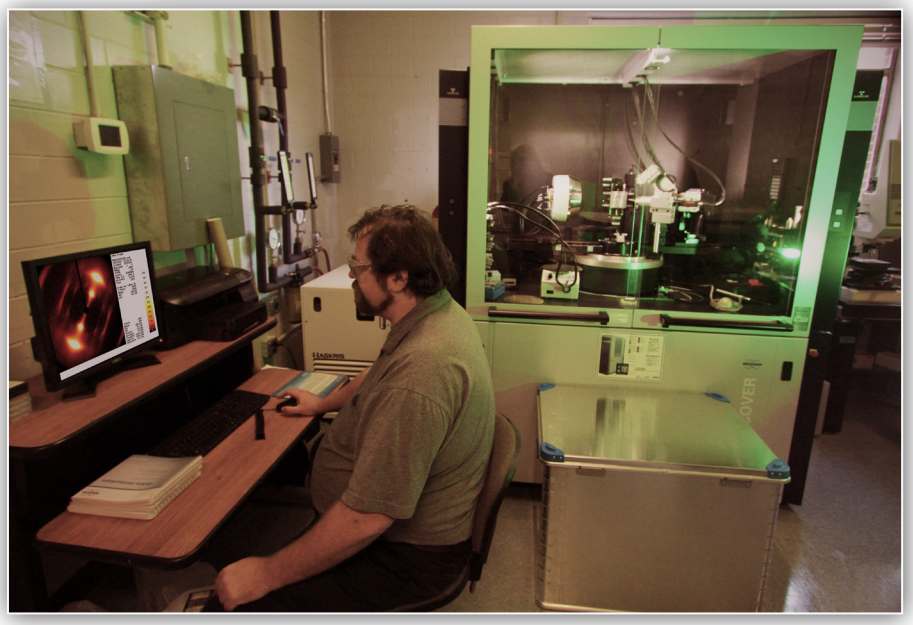
VK-X200 3D Color Laser Scanning Microscope

This microscope is used to capture high-resolution color images with nanometer-level profile and film measurement functions. The system provides 0.5-nm z-axis resolution on almost any material with 7-mm depth of field and is ISO 25178 compliant. The system is used extensively for accurate void and surface topography measurements as well as particle size distribution and crack and fiber filament analysis.



Bruker D8 Discover 2 dimension Wide Angle X-ray Diffraction system (WAXD)

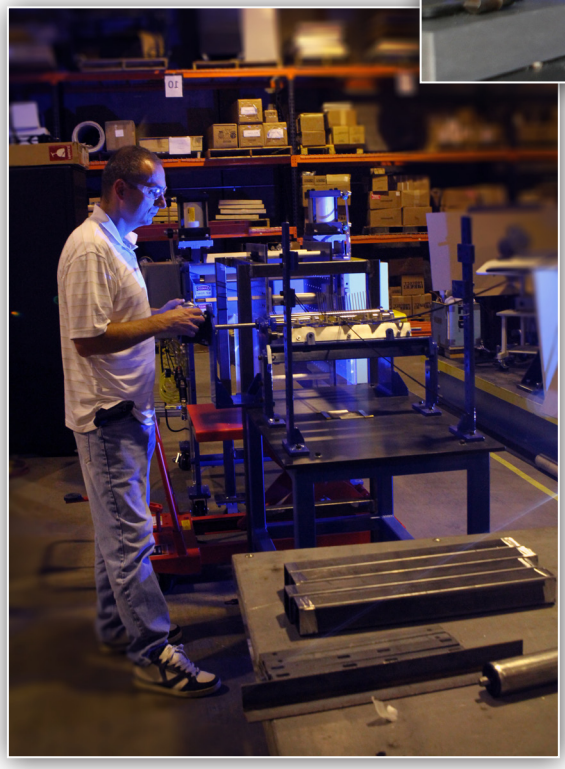
This system has Bruker's newest Vantec 500 area detector, which boasts increased sensitivity and stability compared to the older Hi-Star area detectors. The new system greatly expands UD-CCM's characterization capabilities, enabling the determination of crystal structure in a wide variety of materials including polymers, ceramics, and metals. A major research focus for this facility will be investigation of oriented polymer films and fibers and evaluation of such parameters as degree of crystallinity, degree of crystal orientation, crystallite size, and changes in crystal structure as a function of temperature and mechanical stress.

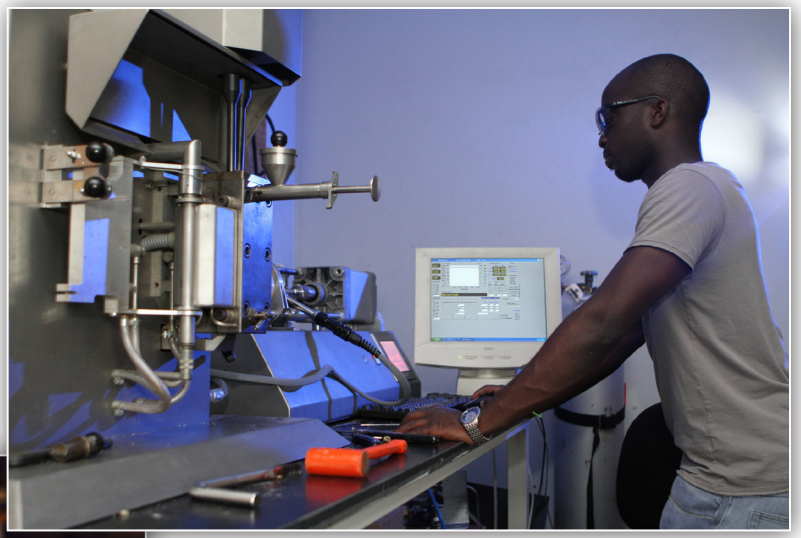


TOP STORY (Continued)

Aqueous Bath Thermoplastic Prepreg Line

This facility addresses the current need for improved processing of high-temperature thermoplastic/carbon fiber materials.





