MA 26: Magnetic Thin Films I of 2

Time: Wednesday 9:30–12:15 Location: H3

MA 26.1 Wed 9:30 H3

Study of magnetization reversal in laterally patterned and continuous thin films via AC-Polarized neutron reflectometry. — •Dmitry Gorkov, Kirill Zhernenkov, Boris Toperverg, and Hartmut Zabel — Institute for Experimental Condensed Matter Physics, Ruhr University Bochum, 44780 Bochum, Germany

Among a number of techniques applied to study magnetization reversal processes in micro- and nanostructures, Polarized Neutron Reflectometry (PNR) is recognized as a unique and powerful tool providing access to depth and laterally resolved magnetization profile. Here we report on further advances of PNR being employed to retrieve information on the magnetization vector time evolution under AC magnetic field. We will show that PNR provides a possibility to distinguish between magnetization reversal driven by the domain wall (DW) nucleation, propagation and annihilation, and coherent magnetization rotation. We argue that additional information on lateral domain formation in individual patterned islands, as well as on magnetization correlations between different islands, can be obtained from off-specular scattering collected simultaneously with specular reflectivity. AC PNR studies were conducted on a set of continues Py films and those laterally patterned into periodic stripe arrays subjected to AC magnetic filed with frequencies up to 1.2 MHz and amplitudes up to 120 Oe. Measurements were carried out with a newly developed AC-PNR set up implemented on the Super ADAM reflectometer at the ILL, France [1,2]. Experimental results on domain kinetics under AC fields will be thoroughly discussed within the frameworks of current theoretical models.

MA 26.2 Wed 9:45 H3

Stretchable Magnetoelectronics for Smart Skin Applications — •Michael Melzer[1], Denys Makarov[1], and Oliver G. Schmidt[1,2] — [1]Institute for Integrative Nanosciences, IFW Dresden, Helmholtzstraße 20, 01069 Dresden, Germany — [2]Material Systems for Nanoelectronics, Chemnitz University of Technology, Reichenhainer Straße 70, 90107 Chemnitz, Germany

Realization of smart skins and interactive textiles fully relies on the development of flexible and stretchable electronics. Ideally, all components should be elastic and withstand many cycles of deformations without degrading in performance.

In this work, we introduce the world's first elastically stretchable spin valves [1], that outperform classical elements relying on giant magnetoresistive multilayers in terms of sensitivity (0.8% /Oe at 12 Oe), stretchability (up to 29%) and cyclic loading stability (>500 cycles). Their superior performance relies on the combination of random wrinkling and a unique periodic fracture mechanism, that introduces a highly stretchable meander-like structure into the functional magnetic nanomembranes. The possibility of a direct transfer of magnetic sensorics from rigid supports to soft membranes will be in the scope of the presentation. This renders magnetoelectronics to be fully integrated into stretchable electronics systems to equip them with magnetic functionalities. The work was supported in part by the German federal ministry of education and research (project Nanett; FKZ: 03IS2011).

[1] M. Melzer et al., Adv. Mat. DOI: 10.1002/adma.201201898 (2012).

MA 26.3 Wed 10:00 H3

Pattern formation in the dipolar Ising model on a two-dimensional honeycomb lattice — •Robert Rüger and Roser Valentí — Institut für Theoretische Physik, Goethe-Universität Frankfurt, Max-von-Laue-Straße 1, 60438 Frankfurt am Main, Germany

The two-dimensional Ising model with ferromagnetic nearest-neighbor interactions and long-range antiferromagnetic interactions is probably the simplest model system for the formation of magnetic domains. We present Monte Carlo simulation results for such a system on the honeycomb lattice and compare those to the known case of the square lattice in order to investigate the underlying lattice's influence on the formation of magnetic domain patterns. To deal with the long-range nature of the dipolar interaction we also present a simple method of evaluating effective interaction coefficients, which can be regarded as a more straightforward alternative to the prevalent Ewald summation techniques.

MA 26.4 Wed 10:15 H3

La_2CrWO_6: A Possible Antiferromagnet Half-Metal — •Mehran Vafaee, Mehrdad Baghaie Yazdi, Vikas Shabadi, Philipp Komissinskiy, and Lambert Alff — Institute of Materials Science, Technische Universität Darmstadt, Petersenstr. 23, 64287 Darmstadt, Germany

Half-metallic antiferromagnets, materials with zero net magnetization and 100% spin polarization of charge carriers, are promising for spintronic applications, but have never been synthesized up to now. La_2CrWO_6 with d^3-d^3 configuration has been suggested as a strong candidate based on density functional theory [1]. However, due to the unusual valence state of W^{3+}, this material is thermodynamically unstable. For the first time, we report the thin film synthesis of La_2CrWO_6 by pulsed laser deposition. X-ray absorption spectroscopy at the Cr K-edge and W $L_{2,3}$-edges show +3 valence state for Cr and a mixed valence state of +3 / +5 for W. X-ray linear dichroism confirms undistorted Cr octahedra symmetry. The magnetization shows *ferri*magnetic instead of antiferromagnetic behavior. X-ray magnetic dichroism measurements indicate that antisite disorder is responsible for the reduced W magnetic moment. Thus, suppression of antisite disorder is an important strategy to obtain half-metallic antiferromagnets in double perovskites.

