Magnetic Interfaces and Nanostructures Technical Group
Room Hall A - Session MI-ThP

Magnetic Interfaces and Nanostructures Poster Session

MI-ThP1 Comparison of Cl@sub2@ and F@sub2@ Based Chemistries for the Inductively Coupled Plasma Etching of NiMnSb Thin Films, ***J. Hong***, *J.A. Caballero, E.S. Lambers, J.R. Childress, S.J. Pearton,* University of Florida, Gainesville

Plasma etching chemistries based on BCl@sub3@/Ar, BCl@sub3@/H@sub2@ and NF@sub3@/Ar were studies for patterning NiMnSb Heusler Alloys thin films and associated Al@sub2@O@sub3@ barrier layers under Inductively Coupled Plasma. Using BCl@sub3@/Ar discharges, high etch rates (@>=@1µm) were achieved either at high source power (1000W) or high dc self bias (-300V) and etch rates showed a strong dependence upon source power, ion energy and gas composition. Hydrogen addition to the BCl@sub3@ created new species (HCl) in the plasma, leading to the fast etching for NiMnSb, in contrast to the situation of Ar addition. Selectivities of @>=@8 for NiMnSb over Al@sub2@O@sub3@ were obtained in BCl@sub3@-based discharges. On the other hand, NF@sub3@/Ar discharges provided a narrow process window for the etching of NiMnSb and etch rates of NiMnSb were much lower compared to BCl@sub3@. The surface of NiMnSb etched with NF@sub3@/Ar was smoother with RMS surface roughness of 1.4nm measured by Atomic Force Microscopy than the surface produced with BCl@sub3@/Ar. In terms of near surface chemistry, etched surface with NF@sub3@/Ar revealed Mn-enriched, indicating the existence of involatile Mn etch products, whereas Mn-deficiency at the near surface was obtained with BCl@sub3@/Ar.

MI-ThP2 Magnetic Moment of fcc Fe in [Fe/Pd@sub x@Rh@sub 1-x@] Multilayers, ***T. Lin***, *M.A. Tomaz,* Ohio University*; W.L. O'Brien,* University of Wisconsin, Madison*; T.K. Sham,* University of Western Ontario, Canada*; G. Retzlaff,* University of Wisconsin, Madison, US*; G.R. Harp,* Ohio University

Results are presented of the magnetic state of fcc Fe in [Fe/Pd@sub x@Rh@sub 1-x@ 10Å] superlattices with x = 0-100%. It was found that 10Å Fe layers have an fcc structure and undergo a magnetic phase transition from paramagnetic to ferromagnetic with increasing x. Its magnetic moment increases to a maximum near x=50%, and then decreases monotonically with increasing x. For thicker Fe layers, a similar behavior is observed, except that the magnetic phase transition can be suppressed. This behavior is explained in terms of small structural variations of the superlattices due to the different lattice constants of Pd and Rh. The sample structures are characterized using x-ray diffraction, and are characterized magnetically using magneto-optic Kerr effect magnetometry and x-ray magnetic circular dichroism.

MI-ThP3 Interface Alloying and Deterioration of the Magnetic Properties in Co/Cu(001), *S. van Dijken, L.C. Jorritsma,* ***T. de Vries***, *B. Poelsema,* University of Twente, The Netherlands

The initial growth of Co-films on Cu(001) and their magnetic properties are studied in a wide temperature range using helium diffraction (TEAS), high resolution low energy electron diffraction (SPA-LEED) and sensitive magneto-optical (SMOKE) measurements. TEAS shows that first an almost perfect bilayer is grown even at relatively low temperatures (250 K). Its microcopic origin is discussed. SPA-LEED data reveal a distinct anomaly in the temperature dependence of the island separation occurring at about 325 K, where the drastic decrease of the separation and a clear broadening of the separation distribution function is attibuted to an increased interface alloying. This morphological change coincides with a substantial decay of the Curie temperature, Tc, of a 2 ML thick Co film as detected with SMOKE measurements and compared to those found for films grown between 250 and 300 K. A lower Tc is also found for different reasons (film roughness!) at deposition temperatures below 225 K.

