Magnetic Interfaces and Nanostructures
Room 304A - Session MI-ThA

Molecular Spintronics and Dynamics

Moderator: S.E. Russek, NIST

2:00pm **MI-ThA1 Semiconductive Behavior of the Single Molecule Magnets Mn@super12@-Ac, Fe@super8@Br@super8@, and V@super15@**, ***N.S. Dalal****, E.S. Choi, D. Zipse, R. Vasic, J.M. North, E. Jobiliong, J.S. Brooks,* Florida State University*; P. Kogerler,* Iowa State University **INVITED**

Single Molecule Magnets (SMMs) are clusters of transition metals that have garnered much theoretical and experimental attention due to their ability to show magnetic hysteresis on the single molecule level, and Macroscopic Quantum Tunneling. In order to advance our understanding of these materials for potential applications, the electrical transport properties of three of the most widely studied SMMs, Mn@sub12@-Ac, Fe@sub8@Br@sub8@, and V@sub15@, as well as the polyoxovanadate cluster V@sub12@ were examined. These materials all showed semiconductive behavior, with varying transport gaps, E@suba@, for each. Under the assumption that the optical band gap is twice the magnitude of the transport gap, E@subg@ = 2 E@suba@, the magnitude of the transport gap for Mn@sub12@-Ac (0.37 eV), V@sub15@ (0.2 eV), and V@sub12@ (0.48 eV) compares well with optical band gap measurements@footnote 1@,@footnote 2@ thus verifying the value of transport measurements in electronic structure calculations for SMMs. These data should provide a sensitive basis for comparing the various theoretical calculations and, thus, for understanding the electronic structure of these materials. @FootnoteText@ @footnote 1@ S.M. Oppenheimer, A.B. Sushkov, J.L. Musfeldt, R.M. Achey, and N.S. Dalal, Phys. Rev. B 65, 054419 (2002).@footnote 2@ J.Choi, L.A.W. Sanderson, J.L. Musfeldt, A. Ellern, and P. Kogerler, Phys. Rev. B 68, 064412 (2003). .

2:40pm **MI-ThA3 High Frequency Investigations of Molecular Nanomagnets by use of a Broadband SQUID-Detected Electron Paramagnetic Resonance Probe**, ***B. Cage****, S.E. Russek,* National Institute of Standards and Technology*; D. Zipse, J.M. North, N.S. Dalal,* Florida State University **INVITED**

We are synthesizing and characterizing (by use of high frequency electron paramagnetic resonance (HFEPR)) molecular nanomagnets (magnetic molecules < 2 nm that behave as single molecule magnetic domains) for high-frequency spintronics applications. We will discuss current efforts to examine the magnetic susceptibility of these nanomagnets as 2-dimensional films vs the 3-dimensional bulk behavior of aligned single crystals. HFEPR data at 95 and 141 GHz, with magnetic resonance fields ranging from 0 - 12 Tesla indicate potential as tunable high-frequency low-applied-field oscillators from 5 - 80 K. This work represents some of the highest temperatures at which these magnets have been characterized, which is of importance for practical spintronics applications. To complement this work we have developed a new experimental technique that uses SQUID detection of the magnetic susceptibility as a function of applied magnetic field through the EPR transition at resonance frequencies > 60 GHz and magnetic fields up to 5 Tesla. One advantage over conventional EPR being the quantitative determination of the level of saturation. We will present data on the large electronic spin (S) S=10 molecular nanomagnet Fe8 that discretely identifies the spin-lattice-relaxation time, T1, of the individual ms quantum spin states. This is in contrast to the current non-resonant techniques, such as AC susceptibility, that only provide information on the global T1 properties averaged across all states.

3:20pm **MI-ThA5 Spin-Dependent Tunneling through Molecules**, ***A.N. Pasupathy****,* Cornell University **INVITED**

We discuss two experiments involving spin-polarized tunneling through molecules. In the first experiment, we study nickel tunnel junctions made using a self-assembled-monolayer of octanethiol as a molecular barrier. The devices exhibit significant magnetoresistance, demonstrating that low-energy electrons can traverse the molecular barrier while maintaining spin coherence. In the second experiment, we measure Kondo-assisted tunneling via a carbon-60 molecule in contact with ferromagnetic nickel electrodes. We find that the Kondo peak in the differential conductance is split, by an amount that decreases as the magnetic moments in the two electrodes are turned from parallel to antiparallel alignment. We observe large negative values of the junction magnetoresistance due to the presence of the Kondo effect. @Footnotetext@In collaboration with J. R. Petta, S. R. Slater, R. C. Bialczak, J. Martinek, J. E. Grose, L. A. K. Donev, P. L. McEuen, D. C. Ralph

