MA 47: Micro- and Nanostructured Magnetic Materials II

Time: Thursday 17:15–19:00 Location: EB 202

MA 47.1 Thu 17:15 EB 202

Magnetism on Curved Surfaces — •Robert Streubel[1,2], Denys Makarov[1], Florian Kronast[3], and Oliver G. Schmidt[1,2] — [1]Institute for Integrative Nanosciences, IFW Dresden, 01069 Dresden, Germany — [2]Material Systems for Nanoelectronics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [3]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, 12489 Berlin, Germany

An elegant way to alter the fundamental magnetic interactions at the nanoscale is to introduce a curvature that leads to local thickness variation. In this respect, we investigated magnetic properties in permalloy (Py, $Ni_{80}Fe_{20}$) caps on both SiO_2 spherical particles with diameters from 100 to 800 nm and tubular non-magnetic rolled-up tubes with diameters from 250 to 1,700 nm. Both equilibrium and remanent states of individual caps and close-packed cap arrays were visualized by means of X-ray magnetic circular dichroism photoemission electron microscopy (XMCD-PEEM). The weak magnetostatic coupling leads to a chirality coupling with specific space-filling patterns. Vortex nucleation and annihilation fields of cap arrays are 5 times *smaller* than of equivalent individual planar disks and more than 3 times *larger* than of close-packed arrays of planar disks. Both temperature-dependent hysteresis measurements and relaxation measurements were performed to estimate the energy barrier for vortex nucleation and annihilation.

MA 47.2 Thu 17:30 EB 202

Energy Landscapes and magnetization dynamics of nanostructured magnetic materials — •David Gallina, Peter Jensen, and Gustavo M. Pastor — Institut für Theoretische Physik, Universität Kassel, 34132 Kassel, Germany

The magnetic relaxation processes in disordered two-dimensional ensembles of dipole-coupled magnetic nanoparticles are theoretically investigated. The energy landscape of the system is explored numerically by calculating saddle points, adjacent local minima and the associated minimum energy paths (MEPs) as functions of the structural disorder and external magnetic field. Representative MEPs between fully-polarized states having opposite magnetization directions $\vec{M}$ and $-\vec{M}$ are illustrated. The changes in energy and magnetization along the reaction coordinate are discussed. A connected (ergodic) network of the thermodynamic-relevant low-energy local minima and the corresponding transition rates between them are determined. As a result, we follow the time evolution of the system for different initial configurations and manipulations of the external magnetic field in order to simulate different experiments on these magnetic systems.

MA 47.3 Thu 17:45 EB 202

Anisotropic magnetoresistance in self-assembled antidot arrays — •Felix Häring, Ulf Wiedwald, Lorenz Lechner, and Paul Ziemann — Institute for Solid State Physics, Ulm University, Germany

Magnetic antidot arrays are prepared by colloidal lithography using size-reduced self-assembled polystyrene (PS) colloids as templates for the subsequent deposition of magnetic thin films. After removal of PS spheres including magnetic caps we obtain hexagonally ordered Fe and FeNi antidot films (thickness typically 20 nm). Based on initially 200 nm PS spheres the antidot diameter is varied in the range 30-180 nm and changes of the hysteresis are examined and compared to a continuous film. We observe strongly increased coercive fields due to huge local shape anisotropy. In-plane anisotropic magnetoresistance (AMR) proofs that magnetization reversal and AMR amplitude heavily depend on the antidot diameter. Averaging over large areas of the array leads to loss of the expected 6-fold anisotropy. Constricting, however, the AMR measurements to highly ordered areas of antidots (about 2μm x 15 μm) by applying focused ion beam (FIB), we locally can study the magnetization reversal in next and next but one neighbor directions. In this way, observation of anisotropy with respect to the antidot lattice becomes feasible. Results are supported by micromagnetic simulations.

MA 47.4 Thu 18:00 EB 202

Magnetization reversal processes in $Fe_{1-x}Tb_x$ nanodot arrays — •C. Schubert[1], P. K. Arekapudi[1], B. Hebler[1], H. Schletter[1], A. Liebig[1], F. Radu[2], and M. Albrecht[1] — [1]Institute of Physics, Chemnitz University of Technology, 09126 Chemnitz, Germany — [2]Department Magnetization Dynamics, Helmholtz Zentrum Berlin, 12489 Berlin, Germany

For spintronic and storage applications rare earth-transition metal alloy films like amorphous ferrimagnetic $Fe_{1-x}Tb_x$ are suitable materials owing to their high perpendicular magnetic anisotropy (7 - 10 Merg/cm^3) and low net magnetization (<300 emu/cm^3) [1]. In particular, arrays of Fe-Tb nanodots can exhibit manifold magnetic properties interesting for future sensor applications.

