MA 39: Micro- and nanostructured magnetic materials

Time: Thursday 9:30–11:15 Location: H 0112

MA 39.1 Thu 9:30 H 0112

Annealing-time and annealing-temperature dependencies of the size of Ni-Mn-In shell-ferromagnetic nano-precipitates by Scherrer analysis — •Lars Dincklake[1], Franziska Scheibel[1], Asli Cakir[2], Michael Farle[1], and Mehmet Acet[1] — [1]Faculty of Physics, University of Duisburg-Essen, 47057 Duisburg, Germany — [2]Mugla Sitki Kocman University, 48000 Mugla, Turkey

Shell-ferromagnetic effects are observed in Ni-Mn-based off-stoichiometric Heuslers decomposed into ferromagnetic precipitates embedded in an antiferromagnetic matrix when the surface-to-volume ratio of the precipitates are sufficiently large. However, since the size of the precipitates have until now not been determined, it is not known which ratios are involved. Here we carry out a Scherrer analysis on decomposed specimens to determine the precipitate-size as a function of decomposition temperature and time.

MA 39.2 Thu 9:45 H 0112

Magnetic Behavior of EuO Tubes Prepared via a Topotactic Nanostructure Transition — •Severin Selzer[1], Bastian Trepka[1], Philipp Erler[1], Tom Kollek[1], Klaus Boldt[1], Mikhail Fonin[1], Daniel Wolf[2], Axel Lubk[2], Sebastian Polarz[1], and Ulrich Nowak[1] — [1]Universität Konstanz, Universitätstraße 10, D-78457 Konstanz — [2]IFW Dresden e.V., Helmholtzstraße 20, D-01069 Dresden

Being one of the few native ferromagnetic semiconductors, europium(II)oxide offers a great potential for the realization of spintronic devices. However, due to its reducing nature no reliable routes for EuO nanoparticle synthesis can be established. Instead of targeting a direct synthesis, the two steps – structure control and chemical transformation – are separated. The generation of a transitional, hybrid nanophase is followed by its conversion into EuO under full conservation of all morphological features.

Via this route EuO nanoparticles with tubular character and lamellar structure are now accessible. This special structure has a large impact on the key magnetic properties of these nanotubes. For a single layer of these tubes magnetic vortex or onion states have been found. Stacked to a tube, these layers couple antiferromagnetically in order to reduce their stray-fields. Owing to thermally activated transitions between these states an unexpected temperature dependence emerges (Trepka et al., Adv. Mater. 2017, 1703612).

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MA 39.3 Thu 10:00 H 0112

Investigation of magnetization reversal processes in bent nanofibers — •Tomasz Blachowicz[1] and Andrea Ehrmann[2] — [1]Silesian University of Technology, Institute of Physics - Center for Science and Education, 44-100 Gliwice, Poland — [2]Bielefeld University of Applied Sciences, Faculty of Engineering and Mathematics, 33619 Bielefeld, Germany

Biologically inspired computer hardware, giving up the classical von Neumann architecture with the strict separation of memory and processor, could be based on artificial ferromagnetic nanofiber networks with additional functionalities. As a first step to understand the magnetic processes in such networks, single nanofibers with varying cross-sections and bending radii were investigated by micromagnetic simulations under different angles with respect to the external magnetic field. Due to the strong shape anisotropy and proposed spatial dimensions, all magnetization reversal processes in these nanofibers took place via domain wall processes. Coercive fields and detailed reversal processes, however, significantly depended on the geometric parameters of the fibers. Variation of cross-sections, bending radii and angles between fiber and magnetic field thus resulted in a broad spectrum of possible magnetization reversal processes in magnetic nanofibers, giving rise to diverse scenarios for fiber-based information storage and processing.

[1] Tomasz Blachowicz, Andrea Ehrmann: Magnetization reversal in bent nanofibers of different cross-sections, arXiv:1711.09370

MA 39.4 Thu 10:15 H 0112

FORC based interaction strength investigations in permalloy micro arrays — •Felix Gross, Sven Erik Ilse, Joachim Gräfe, and Eberhard Goering — Max-Planck-Institut für Intelligente Systeme, 70569 Stuttgart

First-order reversal-curves (FORCs) are a powerful tool to distinguish between microscopic interaction and coercivity contributions. However, most real systems usually violate Mayergoyz' congruency property which has to be fulfilled to easily interpret a FORC diagram. Investigating systems which violate Mayergoyz' criteria gives new fundamental insight into the FORC method. To build such a well-defined system, permalloy micro arrays of alternating width have been designed. By varying width and spacing, we are able to manipulate coercivities and interaction strength. Using a NanoMOKE3[1] we directly measure the low field spatially resolved switching field distribution, which shows binary distributed coercivities around 1 and 3 Oe. Surprisingly, an unexpected positive-negative peak pair appears at negative interaction fields in the FORC density. We could reveal that the two peaks are caused by interaction of high and low coercivity components. More precisely, by the interaction field which causes the small coercivity component to flip at different fields in parallel or antiparallel configuration. From the intensities of the peaks for different spacings, we can conclude, that turning off the interaction leads to fulfilled Mayergoyz' criteria again.