[1] V. Pardo and W. E. Pickett, Phys. Rev. B **80**, 054415 (2009).

MA 26.5 Wed 10:30 H3

Magnetic properties of Fe_xMn_{1-x}/Ni bilayers: an ab initio study — •Svitlana Polesya[1], Sergiy Mankovsky[1], Hubert Ebert[1], Wolfgang Kuch[2], and Jan Minar[1] — [1]Universität München, Department Chemie, Butenandtstr. 5-13, D-81377 München, Germany — [2]Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, D-14195 Berlin, Germany

The TB-KKR Green's function method is used for an ab initio investigation of thin antiferromagnetic Fe_xMn_{1-x} films deposited on a ferromagnetic (FM) Ni substrate. The calculations were performed for the Fe concentration x from 40 to 60 %. It is shown that the ground state magnetic structure of Fe_xMn_{1-x} films on FM Ni depends weakly on the concentration x but is modified essentially upon the change of the film thickness. Using the exchange coupling parameters evaluated on the basis of the selfconsistent electronic structure, the Neél temperature (T_N) of the Fe_xMn_{1-x} films is calculated by means of Monte Carlo simulations. In good agreement with experiment[1] T_N increases with increasing film thickness but exibits a much weaker dependence on the concentration x. The influence of the in-plane and out-of-plane magnetization direction of FM Ni on the magnetic structure and T_N of Fe_xMn_{1-x} films is also discussed.

[1]. M. Stampe, P. Stoll, T. Homberg, K. Lenz, W. Kuch, PRB **81**, 104420 (2010).

15 min. break

MA 26.6 Wed 11:00 H3

High TMR ratio in Co_2FeSi and Fe_2CoSi based magnetic tunnel junctions — •Christian Sterwerf[1], Markus Meinert[1], Manuel Glas[1], Jan-Michael Schmalhorst[1], Günter Reiss[1], and Elke Arenholz[2] — [1]Thin Films and Physics of Nanostructures, Department of Physics, Bielefeld University, 33501 Bielefeld, Germany — [2]Lawrence Berkeley National Laboratory, Berkeley, California 94720, USA

Co and Fe based Heusler compounds are promising materials for spintronic applications, especially because of their high magnetic moments and their high Curie temperatures. More recently, inverse Heusler compounds such as Fe_2CoSi have been proposed as half-metallic electrode materials. [1]

Epitaxial $Co_{2-x}Fe_{1+x}Si$ thin films with x ranging from 0 to 1 were prepared by DC and RF magnetron co-sputtering on MgO (001) substrates. The crystallographic order and the transition from regular to the inverse Heusler compound Fe_2CoSi was investigated by x-ray diffraction. The films exhibit a high degree of structural order. Soft x-ray absorption, magnetic circular dichroism (XMCD) and ferromagnetic resonance (FMR) measurements were performed to determine the magnetic properties.

Magnetic tunnel junctions with MgO tunneling barrier and CoFe counter electrode exhibit TMR ratios ranging up to 159% at room temperature.

[1] Luo *et al.*, JPD 40, 7121 (2007)

MA 26.7 Wed 11:15 H3

Stoichiometric variations of $[La_{2/3}Sr_{1/3}]_{n\pm1}Mn_nO_{3n\pm1}/SrTiO_3$ — •Alexandra Steffen[1], Sabine Pütter[1], Jürgen Schubert[3], Stefan Mattauch[1], and Thomas Brückel[1,2] — [1]Jülich Centre for Neutron Science JCNS, Forschungszentrum Jülich GmbH, Outstation at FRM II, Lichtenbergstr. 1, 85747 Garching — [2]Jülich Centre for Neutron Science JCNS und Peter Grünberg Institut PGI, JCNS-2, PGI-4: Scattering Methods, Forschungszentrum Jülich GmbH, 52425 Jülich — [3]Peter Grünberg Institut PGI, PGI-9: Semiconductor Nanoelectronics, Forschungszentrum Jülich GmbH, 52425 Jülich

Transition metal oxide thin films show a huge variety of fascinating phenomena like ferromagnetism at interfaces of non-magnetic materials as found in $SrTiO_3/KTaO_3$[1]. By oxide Molecular Beam Epitaxy we achieve high quality epitaxial films with exact composition control. Here, we compare single layers of $[La_{2/3}Sr_{1/3}]_1Mn_1O_3$, $[La_{2/3}Sr_{1/3}]_2Mn_3O_8$ and $[La_{2/3}Sr_{1/3}]_3Mn_2O_7$ on $SrTiO_3$. The stoichiometry was adjusted in-situ via quarz-crystal balance and cross-checked with RBS while the growth mode was monitored via RHEED. By LEED, XRR and XRD, the crystalline sample quality was studied. The magnetic properties were determined via SQUID. We report investigations of the depth-dependent distribution of magnetic moments in these layers via neutron reflectometry. At TREFF@FRM II we quantified the thickness of the magnetic dead layer[2,3] at the interface.

