The custom-designed Automated Materials Placement system promises to change the way new materials are evaluated and new processes are developed at UD's Center for Composite Materials.

CCM Develops New Tool for Materials Processing and Design

The Center for Composite Materials at the University of Delaware has developed a custom research tool for evaluation of new materials and development of novel processing techniques.

University of Delaware
Center for Composite Materials

COMPOSITES UPDATE
SEPTEMBER 2011

Click below to read the UDaily story

http://www.udel.edu/udaily/2012/sep/amp-ccm-090611.html

The Automated Materials Placement (AMP) provides an adaptable, modular, and flexible way to carry out a broad variety of composite processing methods, including thermoset and thermoplastic tape placement, out-of-autoclave processing, in-situ consolidation and cure, automated preform/tackifying/binders, MMC ultrasonic tape placement, and spray-on bag technologies (for additional details, see the "About" section at the end of this story).

According to CCM scientist John Tierney, the AMP system promises to change the way new materials are evaluated and new processes are designed at the Center.

TOP STORY (Continued)

"Conducting research in composites manufacturing is an evolving environment as new materials and processing methods continuously enter the market," he says. "The AMP offers us a 'plug-and-play' approach to assessing new technologies.

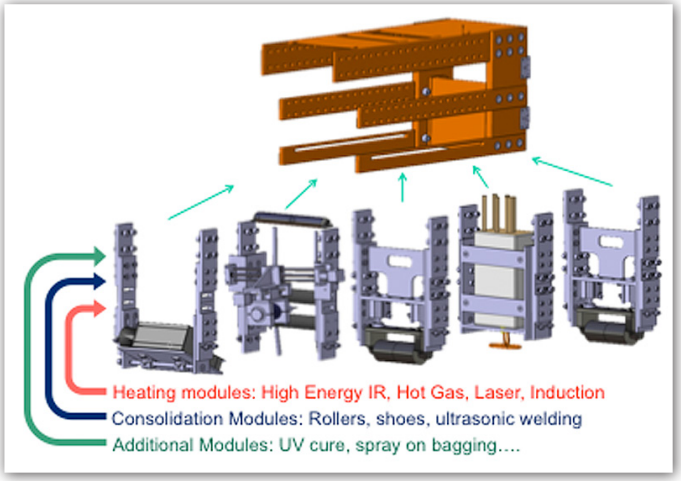
The AMP is configured with swappable modules for various feed systems, heating sources, and consolidation methods through a LEGO®-type connection structure. All of the modules use a common column design, and they all slide out the front of the chassis.

"Process models developed at CCM are used to design new processes and hardware configurations," says Shridhar Yarlagadda, assistant director of research at CCM. "The AMP is then used to validate the models and establish process windows."

"Ideally, our goal is to enable any unit to be changed in under an hour," he adds. "The modular design allows multiple research projects to use the system with little downtime."

CCM director John W. (Jack) Gillespie, Jr. points out that the modular platform allows material, process and new hardware development and optimization prior to locking into final hardware.

"This translates into significant risk reduction for scale-up," Gillespie says. "We're encouraging our industrial partners to use the AMP for their material and product development research."



"This new machine is truly a legacy research tool that builds on all of the previous work we've done on composites design and processing," he continues. "Historically CCM has benefitted from having in-house equipment to aid in working with our industrial and DOD collaborators, and many of the workcells we developed for specific processes in earlier research programs laid the groundwork for this new capability."

TOP STORY (Continued)

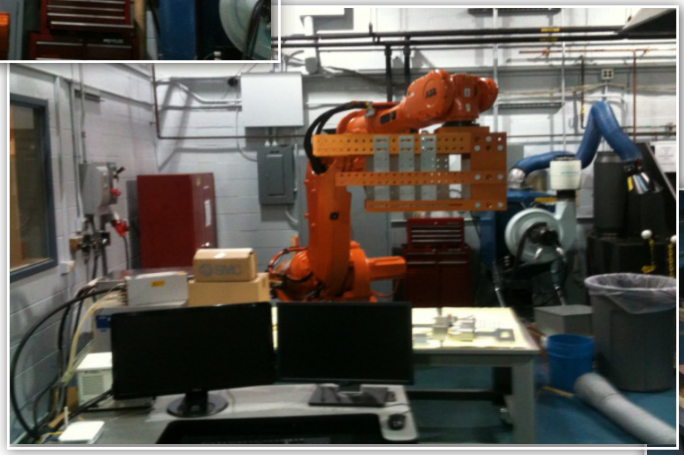
About the Automated Materials Placement (AMP) System

