MA 38: Micro- and Nanostructured Magnetic Materials

Time: Thursday 11:30–12:45 Location: HSZ 401

MA 38.1 Thu 11:30 HSZ 401

Chemically modulated Fe-Ni cylindrical nanowires with asymmetric magnetic response — •Claudia Fernandez[1,2], Alba Berja[2,3], Lucia Aballe[4], Laura Alvaro[1], Carolina Martin[5], Michael Foerster[4], Ruy Sanz[5], Arantzazu Mascaraque[2], Lucas Perez[1,2], and Sandra Ruiz[6] — [1]IMDEA Nanoscience, 28049, Spain — [2]Materials Physics Department, UCM, 28040, Spain — [3]Institute of Ceramics and Glass (CSIC), 28040, Spain — [4]ALBA Synchrotron, 08290, Spain — [5]National Institute of Aerospace Technology, 28850, Spain — [6]MPI for Chemical Physics of Solids, 01187, Germany

The control of the magnetic domain walls (DWs) movement along cylindrical nanowires (NWs) by means of magnetic fields or electric currents is a key aspect in the design of novel spintronic devices. In recent studies, we have demonstrated that local changes in composition along the axis of Fe20Ni80 nanowires can pin the DWs and that the DWs can be moved under the application of magnetic field. Expanding this concept, in this work we propose a gradual change in Fe/Ni ratio along the axial direction of the nanowires in order to create an asymmetric energy landscape with the aim to induce asymmetric domain wall motion. Combining X-ray imaging techniques (XAS and XMCD) we have correlated the chemical structure of single nanowires with their magnetic configuration. In First Order Reversal Curves (FORC) diagrams we have observed that an asymmetry arises evidencing the emerging of asymmetrical magnetization processes in the array.

MA 38.2 Thu 11:45 HSZ 401

Chirality coupling in curvilinear nanoarchitectures — •Oleksii M. Volkov[1], Daniel Wolf[2], Oleksandr V. Pylypovskyi[1,3], Attila Kákay[1], Denis D. Sheka[4], Bernd Büchner[2,5], Jürgen Fassbender[1], Axel Lubk[2,5], and Denys Makarov[1] — [1]Helmholtz-Zentrum-Dresden-Rossendorf, Dresden, Germany — [2]Institute for Solid State Research, IFW Dresdenm Dresden, Germany — [3]Kyiv Academic University, Kyiv, Ukraine — [4]Taras Shevchenko National University of Kyiv, Kyiv, Ukraine — [5]Institute of Solid State and Materials Physics, TU Dresden, Dresden, Germany

Symmetry effects are key building blocks of condensed matter physics as they define not only interactions but also resulting responses for the intrinsic order parameter. Namely, in magnetism geometric curvature governs the appearance of chiral and anisotropic responses [1], that introduce a new toolbox to create artificial chiral nanostructures from achiral magnetic materials [2,3]. Here, we demonstrate both theoretically and experimentally the existence of non-local chiral effects in geometrically curved asymmetric permalloy caps with the vortex texture. We find that the equilibrium vortex core obtain bend and curling deformation, that are dependent on the geometric symmetries and magnetic texture parameters.

[1] D. D. Sheka et al., Comm. Phys. **3**, 128 (2020).
[2] O. M. Volkov et al., Phys. Rev. Lett, **123**, 077201 (2019).
[3] D. Makarov et al., Adv. Mater. **34**, 2101758 (2022).

MA 38.3 Thu 12:00 HSZ 401

Towards magnetic MXenes via thermal activation of $Ti_3C_2T_x$ and Fe intercalation — •Tim Salzmann[1], Hanna Pazniak[2], Ivan Tarasov[1], Michael Farle[1], and Ulf Wiedwald[1] — [1]University of Duisburg-Essen and Center for Nanointegration Duisburg-Essen, Germany — [2]Université Grenoble Alpes, CNRS, Grenoble INP, LMGP, France

