MA 17: Thin Films: Magnetic Anisotropy

Time: Tuesday 9:30–11:00 Location: POT 6

MA 17.1 Tue 9:30 POT 6

Micromagnetic parameters and longitudinal relaxation in ultrathin asymmetrically sandwiched magnetic films — •Oleksii M. Volkov[1], Ivan A. Yastremsky[2], Oleksandr V. Pylypovskyi[1,3], Florian Kronast[4], Claas Abert[5], Eduardo Sergio Oliveros Mata[1], Pavlo Makushko[1], Mohamad-Assaad Mawass[4], Volodymyr P. Kravchuk[6], Denis D. Sheka[2], Boris A. Ivanov[7], Jürgen Fassbender[1], and Denys Makarov[1] — [1]Helmholtz-Zentrum-Dresden-Rossendorf, Dresden, Germany — [2]Taras Shevchenko National University of Kyiv, Kyiv, Ukraine — [3]Kyiv Academic University, Kyiv, Ukraine — [4]Helmholtz-Zentrum Berlin für Materialen und Energie, Berlin, Germany — [5]University of Vienna, Wien, Austria — [6]Karlsruher Institut für Tech, Karlsruhe, Germany — [7]Institute of Magnetism, Nation, Kyiv, Ukraine

Ultrathin asymmetric magnetic films are a prominent material science platform, which combines unique magnetic and electronic properties enabling prospective memory and logic spin-orbitronic devices. Here, we present the quantification mechanism to distinguish all static and dynamic micromagnetic parameters of the layer stack based on magnetometry [1] and quasi-static morphology experiments on domain wall equilibrium tilts [2]. The DW damping is found to be about 0.1 [2] and it is demonstrated to arise from a longitudinal relaxation being dominant among transversal mechanisms for ultrathin films [3].

[1] I. A. Yastremsky et al., Phys. Rev. Appl. **12**, 064038 (2019).
[2] O. M. Volkov et al., Phys. Rev. Appl. **15**, 034038 (2021).
[3] I. A. Yastremsky et al., Phys. Rev. Appl. **17**, L061002 (2022).

MA 17.2 Tue 9:45 POT 6

Control of magnetoelastic coupling in Ni/Fe multilayers using He+ ion irradiation — •Giovanni Masciocchi[1,2], Gyan van der Jagt[3,4], Maria-Andromachi Syskaki[2,5], Alessio Lamperti[6], Niklas Wolff[7], Andriy Lotnyk[8], Jurgen Langer[5], Lorenz Kienle[7], Gerhard Jakob[2], Benjamin Borie[3], Andreas Kehlberger[1], Dafine Ravelosona[3], and Mathias Kläui[2] — [1]Sensitec GmbH, Mainz, Germany — [2]Johannes Gutenberg University Mainz, Mainz, Germany — [3]Spin-Ion Technologies, Palaiseau, France — [4]Universite Paris-Saclay, Gif-sur-Yvette, France — [5]Singulus Technologies AG, Kahl am Main, Germany — [6]CNR-IMM, Agrate Brianza, Italy — [7]Kiel University, Kiel, Germany — [8]Institute of Surface Engineering , Leipzig , Germany

The requirements for the magnetoelastic coefficient in thin films are often demanding. For example, magnetic sensors mostly require strain immunity, while actuators require giant strain effects. One way to obtain the desired value of the saturation magnetostriction, is to use the combination of two or more materials with different magnetic and magnetoelastic properties in a multilayer fashion. However, the material choice alone, does not allow for a local control of the magnetostriction. In this study [1], we investigate the effects of He+ irradiation on the magneto-elastic properties of a Ni/Fe multi-layered stack. The progressive intermixing caused by He+ irradiation at the interfaces of the multilayer, allows us to locally change the magnetoelastic coupling sign with increasing He+ fluences.

[1] Masciocchi, et al. Appl. Phys. Lett. 121.18 182401, 2022

MA 17.3 Tue 10:00 POT 6

Simulating the magnetic structures in twisted double bilayer CrI_3 — •Junichi Okamoto[1], Bowen Yang[2], Tarun Patel[2], and Adam Tsen[2] — [1]University of Freiburg, Freiburg, Germany — [2]University of Waterloo, Waterloo, Canada

After the discovery of superconductivity in twisted bilayer graphene at magic angles, control of material properties by twisting two-dimensional materials has emerged as "twistronics". In this talk, we will discuss the magnetic structures appearing in the Moiré superlattices of twisted double bilayer CrI_3. By using classical spin simulations, we will demonstrate that the subtle competition between the exchange anisotropy and the spatially modulated interlayer coupling is the key to understanding the experimentally observed magnetic transitions. We will further explain how the interlayer charge transport depends on the magnetic structures. The effect of various domain walls and skyrmions will also be scrutinized.