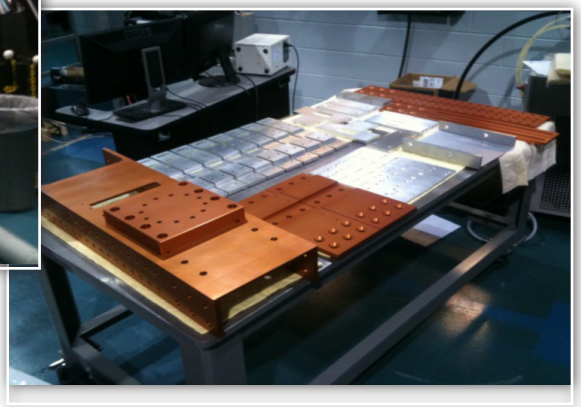
The AMP can process material from ¼" to 8" wide and can fabricate components in excess of 100 square feet. The system is designed to be modular so that various heating and consolidation methods can be studied and optimized with low risk on hardware investment. These flexible modules can be swapped or reordered to include high-energy infrared heating, volumetric induction heating, roller or shoe consolidation, sprayable bagging, ultrasonic welding, powder impregnation, and in-line fabric stitching.

The system is fully instrumented with thermal and modular force measurement capabilities as well as visual inspection and laser position sensors. Detailed design studies can be carried out to compare AMP process temperatures, pressures, and velocities on the final microstructure and the structural performance of a number of composite systems. The system as a whole provides an ideal environment for process design and optimization for a number of industries including aerospace, wind and automotive while generating original research findings for academia.

Article by Diane Kukich

For more information about the AMP, contact John Tierney at 302-831-0548 or jtierney@udel.edu.

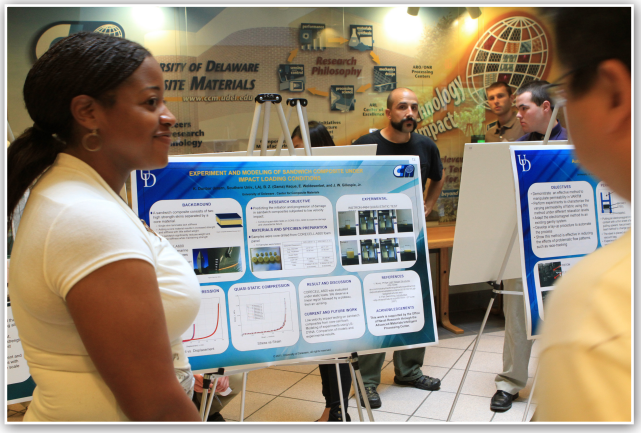




Various AMP Images During Assembly

OTHER NEWS

Southern University Students Spend Summer at CCM



Kayla Dunbar from Southern University, presented her award - winning poster during the 2011 UD CCM Undergraduate Symposium

For almost four decades, CCM has contributed to the education of not only thousands of students from the University of Delaware but hundreds from schools throughout the United States and around the world as well.

During summer 2011, four students from Southern University in Baton Rouge, La., joined those numbers. Three undergrads—Christopher Chambers, Kayla Dunbar, and Derrick Flowers—along with graduate student Lulit Affin spent 10 weeks doing research at the Center.

Their internships were carried out through the Next Generation Composites (NextGenC3) CREST Center at Southern, an HBCU (historically black college and university).

Funded by the National Science Foundation, NextGenC3 conducts basic and applied research in advanced composite materials and provides innovation in the development of next-generation composites. NextGenC3 director Eyassu Woldesenbet is a CCM alum, having earned both master's and doctoral degrees in mechanical engineering at UD, and CCM director Jack Gillespie chairs NextGenC3's external advisory board.

The four students joined the research group of scientist Bazle Haque, working side-by-side with five experienced UD undergrad researchers. "The UD students are so well trained and experienced that they can function like grad students," Haque says. "I began the summer by challenging them to transfer some of their knowledge to their Southern University colleagues."

According to Haque, the strategy worked. "They picked it up and were speaking in the same terminology we use within a very short time," he says. "It was also very valuable to the UD students to serve as mentors."

Derrick Flowers, who is interested in protective equipment for sports, worked on a project addressing glass-phenolic composite processing.

"Working at CCM has had a positive impact on my college career," he says. "I have become more open minded than ever to anything dealing with my mechanical engineering major. The research aspect has given me a feel for grad school as well. The experience has me eager to return next year as well as strongly consider the option to enter graduate school."

