MA 5: Micro- and Nanostructured Magnetic Materials I

Time: Monday 11:00–13:00 Location: H23

MA 5.1 Mon 11:00 H23

Microresonator setup for Ferromagnetic Resonance investigations of nanoobjects — •Anja Banholzer[1], Ryszard Narkowicz[2], Dieter Suter[2], Ralf Meckenstock[1], Jürgen Lindner[1], and Michael Farle[1] — [1]Fakultät für Physik and Center for Nanointegration Duisburg-Essen, Universität Duisburg-Essen, 47048 Duisburg, Germany — [2]Institut für Physik, Universität Dortmund, 44227 Dortmund, Germany

For Ferromagnetic Resonance (FMR) experiments a minimum number of spins on the order of 10^{12} (e.g. for Permalloy) are necessary. To enhance the sensitivity of the FMR detection, we have designed a microresonator setup with very high sensitivity, which allows for investigating small nanoobjects, for which conventional FMR detection would fail. The microresonators are prepared using Electron Beam Lithography. The constant microwave field is generated within the resonator at the position of the sample. Due to the resonator geometry, the resonance frequency for our measurements is fixed at 14 GHz. To observe the FMR, we sweep the externally applied magnetic field. With the microresonator we show the detection of a single Permalloy stripe with the size of 5 μm x 0.5 μm x 0.05 μm. The measured spectra are in good agreement with theoretical calculations. We achieve a sensitivity of $4 \cdot 10^6$ $spins/(G \cdot \sqrt{Hz})$. To demonstrate the flexibility of the approach, FMR measurements are performed on an epitaxial iron disc containing about 10^{10} spins. Financial support by DFG and SFB 491 is acknowledged.

MA 5.2 Mon 11:15 H23

Magnetic Reversal in Iron Thin Films Interspersed with Non-Magnetic Pinning Sites — •Stefan Nau, Ulf Wiedwald, Stefan Wiedemann, Alfred Plettl, and Paul Ziemann — Institut für Festkörperphysik, Universität Ulm, Albert-Einstein-Allee 11, 89069 Ulm, Germany

Magnetic switching of continuous iron thin films is tailored by structuring a periodic array of nonmagnetic holes acting as pinning centers for domain walls. Contrary to common lithographically prepared antidots, nanostructures are prepared by deposition of densely packed monolayers of polystyrene (PS) spheres on silicon and silicon nitride substrates. Isotropic plasma etching leads to adjustable PS diameters between 20% and 80% of the initial value while conserving the particle spacing. The influence on the magnetic reversal process is studied as a function of diameter and distance of the PS spheres. Iron films are deposited by pulsed laser deposition. Antidot arrays of 100 nm period lead to up to 15 times increased in-plane coercive fields at 300 K, depending on dot diameters and film thicknesses. The magnetic reversal is imaged by scanning transmission x-ray microscopy accompanied by micromagnetic simulations in order to understand domain nucleation and propagation in varying external fields.

MA 5.3 Mon 11:30 H23

Analysis of Permalloy films prepared on anodized alumina templates — •Saleh Getlawi, Michael R Koblischka, and Uwe Hartmann — Institute of Experimental Physics, Saarland University, D-66123 Saarbrücken, Germany.

The magnetic properties of Permalloy (Py) systems have been extensively studied for thick films due to the important role in many technological applications, e.g., in magnetoresistive-based sensors and devices. Nanopatterned magnetic media are important for various current approaches in magnetoelectronics and magnetic recording. Commercially available anodized aluminia templates with pore diameters of 100 mm and 30 mm were employed as substrates for Py thin films. The films were prepared by dc-magnetron sputtering. The film thickness was between 7 nm and 30 nm. The obtained antidot patterns were observed by electron and force microscopy. The resulting magnetic domain structures were characterized by means of magnetic force microscopy performed in externally applied magnetic fields. Additionally, the magnetic parameters were characterized by means of SQUID magnetometry.

MA 5.4 Mon 11:45 H23

Effects of hexagonal hole structures on magnetization dynamics in thin nickel films — •Fabian Garbs, Benjamin Lenk, Andreas Mann, Henning Ulrichs, Darius G. Vahdat-Pajouh, and Markus Münzenberg — I. Physikalisches Institut, Georg-August Universität Göttingen

The spin-wave modes in hexagonal magnonic structures in thin nickel films are investigated by ultra short laser pulses (60 fs). In an all optical pump-probe setup the pulses are used both to excite the sample and to observe the magnetic relaxation on the picosecond timescale up to 1 ns. By using the time resolved magneto-optical Kerr effect (TRMOKE) the magnetic oscillations are observed in external fields up to $\mu_0 H_{\text{ext}} = \pm 150\,\text{mT}$, under an angle of up to 30° out of plane.

The magnetic films are structured with periodic micron-sized holes to produce a magnetic metamaterial using a focused ion beam (FIB). Hole structures with different parameters (hole radius and periodic distance) were investigated. The hexagonal structure was chosen because of high symmetry and in comparison to results of rectangular structure experiments. Measurements under different in-plane angles reflect the structural symmetry in terms of the obtained field-dependent dispersion.

Furthermore a missing row in hole structures was investigated in order to find analogies to photonic waveguide behavior, which could be used prospectively for magnonic circuits.

