MA 16 Micro- and Nanostructured Magnetic Materials II

Time: Tuesday 11:45–13:00 Room: HSZ 103

MA 16.1 Tue 11:45 HSZ 103

In-situ measurements of magnetoresistive effects in ferromagnetic microstructures by Lorentz TEM — •Thomas Haug, Anton Vogl, Josef Zweck, and Christian H. Back — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, D-93040 Regensburg, Germany

Recently large magnetoresistive values exceeding 10.000% have been discovered in ferromagnetic nanocontacts. In these experiments it is assumed that the contact area supports almost atomically sharp domain walls, where the conduction electrons suffer strong spin scattering. However, this theory is discussed controversially, as some other reasons could be listed as well, which might explain these extraordinary high effects. Apart from that, many other magnetoresitive experiments can only be explained theoretically or on the basis of micromagnetic simulations. So there is a strong need for direct observation of the micromagnetic behavior of the samples during the magnetoresistance measurement. We report on a four point resistance measurement inside a transmission electron microscope (TEM) and during the imaging process which uses a newly developed specimen holder. Lorentz microscopy allows us to observe the micromagnetic configuration of the ferromagnetic samples. Two different imaging techniques, Fresnel imaging and differential phase contrast (DPC) are used. The latter one allows lateral magnetic resolution down to 10 nm. We present first experiments on ferromagnetic Nickel structures where we can show the direct correlation between the appearance of magnetic domains and anisotropic magnetoresistance.

MA 16.2 Tue 12:00 HSZ 103

Magnetic anisotropy and tunneling anisotropic magnetoresistance in CoPt systems. — •Alexander Shick[1], Franišek Maca[1], Jan Mašek[1], and Tomas Jungwirth[2,3] — [1]Institute of Physics ASCR, Na Slovance 2, 182 21 Praha 8, Czech Republic — [2]Institute of Physics ASCR, Cukrovarnická 10, 162 53 Praha 6, Czech Republic — [3]School of Physics and Astronomy, University of Nottingham, University Park, Nottingham NG7 2RD, UK

First principles full-potential linearized augmented plane wave (FP-LAPW) calculations are used to investigate the magnetic anisotropy energy (MAE) and tunneling anisotropic magnetoresistance (TAMR) for several model systems ranging from simple hcp-Co to more complex ferromagnetic structures with enhanced spin-orbit coupling, namely bulk and thin film $L1_0$-CoPt ordered alloys and a monatomic-Co wire at a Pt surface step edge. Based on ab initio calculations of the anisotropy in the density of states we predict sizable TAMR effects in CoPt-based metallic ferromagnets. This opens prospect for new spintronic devices with a simpler geometry as these do not require antiferromagnetically coupled contacts on either side of the tunnel junction. We also investigate the relation between the TAMR and MAE, and evaluate reliability of the predicted density of states anisotropies by comparing quantitatively our ab initio results for the magnetocrystalline anisotropies in these systems with experimental data.

MA 16.3 Tue 12:15 HSZ 103

Simulation of magnetoelastic properties of magnetic hollow microspheres — •Markus E. Gruner and Peter Entel — Theoretische Physik, Universität Duisburg-Essen, 47048 Duisburg

We investigate the properties of magnetic hollow micropheres consisting of a self-supporting closed packed arrangement of nanoparticles on a surface of a shell. Based on the setup of a recent experiment [1], we propose a model taking into account the dipolar magnetic coupling and a Lennard-Jones-like pair interaction between the individual particles. Computer simulations using the hybrid Monte Carlo method [2] allow us to obtain information on the magnetoelastic properties. Depending on the strength of the attractive interactions considerable deformations are observed. Using a rotating homgeneous magnetic field, a controlled athermal destruction of the structures is achieved, possibly making magnetic microspheres candidates for magnetically targeted drug carriers.

[1] A. Schlachter, M. E. Gruner, M. Spasova *et al.*, Phase Transitions **78**, 741 (2005)
[2] B. Mehling, D. W. Heermann, and B. M. Forrest, Phys. Rev. B **45**, 679 (1992)

MA 16.4 Tue 12:30 HSZ 103

Preparation and characterization of Mn ferrite nano particles via coprecipitation method — •Behshid Behdadfar[1], Morteza Mozaffari[1,2], and Jamshid Amighian[1,2] — [1]Phys. Dept., The University of Isfahan, Isfahan (81746-73441), Iran. — [2]Nanphysics Research Group, Center for Nanosciences and Nanotechnology, The University of Isfahan, Isfahan (81746-73441), Iran.

Soft magnetic oxides, MFe2 O4, where M is a divalent metallic ion, have a spinel structure and in the bulk form have many applications in telecommunication and electronics. Nano particles of these ferrites have different characteristics in comparison with the bulk ones. The use of magnetic particles to induce hyperthermia in biological tissues is an important factor for tumor therapy. Hyperthermia is a therapeutic procedure, which is used to raise the temperature of a region of the body affected by cancer to 42-46oC. This method involves the introduction of ferromagnetic particles in to tissues, and their subsequent irradiation with an alternating electromagnetic field. In this work we have prepared and characterized Mn ferrite nanopowders with a mean particle size of 5 nm. The powders were characterized by XRD method and particle size was calculated by Scherrer*s formula.

MA 16.5 Tue 12:45 HSZ 103

Calculation of the spontaneous magnetization of zinc ferrite unit cells with different distributions of cations at 0 K — •Morteza Mozaffari, Seid Ahmad Rastghalam, and Jamshid Amighian — Phys. Dept., The University of Isfahan, Hezarjarib st., Isfahan 81746-73441, IRAN.

In this work we have calculated spontaneous magnetization of ensembles of zinc ferrite unit cells having one-, ten- and a hundred-million members. For a unit cell of zinc ferrite, about 76.5 % of the cations are on the surface. On the other word broken bond density (BBD), which is the fraction of broken exchange bonds between surface spins with exchange bonds between surface and core spins unaffected, is nearly equal to 1. Bulk zinc ferrite has a normal spinel structure and as zinc ion has no magnetic moment, it has an antiferromagnet order with a Néel temperature of less than 10 K. Experimental studies have shown that nanometer size of zinc ferrite could have an inverse spinel structure with a non zero spontaneous magnetization. This is due to the canting and/or redistribution of spins on different sublattices. For each of the ensembles a pair of cations have been changed randomly for each member. For unit cells with a distribution according to a normal spinel structure we obtained a spontaneous magnetization (4πM,sub,0) of 1319.5 G. For others we obtained a range of spontaneous magnetizations from 188.49 to 4913.45 G. Spontaneous magnetization mean values for the all ensembles were obtained that is 1543.40 G.