MA 18: Magnetic Coupling Phenomena

Time: Tuesday 14:00–15:45 Location: HSZ 403

MA 18.1 Tue 14:00 HSZ 403

Exchange Bias driven by Dzyaloshinskii-Moriya interactions — •Rocio Yanes[1], Jerome Jackson[2], Laszlo Udvardi[3], Laszlo Szunyogh[3], and Ulrich Nowak[1] — [1]Universität Konstanz, Konstanz, Germany — [2]Max-Planck-Institut für Festkörperforschung, Stuttgart, Germany — [3]Budapest University of Technology and Economics, Budapest, Hungary

The exchange bias (EB) effect is an effective unidirectional anisotropy in a heterogeneous magnetic system that leads to a shift in the hysteresis loop. It is widely accepted that the EB is related to the nature of coupling between a ferromagnet (FM) and an antiferromagnet (AFM).

We studied the origin of EB in a metallic $IrMn_3$/Co(111) bilayer, using multiscale modeling, from ab-initio to localized spin model simulations. $IrMn_3$ is a frustrated antiferromagnet which presents a strong second order effective anisotropy and a high Néel temperature. It exhibits a triangular magnetic ground state within the (111) plane. When this alloy is capped by a Co layer, sizable Dzyaloshinskii-Moriya (DM) interactions arise owing to the breaking of symmetry at the interface [1]. DM interactions between the Co and Mn atoms result in an effective DM field on the Co spins, oriented normal to the interface.

A detailed analysis of the hysteresis loops reveals that the DM interactions across the $IrMn_3$/Co interface are the main source of perpendicular EB in this system [2]. This work was partially supported by the FP7-NMP-2013-EU-Japan project HARFIR.

[1] L. Szunyogh et. al., Phys. Rev. B 83, 024401 (2011).
[2] R. Yanes et. al., Phys. Rev. Lett, 111, 217202 (2013).

MA 18.2 Tue 14:15 HSZ 403

Exchange bias up to room temperature in the antiferromagnetic bulk hexagonal Mn3Ge — •Jin-Feng Qian, Ajaya Nayak, Guido Kreiner, Walter Schnelle, and Clauida Felser — Nöthnitzer Str. 40, 01187 Dresden , Germany

This work reports an exchange bias (EB) effect up to room temperature in the binary intermetallic bulk compound Mn3.04Ge0.96. The sample annealed at 700 K crystallizes in a tetragonal structure with ferrimagnetic ordering, whereas, the sample annealed at 1073 K crystallizes in a hexagonal structure with antiferromagnetic ordering. The hexagonal Mn3.04Ge0.96 sample exhibits an EB of around 70 mT at 2 K that continues with a non-zero value up to room temperature. The exchange anisotropy is proposed to be originating from the exchange interaction between the triangular antiferromagnetic host and the embedded ferrimagnetic like clusters. The ferrimagnetic clusters develop when excess Mn atoms occupy empty Ge sites in the original triangular antiferromagnet structure of Mn3Ge.

MA 18.3 Tue 14:30 HSZ 403

Mapping techniques with MOKE on FeMn/Co-exchange bias samples — Mathias Schmidt, Joachim Gräfe, Eberhard Goering, and •Gisela Schütz — Max-Planck-Institut für Intelligente Systeme, Heisenbergstr. 3, 70569 Stuttgart

Exchange bias (EB)-systems are very important for several applications in the area of magnetic storage and spintronics. Inside that class of materials, FeMn/Co thin films are one of the most prominent examples. We used molecular beam epitaxy (MBE) to produce FeMn/Co-systems on (100)-MgO substrates. Since the EB effect is very sensitive to sample properties like layer thickness, roughness and also layer composition which can significantly deviate laterally on co-evaporated films like FeMn, a fast and spatially resolving measuring technique is very useful for a fast and reliable local characterization of the magnetic reversal process. For that issue, we used two applications of the magneto-optic Kerr effect (MOKE), delivering a sub-micrometer resolution and the possibility to measure a full hysteresis loop of a magnetic system in a timescale of milliseconds. At first, we will present maps of magnetic properties like exchange bias and coercive fields using the recently developed sweep-map-technique , an extremely fast method for magnetic sample characterization on a lateral scale up to several millimeters. Furthermore, we will show several examples of measurements with the FORC (first-order reversal-curve)-technique, delivering a dataset of all magnetic states of a system in a two dimensional contour plot and therefore revealing the distribution of local coercive fields and interactions (i.e. exchange bias) in our samples.

