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The DOE Center of Excellence for  
The Synthesis and Processing of  
Advanced Materials



BASIC ENERGY SCIENCES  
DIVISION OF MATERIALS SCIENCES & ENGINEERING

Current  
Center Projects  
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# Isolated and Collective Phenomena in Nanocomposite Magnets



## Objectives

- *Develop improved understanding of magnetic properties and improved magnetic materials using nanoscale mixtures of hard magnets, soft magnets and non-magnetic materials.*

## Tasks

- Synthesis and investigation of isolated magnetic nanoparticles
- Synthesis and investigation of collective behavior in materials with defined microstructures
- Modeling and simulation of nanoscale magnets

## Participants

- Ames, ANL, BNL, INEEL, UI/FSMRL, LANL, LBNL, LLNL, ORNL and SNL

## Coordinator

- Sam Bader, ANL (630) 252-4960, bader@msd.anl.gov

### Sponsoring/Collaborating Organizations

BES/DMS&E

Magnequench,

Rhodia,

IBM,

Motorola,

IAP Inc.

# Controlled Defect Structures in Rare-Earth-BaCu-O Cuprate Superconductors



## Objectives

- *Provide an integrated scientific understanding of lattice defects and their nanoscale structure in the “123” rare-earth cuprates, their dependence on the various methods of synthesis, and their relationship to the resulting superconducting properties.*

## Tasks

- Specimen fabrication by state-of-the-art methods
- Structure and chemical characterization using advanced and specialized methods of TEM
- Electromagnetic characterization by transport, magneto-optical and local probe measurements
- Theoretical modeling including electromagnetic and flux-pinning properties of defects

## Participants

- Ames, ANL, BNL, LANL, ORNL and SNL

## Coordinator

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### Sponsoring/Collaborating Organizations

**BES/DMS&E    EE/HTSC,    American Superconductor,    Oxford Superconductor,  
Intermagnetics General,    Superconductive Components**

# Smart Structures Based on Electroactive Polymers



## Objectives

- *Develop a framework for the rational design of self-assembled nanostructured block copolymers that offer significant advantages over conventional materials for the active regulation of transport phenomena.*

## Tasks

- Modeling properties at the molecular level
- Molecular architecture modeling D
- Development of synthesis and processing methods
- Structural determination and properties measurement

## Participants

- Ames, ANL, BNL, UI/FSMRL, INEEL, LBNL, LLNL, ORNL, PNNL, SNL

## Coordinator

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### Sponsoring/Collaborating Organizations

BES/DMS&E

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# Nanoscale Phenomena in Perovskite Thin Films



## Objectives

- *Develop the scientific basis for controlling nucleation, growth and strain in ferroelectric perovskite thin films.*
- *Determine the relationship between the critical electrical properties and film microstructure, strain and perovskite/substrate interfacial interactions.*

## Tasks

- Controlled growth of perovskite films on silicon substrates
- Nanoscale structure-property relationships on perovskite films

## Participants

- ANL, LANL, ORNL, SNL, Northwestern U., U.N. Carolina, U. Maryland, U. Florida, N. Illinois U.

## Coordinators

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### Sponsoring/Collaborating Organizations

BES/DMS&E, DP, EE/OTT, Agilent, ATMI, Ionwerks, Neocera, Oxxel, Symetrix



**Objectives** • *Close the gap between physics and engineering descriptions of cooperative effects in granular flows by bridging between continuum models and discrete models and thereby develop and understand appropriate constitutive relationships for complex flows.*

**Tasks** • Dynamic constitutive relationships for granular flow (hydrodynamic and kinetic theory via statistical mechanics of large systems)

• Low-dimensional, constrained granular dynamics (granular systems with magnetic, electric and capillary forces, tethers and chain-line constraints; mapping from 2D to 3D)

**Participants** • Ames, ANL, LANL, SNL/NM

**Coordinator** • David Hoffman, Ames Lab (515) 294-9649  
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## Sponsoring/Collaborating Organizations

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MNR Inc.    Duke Univ.    Univ. of Colorado    UC/SD    UNM

# Synthesis and Processing of Carbon-Based Nanostructured Materials



## Objectives

- *Advance the science and technology of Carbon-based materials that will lead to the development of a new generation of MEMS and NEMS devices*

## Tasks

- Synthesis, processing and fundamental mechanical and tribological properties
- Fundamental transport processes at the nanoscale

## Participants

- ANL, LBNL, ORNL, SNL/NM, NE State Univ., Northwestern Univ.

## Coordinator

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### Sponsoring/Collaborating Organizations

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Raytheon

# Experimental and Computational Lubrication at the Nanoscale



**Objectives** • *Develop a scientific understanding of lubrication and strategies to control tribology at the nanoscale capitalizing on recent advances in nonprobe theoretical and computational methods*

**Tasks**

- Synthesis & Processing of New Surface Coatings
- Development of New Probe Methods
- New Theory and Computational Related to Experiments

**Participants** • ANL, LANL, LBNL, SNL/NM, UI/FS-MRL, UCSD

**Coordinators** • Steve Granick (UI/FS-MRL), (217) 333-5720, sgranick@uiuc.edu

## Sponsoring/Collaborating Organizations

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**DOE/DP**

**Interactions w/~12 Companies**

# Spin-Polarized Transport in Complex Oxides



## Objectives

- *Understand, control and manipulate spin-polarized transport within and between highly spin-polarized oxides in order to create and exploit spintronic functionality.*

## Tasks

- Synthesis & Processing: Tailoring Interfacial Chemistry and Structure
- Spin Transport Across and Along Interfaces
- New Theory and Computation Related to Experiments

## Participants

- ANL, BNL, LANL, LLNL, ORNL, UI/FS-MRL, Cornell, Univ. of Tennessee

## Coordinator

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### Sponsoring/Collaborating Organizations

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