MA 46: Magnetic Thin Films II

Time: Wednesday 17:00–19:15 Location: CHE 184

MA 46.1 Wed 17:00 CHE 184

Flash-lamp annealing of Fe_xPt_{100-x} films — •Christoph Brombacher[1], Marcus Daniel[1], Thomas Schumann[2], Sven Häberlein[3], Jörn Donges[4], Andreas Liebig[1], Gunter Beddies[1], Wolfgang Skorupa[2], and Manfred Albrecht[1] — [1]Chemnitz University of Technology, Institute of Physics, Chemnitz, Germany — [2]Institute of Ion Beam Physics and Materials Research, FZD, Dresden, Germany — [3]FHR Anlagenbau GmbH, Dresden, Germany — [4]HASYLAB, DESY, Hamburg, Germany

Flash-lamp annealing with annealing times in the millisecond time regime was used to transform sputter deposited Fe_xPt_{100-x} films ($42 \leq x \leq 60$) from the chemically disordered A1 phase into the chemically ordered $L1_0$ phase which exhibits a large uniaxial magnetocrystalline anisotropy. The evolution of the magnetic and structural properties upon flash-lamp annealing was investigated with respect to the chemical composition and the annealing temperature. It could be demonstrated that an annealing time of 20 ms is sufficient to induce the A1 to $L1_0$ phase transformation. The fabricated polycrystalline $Fe_{52}Pt_{48}$ films exhibit a high degree of $L1_0$ order which leads to an isotropic magnetic behavior with coercivities up to (10.4 ± 0.5) kOe. A variation of the Fe content x from $42 \leq x \leq 60$ revealed that the largest volume fraction of chemically ordered grains is formed for slightly Fe enriched Fe_xPt_{100-x} films, whereas the grain growth was observed to be independent on the chemical composition.

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MA 46.2 Wed 17:15 CHE 184

Charge-induced reversible change of magnetic properties in ultrathin FePt films — •Karin Leistner, Norman Lange, Steffen Oswald, Sebastian Fähler, and Ludwig Schultz — IFW Dresden, PF 270116, 01171 Dresden

FePt has attracted a lot of interest as hard magnetic material due its high magnetocrystalline anisotropy. For various applications fast and reversible changes of magnetic properties induced by an electric field would be ideal. Weisheit et al. [Science 315 (2007) 349] showed that the coercivity of ultrathin FePt films can be changed by 4 % by electronic charging. Larger E-field induced effects are expected at critical points. We study continuous 2 nm thin FePt(001) films where perpendicular magnetocrystalline anisotropy competes with shape anisotropy. The films are charged in an electrolyte by applying an electric voltage of 2 to 3 V vs. Li/Li+. We observe a large reversible change of anisotropy (up to 20 %). At the same time, the magnitude of the anomalous Hall effect as a measure for the moment changes up to 4 %. XPS studies showed that the effect is strongly enhanced in films with a surface iron oxide layer, but smaller in films with low oxygen content. This implies that the moment increase at lower potentials results from electrochemical reduction of surface iron oxide species to metallic iron. The corresponding decrease of perpendicular anisotropy can be attributed to soft magnetic Fe being exchange coupled to FePt. We conclude that electrical charging of exchange coupled composite films allows tuning the magnetic properties reversibly over a broad range.

MA 46.3 Wed 17:30 CHE 184

Magnetic circular dichroism in near-threshold photoemission from an ultrathin Co/Pt(111) film at variable work function — •Kerstin Hild[1], Gerd Schönhense[1], Hans-Joachim Elmers[1], Takeshi Nakagawa[2], Toshihiko Yokoyama[2], Kartick Tarafder[3], and Peter Oppeneer[3] — [1]Institute of Physics, Johannes Gutenberg University Mainz, Germany — [2]Institute for Molecular Science, The Graduate University for Advanced Studies Okazaki, Japan — [3]Department of Physics and Materials Science, Uppsala University, Sweden

In order to disentangle the magnetic dichroism effect [1], [2] of the two excitation steps in a two-photon photoemission process (2PPE) we compare measurements at different work function for the same Co/Pt(111) sample. The work function Φ is adjusted by Cs adsorption and the photon energy $h\nu$ by a tunable Ti:Sa femtosecond laser. For one-photon photoemission (1PPE) at $h\nu = 3$ eV we measure an asymmetry of 6.2 %. A 2PPE process at the same photon energy yields a value of 8.3 %. This suggests the first step to be the major asymmetry creating process. A considerably larger asymmetry (17 %) is observed for 2PPE at $h\nu = 1.5$ eV. The results are explained by interband transitions deviating from the direction of observation Γ-L. These MCD experiments suggest a paradigm shift from the classical model of photoemission that exclusively considers k|| conserving emission processes.

