MA 11: Spindependent Transportphenomena II

Time: Monday 15:15–17:30 Location: H 0112

MA 11.1 Mon 15:15 H 0112

Current-induced domain wall motion and vortex core displacements — •Lutz Heyne[1], Dirk Backes[1,2], Stephen Krzyk[1], Mathias Kläui[1], Ulrich Rüdiger[1], Laura Heyderman[2], Arantxa Fraile-Rodriguez[2], Frithjof Nolting[2], Miguel Nino[3], Tevfik Mentes[3], Andrea Locatelli[3], Konstantin Kirsch[4], and Roland Mattheis[4] — [1]Universität Konstanz, 78457 Konstanz, Germany — [2]Paul Scherrer Institut, 5232 Villigen, Switzerland — [3]Sincrotrone Trieste, 34012 Trieste, Italy — [4]Institute of Photonic Technology, 07702 Jena, Germany

The feasibility of the manipulation of magnetic domains by spin-polarized current injection is of great scientific interest and has large potential for applications. Theoretically the influence of the current is described by an adiabatic and a non-adiabatic term added to the Landau-Lifshitz-Gilbert equation of motion. Here especially the magnitude of the non-adiabatic term is currently much under debate.

We present new results on current induced domain wall motion. Direct X-ray photoemission electron microscopy imaging has been used to probe the magnetization configuration. In Permalloy wires we observe spin-torque induced domain wall transformations from vortex walls to transverse walls and vice versa. These transformations agree with predictions made by theory for the non-adiabatic term mentioned above. Furthermore we observe current induced vortex core displacements in magnetic disks. It is shown that the direction of the displacement depends on the vortex core polarity, i.e. the direction of the out-of-plane vortex core magnetization component.

MA 11.2 Mon 15:30 H 0112

Field- and current-induced single domain wall motion in Permalloy nanowires — Philipp Möhrke[1], Thomas Moore[1], •Mathias Kläui[1], Stephen Krzyk[1], Dirk Backes[1,2], Laura Heyderman[2], and Ulrich Rüdiger[1] — [1]Fachbereich Physik, Universität Konstanz, 78457 Konstanz, Germany — [2]Paul Scherrer Institut, 5232 Villingen PSI, Switzerland

Current-induced domain wall (DW) motion in ferromagnetic nanowires has been found to be a stochastic process. Therefore single shot measurements, rather than static imaging or averaging techniques, are needed in order to gain a full understanding of this phenomenon.
We present measurements of field- and current-induced single DW dynamics in Permalloy ($Ni_{80}Fe_{20}$) nanowires (thickness ∼20 nm, width down to 400 nm) by nanosecond time-resolved focused MOKE. The velocity of an individual DW is captured at various positions on the nanowire. By repeatedly preparing and probing a DW of specific spin structure, velocity distributions with high statistics are gathered. The most probable velocity in 1500 nm wide wires measured at a location 10 μm from the starting position at fields close to the depinning field of ∼10 G was ∼70 m/s, but velocities up to a few 100 m/s occur. The velocity distributions allow quantitative information about the DW motion to be extracted, such as the variation of the pinning field amplitude along the wire or the fluctuation of the DW velocity.
Support by the DPG within the SPP1133 and the EU (Human Resources and Mobility Programme) is acknowledged.

MA 11.3 Mon 15:45 H 0112

Time-dependent spin transport through ferromagnet-metal junction — •Yao-Hui Zhu and Hans Christian Schneider — Physics Department, Kaiserslautern University of Technology, Germany

Time-dependent spin transport is studied theoretically for magnetic multilayers using a dynamical version of the Valet-Fert theory [1]. Starting from a Boltzmann transport equation we find the equivalent of a telegraph equation for the spin current. The wave character inherent in this type of equation enables us to define a finite propagation velocity for spin-switching processes. We show that spin diffusion can be regarded as an approximation of the diffusion-wave behavior of spin transport in the long-time limit. We analyze magnetization switching, current reversal and alternating currents for ferromagent-normal metal contancts.

[1] T. Valet and A. Fert, Phys. Rev. B. 48, 7099 (1993).

