

UD-CCM Assistant Director Dr. Dirk Heider (right) discusses the significant improvement of through-thickness thermal conductivity with German visiting students Martin-Christopher Noll and (left) and Christopher Lenz (center).



International partnership may yield breakthroughs in 3-D composites

Advanced composites offer a wide array of benefits, but thermal conductivity is not one of them. Now, a partnership between the University of Delaware Center for Composite Materials and the Institute for Textile Technology at the University of Aachen, Germany (ITA) may help engineers tailor this property into 3-D polymer composites.

Funded by a three-year \$367,000 grant from the National Science Foundation (NSF), the work has potential use in heat exchangers and other applications requiring the dissipation of heat and/or energy. Equivalent matching funds for the project were provided by NSF's German counterpart, Deutsche Forschungsgemeinschaft (DFG) for the ITA Institute.

"Unidirectional or laminated 2-D composites are often not suitable in areas where heat is generated due to their limited thermal conductivity perpendicular to the direction of the fibers," explains co-PI Dirk Heider, Assistant Director of CCM and Associate Professor in the Department of Electrical and Computer Engineering at UD.

"Here, heat must traverse polymer-rich interlaminar regions with relatively low thermal conductivity and must also pass through several fiber-matrix interfaces. The result is an out-of-plane thermal conductivity that is two to three orders of magnitude smaller than in the in-plane direction."

TOP STORY (Continued)

Heider's co-PI at UD is Suresh Advani, Associate Director of CCM and George W. Laird Professor of Mechanical Engineering. The two are collaborating with Michael Glowania and Thomas Gries from ITA.

The research is aimed at exploring and characterizing the thermal transport mechanisms when highly conductive fibers are integrated perpendicular to the surface into 2-D composites, their arrangement for enhanced out-of-plane thermal conductivity, manufacturing issues associated with processing this class of composites, and experimental validation of the developed fundamental understanding. The material behavior will also be evaluated when integrated with thermally conductive matrix systems and/or conductive surfaces.

According to Heider, the two academic institutions bring highly complementary resources to the project, with ITA providing the fiber and textile expertise and CCM offering materials design, processing, and characterization capabilities.

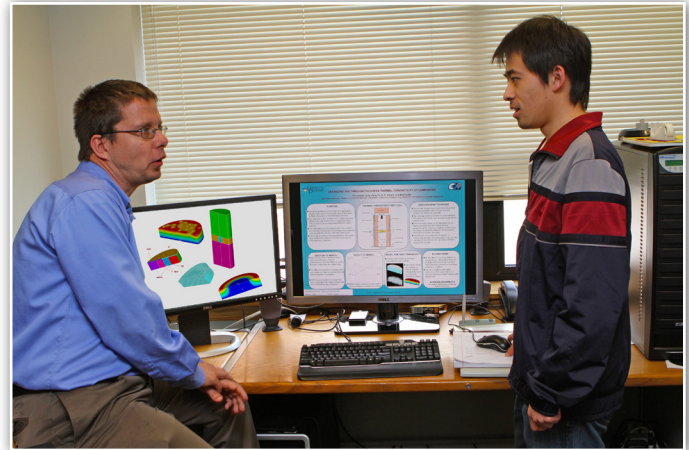
The grant includes an active international exchange component, enabling students from each country to spend time doing research in the other. Chris Lenz, who is working on a master's degree at ITA, recently finished a five-month stint at CCM conducting experimental work for his thesis.

"I enjoyed my whole time here," he said on his last day at the Center. "Whenever I needed help of any kind, there was someone at CCM to answer my questions. At the same time, though, I was allowed to work independently and make decisions on my own, which was a very valuable experience for me."

"I spent six months at CCM myself when I worked on my diploma thesis," says Glowania, who is head of the prepregging research group in the Department for Fibre-Reinforced Composites at ITA. "This research activity is the foundation for the transatlantic cooperation that brings together the best from the two sides of composites – fibers and matrix."

"In an increasingly connected world, it's wonderful to be able to offer students international experience like this," says Advani. "They have the chance not only to work with researchers from another country but also to gain knowledge from a world leader in a related field."

