

RESEARCH CLUSTER N: Nanostructured Materials

Cluster Co-Leaders: Kenneth Carter and Ryan Hayward

Overview

Cluster N research focuses on the preparation and characterization of polymer-based nanostructured materials, including composites and films or coatings. Expertise and interests include molecular design and synthesis of polymers and nanoparticles, self- and directed-assembly of complex nanostructures, characterization of unique structures and properties of nanoscale materials, and development of state-of-the-art approaches to nanolithography. The combination of polymers and nanoparticles into hierarchically organized materials with precisely controlled structures provides unprecedented opportunities to tailor specific properties ranging from mechanical to magnetic to optical. The research areas of this cluster include: photonics, membranes (separations or selective transport), magnetic storage, electronics, optoelectronics, displays, sensors, energy (harvesting and storage), nanomedicine, and adaptive or self-healing materials.

Micro- and nano-patterned surfaces

Cluster researchers have developed a wide range of scalable approaches to fabricate micro- and nano-patterned surfaces that include templated block copolymer assembly, surface buckling instabilities and advanced nanolithography methods. Targeted applications include super-hydrophobic and super-oleophobic surfaces, anti-fogging and anti-icing materials, nanotube and grapheme based sensors and devices, magnetic memory devices and adhesives with tailored properties.

Photonic materials

Using approaches based on self-assembly, mechanical instabilities and multi-layer fabrication, Cluster researchers have established new routes to 1-, 2-, and 3-D photonic materials that yield robust structural color. Application areas of interest include sensors and displays, materials with adaptive coloration, negative index materials and advanced anti-reflective structures.

Nanocomposites

Controlling the level of aggregation or dispersion of nanoparticles in polymer matrices and blends is critical for tailoring the properties of polymer nanocomposites. Cluster researchers have developed new methods to tune particle dispersion and assembly, with particular emphasis on designing materials with high dielectric constant/refractive index, advantageous mechanical reinforcement, desired opto-electronic characteristics, and self-healing/adaptive properties.

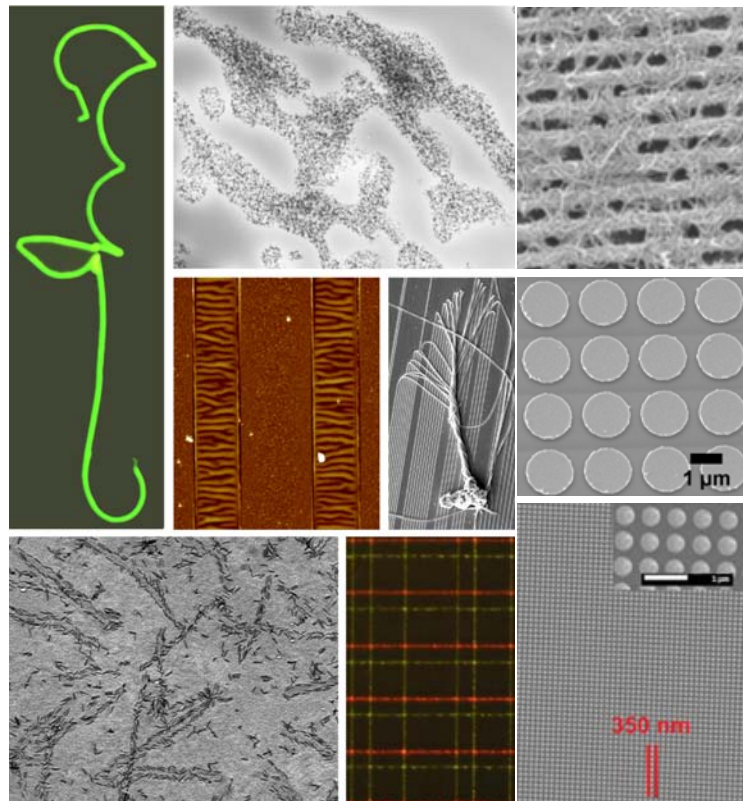
Polymer membranes

Cluster researchers have developed new approaches to structured and porous polymer membranes with precisely controlled nanoscale dimensions and structures. Such membrane materials are of potential interest for applications related to selective and switchable permeability, barrier films, water filtration, non-fouling separation membranes, as well as selective charge transport layers.

World-class characterization facilities

The UMass Amherst campus provides access to an extensive suite of instruments for advanced characterization of nanoscale structures, including X-ray Scattering, scanning probe Microscopy, Electron Microscopy, and super-resolution Optical Microscopy. Recent acquisitions include the FEI Magellan 400 SEM, providing high resolution at low accelerating voltages, EBSD and EDX, and a JEOL JEM-2200FS TEM featuring in-column energy filtering for element-specific imaging and EELS, electron tomographic capabilities, and cryogenic sample holders.

Cluster N also connects industry to nanotechnology research efforts within several departments, including Polymer Science and Engineering, Chemistry, and Physics as well as multi-investigator Centers at UMass such as the NSF Materials Research Science and Engineering Center (MRSEC), the Center for Hierarchical Manufacturing – an NSF Nanotechnology Science and Engineering Center (NSEC), and the DOE Energy Frontier Research Center - Polymer-Based Materials for Harvesting Solar Energy (PHaSE).



Unique nanostructured materials fabricated by Cluster N researchers include crosslinked NP fibers (top left) and grids (bottom center), jammed bicontinuous polymer/NP blends (top center), wrinkled imprinted films (center left), hybrid organic/inorganic fibrils (lower left), CNT sensor elements (top right), photonic structures (center far right and bottom right) and electrodeposited wires within nanoimprinted templates (center right).

Contact Information

To participate in a CUMIRP Part I research cluster please contact:

Center for UMass / Industry Research on Polymers
University of Massachusetts Amherst
Silvio O. Conte Center for Polymer Research
120 Governors Drive
Amherst, MA 01003-4530
Telephone: 413-577-1243
Fax: 413-577-1517
Email: cumirp@mail.pse.umass.edu