MA 11.4 Mon 16:00 H 0112

In situ magnetoresistance measurements of FIB- milled nanoconstrictions — •Daniel Stickler[1], André Kobs[1], Genhua Pan[2], and Hans Peter Oepen[1] — [1]Institut für Angewandte Physik, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg, Germany — [2]CRIST, Faculty of Technology, University of Plymouth, Plymouth, Devon PL4 8AA, UK

Several fundamentally and technologically interesting physical effects emerge when spin polarized currents in ferromagnets pass through a laterally confined domain wall. We perform in situ structuring and consecutive magnetoresistance measurements utilizing a micromanipulator in our UHV FIB/SEM dualbeam system. The flexibility of FIB structuring is used to carve microstructures, which exhibit different micromagnetic behaviour, into a thin 30nm permalloy film, capped with 3nm Pt. In CIP (current in plane) geometry, the magnetoresistance of a constriction connecting two elliptical microstructures is measured. The magnetic vortex structure in the two permalloy structures induces a domain wall in the constriction. In a sequence of measurements with the same film, the width of the constriction was varied from sub-20nm to 200nm. The size dependence of the magnetoresistance will be presented and discussed with respect to the field induced magnetic fine structure in the adjacent microstructures. Financial support by the EU via EU04-586 BMR is gratefully acknowledged.

MA 11.5 Mon 16:15 H 0112

Effects of Ga^+ irradiation on the magnetotransport in NiFe — •André Kobs, Daniel Stickler, Matthias Scholz, Germar Hoffmann, and Hans Peter Oepen — Institut für Angewandte Physik, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg, Germany

The influence of irradiation by 30 keV Ga^+ on Pt capped NiFe wires were studied and quantified with in situ magnetotransport measurements. The wires were milled from 33 nm thick film and then irradiated with 30 keV Ga^+ varying the dose from $5 \cdot 10^{14}$ to $1 \cdot 10^{17}$ Ions/cm^2 using focused ion beam (FIB). The magnetoresistance (MR) behaviour of the structures was determined in current-longitudinal-to- and current-transversal-to-applied-field-geometry via in situ measurements utilizing a micromanipulator. The NiFe wires exhibit the typical anisotropic MR. In the transversal setup an enhancement of ΔR up to doses of $8 \cdot 10^{15}$ Ions/cm^2 in comparison to the untreated NiFe was observed. For higher doses an exponential decrease of ΔR with dose occurred. The increase of the resistance on ion bombardment can be explained with impurity scattering caused by gallium implantation and intermixing of Pt and NiFe, roughening of surface and material removal. The rate of material removal and the root-mean-square roughness have been determined by means of atomic force microscopy (AFM). The changes of composition were monitored by energy-dispersive x-ray spectroscopy (EDX). The magnetic properties were investigated by longitudinal magneto-optical Kerr effect (MOKE). The results of the latter investigation demonstrate the correspondence of features in the magnetisation and MR behaviour.

MA 11.6 Mon 16:30 H 0112

Anomalous Hall effect in epitaxial magnetite thin films — •Andrea Boger, Wolfgang Kaiser, Matthias Opel, Sebastian T. B. Goennenwein, and Rudolf Gross — Walther-Meissner-Institut, BayerischeAkademie der Wissenschaften, 85748 Garching, Germany

The ferrimagnet Fe_3O_4 is an attractive candidate for spintronic devices due to its Curie temperature of about 860 K, and a high spin polarization of $P \leq -(55 \pm 10)\%$ [1]. Although magnetite is already in the focus of research for decades, the anomalous Hall effect of epitaxial thin films, in particular the dependence of the transverse conductivity σ_{xy} on the longitudinal conductivity σ_{xx}, has not yet been studied in detail.