Funded by Carl-Zeiss-Stiftung and the Graduate School of Excellence MAINZ (Kerstin Hild) [1] T. Nakagawa and T. Yokoyama, PRL 96, 237402 (2006). [2] K. Hild et al., PRL 102, 057207 (2009).

MA 46.4 Wed 17:45 CHE 184

Anisotropic Paramagnetic Response Of $CePt_5$ Surface Alloys Studied With XMCD — •Christian Praetorius, Annemarie Köhl, Sebastian Götz, and Kai Fauth — Physikalisches Institut, Universität Würzburg, Am Hubland, 97074 Würzburg

We have investigated the magnetic response of structurally ordered $CePt_5$ surface alloys with X-ray Magnetic Circular Dichroism. Ultrathin CePt films were prepared on Pt(111) by evaporation of Cerium onto the clean surface and subsequent annealing. Depending on the initial Ce coverage these systems order in a variety of hexagonal phases which can be monitored by LEED, as shown in previous studies. Using Ce $M_{4,5}$-XMCD at normal and grazing incidence, respectively, we observe a strong anisotropy in the paramagnetic response which can be rationalized by consideration of the hexagonal crystal field. Likewise, the temperature dependence of the paramagnetic susceptibility is strongly influenced by the crystal field splitting of the Ce $4f^1$ configuration. Our measurements provide access to the relevant energy scales in these surface alloys, which prove to deviate from those known from bulk $CePt_5$. The observed behavior at the lowest accessible temperatures (12 K) is indicative of a ferromagnetic instability around 7 K. Again, this finding contrasts the behavior of bulk $CePt_5$, known to order antiferromagnetically at low temperature.

MA 46.5 Wed 18:00 CHE 184

Structure and magnetic anisotropy of Co/Pt thin films — •Gerrit Winkler[1], André Kobs[1], Wolfgang Kreuzpaintner[2], Simon Hesse[1], Dieter Lott[2], Andreas Schreyer[2], and Hans Peter Oepen[1] — [1]Institut für Angewandte Physik, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg, Germany — [2]Helmholtz-Zentrum Geesthacht, Zentrum für Material- und Küstenforschung GmbH Max-Planck-Straße 1, 21502 Geesthacht, Germany

The crystallographic properties of Co/Pt multilayer films were studied using x-ray reflectometry and x-ray diffraction in order to understand the magnetic anisotropy. The texture of the multilayers depends on substrate. For multilayers on natural oxidized Si the strongest texture is found. The interface quality is almost the same for all substrates. We find a small interface roughness of about one atomic layer while intermixing of Co and Pt appears to a certain amount. The magnetic anisotropy has been investigated by means of the magneto-optic Kerr effect. From the variation of the magnetic anisotropies on Co thickness we determine the volume and interface anisotropy contribution. For multilayers grown on natural oxidized Si we find the highest interface anisotropy while the volume anisotropy is strongest for systems on SiN. The behavior of the magnetic anisotropy is discussed in the framework of the structural results.

MA 46.6 Wed 18:15 CHE 184

Anisotropic interface magnetoresistance in Co/Pt — •André Kobs[1], Simon Hesse[1], Wolfgang Kreuzpaintner[2], Gerrit Winkler[1], Dieter Lott[2], Andreas Schreyer[2], and Hans Peter Oepen[1] — [1]Institut für Angewandte Physik, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg, Germany — [2]Helmholtz-Zentrum Geesthacht, Zentrum für Material- und Küstenforschung GmbH Max-Planck-Straße 1, 21502 Geesthacht, Germany

We report on a magnetoresistance (MR) effect which was detected in sputter-deposited and electron-beam evaporated Co/Pt films in the temperature range from 4.2 to 300 K. In contradiction to the anisotropic MR (AMR) in bulk materials, different values of the resistivity for magnetization in-plane (ρ_t: transverse resistivity) and perpendicular to the film plane (ρ_p: polar resistivity) - while perpendicular to the current - are found with $\rho_p > \rho_t$. To investigate the physical origin of the magnetoresistance anisotropy we systematically varied the Co layer thickness of sputter-deposited Pt/Co/Pt sandwiches from 0.8 to 50 nm. The results reveal an enhancement of the absolute diffusive

scattering probability at the interface of 4% when the magnetization is rotated from the transverse to the polar geometry. In the thin film regime this *anisotropic interface magnetoresistance* (AIMR) is as large as the AMR. This result has a drastic implication on the interpretation of measurements of the *intrinsic* domain wall resistance in Co/Pt. To confirm the transport investigation the structural properties of the films are determined by x-ray reflectivity and diffraction.