MA 5.5 Mon 12:00 H23

Qualitative and quantitative imaging of magnetic stray fields in $RECo_5$ thin films — •Ulrike Wolff[1], Sven Schnittger[2], Jonas Norpoth[2], Christian Jooss[2], Ludwig Schultz[1], and Volker Neu[1] — [1]IFW Dresden, P.O. Box 270116, 01171 Dresden, Germany — [2]Institut für Materialphysik, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

The contribution has been withdrawn.

MA 5.6 Mon 12:15 H23

Spin-wave propagation in a microstructured magnonic crystal — •Andrii V. Chumak[1], Philipp Pirro[1], Alexander A. Serga[1], Mikhail P. Kostylev[2], Robert L. Stamps[2], Helmut Schultheiss[1], Katrin Vogt[1], Sebastian J. Hermsdoerfer[1], Bert Laegel[1], P. Andreas Beck[1], and Burkard Hillebrands[1] — [1]FB Physik, Nano+Bio Center, and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]School of Physics, University of Western Australia, Crawley, Western Australia 6009, Australia

The transmission of spin waves through a magnonic crystal fabricated as permalloy (Py) waveguide with a periodically variable width was studied experimentally and theoretically. Electron beam lithography, molecular beam epitaxy, and lift-off process were used to fabricate the magnonic crystal in the form of a 40 nm thick Py stripe of periodically variable width between 2.5 μm and 1.5 μm. The lattice constant of the magnonic crystal is 1 μm. A bias magnetic field was applied perpendicularly to the waveguide in the film plane. Spin waves were excited by a 1 μm wide copper antenna and their characteristics were measured by spatially-resolved Brillouin light scattering microscopy. A rejection frequency band, where spin waves are not allowed to propagate, was clearly observed. The band gap frequency can be tuned in the range from 6.5 to 9 GHz by varying the applied magnetic field. The measured spin-wave intensity as a function of frequency and propagation distance is in good agreement with model calculations.

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MA 5.7 Mon 12:30 H23

Magnetization dynamics of a CrO_2 grain studied by micro-Hall magnetometry — •Pintu Das[1,2], Jens Müller[1,2], Ashna Bajpai[3], Fabrizio Porrati[2], Franziska Wolny[3], Steffen Wirth[1], Thomas Mühl[3], Michael Huth[2], Rüdiger Klingeler[3], and Bernd Büchner[3] — [1]Max Planck Institute for Chemical Physics of Solids, Nöthnitzer Str. 40, Dresden, — [2]Instiute of Physics, Goethe University, Max von Laue Str. 1, Frankfurt am Main — [3]Instiute for Solid State and Materials Research, Helmholtz Str. 20, Dresden

In the field of magnetism, it is often difficult to gain a complete quantitative understanding of magnetization dynamics in bulk or multigrain systems. Studying the magnetic behaviour of single magnetic entities is thus very important in order to understand the process of magnetization reversal in complex magnetic materials. In this work, we have studied the magnetization reversal of a single CrO_2 grain of size

$\sim 8 \times 2 \times 2\,\mu m^3$ using micro-Hall magnetometry technique. CrO_2 is ferromagnetic and has a T_c of $\sim$ 393 K. The grain has an antiferromagnetic Cr_2O_3 layer of thickness $\sim$ 2-5 nm. We observe that the magnetization in this grain switches through a series of Barkhausen jumps of stochastic nature. In the temperature range of 5 K - 60 K, simultaneously measured magnetization at both ends (along the long axis) of the grain show that these jumps are correlated. The data may allow us to infer the nature of the magnetic domains inside the grain and the behaviour of the domain walls for externally applied magnetic fields. We discuss the results and compare them with micro-magnetic simulations for the magnetic behaviour of this sample.

MA 5.8 Mon 12:45 H23

Magnetization Reversal in Arrays of Gold Nanoparticles Covered with Co/Pt Multilayers — •Carsten Schulze[1], Denys Makarov[1], Herbert Schletter[1], Alan Craven[2], Sam McFadzean[2], Michael Hietschold[1], Ulrike Wolff[3], Volker Neu[3], and Manfred Albrecht[1] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]Department of Physics and Astronomy, University of Glasgow, Glasgow G12 8QQ, UK — [3]IFW Dresden, Helmholtzstr. 20, 01069 Dresden, Germany

The reversal process of Co/Pt multilayers with perpendicular magnetic anisotropy deposited on arrays of self assembled gold nanoparticles with sizes down to 20 nm has been investigated. The magnetic caps on 60 and 40 nm particles show a well defined single domain state. The observed magnetization reversal process suggests, that the neighboring caps are exchange coupled. In this respect, the single domain caps observed in an exchange coupled magnetic film are suggested to occur through the formation of metastable domain patterns such as bubble domains. The reversal behavior on magnetic films on planar substrate and on assemblies of 20-nm-sized particles was found to be similar, but with substantially different size of the magnetic domains. Careful investigation of the magnetization reversal suggests the presence of strong pinning of domain walls on inhomogeneities in the magnetic material due to the particles. The latter indicates that the dense assemblies of gold particles could be considered as a template to realize the concept of perpendicular percolated media [1].

[1] D. Suess et al., J. Appl. Phys. 99 (2006) 08G905