MM 55: Nanomaterials III - Electronic, magnetic and optical properties

Time: Thursday 12:00–13:15 Location: IFW B

MM 55.1 Thu 12:00 IFW B

Dimension and angle dependence of coercivities and magnetization reversal mechanisms in fourfold ferromagnetic systems — •Tomasz Blachowicz[1] and Andrea Ehrmann[2] — [1]Silesian University of Technology, Institute of Physics, Gliwice, Poland — [2]Niederrhein University of Applied Sciences, Mönchengladbach, Germany

Stability of magnetic states during evolution from saturation to anti-saturation and vice-versa, especially at remanence, belongs to the important issues in examination of magnetic nanosamples. Our presentation gives an overview of different fourfold magnetic wire systems, simulated by Magpar. Wire lengths have been chosen from 30 nm to 70 nm, while single wires have length-to-diameter ratios between 3 and 11. All simulations have been carried out for several angular in-plane directions of the externally applied field, ranging from 0° (parallel to a pair of wires) to 45°. Depending on system dimensions and field orientation, different magnetization reversal mechanisms could be observed as well as changes between stable and instable magnetic states [1].

Intermediate states at vanishing external field, reached by minor loops starting at steps in the hysteresis loop, are of special interest for application in novel data storage media systems. The presentation shows different possibilities to create such states and examines their stability by comparing hysteresis loops, special distribution of magnetization, and exchange energy as function of the externally applied field for a number of sample dimensions and external field angles.

[1] T. Blachowicz, A. Ehrmann, J. Appl. Phys. 113, 013901 (2013)

MM 55.2 Thu 12:15 IFW B

Macro-spin modeling of magnetization reversal processes in systems with different anisotropies — •Andrea Ehrmann[1] and Tomasz Blachowicz[2] — [1]Niederrhein University of Applied Sciences, Mönchengladbach, Germany — [2]Silesian University of Technology, Institute of Physics, Gliwice, Poland

Examinations of magnetic systems by use of a single macro-spin can support understanding magnetization reversal processes in principal. Such a macro-spin model, considering perfectly coherent rotation, can reproduce qualitatively all outstanding features of systems in which magnetization reversal is not based on domain wall processes [1].

A calculation based on constant energy minimization during the reversal process from positive to negative saturation and vice versa has been implemented in PTC(R) Mathcad. In this calculation, a simple macro-spin model describes the coherent rotation of a single magnetic moment (macro-spin) using the total energy density, consisting of different magnetic anisotropies as well as the external magnetic field. Thus, hysteresis loops of the longitudinal and the transverse magnetization component can be calculated. Besides coercive fields and shapes of the longitudinal magnetization loop, the calculation can also be used to detect angular orientations of the sample relative to the external magnetic field for which the transverse signals vanish.

[1] A. Tillmanns, S. Oertker, B. Beschoten, G. Güntherodt, J. Eisenmenger, Ivan K. Schuller: Angular dependence and origin of asymmetric magnetization reversal in exchange-biased Fe/FeF2(110), Phys. Rev. B 78, 012401 (2008)

MM 55.3 Thu 12:30 IFW B

Plasma assisted gas phase synthesis and high resolution characterization of bimetallic magnetic core-shell nanoparticles — •Marcel Hennes[1], Andriy Lotnyk[1], and Stefan G. Mayr[1,2,3] — [1]Leibniz-Institut für Oberflächenmodifizierung, Leipzig, Germany — [2]Translationszentrum für Regenerative Medizin, Leipzig, Germany — [3]Fakultät für Physik und Geowissenschaften, Universität Leipzig, Germany

Magnetic nanoparticles (MNPs) can be employed as powerful nanotools in many areas of biology, biophysics and medicine. Therefore, fine tuning of their physical properties is highly desired and can be achieved by controlling their size or shape or by using combinations of materials at the nanoscale. With this background, a setup for synthesis of heterostructured magnetic core-shell nanoparticles (CS-MNPs) relying on optionally pulsed DC plasma assisted inert gas condensation (PA-IGC) has been developed. We demonstrate synthesis of elemental nickel nanoparticles with highly tunable sizes and shapes as well as Ni@Cu CS-MNPs. The particles are characterized with respect to their structural and magnetic properties using AFM, MFM, SEM, HRTEM and EDX measurements. An analytical model is used to describe Cu shell atom deposition on top of Ni-particles in the gas phase. Its predictive power and possible implications for heterostructured NP growth are discussed.

MM 55.4 Thu 12:45 IFW B

Electrical characterization of single FePt nanoparticles — •Ulrich Wiesenhütter[1], Darius Pohl[2], Bernd Rellinghaus[2], Jürgen Fassbender[1], and Artur Erbe[1] — [1]Helmholtz-Zentrum Dresden Rossendorf, D-01328 — [2]Leibniz-Institut für Festkörper- und Werkstoffforschung, D-01069

In order to correlate the size and crystallinity of FePt nanoparticles to their electrical properties, single nanoparticles are contacted to electric leads using electron beam lithography. The particles are prepared from gas phase on electron transparent SiN membranes which allow for imaging the electrically investigated particle by means of transmission electron microscopy. The electrical characterization is carried out by recording current-voltage characteristics. As a result, Coulomb-blockade effects were observed at low temperatures which is in agreement with the dimensions obtained from the TEM studies. Individual properties of the particle - electrode junctions, i.e., capacitances and coupling parameters were derived from reconstructed Coulomb-blockade diamonds.

MM 55.5 Thu 13:00 IFW B

Electroluminescent silver surfaces — •Ines Caspers, Johanna Kirschner, Tobias Haug, Sebastian Bange, and John M. Lupton — Universität Regensburg, Deutschland

Electrically contacted silver island metal films exhibit electroluminescence after deliberate introduction of a tunneling barrier into the film. The nanoscale barrier is formed by application of a direct current, while the subsequent stable light emission is excited by an alternating current. Most of the observed photons are emitted in the near-infrared region and are detected from small emissive centers located within the tunneling junction. We attribute the phenomenon to an inelastic tunneling process of electrons through the barrier formed between adjacent silver nanoparticles. The tunneling electrons are understood to couple to and excite localized surface plasmons that eventually decay radiatively. The emission polarization is correlated with the dipole formed by two nanoparticles and thus partially polarized with a reduced preference for orientation perpendicular to the tunneling current.