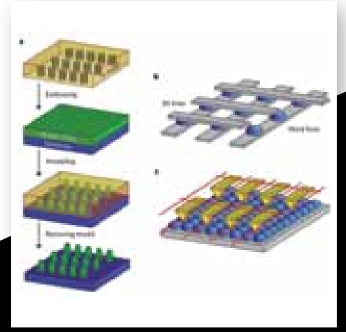
"Start the Presses"
Stephen Ducharme and Alexei Gruverman

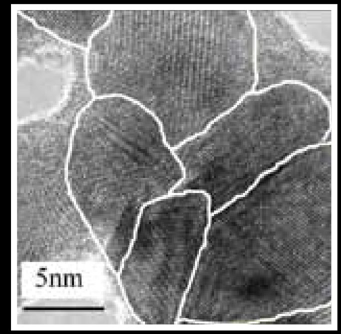
NCMN and Department of Physics and Astronomy

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 operating lifetime. Ferroelectric memories, which store data in a bistable electrical 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 operating lifetimes. In spite of their relatively high costs, ferroelectric memories have already found applications in consumer electronic devices, including smart debit cards and the Sony Playstation 2.



Arrays of ferroelectric polymer structures

"Buckyball" Au17



High-resolution TEM image of two-phase structure

Discovery of the First Metallic Nanocluster: Hollow Gold Nanocages, X.C. Zeng

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.

"The Quest for the Supermagnet"
Jeff Shield, Ralph Skomski and David J. Sellmyer

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 clusters. Their research indicates a pathway towards lighter and more energy-efficient magnets for a broad range of applications—from magnetic-resonance imaging in medicine and computer hard disks to hybrid cars and wind-energy generators.

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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 strives for excellence in research, graduate and postdoctoral education and service in materials science, engineering and nanoscience and is on the forefront 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 Areas

NCMN is concerned with atomic manipulation, properties affected by nanoscale dimensions, self-assembly, ordered nanoarrays, quantum dots and wires, nanoelectronics, quantum computing, nanomechanics, nanoptics, molecular design, nanoelectromechanical systems, and nanobiological function and life sciences. Research work is supported by NSF, DOD, DOE, NASA, NIH, industry, and the private sector.

Graduate and Postdoctoral Education

The Nebraska Center for Materials and Nanoscience provides help to undergraduate and graduate students, as well as postdoctoral assistants of NCMN faculty members through a variety of methods. One example is the high-tech fabrication and characterization equipment available in eight Central Facilities in the Center. NCMN faculty members also participate in several educational programs including NSF-supported Research Experiences for Undergraduates Programs in Nanostructured Materials and Chemistry. Typically, they also support 20-30 undergraduate research assistants paid through external grants each year, several UCARE students, and postdoctoral associates. With the establishment of the NSF MRSEC Center in 2002, faculty members are also significantly involved in education and outreach.

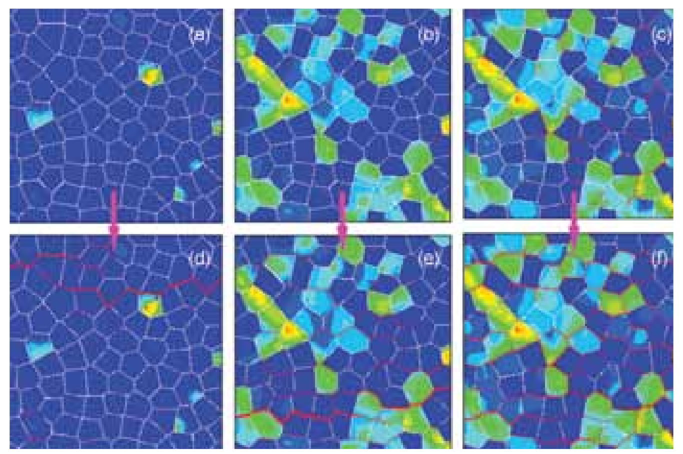
Related Center - NSF MRSEC

QSPINS: Quantum and Spin Phenomena in Nanomagnetic Structures

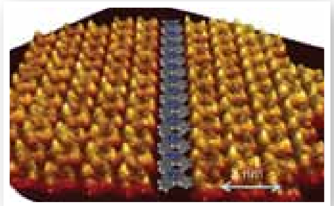
The Materials Research Science and Engineering Center at the University of Nebraska was established in 2002 by the National Science Foundation to carry out research on magnetic structures and materials on a nanometer scale. Many NCMN members are part of this center and have the following emphases:

- IRG 1: Nanoscale Magnetism: Structures, Materials and Phenomena
- IRG 2: Magnetoelectric Interfaces and Spin Transport
- Seed Projects: Electronic DNA Detection via Magnetic Particles Preconcentration, Magnetism of Ferromagnetic Nanospirals, Tunable Magnetic Tunnel Junction with Optical Output
- Educational and Industrial Outreach Programs

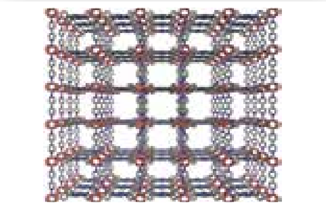
www.mrsec.unl.edu



Distribution of intragranular plastic strain and slipping at shock states



Monolayer of TPP molecules formed by molecular self-assembly on a Ag(111) surface



Crystalline metal-organic frameworks

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.

Facilities, Special Equipment, or Programs

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

1. **Crystallography**

   On-site small molecule crystal structure determination and analysis including unit cell determinations, complete structure determinations, and collection of single crystal data.

   www.unl.edu/ncmn/crystal

2. **Cryogenics**

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

   www.unl.edu/ncmn/facilities/cryogenics.shtml

3. **Electron Microscopy**

   Materials characterization of the topography, morphology, elemental composition, crystalline microstructure, crystal defects, and atomic arrangements of materials, largely on a scale from 10 micrometers down to the near-atomic level.

   www.unl.edu/ncmn/cfem

4. **Materials Preparation**

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

   www.unl.edu/ncmn/matprep/

5. **Metallurgical and Mechanical Characterization**

   A large variety of equipment to characterize the mechanical and physical properties of materials including the failure analyses on components.

   www.unl.edu/ncmn/mech_charact

6. **Nanofabrication**

   Fabrication of electronic, magnetic and other nanostructures.

   www.unl.edu/ncmn/facilities/nanofab.shtml

7. **Scanning Probe Microscopy**

   Nanometer-scale characterization of materials by using Scanning Tunneling Microscopy (STM), Atomic Force Microscopy (AFM), and Magnetic Force Microscopy (MFM).

   www.unl.edu/ncmn/spm/

8. **X-Ray Materials Characterization**

   Materials identification and characterization through non-destructive, X-Ray Diffraction (XRD) and/or X-Ray Fluorescence (XRF) techniques.

   www.unl.edu/ncmn/xray/

Specialized Research Facilities

State-of-the-art equipment: 14 TeslaNMR spectrometer for solid-state NMR, NIMA Langmuir-Blodgett Trough for monolayer and multilayer films, atomic force microscopes, high-field superconductive solenoids, a SQUID magnetometer, angle-integrated photoemission and electron spin analysis facilities, Raman and Brillouin laser light-scattering facilities, comprehensive laboratory for the study of magnetic materials, high-Tc superconducting materials, photoemission and inverse photoemission spectrometers including spin-polarized inverse photoemission, and dedicated minicomputers for theoretical calculations, pulsed laser facilities, atomic force microscope, and comprehensive ellipsometer laboratory.

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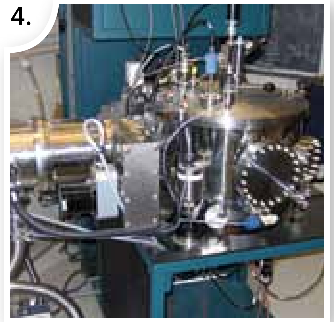

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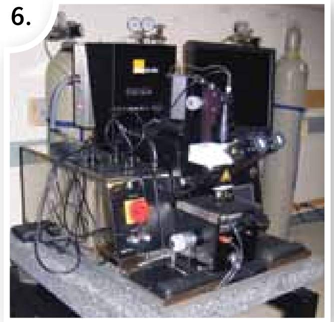

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