[1] J.Gräfe, Rev Sci Instrum, 85(2), 023901; 2014.

MA 39.5 Thu 10:30 H 0112

Nanoscale control of geometrical frustration in a dipolar trident lattice — Alan Farhan[1], •Charlotte Petersen[2,3], Scott Dhuey[1], Luca Anghinolfi[4], Qi Hang Qin[2], Michael Saccone[5], Sven Velten[1,6], Clemens Wuth[1,7], Sebastian Gliga[8], Paula Mellado[9], Mikko Alava[2], Andreas Scholl[1], and Sebastiaan van Dijken[2] — [1]Lawrence Berkeley National Laboratory, Berkeley, CA, USA. — [2]Aalto University, Finland. — [3]Universität Innsbruck, Austria — [4]Università di Genova, Italy. — [5]University of California, Santa Cruz, CA, USA. — [6]Universität Hamburg, Germany. — [7]Daegu Gyeongbuk Institute of Science and Technology, Hyeonpungmyeon, Dalseong-gun, Daegu, Republic of Korea. — [8]University of Glasgow, UK. — [9]Adolfo Ibáñez University, Diagonal Las Torres, Peñalolén, Santiago, Chile.

Artificial spin ice consists of interacting magnetic subunits arranged on a two dimensional lattice. A key feature is the ability to precisely control the geometry, and so manufacture highly frustrated systems that are hindered to minimize their local interactions by lattice constraints. We present a new lattice geometry where the balance of competing interactions between nearest-neighbour moments can be directly controlled [1]. This allows for tuning of the geometrical frustration. By varying the lattice parameters, we observe that the system either accesses a long-range ordered ground state, or under the same conditions, remains in a disordered state with short-range correlations.

[1] A. Farhan et. al., Nature Communications 8, 995 (2017).

MA 39.6 Thu 10:45 H 0112

Two dimensional transport of superparamagnetic beads in periodic artificial magnetic stray field landscapes with inplane magnetization — •Jendrik Gördes[1], Dennis Holzinger[1], Johannes Loehr[2], Daniel de las Heras[3], Thomas M. Fischer[2], and Arno Ehresmann[1] — [1]Institute of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, D-34132 Kassel — [2]Experimental Physics, Universität Bayreuth, D-95440 Bayreuth — [3]Theoretical Physics, Universität Bayreuth, D-95440 Bayreuth

The transport of superparamagnetic beads on top of periodic magnetic patterns is of particular interest for Lab-on-a-chip (LOC) devices, which offer promising applications in biomedicine [1]. Directed transport is achieved by modulation of the magnetic potential energy landscape by superposing a time dependent external magnetic field loop to the internal magnetic field of the pattern. As a result, remotely controlled two dimensional movement is obtained which is topologically robust against perturbations. Magnetic domain patterns of different symmetries were fabricated by lithography and ion bombardment induced magnetic patterning (IBMP). Characterization was done by longitudinal magneto-optical Kerr magnetometry (L-MOKE) and magnetic force microscopy (MFM). Investigations of the transport behavior of superparamagnetic beads above these patterns were carried out by tracking and image analysis techniques.

[1] D. Holzinger, I. Koch, S. Burgard, and A. Ehresmann, ACS Nano 9, 7323-7331 (2015)

MA 39.7 Thu 11:00 H 0112

Magnetic nanostructures in metastable fcc Fe thin films on Cu(100) and Si(100) — •Jonas Gloss[1], Michal Horký[2], Michal Andrýsek[3], Viola Křižáková[3], Lukáš Flajšman[2], Michael Schmid[1], Michal Urbánek[2,3], and Peter Varga[1,2] — [1]Inst. of Appl. Phys., TU Wien, AT — [2]Central EU Inst. of Tech., Brno University of Technology (BUT), CZ — [3]Inst. of Phys. Eng.,BUT, CZ

It has been shown that 5-10 ML thick Fe films grown on Cu(100) single crystal have an fcc structure and are nonmagnetic at room temperature [1]. Ion-beam irradiation of the fcc films causes a structural transformation from fcc to bcc, as well as a magnetic transformation from non- to ferromagnetic [2]. To remove the 10-ML thickness limit of fcc Fe we alloyed it with 22% of nickel to form a metastable fcc $Fe_{78}Ni_{22}$ [3].

To avoid the costly Cu single crystals, we also grew the films on H-terminated Si(100) with a Cu(100) buffer layer. The H-Si was prepared both in-situ by flashing and deposition of atomic H and ex-situ by etching in HF. The as-grown $Fe_{78}Ni_{22}$ films were corrugated yet metastable; we show they provide the opportunity to write magnetic nanostructures with a focused ion beam.

[1] A.Biedermann, et al., Phys. Rev. Lett. **87** (2001) 086103
[2] W. Rupp, et al., Appl. Phys. Lett. **93** (2008) 063102
[3] J. Gloss, et al., Appl. Phys. Lett. **103** (2013) 262405