MA 41: Micro- and Nanostructured Magnetic Materials

Time: Friday 11:30–12:45 Location: H47

MA 41.1 Fri 11:30 H47

Dynamic properties of magnetic Nanoparticles: arrangement-, distance- & frequency-dependent properties — •Nils Neugebauer[1,2], Helmut Schultheiss[3], Xingchen Ye[4], and Peter Klar[1,2] — [1]Institute of Experimental Physics I, Justus Liebig University Giessen, Heinrich-Buff-Ring 16, 35392 Giessen, Germany — [2]Center for Materials Research (LaMa), Justus Liebig University Giessen, Heinrich-Buff-Ring 16, 35392 Giessen, Germany — [3]Helmholtz-Center Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, Bautzner Landstraße 400, 01328 Dresden, Germany — [4]Department of Chemistry, Indiana University, Bloomington, 47405 Indiana, United States

Investigations focusing on the mutual dipolar interactions of magnetic nanoparticles (MNPs) are presented. As nanoparticles may be arranged into highly ordered, crystal-like structures, so called mesocrystals, novel properties may arise due to the introduction of an additional degree of freedom in manipulating the magnetic properties of a material. Manipulating the interparticle distance, distinct spectral features related to the dipole-dipole interaction can be observed. Based on these nano-building blocks, assemblies of MNPs of well-defined size and shape can be constructed. Such assemblies show distinct collective properties, e.g. well-localized magnetic vibrational modes, frequency- and field-dependent characteristics. The experiments are supported by utilizing numerical simulations of corresponding model systems to underline the observed characteristics.

MA 41.2 Fri 11:45 H47

Quantitative analysis of magnetic states in an artificial spin ice by off-axis electron holography — •Teresa Wessels[1,2], Sebastian Gliga[3], Simone Finizo[3], Andras Kovacs[2], and Rafal Dunin-Borkowski[2] — [1]Faculty of Physics and Center for Nanointegration Duisburg-Essen (CENIDE), University Duisburg-Essen, 47057 Duisburg, Germany — [2]Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons and Peter Grünberg Institute, Forschungszentrum Jülich, 52425 Jülich, Germany — [3]Swiss Light Source, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland

The study of emergent phenomena in artificial spin ices (ASIs) consisting of patterned nanomagnets is presently the focus of intense research. We used off-axis electron holography in the transmission electron microscope to quantitatively measure the magnetic phase shift induced by ASI with chiral geometry. The phase shift of the electron wave was measured using an electron biprism and interpreted using a model-based iterative reconstruction algorithm to retrieve the projected in-plane magnetization. The permalloy nanomagnets were patterned on a SiN membrane using lift-off lithography. Magnetic interactions within individual arrays were studied by applying in-plane magnetic fields to the sample. The reconstructed magnetization shows a single-domain state of the nanomagnets with an average magnetic polarization of 0.73 T. The low magnetic polarization value may result from a combination of the microstructure, composition, and oxidation. The project received funding from the ERC (856538) and the DFG (392476493, 405553726).

MA 41.3 Fri 12:00 H47

Monolayer MnX and Janus XMnY (X, Y= S, Se, Te): A New Family of 2D Antiferromagnetic Semiconductors — •Shahid Sattar, Md Fhokrul Islam, and Carlo Maria Canali — Department of Physics and Electrical Engineering, Linnaeus University, Kalmar SE-39231, Sweden

We present first-principles results on the structural, electronic, and magnetic properties of a new family of two-dimensional antiferromagnetic (AFM) manganese chalcogenides, namely monolayer MnX and Janus XMnY (X, Y= S, Se, Te). By carrying out calculations of the phonon dispersion and ab-initio molecular dynamics simulations, we first confirmed that these systems, characterized by an unconventional strongly-coupled-bilayer atomic structure (consisting of Mn atoms buckled to chalcogens forming top and bottom ferromagnetic (FM) planes with antiparallel spin orientation) are dynamically and thermally stable. The analysis of the magnetic properties shows that these materials have robust AFM order, whereas electronic structure calculations reveal that pristine MnX and their Janus counterparts are indirect-gap semiconductors, covering a wide energy range and displaying tunable band gaps by the application of biaxial tensile and compressive strain. Interestingly, owing to the absence of inversion and time-reversal symmetry, and the presence of an asymmetrical potential in the out-of-plane direction, Janus XMnY become spin-split gapped systems, presenting a rich physics yet to be explored. Our findings provide novel insights in this physics, and highlight the potential of two-dimensional manganese chalcogenides in AFM spintronics.

MA 41.4 Fri 12:15 H47

Magnetic properties of cobalt - nanomagnets: towards spin qubit control — •Liza Zaper[1,2], Peter Rickhaus[2], Alexander Stark[2], Floris Braakman[1], and Martino Poggio[1] — [1]University of Basel, Basel, Switzerland — [2]Qnami AG, Muttenz, Switzerland

A promising platform to realise quantum computation uses the spin states of confined electrons to define the qubit. In order to achieve reliable control and high integration of spin qubit devices on a chip, we aim to pattern nanometer-scale magnets that have large magnetic field gradients at the position of the confined electron. We fabricate highly magnetic cobalt nanostructures using focused-electron-beam-induced deposition. We characterize the magnetization properties of the nanomagnets by NV scanning microscopy, as well as magnetotransport. The scanning probe images indicate the structure of the magnetic domains and the profile of the magnetic stray fields, which can be further used as a guideline for qubit device optimisation.

MA 41.5 Fri 12:30 H47

Cellulose nanocomposite with $SrFe_{12}O_{19}$ nanoparticles as a novel magnetic nanopaper coating — •Andrei Chumakov[1], Korneliya Gordeyeva[2], Calvin J. Brett[1,2], Anastasia V. Riazanova[2], Dirk Menzel[3], Daniel Soederberg[2], and Stephan V. Roth[1,2] — [1]DESY, Hamburg, Germany — [2]KTH Royal Institute of Technology, Stockholm, Sweden — [3]TU Braunschweig, Braunschweig, Germany

The possibility of the coating by a new magnetic nanocomposite based on negatively charged cellulose colloids (1360 μmol/g) and positively charged hard magnetic hexaferrite ($SrFe_{12}O_{19}$) nanoparticles with a large permanent magnetic moment was demonstrated. Thin nanofilms of magnetic cellulose composite were obtained by spray deposition on a silicon substrate and studied by microscopic imaging, surface-sensitive X-ray scattering, and magnetic determining techniques. Ferromagnetic nanoparticles are uniformly distributed in the cellulose matrix and form a nanocomposite due to the opposite charges of the initial components. Magnetic nanoplates show a predominant orientation parallel to the plane of the substrate and the resulting nanocomposite has the highest intrinsic coercivity field inherent in the properties of individual nanoparticles. Coatings of magnetic nanopaper with a large coercive field can be widely used from catalysis to promising nanoelectronic devices.