MA 43: Micro- and Nanostructured Magnetic Materials IV

Time: Wednesday 17:00–19:00 Location: HSZ 103

MA 43.1 Wed 17:00 HSZ 103

Domain wall resistance between artificial domains created in exchange coupled bilayers by keV He ion bombardment induced magnetic patterning — •Christoph Schmidt, Dieter Engel, and Arno Ehresmann — Department of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel

Ion bombardment induced lateral magnetic patterning (IBMP) has been used to generate different magnetic patterns (artificial domains) in an exchange bias bilayer system without changes in the surface topography. This technique enables to create adjacent areas with designed magnetization directions stable in remanence. Within the same layer system it is possible to create Bloch or Néel walls. Corresponding magnetical stripe patterns were analyzed by magnetic force microscopy and Kerr microscopy. Magnetoresistance measurements were performed to investigate the domain wall resistance (DWR) at room temperature and low temperatures.

MA 43.2 Wed 17:15 HSZ 103

Domain wall movement assisted transport of superparamagnetic particles on magnetically patterned samples — •Daniel Lengemann, Florian Göllner, Dieter Engel, and Arno Ehresmann — Department of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel

By 10 keV He-ion bombardment IrMn/CoFe exchange biased layers were patterned magnetically into stripes with alternating anisotropy directions. In remanence superparamagnetic particles were deposited onto the Bloch domain walls. The domains of the sample have different magnetization reversal mechanisms in an external magnetic field for each hysteresis loop branch: In the branch towards saturation the reversal is dominated by domain wall movement, in the branch towards remanence domain nucleation and coherent rotation are dominant.

With these mechanisms the particles move due to domain wall movement while no movement is seen for the domain nucleation and rotation. With controlling the x- and the z-direction of the pulsed external field, the direction of the particle movement can be defined.

MA 43.3 Wed 17:30 HSZ 103

Beyond a compact magnetic domain wall — •Philipp Eib, Carl Zinoni, Antoine Vanhaverbeke, Gian Salis, Andreas Bischof, and Rolf Allenspach — IBM Research - Zurich, Säumerstrasse 4, 8803 Rüschlikon, Switzerland

The generally accepted concept that limits magnetic domain wall velocity is the Walker breakdown: It determines the magnetic field at which the wall motion becomes turbulent [1]. This sets an upper limit on the performance of domain wall-based spintronic devices.

To understand the limiting mechanisms, we study domain wall dynamics in $Ni_{80}Fe_{20}$ wires with widths between 300 and 900 *nm*. A time-resolved magneto-optical Kerr effect setup with pump-probe technique is used to detect the moving walls. The wires are fabricated by electron-beam lithography and our nanostencil tool [2].

We find the dynamics of vortex walls to depart significantly from the current description of a compact entity evolving along the wire; instead, the wall is composed of several substructures, each one propagating and evolving in a different dynamic regime with very different velocities. Extensive, parallelized micromagnetic simulations reveal the unusual wall structure and complement the experimental findings. From the insight gained into this complex dynamics we discuss possibilities how to overcome the limits imposed by the Walker breakdown.

[1] R. Cowburn and D. Petit, *Nature Mater.* **4**, 721 (2005)

[2] L. Gross, R. R. Schlittler, G. Meyer, and R. Allenspach, *Nanotechnology* **21**, 325301 (2010)

MA 43.4 Wed 17:45 HSZ 103

Magnetoresistance and thermopower measurements of an individual ferromagnetic metallic nanowire — •Corinna Steinweg[1,2], Harald Austenfeld[1], Saskia F. Fischer[2], William Töllner[3], and Kornelius Nielsch[3] — [1]Werkstoffe und Nanoelektronik, Ruhr-Universität Bochum, 44780 Bochum, Germany — [2]Novel Materials, Humboldt-Universität zu Berlin, 12489 Berlin, Germany — [3]Multifunctional Nanostructures, Universität Hamburg, 20355 Hamburg, Germany

We investigate individual Au-Ni/NiO-Au nanowires to determine magnetotransport properties and the thermopower. The electrochemically deposited Ni nanowire has in situ deposited Au endings to enable low-ohmic contacts. The nanowire is placed on a Si/SiO2 substrate, and the contacts are structured by optical lithography, metal evaporation and a lift off process. The measured resistivity of 7.46 $\mu\Omega$cm of the nanowire is significantly lower than that measured for nanowires with contacts made by electro thermal annealing [1]. The temperature-dependence of the anisotropic magnetoresistance yields switching fields which are in agreement with predictions by the curling mode magnetization reversal of an infinite cylinder [2]. With an additional heating wire we achieve a temperature difference of 1.2 K at 300 K along the ends of the wire. We measure a voltage drop at the ends of the wire as a function of the heating power, e.g., 2.84 μV at 12 mW.

[1] E. Shapira, et al., Nanotechnology 18, 485703 (2007). [2] W. Wenrsdorfer, et al., Phys. Rev. Lett. 77, 9 (1996).

