DS 40: Magnetism in Thin Films: Interaction Phenomena and Heterostructures

Time: Friday 12:15–14:15 Location: H 2032

Invited Talk DS 40.1 Fri 12:15 H 2032

Influence of antiferromagnetic layers on the magnetization dynamics of exchange coupled thin films — •Jeffrey McCord — Institute for Metallic Materials, IFW Dresden, Germany

The strength of unidirectional and uniaxial anisotropy fields together with the effective damping parameter in different types of polycrystalline ferromagnet/antiferromagnet (F/AF; AF:NiO, IrMn) systems is investigated as a function of AF thickness and thermal history. It is shown that, independent of the occurrence of exchange bias, higher order exchange anisotropy terms can be induced. These findings are also compared to complementary magnetic domain studies.The role of the formation of an interfacial layer on coupling, anisotropy, and magnetic damping is discussed. The data implies that the spin structure inside the antiferromagnetic layer is responsible for exchange bias and the dominating contribution to coercivity, the interfacial structure for the overall coupling. The chemical F/AF boundary structure and the thermomagnetic history is relevant and can be used to tailor precessional frequency and magnetic damping of ferromagnetic layers over a wide range.

DS 40.2 Fri 12:45 H 2032

Epitaxial $SmCo_5$/Fe/$SmCo_5$ trilayers - a model system for exchange spring media — •Volker Neu, Katrin Häfner, and Ludwig Schultz — IFW Dresden, P.O. Box 270116, 01171 Dresden, Germany

Exchange coupled hard / soft magnetic nanocomposites have recently found a renewed interest in data storage application as exchange spring media, also named exchange coupled composite (ECC). Developed formerly to improve the energy density of a hard magnetic material by an intimate, direct exchange coupling to a soft magnetic phase with high saturation polarization, as exchange spring media, the soft magnetic phase initiates the switching at moderate fields and thus enables the writability, whereas the high anisotropy of the hard phase guaranties the desired thermal stability in zero field [1]. Epitaxial $SmCo_5$/Fe bilayers and $SmCo_5$/Fe/$SmCo_5$ trilayers with tunable switching behaviour [2] constitute a well defined model system for studying of the above mentioned coupling phenomena. We present time dependent magnetization relaxation data measured at different reversal fields, which allow to compare thermal stability and switching fields for single hard layers and bilayers and trilayers with varying thickness of the soft layer.

[1] Suess et al., Appl. Phys. Lett. 87, 012504 (2005). [2] Neu et al., J. Phys. D : Appl. Phys. 39 5116 (2006).

DS 40.3 Fri 13:00 H 2032

Magnetization reversal in laser-interference patterned Co/Pd multilayer films studied by full-field Kerr microscopy — •Min-Sang Lee[1], Jie Li[1], Björn Redeker[1], Philipp Leufke[2,3], Stephen Riedel[2], Paul Leiderer[2], Johannes Boneberg[2], Manfred Albrecht[2], and Thomas Eimüller[1] — [1]Junior Research Group Magnetic Microscopy, Ruhr-University Bochum, D-44780 Bochum — [2]University of Konstanz, Department of Physics, D-78457 Konstanz, Germany — [3]Forschungszentrum Karlsruhe, Institut für Nanotechnologie, 76021 Karlsruhe, Germany

We investigate magnetization reversal processes in Co/Pd multilayer systems with strong perpendicular magnetic anisotropy which have been structured using direct laser interference patterning technique into a variety of shapes, e.g., stripes, squares, and asterisk-shaped dots. The intense laser irradiation at interference maxima causes chemical intermixing at the Co/Pd interfaces leading to the modification of magnetic properties such as the creation of pinning centres and the reduction in the strength of magnetic anisotropy. Due to this effect, different types of magnetization reversal process were observed in different sample area depending on the laser intensity at which the area was irradiated. The observation was done at our new laser Kerr microscopy setup, where a CCD camera with max. 30 fps was used for fast image acquistion. It enabled us to record motion pictures of magnetization reversals, which will be presented in this contribution. The financial support for this work has been provided by the DFG through SFB 491, SFB 513, and Emmy Noether Programme.