4:00pm **MI-ThA7 Excitation of Microscopic Spin Waves in Ultrathin Films by Spin-Polarized Electron Energy Loss Spectroscopy**, *R. Vollmer, W. Tang,* ***M. Etzkorn****, P.S.A. Kumar,* Max Planck Institute of Microstructure Physics, Germany*; H. Ibach,* Institute for Surfaces and Interfaces, Germany*; J. Kirschner,* Max Planck Institute of Microstructure Physics, Germany **INVITED**

The properties of long wavelength spin waves have been investigated since decades by ferromagnetic resonance (FMR), Brillouin light scattering (BLS) and more recently by time domain optical techniques. The properties of these spin waves are determined largely by macroscopic and static quantities like the magnetization and anisotropy energies. In bulk materials inelastic magnetic neutron scattering can be used to measure microscopic spin waves with wavelength of atomic dimensions. We have shown recently that spin polarized electron energy loss spectroscopy (SPEELS) can be used to study these microscopic spin waves in ultrathin films up to the surface Brillouin zone boundary@footnote 1@. Up to now we have investigated ultrathin films of fcc Co, hcp Co, fcc Fe, fcc Fe, and bcc Fe on various substrates. In most cases the spin wave excitation can be observed as well pronounced peak in the loss spectrum. In this case, the acoustic spin wave branch of the surface spin wave mode can be described surprisingly well by a simple nearest-neighbor Heisenberg model. Nevertheless, the spectra indicate the itinerant character of the spin waves as discussed in Ref.@footnote 2@. The acoustic branch is significantly broadened and no clear indication of an optical mode (expected from a Heisenberg model) could be observed up to now. The spin wave peaks are visible in the SPEEL spectrum only for low (<10 eV) energies of the incident electrons. @FootnoteText@ @footnote 1@ R. Vollmer, M. Etzkorn, P.S. Anil Kumar, H. Ibach, and J. Kirschner, Phys. Rev. Lett. 91, 147201 (2003).@footnote 2@ A. T. Costa, Jr., R. B. Muniz, D. L. Mills, Phys. Rev. B 69, 064413 (2004).

4:40pm **MI-ThA9 Ferromagnetic Resonance: An Ultimate Tool to Study the Dynamical Response of Nanostructured Magnetic Systems**, ***J. Lindner****,* Universität Duisburg-Essen, Germany*; K. Baberschke,* Freie Universität Berlin, Germany*; M. Farle,* Universität Duisburg-Essen, Germany **INVITED**

Ferromagnetic resonance (FMR) measurements probe the dynamical response of magnetic systems subsequent to an excitation within the microwave regime. Due to the high sensitivity of FMR this technique is well suited for the investigation of nanostructures and ultrathin magnetic films or multilayers@footnote 1@. As the resonance condition is determined by internal fields in the sample like anisotropy fields or interlayer coupling fields within layered structures, FMR experiments give a direct access to these quantities based on an analysis that uses the Landau-Lifshitz equation of motion. This will be demonstrated for the case of Ni/Cu/Ni and Ni/Cu/Co films grown epitaxially on Cu(100) subtrates. A unique possibility to grow and measure the films within an ultrahigh vacuum environment allows to stepwise study the layered structures and, thus, also to investigate the effect of capping layers. Besides investigating the FMR resonance field a careful analysis of the FMR linewidth yields information about relaxation processes within the magnetic system. From frequency dependent experiments we show for the case of Fe/V multilayers that a purely Gilbert-like damping term is not sufficient to explain the observed values of the linewidth@footnote 2@. In this system the relaxation is strongly influenced by the decay of the uniform precession mode due to two-magnon processes. Finally, also within laterally structured systems FMR can be applied to study magnetic properties. This is demonstrated for the case of monodisperse Co/CoO core/shell particles of about 10nm diameter, for which the temperature dependence of the anisotropy energy is discussed. @FootnoteText@ @footnote 1@ J. Lindner, K. Baberschke, J. Phys.: Condens. Matter 15, R193 (2003); S465 (2003).@footnote 2@ J. Lindner, K. Lenz, E. Kosubek, K. Baberschke, D. Spoddig, R. Meckenstock, J. Pelzl, Z. Frait, D. L. Mills, Phys. Rev. 68, 060102(R) (2003).

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