MA 23: Magnetic Domain Walls

Time: Wednesday 9:30–10:45 Location: H48

MA 23.1 Wed 9:30 H48

Atomic-scale Insights to Design of High-Performing SmCo based Sintered Permanent Magnets gained by Atom Probe Tomography — •Nikita Polin[1], Stefan Giron[2], Esmaeil Adabifiroozjaei[2], Yangyiwei Yang[2], Alaukik Saxena[1], Oliver Gutfleisch[2], and Baptiste Gault[1,3] — [1]Max-Planck-Institut für Eisenforschung GmbH, Düsseldorf 40237, Germany — [2]Institute of Materials Science, Technische Universität Darmstadt, 64287 Darmstadt, Germany — [3]Department of Materials, Royal School of Mines, Imperial College, Prince Consort Road, London SW7 2BP, United Kingdom

Hard disc drives, electric cars and wind turbines - in all these devices permanent magnets are key components to translate mechanical into electrical energy and vice versa. Enhancing performance of permanent magnets thus contributes to energy transition and sustainability. However, practically the performance of permanent magnets only reaches 20% of the possible maximum (called Brown's paradox). This is related to imperfect nanostructure and nanocomposition where atom probe tomography is a suitable tool to gain atomic-scale insights.

In this talk I will present a structural and magnetical investigation of high-end production-grade $Sm_2(Co,Fe,Cu,Zr)_{17}$ permanent magnets which show unusual regions leading to suboptimal performance. Local differences of nano-structure and nano-composition between both regions are studied by atom probe tomography and transmission electron microscopy combined with micromagnetic simulations. These findings suggest design rules for higher performance of Sm_2Co_{17} magnets.

MA 23.2 Wed 9:45 H48

Magneto-Optic Effects and Domain Imaging in EuO/Co Heterostructure — •Seema Seema[1], Henrik Jentgens[1], Paul Rosenberger[1,2], and Martina Müller[1] — [1]Fachbereich Physik, Universität Konstanz, 78457 Konstanz, Germany — [2]Fakultät Physik, Technische Universität Dortmund, 44221 Dortmund, Germany

Ferromagnetic semiconductors and stable half-metallic ferromagnets with Curie temperatures (Tc) equal to or more than room temperature have been sought for their applications in novel spintronic devices. Europium oxide (EuO) is one of the potential candidates as it possesses strong ferromagnetism of 7 μ_B/Eu atom with a Tc of 69 K. The present work focuses on the magnetization reversal mechanisms and domain images in EuO probed using magneto-optic Kerr microscopy. We aimed to visualize magnetic proximity effect induced changes in magnetic domains and Tc of EuO in a EuO/Metal heterostructure. We synthesized EuO/Co thin film using molecular beam epitaxy and observed differences in the domain saturation behavior as well as the Kerr rotation below Tc. This had been performed by magnetic hysteresis measurement along with simultaneous domain imaging to explore the temperature-dependent magneto-optic effects in EuO in the proximity of Co. This study of magnetic domains in EuO/Co heterostructure can provide insights into achieving room-temperature ferromagnetism in EuO.

MA 23.3 Wed 10:00 H48

Direct observation of bulk-DMI-stabilized Néel-type domain walls in ferrimagnetic rare-earth transition-metal alloys — •Daniel Metternich[1], Riccardo Battistelli[1], Chen Luo[1], Florin Radu[1], Sebastian Wintz[1], Kai Litzius[2], Marcel Möller[3], John Gaida[3], Claus Ropers[3], Manuel Valvidares[4], Pierluigi Gargiani[4], Andrada-Oana Mandru[5], Yaoxuan Feng[5], Hans Josef Hug[5], and Felix Büttner[1] — [1]Helmholtz-Zentrum Berlin, Berlin, Germany — [2]Max Planck Institute for Intelligent Systems, Stuttgart, Germany — [3]Georg-August-Universität Göttingen, Göttingen, Germany — [4]ALBA Synchrotron, Barcelona, Spain — [5]Empa, Dübendorf, Switzerland

Since the discovery of bulk DMI within rare-earth transition-metal alloys, the possibility of bulk-DMI-stabilized skyrmions within these materials is an enticing prospect for potential spintronics applications. However, so far, no direct observation of any bulk-DMI-induced chiral spin textures has been reported in this material class.

We present our study on 50-nm-thick DyCo films, which we imaged with transmission X-ray microscopy. We found domain walls and skyrmions, both of which exhibit strong local variations of the chirality up to pure Néel-type. Due to the large film thickness, we attribute the formation of such Néel walls to the presence of significant bulk DMI in our sample. Moreover, we attribute the strong variations of the chirality to lateral changes of the material composition. Lorentz transmission electron microscopy and magnetic force microscopy measurements support our observations.

MA 23.4 Wed 10:15 H48

Electrostatic shaping of magnetic transition regions in La0.7Sr0.3MnO3 — •Qianqian Lan[1], Michael Schnedler[1], Lars Freter[1], Lei Jin[1], Xian-Kui Wei[1], Thibaud Denneulin[1], András Kovács[1], Philipp Ebert[1], Xiaoyan Zhong[2], and Rafal E. Dunin-Borkowski[1] — [1]Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons (ER-C 1) and Peter Grünberg Institut (PGI-5), Forschungszentrum Jülich GmbH, 52425 Jülich, Germany — [2]Department of Materials Science and Engineering, City University of Hong Kong, Kowloon 999077, Hong Kong SAR, People's Republic of China

Ferroelectric domain walls with no rotation of polarization but a change of magnitude of polarization were reported theoretically and experimentally. However, magnetic domain walls with a similar configuration have not been observed experimentally yet to our knowledge. Here, we report an experimental example of a magnetic transition region in La0.7Sr0.3MnO3 films where the magnitude of magnetization gradually changes without rotation even well below Tc. The magnetic and electrostatic characterization reveals that a charge redistribution governs the shape, magnitude, and extent of the corresponding magnetic transition region. The charge redistribution is caused by the equilibrium between carrier diffusion and drift in the electrostatic field at an interface with sharp Mn compositional change in LSMO. Thus, our results demonstrate a case of the electrostatic shaping of magnetic transition regions, which can be expected to be a general property of complex oxide materials.

MA 23.5 Wed 10:30 H48

Strain-controlled Domain Wall injection into nanowires for sensor applications — •Giovanni Masciocchi[1,2], Mouad Fattouhi[3], Andreas Kehlberger[2], Luis López Díaz[3], and Mathias Kläui[1] — [1]Institute of Physics, Johannes Gutenberg University Mainz, 55099 Mainz, Germany — [2]Sensitec GmbH, 55130 Mainz, Germany — [3]Department of Applied Physics, Universidad de Salamanca, E-37008 Salamanca, Spain

In this study, we address a well-known challenge in magnetic sensor development, which is the effect of packaging-induced strain on the sensor properties. While previously the field operation window has only been studied in idealized operation conditions, in real devices further external factors such as strain play a role.

In this experimental work, we investigate the injection of a 180° domain wall from a nucleation pad into a nanowire, as typically used for domain wall-based sensors, while straining the device along selected directions. Combining our experimental measurements by Kerr microscopy with micromagnetic simulations, we find that strain, regardless of its direction, increases the domain wall injection field due to the magnetoelastic coupling of the magnetic material. The above-described observations can be explained by an effective strain-induced anisotropy in the device.

We find additionally that a careful material preparation, comprising of an annealing step, can reduce the effective anisotropy caused by the strain in the magnetic layer. With this we show that a device free of magnetostrictive behavior can be achieved.