Magnetic Interfaces and Nanostructures
Room 206 - Session MI+NS+NANO 6-ThM

Nanomagnetism
Moderator: P.N. First, Georgia Institute of Technology

8:20am **MI+NS+NANO 6-ThM1 New Directions for Semiconductors*, D.D. Awschalom*[1]**, UC Santa Barbara **INVITED**
PLEASE SEND US AN ABSTRACT. Thank you.

9:00am **MI+NS+NANO 6-ThM3 Electron Spin Relaxation at Nanometer Length Scales Near a Ferromagnet*, B.C. Stipe*,** *D. Rugar, H.J. Mamin, C.S. Yannoni,* IBM Almaden Research Center*; T.D. Stowe, T.W. Kenny,* Stanford University
Long spin relaxation times will be important to the success of many proposed solid-state quantum computing devices, spintronic devices, and to the detection of single spins by magnetic resonance force microscopy (MRFM). However, spin relaxation may be strongly influenced by thermal magnetic fluctuations in nearby materials such as conductors and ferromagnets. We have employed MRFM with 100 spin sensitivity and 20 nm spatial resolution to study the behavior of E' centers in SiO@sub 2@ near a micron-size ferromagnetic PrFeB particle tip. Magnetic resonance was induced within a 1 nm thick selective slice at 6 GHz and 3 Kelvin in a field gradient of 1 Gauss/nm. For detection, spins were manipulated by adiabatic inversion to produce oscillatory forces on the magnetic particle mounted on a sensitive cantilever. A typical spin ensemble consisted of 2000 spins with a net polarization of 100 µ@sub B@. T@sub 1@ was measured as a function of distance from the tip and was found to systematically decrease from 13 seconds when the spins were far from the tip to about 2 seconds within 500 nm of the tip. We interpret our results in terms of magnetic noise at the spin due to small-angle, thermal magnetic moment fluctuations in the particle. No relaxation effect due to proximity to the sample surface was found for depths greater than 50 nm. This work is supported, in part, by the Office of Naval Research.

9:20am **MI+NS+NANO 6-ThM4 Ferromagnetic Resonance of Monodisperse Co Particles*, M. Farle*,** *U. Wiedwald,* Technische Universitaet Braunschweig, Germany*; M. Hilgendorff, M. Giersig,* Hahn-Meitner-Institut Berlin, Germany
Quasi- twodimensional regular arrays of monodisperse 6 nm diameter Co particles can be produced on Carbon substrates by a monophoretic deposition technique from colloidal suspensions. Transmission electron microscopy reveals hexagonal ordering on micrometer scales for deposition at 0.8 Tesla and a bcc crystalline structure of the particles.@footnote1@ Ferromagnetic resonance (FMR) spectra at 296 K show a weak angular dependence near the paramagnetic resonance field with an easy in-plane magnetization axis . This shows a preferential alignment of the superparamagnetic particles in the film plane. A symmetric lineshape and linewidth dH < 0.1 Tesla is observed which indicates the high monodispersity in magnetic and geometric properties of the individual particles. Characteristic differences of the FMR spectra for different substrates and deposition parameters are observed and will be discussed in terms of simple dipolar coupling models. Supported through EC - grant no. HPRN-CT-1999-00150. @FootnoteText@ @footnote 1@ M. Giersig and M. Hilgendorff, J. Phys. D: Appl. Phys. 32 (1999) L111.

9:40am **MI+NS+NANO 6-ThM5 Magnetic Mirages*, H.C. Manoharan*,** *C.P. Lutz, D.M. Eigler,* IBM Almaden Research Center **INVITED**
While the correlated electron physics underlying the diverse manifestations of magnetism and spin have long been studied via macroscopic behavior, only recently have novel local probes opened the door to a new class of studies on the nanometer length scale. On top of these technological advances, the advent of controlled atomic and molecular manipulation provides a unique opportunity not only to detect spin phenomena at atomic length scales, but to manipulate spins as well. This talk will detail new results that exploit these techniques using low-temperature scanning tunneling microscopy.@footnote 1@ We have directly imaged the electronic perturbation arising from the spin-compensation cloud formed around isolated magnetic moments on a metal surface. Utilizing the detection of this many-body state, known as the Kondo resonance, we demonstrate that the spectroscopic signature of an atom may be sampled and projected to a remote location by means of a surrounding two-dimensional electron gas confined in an engineered nanostructure. The ``quantum mirage'' thus cast by a single magnetic atom can be coherently refocused at a distinct point where it is detected as a phantom atom around which the electronic structure mimics that at the real atom. Once materialized, this phantom can interact with real matter in intriguing ways. We have also been developing a novel communication method based on this effect. @FootnoteText@ @footnote 1@ H. C. Manoharan et al., Nature 403, 512 (2000).

