Magnetic Interfaces and Nanostructures Technical Group Room 324/325 - Session MI-TuA

Emerging Materials and Hybrid Structures

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

2:00pm **MI-TuA1 Spin Transport Effects in Ferromagnetic/Superconductor Heterostructures Grown using Molecular Beam Epitaxy*, A.M. Goldman,*** *V.A. Vas'ko, K.R. Nikolaev, V.A. Larkin, P.A. Kraus,* University of Minnesota **INVITED**

Heterostructures consisting of half-metallic ferromagnetic oxides in the lanthanum manganite family and high temperature superconductors in the YBCO family have been fabricated using the technique of ozone-assisted molecular beam epitaxy, and characterized using a number of techniques. These compounds have similar perovskite lattices, and therefore can easily be formed as epitaxial heterostructures. The fabrication and characterization of these heterostructures and the physics of the interplay between ferromagnetism and superconductivity at the interface between the ferromagnet and superconductor the will be discussed. High-resolution X-ray diffractometry, Rutherford back scattering and helium ion channeling were used to characterize the composition and crystal quality of samples. Simple patterning techniques were employed to prepare configurations in which the effects of carrier injection on superconductivity and the properties of the interfaces could be investigated. Injection of carriers from the magnetic oxides, which exhibit the phenomenon of "Colossal Magnetoresistance," into high temperature superconductors was shown to lead to the suppression of superconducting properties such as critical current and critical temperature. This suggests that spin-polarized transport can be used to investigate spin-dependent electronic properties of high temperature superconductors, and opens the possibility of a new class of superconducting devices utilizing spin injection. The differential conductances of superconductor-ferromagnet interfaces were also studied. The most striking feature of these investigations was the observation of a differential conductance dip at zero bias which was a decreasing function of temperature and/or magnetic field. This phenomenon has been interpreted using a picture of Andreev reflection as a consequence of the high spin polarization of the carriers in the half-metallic ferromagnet.

2:40pm **MI-TuA3 Enhanced Curie Temperature of GdN in GdN/Fe Multilayers*, W.J. Antel Jr.,*** *F. Perjeru,* Ohio University*; W.L. O'Brien,* University of Wisconsin, Madison*; G.R. Harp,* Ohio University

Both magnetic and semiconductor systems as distinct entities have found a wide variety of applications, however work on magnetic semiconductor systems is still in its infancy. The GdN/Fe multilayer system is investigated here as a function of GdN thickness. GdN alone is a ferromagnet with a Curie temperature of 60 K. In the multilayer structure, exchange coupling between the Fe and GdN is found to drastically raise the Curie temperature. The films are grown using reactive sputtering with a N and Ar atmosphere for the GdN, and a pure Ar atmosphere for the Fe. Magnetic moment measurements, using x-ray magnetic circular dichroism, are performed at the L@sub 2,3@ edge of Fe and M@sub 4,5@ of Gd. At room temperature, the Gd is found to maintain a significant moment up to a layer thickness of 3 Å. Measurements performed at 100 K indicate a constant Gd moment of approximately 6 µ@sub B@ out to at least a thickness of 10 Å.

3:00pm **MI-TuA4 Unusual Magnetic Ordering at Room Temperature in La-Ca-Mn-O Thin Films*, S.E. Lofland*,** *V.V. Srinivasu, S.M. Bhagat, R. Shreekala, M. Rajeswari, T. Venkatesan,* University of Maryland

Epitaxial thin films with a nominal composition of La@sub 0.8@Ca@sub 0.2@MnO@sub 3@ were grown by pulsed-laser deposition with thicknesses ranging between 300 and 2600 Å. The resistivity of the as-grown films had a peak near 210 K, similar to the value found in the bulk material. Electron spin resonance studies showed the films to be magnetically very inhomogeneous with no indication of ordering above 240 K. Subsequent heat treatment of the films at 900° C for an hour in flowing oxygen led to dramatic property changes. The resistvity peak temperature increased significantly, and in most cases was above 300 K while the magnitude of the resistivity was markedly less. Resonance experiments suggested that treated films less than 1000 Å thick were paramagnetic at room temperature; however, films thicker than 1000 Å showed multiline spectra at 300 K, with at least one line resulting from a ferromagnetic spin system. In the thickest film, resonance data suggested that 10% of the film was ferromagnetic at room temperature. This is in contradiction to the accepted phase diagram ordering temperature of around 220 K and the maximum ordering temperature of 270 K for the La@sub 1-x@Ca@sub x@MnO@sub 3@ system. We discuss how these observations may be reconciled. Supported in part by the National Science Foundation under Grant No. DMR-9632521.

