The Center for Nanophase Materials Sciences

cnms.ornl.gov

OVERVIEW

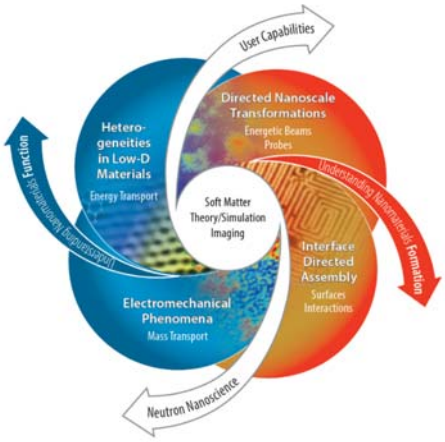
The Center for Nanophase Materials Sciences (CNMS) at Oak Ridge National Laboratory (ORNL) provides a national and international user community access to expertise and equipment for a broad range of nanoscience research, including nanomaterials synthesis, nanofabrication, imaging/microscopy/ characterization, and theory/modeling/ simulation (*see reverse for details*). CNMS also acts as a gateway for the nanoscience community to benefit from ORNL's neutron sources (Spallation Neutron Source, SNS, and High Flux Isotope Reactor, HFIR) and computational resources. All CNMS facilities and capabilities are accessible based on peer-reviewed proposals and are offered at no cost to users who intend to publish their results.

CNMS is one of five Department of Energy (DOE) funded Nanoscale Science Research Centers (NSRCs). Of particular importance to CNMS users is the access not only to instrumentation and facilities, but to highly trained researchers with a mission to help users succeed. A broad range of projects are possible, either using a single capability, such as imaging, or using an entire "suite" of laboratories to perform research that spans from synthesis/ fabrication to measurements to theoretical analysis.

The work at CNMS ties closely to neutron science capabilities at ORNL, with about one-sixth of CNMS users also accessing either SNS or HFIR. CNMS's Nanomaterials Theory Institute provides users with expertise in modeling and simulation and ties closely to ORNL's capabilities in high-performance computing (ORNL's Leadership Computing Facility and the National Center for Computational Sciences). CNMS hosts over 650 unique users per year, with about 50% coming from U.S. universities. Depending on the scope of work, users spend as little as a few days to as much as several months at CNMS.

IN-HOUSE RESEARCH

The CNMS in-house research effort aims to understand the effects of dimensional and spatial confinement on formation and function, in order to enable the design of responsive nanomaterials that efficiently capture, transport, and/or convert energy.



Reflecting the importance of combining activities in synthesis and in understanding nanomaterials, the in-house research is structured into four themes. Two of these themes ("Interface Directed Assembly" and "Directed Nanoscale Transformations") focus primarily on the formation of materials and an understanding of synthesis and assembly mechanisms. The other two themes ("Electromechanical Phenomena" and "Heterogeneities in Low-Dimensional Materials") emphasize the study and understanding of nanomaterials functionality.

Contact:

Hans Christen
Director, Center for Nanophase Materials Sciences
865-574-5081
christenhm@ornl.gov

User Contact:

Brad Lokitz
CNMS User Program Coordinator
865-574-9573
cnmsuser@ornl.gov

Managed by
UT-Battelle for the
US Department of Energy

The Center for Nanophase Materials Sciences

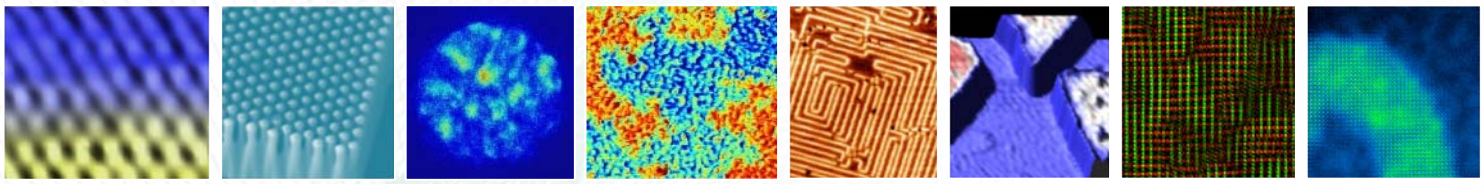
cnms.ornl.gov

RESEARCH CAPABILITIES (SEE CNMS.ORNL.GOV FOR COMPLETE LIST)

The main CNMS facility is located on the Chestnut Ridge Campus of ORNL, adjacent to the Spallation Neutron Source, while some microscopy and atom-probe tomography instruments are located on the main ORNL campus. CNMS is equipped with a wide range of specialized tools for synthesis, characterization, and fabrication of novel nanoscale materials and assemblies, including the 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.

- **Imaging, Microscopy, and Nanoscale Characterization**: Scanning probe microscopy for imaging and dynamics in nanostructures including ionic and electronic transport, electromechanics, energetics, magnetic properties, chemical reactions, and electronic, structural and spin phases and transitions. Sub-Ångstrom scanning transmission electron microscopy (STEM) and spectroscopy, soft-matter TEM, He-ion microscopy, and atom-probe and electron tomographies. Special emphasis on multimodal and chemical imaging (based on mass spectrometry and on optical spectroscopy). Development and implementation of data analytics methods.
- **Theory, modeling, and simulation**: Multiscale modeling, nanomaterials design, virtual synthesis and characterization using high performance computing capabilities to establish and enhance links with experiments and to aid understanding, prediction, and exploration.
- **Synthesis and fabrication:** Controlled synthesis and directed assembly of nanomaterials in a Class 1000 cleanroom environment ("Nanofabrication Research Laboratory"); chemical and biological functionalization of nanoscale materials, special emphasis on the directed assembly of 3-dimensional structures. Synthesis of 2D materials, hybrid structures, epitaxial oxide layers.
- **Soft matter synthesis and characterization**: Synthesis and molecular level characterization of small molecule building blocks, polymers, and polymer-modified interfaces, including biologically inspired systems, site-specific deuteration of molecules and polymers for neutron scattering studies.
- **Functional characterization of nanomaterials**: Optical characterization and laser spectroscopy. Electrical and optoelectronic characterization. Magnetometry and magnetotransport. X-ray diffraction, including small-angle x-ray scattering.

Many user projects take advantage of multiple capabilities in tackling research to understand complex nanoscale phenomena. The Nanomaterials Theory Institute provides collaborative workspaces, visualization equipment, and high-speed connections to the ultrascale computing facilities of the National Center for Computational Sciences. The intense neutron beams from the Spallation Neutron Source and from the High Flux Isotope Reactor afford unique and expanding opportunities for fundamental studies of the structure and dynamics of nanomaterials.



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, the private sector, and research institutes worldwide. Users join a vibrant research community that brings together ORNL research staff, technical support staff, students, postdoctoral fellows, and collaborating guest scientists. The program accommodates both short-term and long-term collaborative research partners. Access is obtained through a brief peer-reviewed proposal with no charge for users who intend to publish their results. Access is available on a cost-recovery basis for research that is not intended for publication. Prospective users are encouraged to consult CNMS staff to learn more about the Center's science and capabilities.

Revised 11-22-2017