10:20am **MI+NS+NANO 6-ThM7 Correlation of Structural and Magnetic Properties of Ultra-Thin Fe-Films on W(110) by Spin-Polarized STM/STS*, A. Kubetzka*,** *O. Pietzsch, M. Bode, R. Wiesendanger,* University of Hamburg, Germany
To investigate magnetism at the nm-scale and to improve the understanding of its underlying principles, a magnetic imaging technique with ultra-high resolution is of vital importance. Recently, spin-polarized scanning tunneling microscopy/spectroscopy has been developed to a reliable tool to allow such investigations down to the atomic level.@footnote 1,2@ We investigated Fe-films on W(110) at T = 15 K in a coverage range of 1 to 2 ML. In this regime Fe grows as double layer islands interconnected by a closed ML, where the island size can be tuned by the amount of evaporated Fe. By using ferromagnetically coated tips with a magnetization direction along the tip axes, we are sensitive to the out-of-plane component of the sample magnetization. Our measurements reveal that above a critical width of about 2.5 nm along the [1-10] direction, the islands are magnetized perpendicularly to the film plane. Below this width we do not observe a magnetic contrast which we attribute to a reorientation of magnetization to in-plane. Whereas the small perpendicularly magnetized islands are in a single domain state, we observe domain walls above a coverage of 1.5 ML, with wall widths of w = 7±1 nm. @FootnoteText@ @footnote 1@ Pietzsch et al., Phys. Rev. Lett. 84, (2000). @footnote 2@ Heinze et al., Science (accepted).

10:40am **MI+NS+NANO 6-ThM8 Current-driven Magnetization Reversal in Nanopillars*, F.J. Albert*,** Cornell University*; J.A. Katine,* IBM Almaden*; R.A. Buhrman,* Cornell University*; R.H. Koch,* IBM Research Division*; E.B. Myers, D.C. Ralph,* Cornell University
As reported elsewhere, we have successfully fabricated functional F/N/F thin film nanopillar devices with lateral dimensions down to 60 nm, and with one ferromagnetic layer considerably thicker (magnetically harder) than the other. A substantial shape anisotropy has been introduced by patterning a 2 to 1 aspect ratio into these nanopillars. This shape anisotropy is confirmed with the behavior of the measured switching field as a function of angle to the elongated axis. The resistance of these devices shows abrupt, single-domain-like switching when the spin-polarized current flowing through the nanopillar exceeds a critical value and forces the two F layers either into parallel or anti-parallel alignment, depending on the current direction. Here we will report on the results of detailed studies of this spin-transfer switching effect as a function of magnetic field, magnetic orientation and nanopillar composition. Also we will report on the spin-transfer switching dynamics of these devices, measured by probing them with extremely short pulses of current. We are also pursuing the thickness dependence of the switching behavior and will report these results.

11:20am **MI+NS+NANO 6-ThM10 Patterning of Co/Pt Multilayers: Topological vs. Magnetic*, V. Metlushko*,** *G. Crabtree, V. Vlasko-Vlasov, P. Baldo, L. Rehn, M. Kirk,* Argonne National Laboratory*; B. Ilic,* Cornell University*; S. Zhang, S.R.J. Brueck,* University of New Mexico*; B.D. Terris,* IBM Almaden Research Center
Using magnetron sputtering for Pt and e-beam deposition for Co the [Co4/Pt10]n multilayers were prepared on a Si/SiO2 substrate. The patterning of submicron periodic arrays were done in two ways, using traditional interference- or e-beam lithography and lift-off which modulates the material composition of the film, and using 30 keV He ion irradiation through a mask which leaves the chemical composition and topography unchanged but reduces the magnetic anisotropy. The results of systematic characterization of arrays for different doses ranging from 1e15 to 5e16 ions/cm2 with SQUID magnetization to determine the magnetic anisotropy and moment size, with atomic force microscopy (AFM) and magnetic force microscopy (MFM) to determine the topography and the magnetic order in the periodic arrays, and with magneto optical imaging to visualize the moment reversal process during a magnetization cycle will be presented. @FootnoteText@ This work was supported by the U.S. DOE, BES-Materials Sciences, under contract W-31- 109-ENG-38 (V.M., G.C.) and by DARPA (S.Z., S.R.J.B.).

[1] **Featured Speaker - Science and Technology in the 21st Century**

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