Invited Talk DS 40.4 Fri 13:15 H 2032

Ion Beam Induced Magnetic Nanostructures — •Peter Varga — Inst.f.Allgemeine Physik, TU Wien, Austria

For iron films with 5 to 10 layers epitaxially grown on Cu(100) stabilization of the face-centered cubic (fcc) γ-phase (which is non magnetic,) can be obtained above room temperature. This is in contrast to bulk iron for which the fcc phase is stable only above 1184 K, whereas below this temperature the body-centered cubic (bcc) α-phase (which is ferromagnetic) is thermodynamically stable. Films with more than 10 layers will exhibit a spontaneous structural transition to the bcc structure with in palne magnetization whereas below 5 layers a strained bcc structure shows an out of plane magnetic moment at room temperature[1]. We have shown by STM (Scanning tunneling microscopy) with atomic resolution and LEED (Low Energy Electron Diffraction) that this 5-10 ML thick fcc Fe films undergo a transition from fcc to bcc by ion beam irradiation. Since iron is ferromagnetic only if it is bcc or at least strained bcc but never if it is fcc[1] this gives the possibility to transform a nonmagnetic film into a ferromagnetic one directly by ion bombardment and especially to form magnetic nanostructures with a size determined by the diameter of the used ion beam only [2].

[1] A. Biedermann et al. Phys. Rev. Lett. 86 (2001), pp. 464*467 and 87 (2001) 86103 [2] W.Rupp, B.Kamenik, R.Ritter, A.Biedermann, Ch.Klein, E.Platzgummer, M.Schmid, and P.Varga, to be published

DS 40.5 Fri 13:45 H 2032

Magnetic texturing of ferromagnetic films by sputtering induced ripple formation — •Hans Hofsäss[1], Kun Zhang[1], Michael Uhrmacher[1], and Johann Krauser[2] — [1]II. Physikalisches Institut, Universität Göttingen, 37077 Göttingen — [2]Fachbereich Automatisierung und Informatik, Hochschule Harz, 38855 Werningerode

Ripple patterns created by sputter erosion of iron thin films induce a correlated magnetic texture of the surface near region. We investigated the magnetic anisotropy as a function of film thickness and determined the thickness of the magnetically anisotropic layer as well as the magnitude of the magnetic anisotropy using MOKE and RBS measurements. Ripple patterns were created by sputter erosion with 5 keV Xe ions at 80° incidence with respect to the surface normal. For ion-fluences above $1\text{x}10^{16}$ cm^{-2} ripples with wavelengths of 30 nm - 80 nm oriented parallel to the ion beam direction are observed. MOKE measurements reveal a uniaxial magnetic anisotropy of the surface region of the films with orientation parallel to the ripple orientation. The magnetic texture is confined to a 12+/-3 nm thick layer, in accordance with the average grain size. The magnetic anisotropy within this layer varies from 25% for thick films towards 100% for films with less than 30 nm thickness. The magnitude of the anisotropy is determined by the shape anisotropy of the rippled surface as well as the interface roughness. We have demonstrated that sputter erosion yields highly anisotropic magnetic thin films and can be used to fabricate nanorods and nanowires with pronounced uniaxial magnetic anisotropy.

DS 40.6 Fri 14:00 H 2032

Magnetism of the Heusler compound $Co_2Cr_{0.6}Fe_{0.4}Al$ at interfaces with Cr and AlO_x — •Martin Jourdan[1], Elena Arbelo-Jorge[1], Christian Herbort[1], Timothy Charlton[2], and Sean Langridge[2] — [1]Institut für Physik, Johannes Gutenberg Universität Mainz, 55099 Mainz, Germany — [2]ISIS facility, Rutherford Appleton Laboratory, Oxfordshire OX11 0QX, UK

$Co_2Cr_{0.6}Fe_{0.4}Al$ (CCFA) belongs to the Heusler compounds for which a huge spin polarization is theoretically predicted. However, for spintronics applications the electronic properties at the interface with insulating barriers (tunneling devices) or paramagnetic metals (spin valves) are of major importance.

We investigate the ferromagnetic moment of CCFA at interfaces with Cr and AlO_x by polarised neutron reflectometry (PNR). Fitting the reflectometry data to a model which allows layers of the CCFA with different magnetic moments compared to the bulk moment, evidence for a reduced moment in a 1-2nm interface layer of the CCFA was identified. However, the reduction is clearly smaller at the Cr interface compared to the AlO_x interface.

Additionally, at the Cr interface the best fits are obtained, if ferromagnetic order of the complete 6nm Cr layer is assumed (with $\simeq 0.3\mu_B$/Cr-atom). This surprising observation is discussed in the framework of epitaxially induced stress of the Cr layer.