



Center for Nanophase Materials Sciences

The Center for Nanophase Materials Sciences (CNMS) at Oak Ridge National Laboratory (ORNL) integrates nanoscale science with neutron science; synthesis science; and theory, modeling, and simulation. Operating as a national user facility, the CNMS has a highly collaborative and multidisciplinary environment for research to understand nanoscale materials and phenomena.

Scientific Themes

Research at the CNMS focuses on understanding, designing and controlling the dynamics, spatial chemistry, and energetics of functionality and properties of nanoscale materials and architectures.

- **Origins of Functionality on the Nanoscale**

This theme focuses on the development of instrumentation to image functionality in nanoscale materials and interacting assemblies. Research into the new emerging physics and chemistry at the nanoscale is advanced through ORNL's expertise in developing tools and techniques for forefront research with scanning probes and spectroscopy, neutron scattering, electron microscopy, and related techniques.

- **Functional Polymer Architectures**

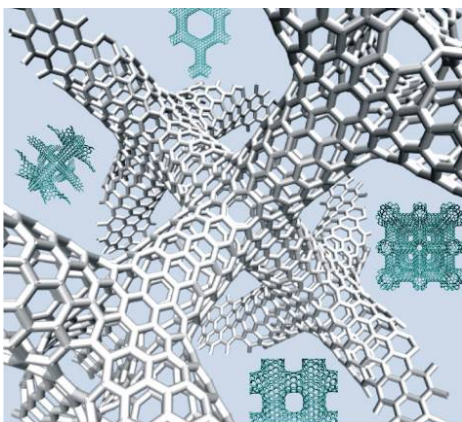
This theme focuses on advancing our fundamental understanding and control of polymer structure, property and function that are controlled by weak forces and whose properties are largely dependent on interfacial phenomena. This theme is rooted in controlled synthesis of well-defined polymers and bio-inspired polymers, and in rigorous nanoscale characterization.

- **Understanding Emergent Behavior**

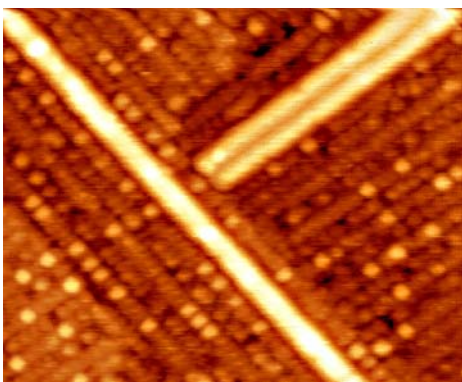
This theme builds on a strong theoretical effort, focusing on understanding the emergence of collective behavior at every scale from the electronic structure to the mesoscale and includes multiscale aspects of functionality in complex systems and assemblies of nanoscale materials such as oxides and bio-inspired nanomaterials.



Cu-TCNQ nanowires on ZnO nanowires



Theoretical studies of 2D and 3D ordered networks of carbon nanotubes; J. M. Romo-Herrera et al., Nano Lett. 7, 570 (2007)



Conductive nanowires of GdSi₂ grown on Si(100)



Research Capabilities

The CNMS is housed in an 80,000-ft² facility on the Chestnut Ridge Campus of ORNL, adjacent to the Spallation Neutron Source. It is equipped with a wide range of specialized tools for synthesis, characterization, and integration of hard and soft materials. CNMS encompasses expertise and instrumentation for user research in a broad range of disciplines selected to address forefront research in nanoscience and nanotechnology. Many user projects take advantage of multiple capabilities in tackling research to understand complex nanoscale phenomena.

- **Macromolecular Nanomaterials:** Synthesis and molecular level characterization of organic and polymeric nanomaterials and interfaces, including biologically inspired systems; deuterated molecules and polymers for neutron scattering studies.
- **Catalytic Nanosystems:** Synthesis and characterization of inorganic and hybrid nanomaterials with emphasis on catalytic performance for energy applications.
- **Functional Hybrid Nanostructures:** Laser, chemical, and CVD synthesis of inorganic nanomaterials including carbon nanotubes, nanoscale oxide heterostructures, and related structures; tunable (including ultrafast) laser spectroscopy of nanostructures with high spatial resolution.
- **Scanning Probes:** Imaging of functionality and dynamics in nanostructures including magnetic domains, electro-mechanics, energy transformation and dissipation, chemical reactions and local phase transitions, mesoscale and quantum electrical transport, electronic, structural and spin phases, electro-optical and photovoltaics.
- **Electron Microscopy, Neutron and X-ray Scattering:** Evolution of atomic-level and nanoscale structure and dynamics with varying environments; nano-manipulation for multifunctional electron microscopy imaging.
- **Nanomaterials Theory Institute:** Multiscale modeling, nanomaterials design, and virtual synthesis using terascale computing capabilities.
- **Nanofabrication Research Laboratory:** Controlled synthesis and directed assembly of nanomaterials in a 10,000-ft² cleanroom environment; chemical and biological functionalization of nanoscale materials.

CNMS has established partnerships with other ORNL user programs. The CNMS Nanomaterials Theory Institute provides collaborative workspaces, visualization equipment, and high-speed connections to the terascale computing facilities of ORNL's National Center for Computational Sciences. The intense neutron beams from the Spallation Neutron Source and from the recently upgraded High Flux Isotope Reactor afford unique and expanding opportunities for fundamental studies of the structure and dynamics of nanomaterials. The CNMS also provides a gateway to electron microscopy, atom probe, nanoindentation and other capabilities in the Shared Research Equipment and High Temperature Materials Laboratory user programs.

User Program

The CNMS user program provides access to equipment and technical expertise for nanoscale research that defines the state of the art. The program is open to users from academia, business and industry, and research institutes worldwide. Users join a vibrant research community that brings together ORNL research staff, technical support staff, students, postdoctoral scholars, and collaborating guest scientists. The program accommodates both short-term and long-term collaborative research partners. Access is through a brief peer-reviewed proposal and there is no charge for users who intend to publish their results. Access is also available on a cost-recovery basis for research that is not intended to be published. Prospective users are encouraged to consult CNMS staff members to learn more about the center's science and capabilities.

User Point of Contact: Tony Haynes • CNMS User Coordinator • Oak Ridge National Laboratory
P.O. Box 2008 • Oak Ridge, TN 37831-6488 • Phone: (865) 576-2858 • E-mail: cnmsuser@ornl.gov
<http://www.cnms.ornl.gov>