Magnetic Interfaces and Nanostructures
Room 204 - Session MI+NS-TuM

Magnetic Nanostructures, Surfaces, and Interfaces

Moderator: R.A. Lukaszew, University of Toledo

8:20am **MI+NS-TuM1 Size Effect and Chemical Ordering in [FePt]@sub 100-x@Cr@sub x@ Nanoparticles**, *C. Srivastava,* ***G.B. Thompson****, J.W. Harrell, D.E. Nikles,* University of Alabama

FePt nanoparticles have received considerable attention as candidate materials for achieving ultra-high areal storage densities. Recent experimental and modeling studies have suggested that FePt must achieve a critical size near 4 nm for the chemically ordered L1@sub 0@ phase to be stable. We report the use of Cr in controlling the size and ordering temperature in FePt nanoparticles. Two series of [FePt]@sub 100-x@Cr@sub x@ nanoparticles (x = 5, 10 and 16 at. %) were chemically synthesized by a high-temperature salt-decomposition process yielding as-prepared diameters of 2 nm and 4 nm. XRD and STEM-EDS confirmed that the Cr formed a solid solution within the A1 FePt phase. Upon annealing, the as-synthesized 4 nm [FePt]@sub 100-x@Cr@sub x@ particles ordered at 450°C while maintaining ~4 nm size. In contrast, the as-synthesized 2 nm [FePt]@sub 100-x@Cr@sub x@ particles ordered at 550°C. It was noted that the initial 2 nm particles had achieved an ~4 nm sintered particle size at 550°C. Thus, the initial particle size is critical before chemical ordering can commence. Once the critical size is achieved, Cr was able to reduce the ordering temperature. The initial 4 nm FePt nanoparticles ordered at ~500°C and experienced rapid particle sintering at the onset of its ordering temperature. In contrast, the Cr alloyed nanoparticles were shown to have reduced grain growth at elevated temperatures. Magnetrometry measurements of the nanoparticles indicated that the coercivity is reduced with Cr content.

8:40am **MI+NS-TuM2 Core Size Effects on Core-Shell Structured Fe/FeO@sub x@ Nanopaticles**, ***A. Ceylan***[1]*, S. Shah,* University of Delaware*; K. Hasanain,* Quaid-e-Azam University, Pakistan

In this study, we examined the particle size dependence of magnetic properties of Fe/Fe-oxide core/shell structured nanoparticles. Inert gas condensation has been used to synthesize the nanoparticles. Structural and magnetic properties of the samples have been investigated by various techniques. It has been observed that the effect of AFM shell can be relatively enhanced by decreasing the core size such that much higher exchange bias than larger particles is obtained. Furthermore, as an indication of pinned spins, which are attributed as one of the reasons of higher exchange bias field, at the AFM-FM interface, a vertical shift at the hysteresis loops has also been observed in small nanoparticles. Room temperature magnetic measurements have revealed that small particles show superparamagnetic behavior. However, the system does not reach to saturation even at 4T which indicates high anisotropy. These observations reveal that superparamagnetic behavior is related to the small size rather than a lack of anisotropy.

9:00am **MI+NS-TuM3 Magnetic Field Effects in Ferromagnetic/Organic Hybrid Structures**, ***J. Shi,*** University of Utah **INVITED**

Spin injection/detection and coherent spin transport are key ingredients in Spintronics, which were first demonstrated in the giant magnetoresistance or GMR effect in all-metal systems. In this talk, I will present our recent progress using organic semiconductors. In spin valves consisting of two ferromagnetic layers (La2/3Sr1/3MnO3 or LSMO and Co) and an organic semiconductor spacer (Alq3), we have successfully shown electrical spin injection/detection and coherent spin transport through the GMR effect. In addition, we have also found a high-field magnetoresistance effect in these structures. Our work shows that this high field effect originates from the magnetic field enhanced carrier injection due to the anomalous Fermi level shift in double exchange ferromagnets such as LSMO.