Micro-scale Extrusion and Injection Molding Machine

This machine is capable of producing small batches, 15 cm3 of material, and directly molding ASTM-sized test specimens. This process is ideal for completing studies on thermoplastic nanocomposites and polymer blends.

A Dimension Icon Atomic Force Microscope (AFM)

This microscope was purchased by UD-CCM from the Bruker Corporation, a world leader in AFM. The new AFM will extend UD-CCM's capabilities to explore the multi-scale properties (i.e., mechanical, electrical, topographical, etc.) of materials down to molecular length scales.

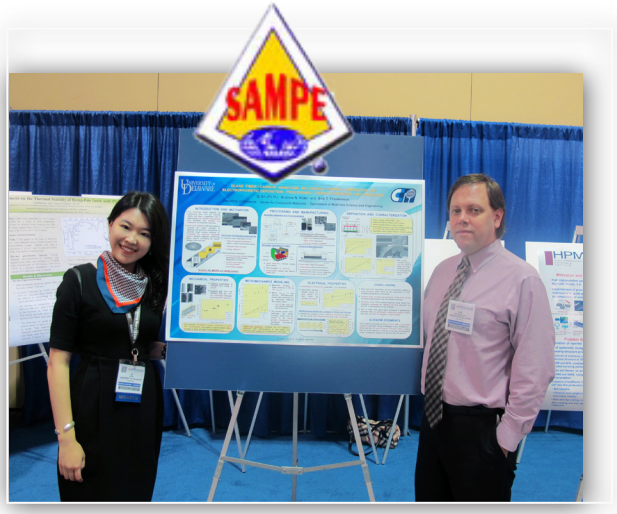
OTHER NEWS (Continued)

CCM Student Wins Grand Prize in SAMPE Competition

Qi An, a third-year Ph.D. student in materials science and engineering, received the first overall ("grand") prize in the student poster competition at the SAMPE Technical Conference held in Charleston, S.C. from October 22-25, 2012.

An, who is affiliated with CCM and advised by assistant professor Erik Thostenson, also presented a paper at the conference. Her research focuses on processing and characterization of nanotube/fiber hybrid composites.

The SAMPE competition, which was held this fall for the first time, included 32 posters from 20 universities around the country. Posters were judged based on the depth of technical content, relevance to composite materials and their processing, and effective presentation.



Qi An (PhDMSE) and Asst Prof Erik Thostenson

Position Available

CCM is hiring a **POSTDOCTORAL RESEARCHER** in the area of electrical conductivity modeling of carbon composites. Qualifications include a PhD in engineering or related field with an emphasis in electrical engineering and/or composites. Research work will be aimed at the development of a modeling foundation to capture the fundamental electrical transport mechanisms for CFRP materials. The conduction physics will be developed initially for unidirectional prepreg and extended for other material forms. The influence of high electric currents due to lightning strike events will be evaluated. The position requires a good understanding of FEA and multi-physics modeling. Hands on experience in fabricating and testing of composites are also a plus. Good written and oral communication skills; ability to interact effectively with industrial sponsor, as well as other CCM staff and students.

To apply, email cover letter and resume to
Corinne Hamed **hamed@udel.edu**

NEW PUBLICATIONS

Journals

Campanella, A., R.P. Wool, M. Bah, S. Fita, and A. Abuobaid, "**Composites from Northern Red Oak (Quercus robur) Leaves and Plant Oil-Based Resins**," Applied Polymer, DOI: 10.1002/app.36663.

McAllister, Q.P., J.W. Gillespie, Jr., and M.R. VanLandingham, "**Evaluation of the three-dimensional properties of Kevlar across length scales**", J. Mater. Res., 27 (14), pp 1824-1837, 20120.

McAllister, Q.P., J.W. Gillespie, Jr., and M.R. VanLandingham, "**The influence of surface microstructure on the scratch characteristics of Kevlar fibers**" J. Mater. Sci., DOI: 10.1007/s10853-012-6872-6, 2012.

Minnicino, M.A., and Santare, M.H., "**Modeling the Progressive Damage of the Microdroplet Test using Contact Surfaces with Cohesive Behavior**," Composites Science and Technology, 72 (16), p. 2024-31, 2012.

Conferences

Gangloff, Jr., J. J., W. R. Hwang, and S. G. Advani, "**Modeling Void Drainage with Thin Film Dynamics,**" Proceedings of the COMSOL 2012 Conference, Boston, MA., October 3-5,

CONSORTIUM MEMBER NEWS

We would like to thank **CelluForce, Inc.**, Montreal, Canada, and **Dow Electronic Materials**, Newark, DE, for becoming our newest consortium members. We also wish to thank **Composite Sourcing Solutions**, Yardley, PA, **Milliken and Company**, Spartanburg, SC, **Northrop Grumman Aerospace Systems**, El Segundo, CA, **Owens Corning**, Granville, OH, and **Warrior Sports, Inc.**, Warren, MI, for the recent renewal of their memberships and for continuing to participate in our research and development activities.

To learn more about the benefits of becoming a member, please visit us on the web at **www.ccm.udel.edu/Consortium/benefits.html**

Celebrating 38 years of significant contributions to composites science and technology, the education of students, and the creation and transfer of technology to industry.

38th Anniversary

CELEBRATING 38 YEARS OF SIGNIFICANT CONTRIBUTIONS TO SCIENCE AND TECHNOLOGY, THE EDUCATION OF STUDENTS, AND THE CREATION AND TRANSFER OF TECHNOLOGY TO INDUSTRY

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