MI-ThP4 Unique Photoelectron Spectrometers for Spin-Polarized Photoemission Studies, ***G.D. Waddill***, *A. Jones, T.R. Cummins,* University of Missouri, Rolla*; J.G. Tobin,* Lawrence Livermore National Laboratory*; S.R. Mishra,* Virginia Commonwealth University*; D.P. Pappas,* National Institute of Standards and Technology*; R. Negri, E. Peterson,* Physical Electronics, Inc.*; R. Gunion,* ESG Consulting*; M. Hochstrasser, R.F. Willis,* Pennsylvania State University

The design and performance of two novel photoelectron spectrometers for elementally-specific spin-polarized measurements of magnetic surfaces and thin films are presented. Both instruments combine a large diameter hemispherical electron energy analyzer with a unique electron detection scheme that can be switched in situ between spin-dependent and spin-independent measurements. Spin-polarization is determined by use of a mini-Mott detector. Spin-independent measurements can be made using an energy dispersive multi-channel electron detection scheme. One instrument has a fixed angle between the incident photons and the detected photoelectrons, while use of a novel electron lens system enables this angle to be varied through a wide range for the second instrument. Both instruments are based at the Advanced Light Source (the fixed angle instrument at the Spectromicroscopy Facility, and the variable angle instrument at the Elliptically Polarized Undulator). Results of preliminary investigations of both magnetic and nonmagnetic materials using variants of magnetic x-ray linear and circular dichroism will be presented. The work at UMR and PSU was supported by the Department of Energy, Office of Basic Energy Sciences (DE-FG02-96ER45595). The work at LLNL was performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under contract number W-7405-ENG-48. The Spectromicroscopy Facility, the Elliptically Polarized Undulator, and the Advanced Light Source were constructed and are operated with the support of the Department of Energy, Office of Basic Energy Sciences.

MI-ThP5 Minor Loops in a Bimodal Magneto-Optical Medium, ***R.A. Fry***, *L.A. Bennett, E. Della Torre,* The George Washington University

Bimodal magnetic behavior was recently encountered in a (0.3nm Co/1.2nm Pt)@sub 15@ multilayer magnetic film with perpendicular magnetization by using an automated magneto-optical Kerr effect (MOKE) magnetometer.@footnote 1@ In the two separate magnetic transitions, differences in the ratio of the Kerr rotation to ellipticity were noted. To explain this behavior, it was postulated that there are two different magnetic entities (layers) in this material, each with a characteristic switching field, Kerr rotation, and Kerr ellipticity. To further investigate the magnetization behavior in this material, including magnetic exchange interactions between the two magnetic species, a series of minor loop experiments was performed. From the major loop data, two critical switching field values were observed, H@sub K1@ and H@sub K2@, where H@sub K1@ > H@sub K2@. H@sub K1@ is the smallest reversal field required to fully saturate the material, and H@sub K2@ is the field at which the observed step in the loop occurs. From the minor loops, a third critical field is identified as H@sub K3@. The observed magneto-optical behavior can be explained by defining two interacting magnetic entities, A and B, with intrinsic coercivities, H@sub A@ and H@sub B@. H@sub K1@ is the sum of H@sub A@ and the interaction field (H@sub i@); H@sub K2@ is the sum of H@sub B@ and H@sub i@; and, H@sub K3@ is the sum of -H@sub B@ and H@sub i@. The height of the minor loop is directly related to where on the major loop the reversal is initiated. By using minor loop MO measurements, the observed bimodal magnetization behavior was decomposed into two individual loops which are mutually interacting. From this decomposition, the intrinsic coercivities of the individual magnetic entities, as well as the interaction field between them, was obtained. This paper presents the experimental data and the excellent fit to this proposed model. We thank Dr. R.F.C. Farrow for providing these samples and N.I.S.T. for financial support. @FootnoteText@ @footnote 1@R.A. Fry, L.H. Bennett, E. Della Torre, R.D. Shull, W.F. Egelhoff, Jr., R.F.C. Farrow, and C.H. Lee, to be presented at Seventh International Conference on Magnetic Recording, (1998)

