Center for Emergent Materials

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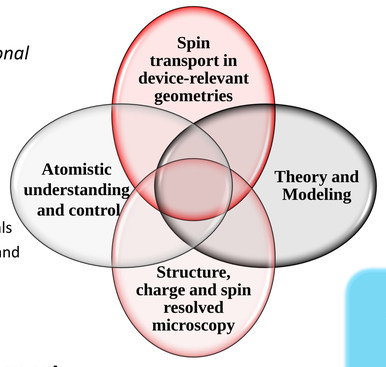
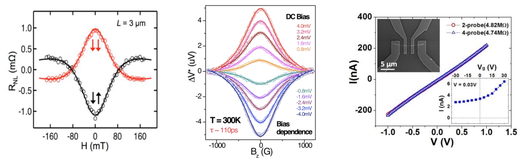
IRG-1: Fundamentals of Spin Functionality

- *Foundations of spin functional networks*
  - Injection, transport, and manipulation of spin
  - Spin-preserving materials
- *Unique approach*
  - Materials-generic probes
  - Integration of diverse materials
  - Comprehensive spin, charge and structural microscopy

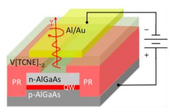


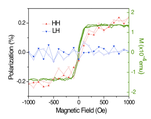
Transport

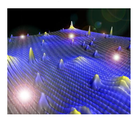


Carbon Silicon Nanowires

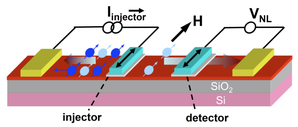
- *Organic Spintronics*
  - First organic/inorganic spin valves
  - First all-organic spin valve
  - First organic/inorganic all-semiconductor spin injection
- *Spin in Graphene*
  - Record efficiency for spin injection into graphene
  - Record spin lifetimes in graphene
- *Controlling dopants at the atomic level*
  - First tuning of single dopant binding energy
  - First nonvolatile control of single dopant ionization state



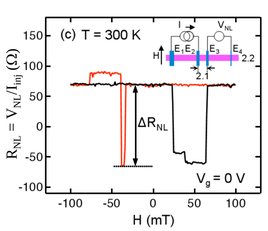


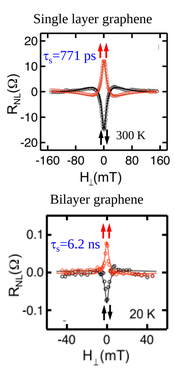


Spin injection into graphene: long spin lifetimes



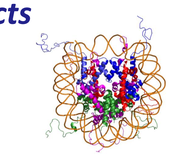
Ti-seeded MgO tunnel barriers on graphene

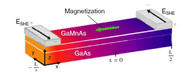


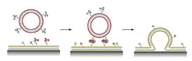


Proto-IRG Seed Projects

- *Magnetic Resonance Studies of Chromatin Structure and Dynamics*
  - SSNMR, CW EPR and NV diamond ODMR studies of Chromatin dynamics
- *Thermal Spintronics: Engineering Spin Currents and Dissipation*
  - *Phonon drag mechanism for Spin Seebeck*
- *Characterization & Synthesis of Mimetic Cell-Secreted Exosomes for Cell Signaling*
  - Started September 2011







Seed Program

Foundational research and innovation toward spin functional materials and networks

IRG-1
Towards Spin-Preserving, Heterogeneous Spin Networks

Industrial Interaction
- Instrument Development
- Sample characterization
- Internships

IRG-2
Double Perovskite Interfaces and Heterostructures

Intl Mat Res Alliance (IMRA)
- Joint workshops
- Student exchanges

Leibniz Institute for Solid State and Materials Research Dresden

Ensuring future scientific excellence
Diversity Learning research
STEM outreach HS courses
Grad, undergrad and PD education

Shared User Facilities
- Characterization, fab and growth
- Training and Education
- Staff engagement in research