By Diane Kukich



UD-CCM student Hang Yu investigates the fundamental heat transfer of 3-D composites.

OTHER NEWS

Center hosts multinational group during TTCP meeting

On March 4, 2011, the University of Delaware Center for Composite Materials hosted a half-day program for an international contingent of scientists and engineers in conjunction with a TTCP meeting held by the U.S. Army Research Laboratory at Aberdeen, Maryland.

The Technical Cooperation Program (TTCP) is an international organization that collaborates in defense scientific and technical information exchange, program harmonization and alignment, and shared research activities for five nations: Australia, Canada, New Zealand, the United Kingdom, and the United States.

Meetings are hosted by the participants on a rotating basis. This year's event at ARL was coordinated by Dr. James Sands, team leader for the Emerging Materials and Processing Composites and Hybrids Branch, with support from Dr. Roger Crane, senior composites engineer in the Advanced Materials and Structures Branch at the Naval Surface Warfare Center-Carver Division.



**TTCP Attendees****Front row:**

Garry Wells (DSTL), David Mollenhauer (AFRL), Jack Gillespie (CCM), Royale Underhill (DDRC), Ray Meilunas (NAVAIR), Maureen Foley (NSWCCD), Dirk Heider (CCM)

Back row: James Sands (ARL), Andrew Johnston (Nat. Research Council Canada), Thomas Plaisted, USARL, Roger Crane (NSWCCD), Paul Curtis (DSTL), Paul Callus (DSTO), Joseph Deitzel (ccm), Gaurav Nilakanthan (CCM)

Center researchers shared ongoing work in five technology areas:

- Composite performance and long-term durability
- Smart and multifunctional materials and structures and emerging composite technologies
- Composites processing
- Impact performance
- Joining technology and repair

“We chose to include CCM on the agenda because it’s a local academic institution that does significant research for the government,” Crane said. “The visit gave us an opportunity to share this work with the other countries in the TTCP. It gives them a chance to see what CCM is doing and opens the door for new collaboration between UD and our global partners. The connections established through this program benefit everyone.”

Crane noted that CCM’s outstanding capabilities for technology transition were of particular interest to the group.

By Diane Kukich

OTHER NEWS

UDaily Story

CCM Participates in UD Day in Washington D.C.

8:13 a.m., March 16, 2011----A group of University of Delaware faculty, administrators and students packed their prototypes, their posters, their interactive displays and their UDairy ice cream and brought them all on a quick trip down Interstate 95.

The people and their displays became a showcase of UD's federally funded research projects on Capitol Hill at UD Day in Washington, D.C., on March 8. Invited guests included alumni, staffers representing several congressional offices and federal program officials representing the National Science Foundation and the Department of Defense, as well as Delaware's congressional delegation. Delaware's U.S. senators, Tom Carper and Chris Coons, and congressman, John Carney, all commented on UD's research prowess.



UD-CCM Attendees (from left): Dirk Heider, Shridhar Yarlagadda, Jack Gillespie, Mike Kubota, John Gangloff, Sarah Friedrich and Cedric Jacob

[View a slideshow of the event](#)

“The University of Delaware really is a world-class research university,” Coons said. “I am a big believer in the power of innovation and invention to solve the problems that face not just America but the entire world.”

With federal lawmakers working to cut spending in the nation's budget, research could suffer funding reductions. UD sought to display the value of federal funding in projects happening across campus. Last year, UD conducted \$120 million of sponsored research, more than \$90 million of which was funded by federal agencies.

Carney said he sees the value in funding research.

“You can't cut the things that are going to provide the economic opportunities of the future and that's the sciences and technology,” he said

[Click here to read full story in UDaily.](#)

OTHER NEWS

UDaily Story

MSNBC news program to feature ACRES hydrogen storage research

2:17 p.m., March 29, 2011----MSNBC came to campus asking questions about the future of energy.

Dylan Ratigan, host of The Dylan Ratigan Show, and a television crew taped a segment on the [University of Delaware's Affordable Composites from Renewable Sources \(ACRES\) program](#). Chemical engineering doctoral student Erman Senoz detailed in an interview how the research group uses chicken feathers to store hydrogen for use in cars, buses and other forms of transport.