MA 18.4 Tue 14:45 HSZ 403

Temperature dependent study of the magneto-electric coupling in $BiFeO_3$/$La_{0.7}Sr_{0.3}MnO_3$ (BFO/LSMO) artificial multiferroic heterostructures by high resolution x-ray microscopy — •S. Finizio[1], C. Mix[1], M. Buzzi[2], F. Kronast[3], F. Nolting[2], G. Jakob[1], and M. Kläui[1] — [1]Institut für Physik, Johannes Gutenberg Universität, 55128 Mainz, Germany — [2]Swiss Light Source, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland — [3]Helmholtz Zentrum für Materialien und Energie GmbH, 12489 Berlin, Germany

Artificial multiferroic systems, where coupling between the ferroelectric and ferromagnetic order is expected, have been object of intense research in the last years. One of such systems is the artificial multiferroic heterostructure BFO/LSMO, which combines BFO (ferroelectric and antiferromagnetic) with LSMO (ferromagnetic), for which an exchange-bias driven coupling, which could allow for the magnetic switching of the LSMO by switching the ferroelectric polarization in the BFO, is expected. In this contribution, a temperature-dependent analysis of the artificial multiferroic heterostructure BFO/LSMO has been carried out with high resolution x-ray microscopy. It was observed that the magnetization of the LSMO layer changes with the temperature, switching from an elongated stripe-like domain structure, typical of LSMO thin films without BFO, to a grain-like domain structure, which resembles the antiferromagnetic domains of the BFO layer. This leads thus to the observation that the BFO layer influences the magnetic structure of the ferromagnetic LSMO.

MA 18.5 Tue 15:00 HSZ 403

Exchange bias and long-range interlayer coupling in Co/Mn/Co trilayers — •Bin Zhang, Chii-Bin Wu, and Wolfgang Kuch — Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany

Epitaxial Co/Mn/Co trilayers with a wedged Mn layer were grown on Cu(001) to study the exchange bias and interlayer coupling by magneto-optical Kerr effect measurements. The coercivity of the trilayers as a function of thickness starts to increase at around 4.7 ML. Exchange bias appears around 10 ML. The hysteresis loops exhibit two separate steps above 10 ML Mn thickness, corresponding to the switching of the two FM layers. From minor loop measurements both the coercivity and the remanence of the top Co layer have been determined. Both show an oscillation with 1 ML period as a function of the Mn layer thickness. We attribute this to roughness oscillations at the upper interface due to the layer-by-layer growth of Mn on Co. The magnetic coupling of the top and bottom Co layer through the Mn layer exhibits an oscillation with a period of 2 ML Mn thickness above a thickness of 10 ML. In addition, a long-period interlayer coupling of the two FM layers with antiparallel coupling maxima at Mn thicknesses of 2.5, 8.2, and 13.7 ML is observed and attributed to RKKY-type coupling. There is no oscillatory behavior of the exchange bias in the bottom layer.

MA 18.6 Tue 15:15 HSZ 403

Thickness dependent exchange bias in martensitic phase of Ni-Mn-Sn thin films — •Anna Behler[1,2], Niclas Teichert[3], Biswanath Dutta[4], Anja Waske[1], Tilmann Hickel[4], Alexander Auge[3], Andreas Hütten[3], and Jürgen Eckert[1,5] — [1]IFW Dresden, Institute for Complex Materials, 01171 Dresden, Germany — [2]Department of Physics, Institute for Solid State Physics, Dresden University of Technology, 01062 Dresden, Germany — [3]Department of Physics, Thin Films and Physics of Nanostructures, Bielefeld University, 33501 Bielefeld, Germany — [4]Max-Planck Institut für Eisenforschung, 40237 Düsseldorf, Germany — [5]Institute of Materials Science, Dresden University of Technology, 01062 Dresden, Germany

In the low temperature martensitic phase of epitaxial Ni-Mn-Sn thin films we found an exchange bias (EB) effect after field cooling and zero field cooling (ZFC) the system. The high values of the thickness dependent EB after ZFC can be retained down to very small thicknesses. In comparison for a Ni-Mn-Sn thin film, which differs in composition and therefore does not undergo a martensitic transition, no exchange bias is observed. The EB behavior is attributed to the unidirectional anisotropy due to the coupling between ferromagnetic (FM) and antiferromagnetic (AFM) interactions. Our magnetization measurements suggest that a significant interplay between FM and AFM regions is

only present in the low temperature martensitie. This is qualitatively supported by ab initio calculations showing the AFM order is stabilized in this phase compared to the austenitic state. Particular attention is paid to the need of the martensitic phase of Ni-Mn-Sn for EB.

MA 18.7 Tue 15:30 HSZ 403

Annealing temperature dependence and stability towards external magnetic fields of the exchange bias field in $Mn_{83}Ir_{17}/Co_{70}Fe_{30}$-bilayers — •Timo Ueltzhöffer, Alexander Gaul, Sebastian Kübler, Dennis Holzinger, and Arno Ehresmann — Department of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel

The annealing temperature dependence of the exchange bias field of sputter deposited $Mn_{83}Ir_{17}/Co_{70}Fe_{30}$-bilayers and their stability towards external magnetic fields at different temperatures is studied. By further developing the York protocol (YP) [1], a measurement sequence for reproducible determination of the blocking temperature, reproducible results for the characteristic blocking temperature ($T_{B,YP} = 458$ K) as well as the activation temperature ($T_{act} = 360$ K) could be determined. With the experimental results an estimate of the grain size distribution in the antiferromagnet was achieved.

[1] K. O'Grady, L.E. Fernandez-Outon and G. Vallejo-Fernandez, J. Magn. Magn. Mater. 322, 883 (2010)