Physical Chemistry Student Seminar

"Using Solution Phase Self-Assembly to Control the Properties of Magnetic and Magnetoelectric Nanostructures"

This talk will focus on the use of nanoscale architectures to control properties in magnetic and magnetoelectric materials. Magnetoelectric materials combine ferromagnetism and ferroelectricity in a single material, allowing control of one parameter with the other. Here we use solution-phase self-assembly and wet chemistry as a new method to produce these materials. In this talk, we will specifically focus on four systems. We begin with electrochemically deposited Ni-Cu nanowire stacks and explore potential new geometries for spin-torque devices. Next, coupled 1D chains of ferromagnetic FePt nanoparticles are aligned within block co-polymer nanopatterns to control coupling between nanoparticles. Within magnetoelectrics, we have focused on tuning materials' properties using strain. Using solution-phase self-assembly of block copolymers and inorganic precursors we have been able to create mesoporous versions of the magnetoelectric material $BiFeO_3$. We find that porosity and the mechanical flexibility that accompanies the porosity leads to enhanced magnetoelectric properties. Finally we mechanically couple superparamagnetic Ni nanocrystals to a piezoelectric substrate and show that electric-fields can be used to induce strain in the nanocrystals. This results in magnetic anisotropy that can be used to convert these soft magnetic nanocrystals to single domain ferrimagnets. Taken together, this work shows that control of nanoscale architectures is a powerful method to engineer magnetic and magnetoelectric properties in materials.

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