[1] R. Oja et al., Phys. Rev. Lett. 109, 127207 (2012) [2] M. Angeloni et a., J. Appl. Phys. 96, 6387 (2004) [3] M. Huijben et al., Phys. Rev. B, 78, 094413 (2008)

MA 26.8 Wed 11:30 H3

Out-of-plane vectorial magnetometry on a thin $(CoFe)_{77}Tb_{23}$ film investigated by a new multichromatic dual-beam magnetometer based on the magnetooptic Kerr effect — •Timo Kuschel, Gerhard Götz, Zoe Kugler, and Günter Reiss — University of Bielefeld, Germany

Magnetic thin films with out-of-plane (OOP) magnetic easy axis are key components for spintronic devices like magnetic tunnel junctions which use OOP magnetization. Current investigations focus on thin $(CoFe)_{1-x}Tb_x$ films which are partially preferred OOP magnetized.

In order to illustrate the OOP reversal process of the magnetization in such magnetic systems a detailed vectorial magnetometry study is performed on an exemplary $(CoFe)_{77}Tb_{23}$ film. A new home-built multichromatic dual-beam magnetometer is used for the measurements based on the magnetooptic Kerr effect. The components of the magnetization vector during the reversal process can be determined using s- and p-polarized incident light and varied azimuthal sample alignment with respect to the plane of incidence of light.

The results show a monodomain remanent state which is not completely OOP aligned. The observed details of the reversal process reveal a coherent rotation of the magnetization from OOP alignment (0°) in magnetic saturation to more than 45° tilting for small reversed OOP magnetic field strength. During the magnetic switching the magnetic moment of the film is decreased down to less than 25% due to domain splitting. Afterwards, the monodomain state is reached again and the magnetization rotates coherently into reversed OOP direction.

MA 26.9 Wed 11:45 H3

Influence of spin disorder on the relation between magnetic anisotropy and orbital magnetism. — •Leonid Sandratskii — Max-Planck-Institut für Mikrostrukturphysik Weinberg 2, D-06120 Halle, Germany

The close relation between the magnetic anisotropy and the anisotropy of the orbital moments is widely accepted. On the other hand, the question, how the temperature-induced spin-disorder influence the relation between magnetic anisotropy and orbital magnetism remains unknown. Using first-principles approach that takes into account both spin disordering and spin-orbit coupling we obtain principally different behavior of orbital magnetism and magnetic anisotropy for different films. While the magnetic anisotropy of the Co film tends to decrease with spin disordering, in the Fe film an opposite trend to an increase of the magnetic anisotropy is obtained. In FePt film we obtain complex interplay of the orbital and spin magnetism leading to the orthogonality of the spin and orbital moments of the Fe atoms at certain level of spin disorder. We explain the variety of behavior by different response of the electronic structure to the spin disordering and relate it to the variety of the experimentally detected temperature dependences of the magnetic anisotropy in thin films.

MA 26.10 Wed 12:00 H3

Epitaxial $DyCo_5$ thin films with magnetic compensation — •Benjamin Schleicher, Marietta Seifert, Ludwig Schultz, and Volker Neu — IFW Dresden, Institute for Metallic Materials, Dpt. Magnetic Microstructures, Helmholtzstr. 20, D-01069 Dresden

Epitaxial $DyCo_5$ thin films with a thickness of 50 nm were prepared by pulsed laser deposition from elementary targets in an UHV environment. The use of Cr-buffered MgO (110) and Ru-buffered Al_2O_3 (0001) substrates results in an in-plane and out-of-plane growth of the unit cells' crystallographic c-axis, respectively. The structural properties were investigated with XRD and texture measurements and the (1:5)-phase was confirmed through the successful verification of the appropriate XRD-peaks and pole figures. Subsequently, magnetization has been measured as a function of temperature with a 9 T vibrating sample magnetometer in a temperature range from 20 K to 400 K. Additionally, hysteresis loops were measured at discrete temperatures and different field angles with respect to the crystals c-axis to probe the anisotropic behavior of the samples.

The ferrimagnetic coupling between the heavy rare earth Dy and the transition metal Co was confirmed by identifying a minimum of the magnetization (and thereby of the magnetic moment) of the sample at a certain temperature (compensation point), and the value of roughly 110 K is in qualitative agreement with literature data of single crystals. In addition to that, a spin reorientation transition from easy axis via easy cone to easy plane was observed in a temperature range of 250 - 400 K.