NANOTECHNOLOGY AT UMASS AMHERST

The University of Massachusetts Amherst is a significant player in interdisciplinary research in nanoscale particles, materials, devices, and systems. Its scientists and engineers have built an impressive track record at the frontier of the super-small. Nanotechnology research from UMass labs has implications in such areas as enhanced computer memory, microelectronic device fabrication, ultra-fine resolution on computer and television screens, ultra-selective and sensitive sensors, small-scale optical devices, and environmentally friendly petrochemical processes.

Research Performance

Since 1997, UMass Amherst scientists have received over $36 million in highly competitive nanotechnology research funding from sources such as the National Science Foundation, Dept. of Defense, Dept. of Energy, National Institutes of Health, NASA, and industry. The university's research projects include four NSF Nanoscale Interdisciplinary Research Team (NIRT) awards, a Multidisciplinary University Research Initiative (MURI) project, and an NSF IGERT Program on nanoscale device development. The Materials Research Science and Engineering Center (MRSEC) on Polymers provides a strong focus on nanostructured materials.

Over 50 faculty investigators from 8 departments conduct research in nanoscale science and engineering. The university's MassNanoTech Institute (www.umass.edu/massnanotech) coordinates larger scale efforts, fosters partnerships, and provides a consortium program for industry participation. A similar consortium program in the Polymer Science & Engineering area features industry engagement in nanostructured polymer-based materials. Infrastructure includes outstanding characterization facilities and a growing base of nanofabrication tools. Current UMass Amherst directions in nano/micro technology include nanomanufacturing, nanoelectronic devices, biomaterials, and energy applications.

	Nanoscale Materials and Processes	Nanoscale Electronic Devices	Bionanotechnology
Study Areas	• Molecular Self Assembly • Nanoparticles • Materials Deposition • Templating Nanostructures • Supercritical Fluid Processing • Micro/Mesoporous Materials • Micro/Nanomechanics	• Integrated Nanofabrication • Nanomagnetics • Organic Electronics • Nanoelectronic Architectures • Electrochemical Nanosystems • Thermoelectric Devices	• Biological • Biomaterials • Physics/Engineering • Synthesis
Applications	• Microelectronic Devices • Data Storage • NEMS/MEMS • Microfluidics • Fuel Cells • Catalysis/Separations	• Data Storage and Processing • Energy Conversion Devices • Battery Technology • Physical Sensors • Thermoelectric Devices • Display Technology	• Biomarkers/Biosensors • Drug Delivery • Therapeutics • Tissue Engineering / Medical Materials • Food Products

Nanomanufacturing

A new research focus at UMass Amherst is nanomanufacturing: tools and processes for engineering, fabricating, assembling and integrating nanoscale materials and particles into larger-scale structures, devices, and systems. Patterned self-assembly of polymer-based materials is a core competency at UMass Amherst, leading to various routes for nanoscale device fabrication. UMass Amherst is working with companies on the development of industry-tested nanomanufacturing methods and techniques. Major technical capabilities in nanomanufacturing include:

- Ordered arrays over large areas in block copolymers (BCP)
- Imprint lithography with new materials
- Stable 3-D nanoporous structures
- BCP tissue engineering scaffolds
- Functional surfaces, particles and device layers
- Nanoscale device design

Nanomanufacturing Applications-Oriented Projects

- 3-D nanoscale capacitors for memory devices
- BCP arrays for nonmagnetic data storage
- 3-D mesoporous structures including ultra-low dielectric constant films
- Imprint lithography for devices
- Next-generation photovoltaics
- Nanostructured hydrogels for tissue engineering
- Nanoscale circuitry
- Nanoparticles for cancer therapy
- Other emerging projects

Laboratory Resources

- Keck Foundation Nanostructures Laboratory
- Keck Microscopy Laboratory
- Surface Analysis Laboratory
- Nanophysics Materials and Device Laboratory
- Semiconductor VSLI Device Fabrication Facility
- Nanoimprint Lithography Lab *(new in 2006)*
- Shared Experimental Laboratories of the MRSEC on Polymers include computing, molecular weight, x-ray, NMR, optical microscopy, rheology, surface science, and spectroscopy.

Technology and Collaborative R&D

Patents and Licensing: The first block copolymer templates for the fabrication of nanostructures were developed at the UMass Amherst. Today, 25 UMass Amherst nano/micro technologies are available for licensing through the Office of Commercial Ventures and Intellectual Property (http://amherst.cvip-umass.net)

MassNanoTech Partners: UMass Amherst operates an industry affiliates program for nanotechnology, connected to the MassNanoTech academic research center. Companies joining MassNanoTech Partners benefit through early access to potentially commercializable research underway in the program's three Technical Research Groups: Nanoscale Materials and Processes, Nanoscale Electronic Devices, and Bionanotechnology. (www.umass.edu/massnanotech)

Polymer Research: In addition to the MassNanoTech center and the MassNanoTech Partners consortium, the Center for UMass-Industry Research on Polymers (CUMIRP) features an industry-supported Nanoscopic Structures research cluster focusing on the generation and fabrication of polymer-based nanostructured materials through molecular design, synthesis and characterization of block copolymers, hybrid polymers and functionalized nanoparticles (www.pse.umass.edu/cumirp).

Education

208 graduate students and 62 undergraduates are currently conducting research in nanotechnology. The interdisciplinary doctoral traineeship program "IGERT: Research and Innovation in Nanoscale Device Development" received five-year funding from the National Science Foundation in July 2005. This program, focusing on the progression of nanoscale science and engineering from the laboratory to commercialized products, involves students and faculty from six disciplines: Chemical Engineering, Chemistry, Electrical & Computer Engineering, Mechanical & Industrial Engineering, Physics, and Polymer Science & Engineering. Four to five new IGERT Fellows per year are funded in the program with $30,000 two-year stipends.

Contact

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