Education and Human Resource Development

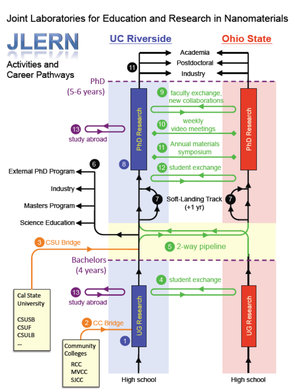
- *Understanding how **misconceptions** hinder learning in a Materials Science & Engineering introductory course (~600 students/yr).*
  - Developed pilot curricular material, tested in small groups
  - Documented learning gains
  - Disseminating to other universities; applying to upper level OSU courses
- *Developing High School (HS) materials course*
  - Participating in ASM teachers' camps (basic and advanced)
  - Supporting HS teacher in starting elective materials science courses
- *Scientific Thinkers Program*
  - Graduate and undergraduate students teach 4th and 5th grade inquiry-based science lessons at a local elementary school.

Shared Facilities

- Expanding customer base through quality service and advertisement
- FY2011
  - **117** supported users
  - **22** female users
  - **39** supported research groups
  - **4** industrial customers
  - **69** accounts/research projects benefitting from ENSL use

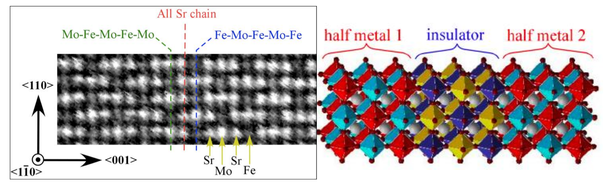
Partnership in Research and Education in Materials (PREM)

- *CEM is partnering on an NSF PREM proposal to be submitted by UC Riverside*
  - Hispanic Serving Institution
- *Joint Laboratories for Education and Research in Nanomaterials (JLERN)*
- *$600—$700k/year for 5 Years to UCR*
- *Proposal submitted Autumn 2011*

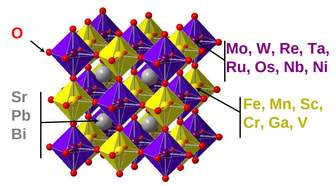


IRG-2: Double Perovskite Films, Interfaces and Heterostructures

Lay the scientific foundation for understanding double perovskite oxides with multiple functionalities within a common structural framework…

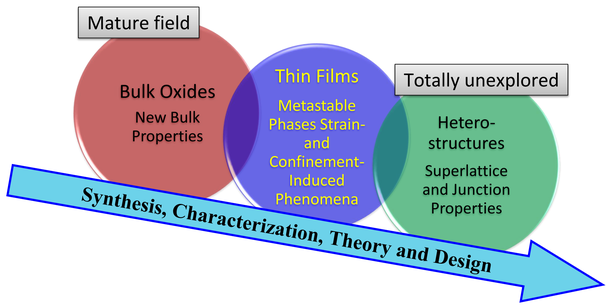


…to enable advances in multifunctional electronics and spintronics.



Sr_2FeMoO_6 Ferrimagnetic Half-Metal
Sr_2CrOsO_6 Ferrimagnetic Semiconductor
Sr_2VMoO_6 Nonmagnetic Metal
Sr_2GaNbO_6 Diamagnetic Insulator
Pb_2ScTaO_6 Relaxor Ferroelectric
Bi_2MnNiO_6 Ferroelectric Ferromagnet

- Multiple Functionalities
- Lattice & Electronic Structure Matching at Interfaces
- Heterostructures



- First DP modeling that can handle finite temperature, nonstoichiometry and disorder
- Direct imaging of Sr_2FeMoO_6 ordering and first demonstration of magnetic shape anisotropy in Sr_2FeMoO_6 films
- Sr_2CrOsO_6 is a multiband Mott insulator whose magnetism arises from superexchange interactions and frustration
- First samples of Sr_2FeOsO_6 and Sr_2CoOsO_6 and showed they are antiferromagnetic insulators
- First fully ordered Sr_2CrReO_6 films and showed that this compound is a ferrimagnetic semiconductor at room temperature