OTHER NEWS

Haque credits Chambers with working successfully on a computational project that resulted in co-authorship of a journal paper. In addition, Dunbar won third place in a poster competition at UD's Undergraduate Research and Service Scholar Celebratory Symposium, held on August 10, for her work, "Experiment and Modeling of Sandwich Composites Under Impact Loading Conditions." Dunbar spent last summer at UD as well and is considering returning for a master's degree after she graduates.

Affin, who has a bachelor's degree in chemistry and is working on a master's degree at Southern, conducted independent research on self-healing composites. "She conducted a literature review and wrote a proposal that incorporated novel ideas on this subject," Haque says.

Overall, the summer experience was a positive experience for the entire research group, and Woldesenbet appreciates the opportunities his students were given through CCM.

"The students who intern at UD CCM appreciate the research experience and guidance they received," he says. "Most of these students immediately started to plan and talk about attending graduate school when they came back. We are planning to send students to CCM every summer for the foreseeable future.

Article by Diane Kukich

Tsu-Wei Chou (right), recently named among the top 100 materials scientists of the past decade, and mechanical engineer Erik Thostenson are using nanotubes to detect micro-cracks in

UD Research Magazine Story

Tiny Tubes Track Trouble

Imagine what you could do with a material that is 30 times stronger than high-strength steel, as stiff as diamonds and a thousand times more conductive than copper, yet weighs only half as much as aluminum. While this might sound like the stuff of science fiction, the carbon nanotube actually has all of these properties and more.

Two researchers at the University of Delaware have done more than just imagine what they would do with these tiny cylinders that are about 1/50,000th as wide as a human hair — they have discovered a way to use them in detecting defects and damage in advanced composite structures. The technology is similar to the way the human body signals injury through the nervous system.

The research is the work of Tsu-Wei Chou, Pierre S. du Pont Chair of Engineering, and Erik Thostenson, assistant professor of mechanical engineering. In August 2010, the pair was awarded a patent on the method and system for this application.

The composite materials Chou and Thostenson are working with comprise a polymer matrix reinforced with glass fibers. The difference in strength between the matrix and the fibers can result in areas of weakness at the interface between the two, where tiny microcracks can develop. Over time, the microcracks can grow and threaten the integrity of the composite.

Click here to read entire story in UD Research Magazine.

UDaily Story

UD's Tsu-Wei Chou selected World Fellow of composites

1:32 p.m., Sept. 8, 2011--The University of Delaware's Tsu-Wei Chou, Pierre S. du Pont Chair of Engineering, was recently honored as a World Fellow of composites at the 18th International Conference on Composite Materials (ICCM).

Tsu-Wei Chou, Pierre S. du Pont Chair of Engineering, left, accepts the World Fellow award from Michael Wisnom, president of the Executive Council of the International Committee on Composite Materials.

ICCM, held bi-annually, is the largest international conference in the field of composites. The event, which was held Aug. 21-26 in Jeju, Korea, included nearly 1,600 delegates from 47 countries.

Since 2001, fewer than 20 ICCM members have been honored as World Fellows. Chou was named a life member of ICCM in 2009.

Well-known as an international composites expert, Chou delivered a plenary lecture, entitled "Carbon Nanotube Fibers: Challenges and Opportunities," during the conference. His presentation detailed an assessment of the potential of carbon nanotube fibers to reinforce multi-functional composites.

Chou's own research on carbon nanotube fibers has focused on the characterization and modeling of their performance, as well as applications to multi-functional composites.

The work is funded by the Air Force Office of Scientific Research and the Korean Foundation for International Cooperation of Science and Technology through the Global Research

Laboratory program. Other contributors to this work from mechanical engineering include research associates Weibang Lu and Amanda Wu, who also presented at the conference; and Mei Zu, a visiting scholar conducting research in mechanical engineering and the Center for Composite Materials (CCM) from Tongji University in China.

"Prof. Chou's contributions in the field of composites reinforce the strength and worldwide recognition of the Department of Mechanical Engineering and the Center for Composite Materials," said Anette Karlsson, department chair in mechanical engineering. "The acknowledgement provided by the ICCM is a testimony to his exceptional dedication to research."

Click here to read entire story in UDaily.

NEW AWARDS

Erik Thostenson, a mechanical engineering professor at the University of Delaware

UDaily Story

UD receives grant to enhance infrastructure for nanomaterials research, education

8:53 a.m., Sept. 7, 2011--Nanomaterials are tiny but mighty, offering the potential for use in a vast array of applications from fuel cells to drug delivery systems. Their size—the diameter of a nano-fiber is approximately one-thousandth that of a human hair—underlies both their power and the challenge of harnessing that power.