3:20pm **MI-TuA5 Flux Pinning in Superconductors by Arrays of Submicron Structures*, *I.K. Schuller,*** University of California, San Diego **INVITED**

We have used electron beam lithography to prepare triangular and square lattices, lines, etc. of submicrometer magnetic dots (Ni, Co, and Fe) and holes and studied their properties using a variety of techniques including magnetotransport, magnetization, Magnetic Force Microscopy and light scattering. We showed that the interaction between an ordered array of small magnetic particles and superconducting thin films leads to strong pinning effects due to the synchronized interaction with the vortex lattice. The resistivity vs. magnetic field curves present sharp minima close to the transition temperature, whereas the transport critical currents exhibit pronounced maxima. These minima and maxima appear at constant field intervals (@Delta@H), clearly related with the lattice parameter of the vortex lattice array. The angular dependence reveals that this interval @Delta@H increases with the angle between the field and the film normal (@theta@) as @Delta@H proportional to 1/cos@theta@, showing that only the perpendicular component of the magnetic field is relevant for this synchronized pinning effect. Comparisons with arrays of holes and normal submicrometric dots reveal the magnetic origin of these effects. Studies as a function of the various geometric parameters helps elucidating the pinning mechanisms involved. *Work done in collaboration with A. Hoffmann, Y. Jaccard, P. Prieto, M.-C. Cyrille, F. Sharifi, J. Martin, M. Velez, J. Nogues, J.-M. George, M. Grimsditch, M.J. Van Bael, K. Temst, C. Van Haesendonck, V.V. Moshchalkov and Y. Bruynseraede. Supported by the US-DOE and AFOSR.

4:00pm **MI-TuA7 Low-Field Magnetoresistive Properties of Manganite and Chromium Oxide Films*, A. Gupta,*** IBM T.J. Watson Research Center **INVITED**

The magnetotransport properties of the manganites has been the subject of intense research during the past few years. These oxides exhibit orders of magnitude change in resistance when subject to a magnetic field in the Tesla range. Reducing the field scale for magnetotransport has been a major goal of many research groups. We have followed two approaches in reducing the field scale in the manganites: (1) exploiting the spin-dependent scattering at grain boundaries by using polycrystalline and bi-epitaxial films for pinning the magnetic domains; and (2) fabrication of magnetic tunnel junctions, in the form of manganite/insulator/manganite structures, where the tunneling current between the ferromagnetic manganite layers depends sensitively on the relative orientation of their magnetization vectors. Both approaches benefit from the nearly half-metallic nature of the manganites and result in significant low field magnetoresistance (up to 100%) at low temperatures. Recent magnetoresistance results obtained using another half-metallic system, chromium oxide, will also be presented and the similarities and differences between the two systems will be discussed.

4:40pm **MI-TuA9 Epitaxial Growth of Co Layers on Sb-passivated GaAs(110) Substrates*, M. Martin*,** *C. Teodorescu,* LURE, Centre Universitaire Paris Sud and ICMM, France*; H. Ascolani,* Centro Atomico Bariloche, Argentina, Argentine*; J. Chrost, J. Avila, M.C. Asensio,* LURE, Centre Universitaire Paris Sud and ICMM, France

The growth of magnetic epitaxial layers on semiconductors has attracted considerably attention since it allows the integration of low dimensional magnetic materials with the silicon technology. The largest body of work has been focused to the magnetic 3d transition metals and the zinc blende semiconductors, which have similar lattice constants . In practice, however, the growth of transition metals on semiconductor substrates is difficult due to intrinsic surface states present at the gap of the semiconductors which dominate the electronic and reactivity of the interfaces. Pervious studies on Co/GaAs(110) have indicated that BCC Co can be grown epitaxially for thicknesses up to 300 Å. However, the metallic films are not flat and the As interdiffusion modifies the magnetic properties of the Co overlayer. In this work, we present new results of the growth of Co on a pervious Sb-GaAs(110) passivated surface, where the interdiffusion process is dramatically reduced and the quality of the metallic Co overlayer enhanced. The reactivity of the interface has been tested at different temperature and coverage conditions by high energy resolution synchrotron radiation photoemission and the morphology of the metallic overlayer determined by photoelectron diffraction.

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