We present an investigation of the structural properties and the magnetization reversal process of amorphous $Fe_{1-x}Tb_x$ nanodots with a diameter of 30 nm, a height of 20 nm, and a period of 60 nm in the composition range from x = 0.19 to 0.23. All depositions were realized by magnetron (co-)sputtering on pre-patterned SiO_2/Si(100) substrates, which were fabricated by nano imprint lithography. The magnetization reversal of the nanodots occurs largely via coherent rotation as observed from angular dependent MOKE measurements in a polar geometry and by MFM imaging which shows single domain states.

[1] Y. Mimura et al., *J. Appl. Phys.* **49**, 3 (1978)

MA 47.5 Thu 18:15 EB 202

Hard magnetic (001)-textured FePtCu bit patterned media — •Patrick Matthes[1], Torbjörn Eriksson[2], Thomas Werner[3], Beate Mainz[1], and Manfred Albrecht[1] — [1]Inst. of Physics, Chemnitz University of Technology, DE-09107 Chemnitz — [2]Obducat Technologies AB, SE-20125 Malmö — [3]Center for Microtechnology, Chemnitz University of Technology, DE-09126 Chemnitz

To overcome the areal density limit of conventional magnetic materials for hard disk drives due to thermal instability problems, new materials with high K_u and new concepts for magnetic recording will be necessary [1]. In order to resolve the „recording trilemma“ the recording principle of bit patterned media has been proposed [2] and in combination with FePt based alloys an areal density beyond 1 Tb/in.^{2} is possible [1]. In this study hard magnetic 6 nm thick FePtCu films were prepared by sputtering at room temperature and post annealing. A dot array with a dot size of 20 nm and a period of 60 nm was then fabricated by post patterning using nanoimprint lithography. The fabricated dots are in a single domain state and reveal a rather sharp switching field distribution. The latter can be explained by the post-patterning process which induces damage to the side walls of the dots affecting their switching field. [3].

[1] S.N. Piramanayagam et al., J. Magn. Magn. Mater. **321**, 485 (2009)
[2] R.M.H. New et al., J. Vac. Sci. Technol., B **12**, 3196 (1994)
[3] J. Lee et al., Appl. Phys. Lett. **99**, 062505 (2011)

MA 47.6 Thu 18:30 EB 202

Magnetization reversal in dipolarly coupled PdFe nanodot arrays — •Melanie Ewerlin, Derya Demirbas, Frank Brüssing, Oleg Petracic, and Hartmut Zabel — Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, 44780 Bochum, Germany

We have studied a 2-dimensional XY macrospin model system by fabricating nanodot arrays from Pd1-xFex with low Fe-concentrations as magnetic material. Pd1-xFex films of 10 nm thickness and various Fe concentrations x were deposited by ion beam sputtering. Structural as well as magnetic characterizations were performed using superconducting quantum interference device (SQUID) magnetometry, magneto-optic Kerr effect (MOKE), atomic force microscopy (AFM) and x-ray diffraction (XRD). For the nanostructuring we used films with x=13 at% showing a Curie temperature of 290 K to ensure that the system can be cooled from a completely paramagnetic state into the macrospin state. We have fabricated circular dots with a diameter of 150 nm showing a single domain state. The dots are arranged on a square lattice with various inter-dot distances. The magnetization reversal of the entire system was studied using a low-temperature MOKE setup and compared to model expectations of a XY system with dipolar interactions. The results indicate a two step ordering process from intra-island to inter-island with decreasing temperature. To this end micromagnetic simulations are performed to determine the magnetization configuration of the dots depending on their thickness, diameter and distances.

MA 47.7 Thu 18:45 EB 202

Co/Pd multilayers on SiO_x pillar arrays at ultra-high density — •Fabian Ganss[1], Birgit Hebler[1], Andrea Cattoni[2], Anne-Marie Haghiri-Gosnet[2], and Manfred Albrecht[1] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]Laboratory for Photonics and Nanostructures, CNRS, 91460 Marcoussis, France

In order to demonstrate the preparation of ultra-high density bit patterned media, Co/Pd multilayers with perpendicular magnetic anisotropy were sputter deposited onto arrays of SiO_x pillars. These substrates were prepared by electron beam lithography and high temperature post-baking of HSQ resist [1] and provide pillars of various diameters at different pitches down to 26 nm, the latter corresponding to a potential storage density of 1.1 Tbit/in^2. The deposition was carried out under different deposition angles up to 60° to investigate the benefit of the shadowing effect while keeping a constant layer thickness by compensating the lower effective deposition rate by an increased process time. SQUID-VSM measurements of these films on planar substrates confirm comparable magnetic properties. The coated pillar arrays were investigated by MFM to prove exchange decoupling between the magnetic dots and estimate the switching field distributions. The exchange decoupling was proven successfully at densities up to 0.95 Tbit/in^2.

[1] A. Cattoni et al., Microelectron. Eng. 87, 1015-1018 (2010)