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# UMass Amherst Nanotechnology Center Receives $20 Million Renewal of Federal Grant to Boost Advanced Manufacturing, Economic Growth

***Massachusetts Industries are Key Partners in Applying Emerging Technologies***

AMHERST, Mass. – The University of Massachusetts Amherst has received a five-year, $20 million grant from the National Science Foundation (NSF) to support a national research center on nanomanufacturing. The grant will fund the university's Center for Hierarchical Manufacturing (CHM). A signature CHM effort is focused on roll-to-roll nanoscale processing of flexible electronics and high technology devices such as solar cells, cell phone displays, batteries and sensors. Roll-to-roll processing is similar to how photographic film moves through a camera from one spindle to another or how newspapers are printed, but with chemical and physical processing in between.

This is the second round of NSF funding for the center. The center works closely with private industry seeking to boost their business and the Massachusetts economy by tapping into the advanced technology generated and refined by the center. The center received a $16 million federal grant and $7 million in state matching funds when it was created in 2006.

UMass Chancellor Robert C. Holub, Eric T. Nakajima of the state's executive Office of Housing and Economic Development, and industry executives James M. Casey from FLEXcon of Spencer, and Michael D. McCreary of E Ink of Cambridge, attended today's grant announcement at the Conte Polymer Research Center. Under the grant the center will concentrate its efforts on its new Roll-to-Roll (R2R) Process Facility for Nanomanufacturing. Working with Carpe Diem Technologies of Franklin, CHM scientists have developed a custom manufacturing laboratory to scale-up and integrate nanoimprint patterning and coating of self-assembling materials onto a high-speed web.

The CHM specializes in the science and engineering of creating nanometer-scale structures—thousands of times smaller than the width of a human hair—as building blocks for manufacturing device components and systems. Initial work at the center has concentrated on how nanoscale structures can be engineered from polymers for applications in precision microelectronics, focusing primarily on silicon-wafer based computer chip technology. With the new grant, the CHM will turn its attention to a large-volume, low-cost, roll-to-roll manufacturing processes currently used in the advanced printing, coating and flexible electronics industries.

CHM director James Watkins, a faculty member in polymer science and engineering, says, "Massachusetts has a rich history in papermaking, printing and coating technologies. We'd like to design tools and processes that are as close as possible to the roll-to-roll platforms that area companies are familiar with. This approach has the potential for terrific synergy with local industry and the possibility of creating advanced manufacturing jobs that are anchored in the region."

Michael F. Malone, vice chancellor for research and engagement, says having an impact on advanced manufacturing is aligned with UMass Amherst's desire to promote innovation and applied research in collaboration with industry. “The new experimental facility we are announcing with the award of this grant will enable companies to explore these emerging nanomanufacturing methods with us and to be part of the innovation process within the growing field of printed electronics.”

Watkins is convinced that cost-effective manufacturing of nanotechnology-enabled products and materials is critical for American manufacturing competitiveness in sectors such as energy generation and storage, chemical separations, flexible displays and electronics, and sensors. “Nanotechnology can lead to significant performance enhancements in each of these areas, but keeping costs down is a number one concern for many kinds of products,” he said. “By designing new ways to mass-produce high-technology devices cheaply and quickly, we hope to allow innovations that can benefit society to move more rapidly from the laboratory into real products. That’s really the value this center provides.”

Because the objective of roll-to-roll is to get around expensive top-down processing techniques commonly employed in the semiconductor industry, the CHM focuses on the design of devices that make sense for these assembly techniques. Mark Tuominen, a physics faculty member who co-directs the CHM, notes that the process can create structures that actually exhibit new behavior. “Our devices are often designed to exploit the unique character of the materials produced,” he says.

The university’s top-rated polymer science and engineering program leads the CHM’s multi-disciplinary approach to nanotechnology and advanced manufacturing. Other partners on the grant include the Massachusetts Institute of Technology (MIT), the National Institute of Standards and Technology (NIST), Rice University, University of Michigan, University of Puerto Rico Rio Piedras, University of Indiana and Mount Holyoke College. The CHM is designated by the NSF as one of the elite Nanoscale Science and Engineering Centers in the U.S.

With a roll-to-roll based manufacturing system capable of generating literally billions of individual electronic devices every minute, accuracy and quality are of prime importance. The role of NIST and MIT in the center involves the development of measurement techniques to control manufacturing processes at the nanoscale.

The core technology of the center is based on chemical methods for synthesizing ordered hybrid materials, nanoscale templates and patterns, primarily out of polymers. The polymers are designed to “self-assemble,” spontaneously organizing into specified nanoscale structures upon simple coating from solution. Processes like this, which scientists at UMass Amherst including Professor Tom Russell have pioneered since the 1990s for applications in precision electronics, result in “massively parallel” arrays of precisely designed nanostructures. These approaches are now being extended to multi-component, functional hybrid materials and will be combined with nanoimprint lithography (NIL) to build devices on flexible substrates. NIL technology provides a means of printing or embossing nanoscale features on a moving web that can serve as part of the device or be used in a process to pattern the device. NIL is a direct link to the roll-to-roll manufacturing line moving at speeds of up to meters per minute.

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