MA 17.4 Tue 10:15 POT 6

Characteristics and origin of a $SrRuO_3$ exchange spring — •Martin M. Koch, Antonia Rieche, Diana A. Rata, and Kathrin Dörr — Martin-Luther-Universität Halle-Wittenberg

A particular type of strong interface coupling between magnets is the exchange spring which resembles an interface-parallel domain wall formed in one (or both) magnets. Advances in thin film growth and resulting interface quality of magnetic oxides improve chances to observe such strong exchange coupling across interfaces. Nevertheless, known exchange springs in oxides are yet scarce [1], since the unambiguous identification is not straightforward. An intensely studied model system for strong interface coupling is $SrRuO_3/La_{0.7}Sr_{0.3}MnO_3$ coherently grown on $SrTiO_3$(001) substrate. We summarize here the characteristics and suggested origin of the Bloch-type exchange spring forming at this interface in bilayers grown by pulsed laser deposition. Strikingly, the spring forms in hard-magnetic $SrRuO_3$ where magnetic anisotropy is suppressed within few unit cells from the interface. We suggest the transfer of oxygen octahedra rotations / tilts to be responsible, a structural coupling mechanism occurring at many other coherent oxide interfaces. Implications of the noncollinear spin configuration for spintronic functionalities will be addressed.

[1] A. M. Kane, Phys. Rev. Mater. 3, 014413 (2019)

MA 17.5 Tue 10:30 POT 6

Characterization of buffer-free $Sm(Co_{5-x}Cu_x)_5$ thin films grown by molecular beam epitaxy — •Georgia Gkouzia[1], Damian Günzing[2], Teresa Wessels[2,3], Marton Major[1], Alpha T. N Diaye[4], Andras Kovacs[3], Heiko Wende[2], Katharina Ollefs[2], and Lambert Alff[1] — [1]Technical University of Darmstadt, Materials Science, Darmstadt, Germany — [2]University of Duisburg-Essen, Faculty of Physics and Center for Nanointegration, Duisburg, Germany — [3]Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons and Peter Gruenberg Institute, Forschungszentrum Juelich, Germany — [4]Lawrence Berkeley National Laboratory, Berkeley, USA

$SmCo_5$ permanent magnets were already known in the 60s due to their enormous uniaxial magnetic anisotropy K1=17.2 MJ/m^3 which has made them key materials for many applications. Sm-Co system, in a certain parameter range, undergoes a phase decomposition into a nanocomposite of $SmCo_5$ and Sm_2Co_{17} phases. Since it is known that Cu stabilizes the $SmCo_5$ phase, in this work, buffer-free $Sm(Co_{5-x}Cu_x)_5$ thin films have been grown by molecular beam epitaxy (MBE). The films have been characterized by x-ray diffraction (XRD), superconducting quantum interference device (SQUID), and transition electron microscopy (TEM). High coercivity, 1.67 T has been achieved, among the largest values for buffer-free $SmCo_5$ films. X-ray magnetic circular dichroism (XMCD) element-specific hysteresis loops show clear evidence of the Sm-Co de-coupled moments due to Cu substitution in the Co-sublattice.

MA 17.6 Tue 10:45 POT 6

Europium oxide: Growth guide for the first monolayers on oxidic substrates — •Paul Rosenberger[1,2] and Martina Müller[2] — [1]Fakultät Physik, Technische Universität Dortmund, 44221 Dortmund, Germany — [2]Fachbereich Physik, Universität Konstanz, 78457 Konstanz, Germany

Interfacial oxygen exchange at oxide interfaces bears huge potential in stabilizing metastable or novel phases of functional oxides down to the monolayer limit. Consequently, controlling the underlying interfacial processes opens up the possibility to tailor and tune functionalities of oxide interfaces. By taking advantage of active oxygen supply of the substrate material, waiving any external oxygen dosage, high-quality, crystalline ultrathin films of the Heisenberg ferromagnet europium monoxide (EuO) were stabilized on YSZ (001)[1]. This so-called redox-assisted growth mode was monitored end to end by in situ x-ray photoelectron spectroscopy. The evolution of Eu 3d core levels allows us to disentangle the processes of interfacial oxygen diffusion and vacancy formation in stabilizing the very first monolayers of EuO on YSZ (001). An expedient background correction analysis is presented, which allows us to quantify the critical Eu^{3+}/Eu^{2+} ratio in the ultrathin film regime. We concluded on the key mechanisms of redox-assisted EuO/YSZ (001) thin film synthesis, merging in a universal three-process growth model that may serve as guideline for redox-assisted synthesis of metastable low-dimensional oxides.

[1] P. Rosenberger and M. Müller, Phys. Rev. Mater. 6, 044404 (2022).