"Strange things happen when materials get that small," says Erik Thostenson, a mechanical engineering professor at the University of Delaware. "Exploiting the unique properties of nanomaterials requires a highly integrated approach involving scientists and engineers from diverse fields. For engineers to be well versed in nanotechnology, it's crucial to introduce the topic early."

Thostenson is leading a team that recently received a $200,000 grant from the National Science Foundation's Nanotechnology Undergraduate Education (NUE) in Engineering program. The grant will support research-based educational opportunities for undergraduate students in a number of areas, including energy applications and sensing and actuating devices for smart multifunctional materials. UD's Center for Composite Materials will serve as a focal point for active exchange and interaction in the program.

Click here to read the entire story in UDaily
Click here to read details of this award on the NSF website

NEW AWARDS

Collaborators Awarded ESTCP Project of the Year: The Low VOC/HAP Compliant Resins for Military Applications program

Led by Principal Investigator Dr. John La Scala, Chief of Coatings, Corrosion, and Engineered Polymers Branch, Weapons & Materials Research Directorate, Army Research Laboratory, the low HAP team consisted of University of Delaware Center for Composite Materials, Drexel University, the U.S. Naval Surface Warfare Center, Carderock Division, Advanced Composite Office, Red River Army Depot, and Applied Poleramics, Inc.

Dr. John La Scala and his team received the ESTCP Project of the Year award

Dr. La Scala and his colleagues demonstrated and validated low-HAP resins for the manufacture and repair of composite components used in military applications. These components include shelters and hoods for light tactical vehicles for the Army and Marine Corp, composite rudder for the Navy and aircraft canopy covers for the Air Force.

The objective of this project has been to demonstrate and validate low volatile organic compound (VOC) and hazardous air pollutant (HAP) resin technology for Department of Defense (DoD) applications, quantify the impact on facility-wide emissions, and establish cost-savings potential. The military is rapidly moving to increasingly advanced composite materials that offer great advantages over traditional materials such as steel. But as these new lightweight and high performance composite structures are exploited for military applications, the environmental consequences associated with their applications need to be reduced.

Their work has shown that these resin formulations meet the critical military requirements and that the green, low-HAP composites have improved weather ability and durability relative to the baseline composites. These composites will significantly decrease worker exposure during manufacturing and minimize the expense and time associated with managing permits and air pollution recovery units.

PUBLICATIONS

Journals

Nilakantan, G., M. Keefe, E. D. Wetzel, T. A. Bogetti, J. W. Gillespie, Jr., **"Computational Modeling of the Probabilistic Impact Response of Flexible Fabrics,"** Composite Structures, 93, pp. 3163-3174, 2011.

Nilakantan, G., A. Abu Obaid, M. Keefe and J. W. Gillespie, Jr., "**Experimental evaluation and statistical characterization of the strength and strain energy density distribution of Kevlar KM2 yarns: exploring length-scale and weaving effects**," Journal of Composite Materials, 2011 45: 1749 originally published online 8 November 2010

Conferences

McAllister, Q., G. Stan, J. W. Gillespie, Jr., and M. R. VanLandingham, **"The Elastic-Plastic Local Contact Response of Composite Constitutive Fibers,"** The 26th ASC Technical Conference (The Second Joint US-Canada Conference on Composites), Montreal, Quebec, Canada, September 26-28, 2011.

Chowdhury, S. C., B. Z. (Gama) Haque, D. R. Hartman, and J. W. Gillespie, Jr., **"Molecular Dynamics Simulation of Carbon Nanotubes under Combined Loading,"** The 26th ASC Technical Conference (The Second Joint US-Canada Conference on Composites), Montreal, Quebec, Canada, September 26-28, 2011.

NEWS

CONSORTIUM

We wish to thank **BASF-The Chemical Company,** Florham Park, NJ, and **AC Wind-Salisbury, LLC**, Salisbury, MD, for becoming our newest consortium member. We would also like to thank **Alliant Techsystems**, Rocket Center WV, and **Composite Sourcing Solutions**, Tardley, PA, for the recent renewal of their memberships, and for continuing to participate in CCM's 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 35 years of significant contributions to composites science and technology, the education of students, and the creation and transfer of technology to industry.

35th Anniversary CELEBRATION
1974-2009

This is a newsletter publication of the University of Delaware Center for Composite Materials
Please visit us on the web at **http://www.ccm.udel.edu**

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