NCMN and Department of Physics and Astronomy
UNL research in nanoscale ferroelectrics is an area involving simple nanoimprinting methods that creates arrays of ferroelectric polymer structures suitable for low-cost non-volatile memories. Almost since the dawn of computing, digital information has been stored predominately in two kinds of structure: silicon transistor arrays (for fast, volatile random-access memories) and magnetic media (for low-cost, nonvolatile mass data storage). A relative newcomer is the flash drive, a form of semiconductor memory that provides both random access and non-volatile storage, but at higher cost, with inferior speed and compromised opening lifetime. Ferroelectric materials, which store data in a stable electric polarization state can be switched by a short voltage pulse, and are, like flash, non-volatile and provide random access, yet are inherently faster and have greater opening lifetimes. In spite of their initially high cost, ferroelectric memories, including smart debit cards and the Sony Playstation 2.

NCMN and Department of Chemistry
Research by UNL chemist Xiao Cheng Zeng, graduate research assistant Satya Bulusu and colleagues studying gold's structure at the nanoscale has discovered hollow cage-like structures made of pure gold atoms. Zeng’s team was the first to combine quantum chemistry calculations with powerful computerized search techniques to identify previously unknown nanoscale structures and substances. This finding was featured in the Proceedings of the National Academy of Sciences, The New York Times, Nature, C&EN, Science, UK Royal Society of Chemistry, Science Daily, and Nano Today. Scientists might someday be able to harness these nanocages to carry useful guest atoms for medical or industrial purposes.

NCMN and Department of Mechanical Engineering, Department of Physics and Astronomy
Permanent magnet nanostructures that are virtually impossible to produce by conventional processing routes are being studied by a collaborative team of UNL researchers. As one of the pioneers and worldwide leaders in this intriguing research, they have created Fe-Pt two-phase magnets on length scales never achieved before. The magnetic energy density of the two-phase clusters is more than double compared to single-phase elements. Their research indicates potentially lightweight, high energy-efficiency magnets for a broad range of applications. Core magnetic resonance imaging technology and computer aided design will drive these innovations.

University of Nebraska–Lincoln
The Nebraska Center for Materials and Nanoscience

The Nebraska Center for Materials and Nanoscience (NCMN) at the University of Nebraska is a multidisciplinary research organization involving over 70 faculty members from the Departments of Physics, Chemistry, Electrical Engineering, Mechanical Engineering, Engineering Mechanics, Chemical Engineering and others. NCMN aims to advance research in materials science, engineering and nanotechnology and to foster the growth of research in one of the highest-priority national programs, The National Nanotechnology Initiative. NCMN also works with state and national industries in support of Nebraska’s overall economic development.

Research Interests

NCMN is concerned with atomic manipulation, properties affected by nanoscale dimensions, self-assembling and non-self-assembling systems, quantum dots and wires, nanomagnetism, quantum computing, nanomechanics, magnetic, molecular design, nanoelectromechanical systems, and nanotransfer and nanofabrication equipment and technologies. Research work is supported by NSF, DOE, DOD, NASA, NIH, industry, and the private sector.

Graduate and Postdoctoral Education

The Nebraska Center for Materials and Nanoscience provides both undergraduate and graduate students, as well as postdoctoral associates of NCMN faculty members, a variety of research opportunities. One example is the high-tech research work that NCMN faculty members do with state and national industries in support of Nebraska’s overall economic development.

Research Areas

- Materials science, engineering and nanoscience
- Nanoscale structures and materials on a nanometer scale
- Many NCMN members are part of this center and have the following emphases:
  - IRG 1: Nanoscale Magnetism: Structures, Materials and Phenomena
  - IRG 2: Magnetoelectric Interfaces and Spin Transport
  - QRSPINS: Quantum and Spin Phenomena in Nanomagnetic Materials and Phenomena

Facilities: Special Equipment, or Programs

The Nebraska Center for Materials and Nanoscience operates and coordinates the following Central Service Facilities:

1. Cryogenics
   - Liquid nitrogen and liquid helium for low temperature research, cold traps, etc.

2. Crystallography
   - On-site small molecule crystal structure determination and analysis including unit cell determinations; complete structure determinations; and collection of single crystal data.
   - State-of-the-art equipment: 14 Tesla NMR spectrometer for solid-state NMR, SQUID magnetometer, angle-integrated photoemission and electron spin-echo detection facilities, and comprehensive ellipsometer laboratory.
   - State-of-the-art equipment to prepare novel nanostructured materials, thin films and micro/ nanofabrication.
   - On-site small molecule crystal structure determination and analysis including unit cell determinations; complete structure determinations; and collection of single crystal data.
   - State-of-the-art equipment: 14 Tesla NMR spectrometer for solid-state NMR, SQUID magnetometer, angle-integrated photoemission and electron spin-echo detection facilities, and comprehensive ellipsometer laboratory.

3. Electron Microscopy
   - Materials characterization of the topography, morphology, elemental composition, crystalline microstructures, crystal defects, and atomic arrangements of materials, largely on a scale from 10 micrometers down to the near-atomic level.
   - Nanometer-scale characterization of materials by using Scanning Tunneling Microscopy (STM), Atomic Force Microscopy (AFM), and Magnetic Force Microscopy (MFM).
   - Scanning Probe Microscopy
   - Scanning Tunneling Microscopy (STM), Atomic Force Microscopy (AFM), and Magnetic Force Microscopy (MFM)
   - X-Ray Microscopy
   - X-ray Microscopy

4. Materials Preparation
   - State-of-the-art equipment to prepare novel nanostructured thin films from a variety of materials.
   - State-of-the-art equipment to prepare novel nanostructured thin films from a variety of materials.

5. Metallurgical and Mechanical Characterization
   - A large variety of equipment to characterize the mechanical and physical properties of materials including the failure analysis on components.

6. Nanofabrication
   - State-of-the-art equipment: 14 Tesla NMR spectrometer for solid-state NMR, SQUID magnetometer, angle-integrated photoemission and electron spin-echo detection facilities, and comprehensive ellipsometer laboratory.

7. X-Ray Materials Characterization
   - State-of-the-art equipment: 14 Tesla NMR spectrometer for solid-state NMR, SQUID magnetometer, angle-integrated photoemission and electron spin-echo detection facilities, and comprehensive ellipsometer laboratory.

8. Materials Characterization
   - Materials identification and characterization through non-destructive, X-ray Diffraction (XRD) and/or X-ray Photoelectron Spectroscopy (XPS) techniques

Specialized Research Facilities

State-of-the-art equipment 14 Tesla NMR spectrometer for solid-state NMR, SQUID magnetometer, angle-integrated photoemission and electron spin-echo detection facilities, and comprehensive ellipsometer laboratory.

The overall goal of NCMN is to provide for the State of Nebraska and the University of Nebraska a nationally recognized center of excellence in materials research science and engineering, nanoscience, and nanotechnology.