9:40am **MI+NS-TuM5 Magnetic Stripes at the Spin Reorientation Transition of a Magnetic Thin Film**, ***Z. Qiu,*** University of California at Berkeley **INVITED**

One fundamental issue in magnetic nanostructure research has concerned the presence of magnetic long-range order in a two-dimensional (2D) magnetic system. It has long been established that an isotropic 2D Heisenberg system does not carry long-range order at nonzero temperature. The magnetic order observed in ultrathin films is usually attributed to the existence of magnetic anisotropy. In an ultrathin film with perpendicular magnetocrystalline anisotropy, the spin direction could exhibit the so-called spin reorientation transition (SRT) from perpendicular to the in-plane direction of the film. At the SRT point, the perpendicular magnetocrystalline anisotropy is balanced out by the dipolar shape anisotropy and the system approaches to an isotropic Heisenberg system. Thus an investigation of the magnetic phase near the SRT point is expected to reveal the magnetic origin of 2D magnetic systems. In this talk, I will present an overview and our most recent experimental result on this subject. Using photoemission electron microscopy (PEEM) to do element-specific measurement, we studied the SRT in magnetically coupled sandwiches. We show that a crossover from the anisotropy length to the dipolar length governs the formation of the magnetic stripe phase.

10:20am **MI+NS-TuM7 Inhomogeneous Magnetic States in Gd/Fe and SmCo/Fe Nanolayers**, ***D. Haskel,*** Argonne National Laboratory **INVITED**

The reduced size and dimensionality of layered magnetic nanostructures enhances the role that surfaces and interfaces play in determining their magnetic structures. This can result in inhomogeneous magnetic states, wherein the local magnetization varies with distance away from surfaces or interfaces. Using hard x-ray magnetic circular dichroism and x-ray resonant magnetic scattering, we explore the nature of such inhomogeneous states in Gd/Fe metallic multilayers and SmCo/Fe spring magnets. In collaboration with Y. Choi, J. Lang, D. Lee, G. Srajer, C. Kmety, J. Pollmann, C. Nelson, R. Camley, J. Meersschaut, J.S. Jiang, S.D. Bader Work at Argonne is supported by the U.S. Department of Energy, Office of Science under contract No. W-31-109-ENG-38.

11:00am **MI+NS-TuM9 Magnetic Quantum Tunneling and Relaxation in Molecular Magnets**, ***L.J. de Jongh,*** *A. Morello, F. Luis, M. Evangelisti, F. Mettes,* Leiden University, The Netherlands **INVITED**

For strongly anisotropic magnetic clusters, like Fe@sub 8@ and Mn@sub 12@-ac, quantum tunneling of the cluster spins below their blocking temperatures T@sub B@ of a few K has been observed by several groups, and is expected to be triggered by the dynamic hyperfine interaction of the cluster spins with their surrounding nuclear spins, as recently predicted by Prokof'ev and Stamp.@footnote 1@ In that model, however, the ensuing relaxation of the electron spins is towards the nuclear spin system, leaving open the question if and at what stage, by which mechanism and at what rates the nuclear and electronic spin systems relax to the lattice phonons. That such phonon relaxation channels are indeed operative even deep in the quantum regime, could be proven unambiguously by our measurements of the specific heat contributions of both nuclear and electronic spin systems at temperatures T<<T@sub B@.@footnote 2-4@ Nuclear Magnetic Resonance is the technique of choice for studying the nuclear spin-dynamics involved in these processes. In addition, since the nuclear spins have to relax to the lattice via the electron spin system, also the dynamics of the latter is probed. In the talk such data (taken down to 20 mK), will be presented@footnote 5@ and analysed in the light of earlier developed theories for dynamic nuclear polarization and nuclear relaxation by paramagnetic impurities in insulating compounds, leading to new insights in the quantum relaxation mechanisms in molecular nano-magnets. @FootnoteText@ @footnote 1@ N.V. Prokof'ev and P.C. Stamp, Phys. Rev. Lett. 80, 5794 (1998). @footnote 2@ F.L. Mettes et al. Phys.Rev. B64, 174411 (2001);Phys. Rev. Lett. 85, 4377 (2000). @footnote 3@ M. Evangelisti et al. Phys. Rev. Lett. 93, 117202 (2004). @footnote 4@ A. Morello et al. Phys. Rev. Lett. 90, 017206 (2003). @footnote 5@ A. Morello et al. Phys. Rev. Lett. 93, 197202 (2004).

[1] **Falicov Student Award Finalist**

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