MA 46.7 Wed 18:30 CHE 184

Metamagnetism in epitaxial $BaFe_{1.8}Cr_{0.2}As_2$ thin films — •Jan Engelmann, Silvia Haindl, Karl-Hartmut Mueller, Kazumasa Iida, Konstantin Nenkov, Ludwig Schultz, and Bernhard Holzapfel — IFW Dresden

The itinerant magnetic behaviour has attracted wide interest within the newly discovered Fe-based superconductors. To study the influence of Cr doping on $BaFe_2As_2$ we prepared epitaxial thin films of $BaFe_{1.8}Cr_{0.2}As_2$ on single crystalline (La,Sr)x(Al,Ta)O_3 (LSAT) substrates under ultra high vacuum conditions by pulsed laser deposition. Magnetic measurements were performed using a vibrating sample magnetometer. A metamagnetic transition was observed at low temperatures and fields above 4 T.

MA 46.8 Wed 18:45 CHE 184

Sabilization of Skyrmion textures in thin layers of cubic helimagnets — •Anna B. Butenko, Andrei A. Leonov, Ulrich K. Rössler, and Alexei N. Bogdanov — IFW Dresden

In cubic noncentrosymmetric ferromagnets, uniaxial distortions effectively suppress one-dimensional modulations (helical states) and stabilize Skyrmion lattices in a broad range of thermodynamical parameters [1]. Recently the first direct observations of Skyrmion states have been reported in $Fe_{0.5}Co_{0.5}Si$ nanolayers [2]. In this contribution we develop a phenomenological theory of chiral modulations in thin layers of cubic helimagnets and demonstrate that hexagonal Skyrmion lattices in (Fe,Co)Si layers [2] are stabilized due to a combined effect of surface induced unaxial anisotropy and an applied magnetic field. We derive the equilibrium parameters of the Skyrmion and helical states as functions of the applied magnetic field and induced uniaxial anisotropy and construct the magnetic phase diagram which allows to formulate practical recommendations how to stabilize Skyrmion states at low temperatures in MnSi, FeGe, (Fe,Co)Si and similar intermetallic compounds with B20 structure.

[1] A.B. Butenko et al., Phys. Rev. B **82** (2010) 052403; U. K. Rößler et al. arXiv:1009.4849.

[2] X.Z. Yu et al., Nature **465** (2010) 901.

MA 46.9 Wed 19:00 CHE 184

Effect of anisotropic lattice changes on ferromagnetic order in $Sr_{1-x}Ca_xRuO_3$ — •Markus Wissinger[1], Dirk Fuchs[1], Levin Dieterle[2], Harald Leiste[3], Rudolf Schneider[1], Dagmar Gerthsen[2], and Hilbert v. Löhneysen[1,4] — [1]Karlsruher Institut für Technologie, Institut für Festkörperphysik, 76021 Karlsruhe, Germany — [2]Karlsruher Institut für Technologie, Laboratorium für Elektronenmikroskopie, 76131 Karlsruhe, Germany — [3]Karlsruher Institut für Technologie, Institut für Materialforschung, 76131 Karlsruhe, Germany — [4]Karlsruher Institut für Technologie, Physikalisches Institut, 76131 Karlsruhe, Germany

Thin films of $Sr_{1-x}Ca_xRuO_3$ were prepared on (001) oriented $SrTiO_3$ and $(La_{0.3}Sr_{0.7})(Al_{0.65}Ta_{0.35})O_3$ single crystal substrates via pulsed laser deposition. The films experience epitaxial strain ranging from compressive to tensile. Increasing compressive strain leads, independently of the Ca content x, to a shrinking unit cell volume. For constant x, compressive (tensile) strained films showed a decrease (increase) of the ferromagnetic Curie temperature, T_C, compared to the bulk value. The strain induced reduction of T_C was found to be strongly correlated to the decrease of the unit-cell volume V_{UC}, i. e., $\partial T_C/\partial V_{UC} \approx 26.2\,K\mathring{A}^{-3}$, nearly independent of x. Surprisingly, the anisotropic biaxial strain in our films leads to almost the same value of $\partial T_C/\partial V_{UC}$ that has been deduced for bulk $SrRuO_3$ under isotropic hydrostatic pressure.