MA 43.5 Wed 18:00 HSZ 103

Fabrication and investigation of regular arrays of Fe, Ni and Co nanowires using template synthesizing technique — •Nina Winkler, Yong Lei, and Gerhard Wilde — Institute of Materials Physics and Center for Nanotechnology, University of Münster, 48149 Münster, Germany

Regular arrays of magnetic nanowires with a high aspect ratio have possible applications in high density magnetic recording media. Basic knowledge about magnetism may be obtained from these nanowire arrays as transition of multi-domain to single-domain wires occurs at the nanoscale. Modified Porous Alumina Membranes (PAMs) with pore diameters from 20 to 80 nm are well suited as templates for electrodeposition due to their high pore regularity. The pores of the PAM were filled with nickel, iron, cobalt, and multilayer structures of these metals, resulting in different metallic nanowire arrays. The deposition conditions for growing metallic nanowires are investigated in detail. The homogeneous structure and morphology of the template-prepared nanowire arrays is observed by SEM and TEM. The TEM and X-ray measurements indicate that the crystalline structure is either polycrystalline or amorphous depending on the deposition conditions. The magnetic properties of the nanowire arrays are investigated with vibrating sample magnetometry , which shows a preferential direction of magnetization along the wire axis due to the high aspect ratio of the nanowires. The wire interaction in the array is observed qualitatively with magnetic force microscopy.

MA 43.6 Wed 18:15 HSZ 103

An individual iron nanowire-filled carbon nanotube probed by micro-Hall magnetometry — •Stefan Bahr[1], Kamil Lipert[1,2], Franziska Wolny[1], Paola Atkinson[1], Uhland Weissker[1], Thomas Mühl[1], Oliver G. Schmidt[1], Bernd Büchner[1], and Rüdiger Klingeler[2] — [1]Leibniz Institute for Solid State and Materials Research IFW, 01069 Dresden, Germany — [2]Kirchhoff Institute for Physics, INF 227, D-69120 Heidelberg, Germany

We report on the magnetic properties of an individual, high-quality single-crystalline iron nanowire with diameter d=26 nm. The nanowire is embedded in a carbon nanotube which provides complete shielding against oxidation.

The magnetic properties are investigated by micro-Hall magnetometry which has a potential sensitivity of up to $10^4\mu_B$. We use a two-dimensional electron gas confined in an n-type GaAs/AlGaAs modulation doped heterostructure 90 nm below the surface to measure the magnetic stray fields of our individual iron nanowire.

Magnetization reversal of the individual iron nanowire is associated with domain wall formation where domain nucleation is initiated by curling. The observed nucleation fields of up to 900 mT at low temperatures are much higher than reported previously and nearly reach the shape anisotropy field of iron nanowires.

MA 43.7 Wed 18:30 HSZ 103

Quantum oscillations and ferromagnetic hysteresis observed in iron filled multiwall carbon nanotubes — •Jose Barzola-Quiquia[1], Niko Klingner[1], Axel Molle[1], and Albrecht

Leonhardt[2] — [1]Division of Superconductivity and Magnetism, University of Leipzig, D-04103 Leipzig, Germany — [2]Leibniz Institute for Solid State and Materials Research (IFW) Dresden, Helmholtzstrasse 20, 01069 Dresden, Germany

Carbon-based materials as multiwall carbon nanotubes (MWCNT) are attractive for spintronics because spin is only weakly coupled to the lattice, leading to large spin-flip scattering length and long spin relaxation times. In this contribution we have investigated the electrical transport properties of iron filled MWCNT (outer diameter 150 nm, inner diameter 25 nm and length 2000 nm) as a function of temperature and magnetic field. We observed quantum interference effects, i.e. universal conductance fluctuations, and weak localization effects. The in-plane magnetoresistance shows typical butterfly structure revealing the ferromagnetic properties of the Fe-filled MWCNT. The ferromagnetic hysteresis was observed up to 40K.

MA 43.8 Wed 18:45 HSZ 103

Examination of the Switching Field Distribution (SFD) and the shape anisotropy constant of nickel nanorods — •Florian Krämer, Philipp Bender, Andreas Tschöpe, and Rainer Birringer — Universität des Saarlandes, Saarbrücken

Nickel nanorods with diameters $D < 64$nm and aspect ratios $n > 3$ are expected to be uniaxial ferromagnetic single domain particles. The most simple approach to estimate their magnetic behavior is the Stoner-Wohlfarth-Modell (SWM), where magnetic reversal of ellipsoidal particles is assumed to occur by delocalized coherent rotation. However measurements of Ni nanorods show that their coercivity is significantly smaller than predicted by the SWM. There are two possible explanations for this discrepancy: first, a reduced shape anisotropy constant, and second, deviations from the proposed delocalized coherent rotation.The objective of this work was to study the magnetism of Ni nanorods with varying geometry ($D = 12 - 22$ nm, $n > 5$), in terms of their switching field distribution and shape anisotropy constant.The Ni nanorods were synthesized by current-pulsed electrodeposition of Ni into hexagonally ordered porous alumina templates. The nanorods were released from the templates by dissolution of the alumina in aqueous NaOH and dispersed in gelatine solutions (10 wt% gelatine) at 60 °C. Applying an external homogenous magnetic field during gelation enables the preparation of magnetically textured ferrogels with negligible dipolar interaction between the rods.The shape anisotropy constant and SFD's of the nanorods were determined from static magnetization measurements of the uniaxial ferrogels.