[Click here to read full story in UDaily.](#)

Photo courtesy of UDaily



Erman Senoz, a UD doctoral student, and Dylan Ratigan with the MSNBC camera crew.

NEW PUBLICATIONS

Conferences

Thostenson, E. T., "Carbon Nanotube-Based Multifunctional Composites, SPE Polymer Nanocomposites Conference, Lehigh University, Bethlehem, PA, March 7-9, 2011.

Varischetti, J., University of Nevada, Reno; J-S. Jang and J. Suhr, University of Delaware, "Strain Dependent Visco-Elastic Response of CNFs Reinforced Epoxy Composites," SPIE Smart Structures/NDE 2011 – Behavior and Mechanics of Multifunctional Materials and Composites V, San Diego, California, March 6-10, 2011.

Kim, Y-I, University of Delaware; E-C. Kang, Sauer-Danfoss-Dailing Ltd. (Korea, Republic of); J-S. Jang and J. Suhr, University of Delaware, " Spherically Shaped Micron-Size Particles Reinforced PC and PMMA Composites for Improving Energy Absorption Capability," SPIE Smart Structures/NDE 2011 – Behavior and Mechanics of Multifunctional Materials and Composites V, San Diego, California, March 6-10, 2011.

PUBLICATIONS

NEW

Journals

Alfredsson, K. S., A. A. Gawandi, J. W. Gillespie, Jr., L. A. Carlsson, and R. A. Bogetti, "Stress Analysis of Axially and Thermally Loaded Discontinuous Tile Core Sandwich With and Without Adhesive Filled Core Gaps," *Composite Structures*, doi:10.1016/j.compstruct.2011.01.015

Gawandi, A., E. T. Thostenson, and J. W. Gillespie, Jr., "Tow Pullout Behavior of Polymer-Coated Kevlar Fabric," *Journal of Materials Science*, Volume 46, Number 1, 77-89, DOI: 10.1007/s10853-010-4819-

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*, November 8, 2010, doi: 10.1177/0021998310387667.

Manzella, A. F., B. A. Gama, and J. W. Gillespie, Jr., "Effect of Punch and Specimen Dimensions on the Confined Compression Behavior of S-2 Glass/Epoxy Composites," *Composite Structures*, published on-line 2/20/11 – <http://dx.doi.org/10.1016/j.compstruct.2010.11.006>.

Gama, B. A. and J. W. Gillespie, Jr., "Finite Element Modeling of Impact, Damage Evolution and Penetration of Thick-Section Composites," *International Journal of Impact Engineering*, submitted October 2009, doi:10.1016/j.ijimpeng.2010.11.001.

Abu Obaid, A., J. M. Deitzel, J. W. Gillespie, Jr. and J. Q. Zheng, "The Effects of Environmental Conditioning on Tensile Properties of High Performance Aramid Fibers at Near-Ambient Temperatures," *Journal of Composite Materials*, July 2010, doi: 10.1177/0021998310381436

Yoon, M. K., D. Heider, and J. W. Gillespie, Jr., "Local Damage Detection with the Global Fitting Method using Operating Deflection Shape Data," *Journal of Nondestructive Evaluation*, 29 (1), pp. 23-37, March 2010.

Lopatnikov, S. and J. W. Gillespie, Jr., "Poroelasticity – I: Governing Equations of the Mechanics of Fluid-Saturated Porous Materials," *Transport in Porous Media*, DOI 10.1007/s11242-010-9515-x, January 28, 2010.

CONSORTIUM MEMBERS

We would like to thank **Hyundai Motor Company**, Jeonbuk, Republic of Korea, for becoming our newest consortium member. We would also like to thank **Honeywell Aerospace Advanced Technology**, Morristown, NJ, **Kubota Research Associates, Inc.**, Hockessin, DE, and **V System Composites, Inc.**, San Diego, CA, for renewing their memberships and continuing to participate in CCM's research and development activities.

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*Celebrating 35 years of
significant
contributions to
composites science and
technology, the
education of students,
and the creation and
transfer of technology to
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