We have grown epitaxial Fe_3O_4 thin films in three different crystalline orientations by pulsed laser deposition. X-ray diffractometry proves the high crystalline quality of the films, demonstrated by a FWHM of the rocking curves of the (004), (440) and (222)-reflection of only 0.04° for (001), (110) and (111) orientation, respectively. Electrical transport measurements were performed at temperatures between 90 K and 375 K at magnetic fields up to 14 T. We have found that σ_{xy} is proportional to σ_{xx}^{β} with $\beta \simeq 1.6$ for (001) and (111) orientation. In contrast, (110) oriented samples show a change, likely due to the Verwey transition [2], from $\beta = 1.5$ below 120 K to $\beta = 1.8$ above.
[1] M. Fonin et al., Phys. Rev. B **72**, 104436 (2005)

[2] E. J. W. Verwey, Nature **144**, 327-328 (1939)
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MA 11.7 Mon 16:45 H 0112

Electronic structure and its influence on the magnetic properties of uranium ternaries UTM — •Malgorzata Samsel-Czekala — Leibniz-Institut für Festkörper- und Werkstoffforschung, IFW Dresden, PF 270116, D-01171 Dresden, Germany — Institute of Low Temperature and Structure Research, Polish Academy of Sciences, P.O. Box 1410, 50-950 Wrocław 2, Poland

The electronic structure of uranium UTM compounds, where (T = Ru, Ir; M=Al, Ga, Si), is reviewed. The obtained results of band-structure calculations, employing the modern full-potential local-orbital (FPLO) minimum basis code [1], are compared with experimental data of x-ray photoelectron spectroscopy (XPS) and transport and magnetic properties, obtained for single-crystalline samples [2,3]. Good agreement is achieved between theoretical and experimental results, showing a high degree of 5f electrons delocalization in these compounds. Such phenomena as spin fluctuation or Kondo-like behavior have been revealed in the experiments.

[1] FPLO-5.00-18 (improved version of the original FPLO code by K. Koepernik and H. Eschrig, Phys. Rev. B **59**, 1743 (1999)]; http://www.FPLO.de;

[2] M. Samsel-Czekała, E. Talik, R. Troć, J. Stepien-Damm, submitted to Phys. Rev. B.

[3] M. Samsel-Czekała, E. Talik, R. Troć, to be published.

MA 11.8 Mon 17:00 H 0112

Giant magnetoresistance and extraordinary magnetoresistance in inhomogeneous semiconducting *RE*NiBi compounds — •Frederick Casper and Claudia Felser — Institute of Inorganic and Analytical Chemistry, Johannes Gutenberg - University, 55099 Mainz

Some inhomogeneous semiconducting $C1_b$ compounds *RE*NiBi (*RE* = Gd, Dy, Er) show a negative giant magnetoresistance (GMR) above the magnetic ordering temperature in the paramagnetic temperature regime. Except for a weak deviation, this magnetoresistance scales roughly with the square of the magnetization in the paramagnetic state, and is related to the metal-insulator transition. At low temperature, a positive magnetoresistance is found, which can be suppressed by high magnetic fields. The nonmagnetic inhomogeneous semiconducting compound LuNiBi shows a large postitve MR ratio of 25% at room temperature. The positive MR may be due to metallic bismuth impurities in the sample that cause an extraordinary magnetoresistance (EMR).

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MA 11.9 Mon 17:15 H 0112

Electrical Nonlinearity in Manganite Films — •Vasily Moshnyaga[1], Kai Gehrke[1], Lakshmana Sudheendra[1], Stephanie Raabe[1], Konrad Samwer[1], Alexandr Belenciuc[2], Oleg Shapoval[2], Oleg I. Lebedev[3], and Gustaaf van Tendeloo[3] — [1]I. Physikalischers Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Institute of Applied Phyiscs, Academiei 5, MD-2028, Chisinau, Moldova — [3]EMAT, University of Antwerp, Groeneborgerlaan 171, B-2020 Antwerpen, Belgium

We address the nature of nonlinear electrical 3rd harmonic voltage in epitaxial La0.7Ca0.3MnO3 (LCMO) and La0.7Sr0.3MnO3(LSMO) manganite films. In LCMO the nonlinearity is strongly enhanced only close to the para-ferromagnetic phase transition (Tc=270 K) and can be suppressed by magnetic field, showing very large nonlinear CMR˜10(5) %. In the low temperature ferromagnetic metallic state the nonlinearity is small, -90 dB, and comparable to that for a metallic resistor. In contrast, LSMO is an essentially linear metallic material in the whole range of temperatures, T=4-400 K, and magnetic fields, B=0-5T. Such an intrinsic nonlinear behaviour is consistent with the temperature dependence of correlated polarons in LCMO and the absence of correlated polarons in LSMO.