MXenes are 2D materials obtained from a MAX phase precursor. The $Ti_3C_2T_x$ MXene surface is stabilized by a T_x termination in the form of −F, −Cl, = −O, −OH [1]. $Ti_3C_2T_x$ MXenes deposited on Si(100)/SiO_2 are annealed at T=1023 K in ultrahigh vacuum removing −F, −Cl and −OH confirmed by in situ mass spectroscopy, and Auger electron spectroscopy (AES). Additionally, we find a reduction of interplanar spacing between MXene sheets ($d_{ini} - d_{ann} = 0.30 \pm 0.04$ nm) by X-ray diffraction (XRD). Subsequently, a 6 nm thick Fe film is deposited and annealed between 550 K and 1000 K. AES displays a linear decrease of the Fe concentration at the surface from 85% to 15% as a function of annealing temperature. The intercalation of Fe is confirmed by XRD measurements showing an increase of the interplanar spacing between MXene sheets ($d_{int} - d_{ann} = 0.16 \pm 0.02$ nm). In plane vibrating sample magnetometry reveals a saturation magnetization of 1728 ± 150 kA/m for the 6 nm Fe film on top of MXenes confirming bulk metallic Fe. After annealing up to 800 K, the magnetization decreases to 660 ± 80 kA/m and the Curie temperature to 485 K. Funded by DFG-Project-ID 405553726-TRR 270.

[1] James L. Hart et al., ACS Nanoscience Au 2022 2, 433-439

MA 38.4 Thu 12:15 HSZ 401

Magneto-optical investigation of 3D-curved toroidal ferromagnetic thin films — •Christian Janzen[1], Sapida Akhundzada[1], Bhavadip Bharatbhai Rakholiya[1], Arne Vereijken[1], Claudio Beck[1], Piotr Kuświk[2], Michał Matczak[2,3], Michael Vogel[1,4], and Arno Ehresmann[1] — [1]Institute of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Germany — [2]Institute of Molecular Physics, Polish Academy of Science, Poznań, Poland — [3]Faculty of Physics, University of Białystok, Poland — [4]Department of Materials Science, University of Kiel, Germany

Magnetic thin films, typically examined as flat two-dimensional systems, may be extended to the third dimension by deposition of the magnetic material on curved substrates. To experimentally investigate physical effects induced by the geometry and curvature of a thin film magnet, micron-sized curved structures with minimal surface roughness were prepared by optimized two-photon polymerization lithography processes. These structures are deliberately placed with well-defined lateral as well as axial spacing, leading to periodic arrays where, e.g., the influence of varying magnetostatic interactions between the individual objects can be investigated. In this work, the magnetization reversal of periodic arrays of hemispherical tori with varying lattice geometry of the periodic array will be investigated by magneto-optical Kerr magnetometry/microscopy. The experimental results are further compared with micromagnetic simulations.

MA 38.5 Thu 12:30 HSZ 401

Sprayed Nanometer-Thick Hard Magnetic Coatings with Strong Perpendicular Anisotropy for Data-Storage Applications — •Andrei Chumakov[1], Calvin J. Brett[1,2], Korneliya Gordeyeva[2], Dirk Menzel[3], Lewis O. O. Akinsinde[4], Marc Gensch[1], Matthias Schwartzkopf[1], Wei Cao[5], Shanshan Yin[5], Manuel A. Reus[5], Michael A. Rübhausen[4], Peter Müller-Buschbaum[5,6], Daniel Söderberg[2], and Stephan V. Roth[1,2] — [1]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany — [2]DE 118714904 — [3]Notkestraße 85, DESY — [4]Universität Hamburg, Hamburg, Germany — [5]Technische Universität München, Garching, Germany — [6]Heinz Maier-Leibnitz Zentrum, Garching, Germany

We present a study of a facile technology for establishing mono- and multi-layer surfaces from various single-domain flat magnetic nanoparticles that exhibit a strong perpendicular-oriented magnetic moment on solid and flexible substrates. Surfactant-free, hard ferromagnetic and single-domain anisotropic strontium hexaferrite nanoparticles with perpendicular magnetic moment orientation and two different aspect ratios are self-ordered into magnetic thin nanofilms exploiting the templating effect of cellulose nanofibrils and magnetic fields. Uniform magnetic coatings obtained by scalable layer-by-layer spray deposition from a monolayer coverage up to thicknesses of a few tens of nanometers show preferred in-plane orientation of the hard-magnetic nanoparticles.