MI-ThP6 X-Ray Magnetic Linear Loops (XMLL), ***M.M. Schwickert***, Ohio University*; W.L. O'Brien,* University of Wisconsin, Madison*; G.R. Harp,* Ohio University

The x-ray magnetic linear dichroism (XMLD) in absorption relies upon the dichroic contrast of two perpendicular magnetization states. We introduce a novel variation to the conventional XMLD experiment which we term XMLL. We have observed the photoabsorption of linearly polarized light while rotating the magnetizaton vector M via an applied magnetic field with frequency w. Extracting the magnetic information from the absorption background leads to the x-ray magnetic linear loops (XMLL). The presented results were obtained by using linearly polarized synchrotron radiation at the L_3 absorption edge of Fe. In accordance with the M^2 dependence of the XMLD effect, we have found that the XMLL frequency spectrum is dominated by 2w, as opposed to possible w or 4w contributions. We applied this technique to Fe/Cr(001) multilayers that are antiferromagnetically exchange coupled. In low magnetic fields when the sample is in the spin-flop state the XMLLs are inverted as compared to ferromagnetic samples, such as Fe thin films. XMLL results for these

samples are presented and we discuss applications of XMLL as a characterization tool especially suited to antiferromagnetic materials.

MI-ThP7 Nonlinear Magneto-Optical Kerr Effect in Co-Cu Nanogranular Films, ***T.V. Misuryaev***, *E.A. Ganshina, S.V. Guschin, T.V. Murzina, O.A. Aktsipetrov,* Moscow State University, Russia

Magnetic nanostructures and surfaces of magnetic materials have attracted a lot of attention recently because of the observation of new magnetic effects which are not observed in the bulk materials. Apart from magnetic phenomena such as giant magnetoresistance and oscillatory coupling through nonmagnetic spacers magnetic nanostructures can reveal significant nonlinear-optical effects induced by magnetization, e.g. the giant nonlinear magneto-optical Kerr effect (NOMOKE). Magnetization induced optical second harmonic generation (MSHG) has been demonstrated to be effective, sensitive and versatile probe of macroscopic magnetic properties of surfaces and buried interfaces. In this paper both magneto-optical Kerr effect (MOKE) and NOMOKE are studied in granular films composed by nanocrystals of Co in Cu matrix. The samples of Co-Cu granular films were prepared by the co-deposition of Co and Cu on fused quartz substrate. The films thickness is about 200 nm. The mean size of Co nanocrystals is about 60 nm for the Co@sub 0.42@Cu@sub 0.58@ film measured by STM technique. The output of a Q-switched YAG:Nd@super +3@ laser at 1064 nm, with a pulse duration of 15 ns and an intensity of 2 MW/cm@super 2@ is used for the MSHG studies. MOKE spectra for Co@sub 0.42@Cu@sub 0.58@ film are measured in the energy range of 1.2-3.6 eV. The azimuthal anisotropy of the SHG intensity observed can be attributed to the existence of a polar axis in the structure of the Co-Cu granular films, which gives rise to a bulk electrodipole susceptibility. This polar structure can be caused by a predominant regular asymmetry of the filmvacuum interface during film processing. MSHG is studied in the polar, longitudinal and transversal NOMOKE configurations. The magneto-induced rotation the second harmonic (SH) wave polarization, the magneto-induced shift of the SH wave phase (the MSHG interferometry) and magneto-induced changes in the SHG intensity are measured. For all configurations, the NOMOKE parameters exceed the MOKE parameters at least by an order of magnitude. The interference in the far-field region of the SH fields generated by the interface and bulk nonmagnetic and magneto-induced contributions to the nonlinear polarization is suggested as a mechanism of the NOMOKE enhancement.

Author Index

Bold page numbers indicate presenter