MA 5: Spindependent Transportphenomena I

Time: Monday 10:15–13:00 Location: H 0112

MA 5.1 Mon 10:15 H 0112

Resistance Switching in Nanocolumnar La0.7Sr0.3MnO3 Films — Markus Esseling[1], Lakshmana Sudheendra[1], •Vasily Moshnyaga[1], Konrad Samwer[1], Oleg I. Lebedev[2], and Gustaaf van Tendeloo[2] — [1]I. Physikalisches Institut, Universität Göttinge, Friderich-Hund-Platz 1, 37077 Göttingen, Germany — [2]EMAT, University of Antwerp, Groenenborgerlaan 171, B2020 Antwerpen, Belgium

We report large (700 %) and reversible electric field induced switching of the resistance in LSMO films, grown by a metalorganic aerosol deposition technique on Al2O3(0001) substrates. The films show nanocolumnar microstructure, formed predominantly by (0001) out-of-plane oriented triangle shaped grains. Magnetotransport behaviour is dominated by the epitaxial (10-10) 60°- and (1-210) 30°- grain boundaries (GB), yielding a pronounced tunnelling magnetoresistance effect. The I(V) curves of microstructured samples (˜1x1 mkm2) are strongly nonlinear for small voltages and show reversible switching from a high to the low resistance state at +-7 V. A mechanism for resistance switching is suggested based on the reversible voltage induced change of the angle of Mn-O-Mn bindings at the GB's. SFB 602 TP A2 is acknowledged.

MA 5.2 Mon 10:30 H 0112

Influence of spin-orientation on Tc in superconducting spin-valves CoFeHf/Nb/CoFeHf — •Yuansu Luo and Konrad Samwer — I. physikalisches Institut, Universität Göttingen, Friedrich-Hund Platz 1, 37077 Göttingen

Spin-valve-like structures CoFeHf/Nb/CoFeHf were investigated to show a potential influence of the spin orientation on superconducting transition temperature Tc of the space layer Nb, where the alloy of CoFeHf with 25at.%Hf was chosen as magnetic layers due to its amorphous and soft magnetic properties, having a high resistivity and a low saturation magnetization which may effectively diminish the proximity effect. The layer thicknesses used are 2-6nm for CoFeHf and 15nm for Nb, i.e. less than the coherence length. The upper magnetic layer deposited at room temperature exhibits a coercive field of a few Oe, which is smaller than that of the bottom magnetic layer prepared at 300°C and pinned additionally by a hard magnetic layer of CoFe(2nm). Transport measurements were carried out at low temperatures with an electric current and a magnetic field both in plan. The critical temperature Tc was measured to be 5.40K for the multilayered samples. It slightly shifts upwards about 25mK when changing the spin configuration of two magnetic layers from parallel to antiparallel. The small superconducting spin-valve effect might be related to strongly enhanced critical magnetic field. (Supported by DFG-Leibniz program)

MA 5.3 Mon 10:45 H 0112

Tunneling magnetoresistance and tunneling anisotropic magnetoresistance in ferromagnet/semiconductor/ferromagnet tunnel junctions — •Alex Matos-Abiague and Jaroslav Fabian — Institue for Theoretical Physics, University of Regensburg, 93040 Regensburg, Germany

We investigate transport properties of asymmetric ferromagnet/semiconductor/ferromagnet tunnel junctions. We show that in such structures both the tunneling magnetoresistance (TMR) and anisotropic tunneling magnetoresistance (TAMR) effects can coexist. Three different terms contribute to the total magnetoresistance. The dominant contribution corresponds to the TMR which depends on the relative but not on the absolute magnetization directions in the ferromagnets. Conversely, the TAMR contribution is determined by the absolute orientation of the magnetization in one of the ferromagnets [1]. A third mixed contribution exhibits a dependence on both relative and absolute magnetization orientations. This contribution, like the TAMR, originates from the interference of Rashba and Dresselhaus spin-orbit couplings at the ferromagnet/semiconductor interfaces [1,2]. Model calculations for Fe/GaAs/Fe tunnel junctions are presented. Furthermore, based on rather general considerations, we present a simple model that reveals the magnetoresistence dependence on the absolute and relative magnetization directions in the ferromagnets. [This work was supported by the DFG through SFB 689]

[1] J. Moser et al., Phys. Rev. Lett. 99, 056601 (2007).

[2] J. Fabian et al. Acta Phys. Slov. 57, 565 (2007).

MA 5.4 Mon 11:00 H 0112

Ballistic and Diffusive Current Spin Polarization in L1$_o$-ordered FePt and FePd — •Klaus M Seemann[1], Vincent Baltz[1], Mark C Hickey[1], Maureen MacKenzie[2], Jorge Miguel[3], Florian Kronast[4], Wolfgang Kuch[3], John N Chapman[2], Christopher H Marrows[1], and Bryan J Hickey[1] — [1]E.C. Stoner Laboratory, School of Physics and Astronomy, University of Leeds, Leeds, United Kingdom — [2]Department of Physics and Astronomy, University of Glasgow, Glasgow, United Kingdom — [3]Institut für Experimentalphysik, Freie Universität Berlin, Berlin, Germany — [4]BESSY, Albert-Einstein-Strasse 15, Berlin, Germany

We report on the discrepancy of the current spin polarization in the ballistic and diffusive electron transport regime in L1$_o$-ordered epitaxial FePt and FePd layers. The films studied displayed a chemical long range order parameter of $0.4 < S < 0.9$ and a very strong perpendicular magnetic anisotropy. XMCD-PEEM results confirm the magnetic domain structure that we obtain from simulations employing the Landau-Lifshitz-Gilbert equation very well. By evaluating the spin current conductivity asymmetry based on the Levy-Zhang spin mistracking model we are able to assess the diffusive spin current polarization to be 80-90% [1]. On the other hand, to study the ballistic transport regime we have performed point-contact Andreev-reflection measurements at 4.2K. We obtained a value for the ballistic current spin polarization of 50%.

[1] K.M. Seemann, V. Baltz, M. MacKenzie, J.N. Chapman, B.J. Hickey, and C.H. Marrows, Phys. Rev. B at press, arXiv:0707.2943

MA 5.5 Mon 11:15 H 0112

Spin polarized tunneling into superconducting Al-Si and Al-Cu with MgO tunnel barrier — •Sarah Dierk[1], Oliver Schebaum[1], Andy Thomas[1], Günter Reiss[1], and Jagadeesh Moodera[2] — [1]Department of Physics, University of Bielefeld, D-33615 Bielefeld, Germany — [2]Francis Bitter Magnet Laboratory, Massachusetts Institute of Technology, Cambridge MA, USA

The determination of the tunneling spin polarization with superconducting tunnel junctions plays an important role in spintronics.

The tunneling spin polarization can be measured directly with a great accuracy [1]. Superconducting tunnel junctions with Al-Si and Al-Cu as superconductors have been prepared using two different shadow masks in a magnetron-sputter-deposition system. MgO has been used as the barrier material. The spin polarization of Co on top of the barrier was measured using the method of R. Meservey and P.M. Tedrow [1]. The results of annealed and not-annealed samples were compared, to determine the differences in cristallinity. The measurements were accomplished in an 3He/4He-cryostat at 0.46K and H=2.9T and H=3.31T. The spin-orbit scattering rates of Al-Si and Al-Cu have been compared in order to determine the influence of the higher atomic number of Cu on the spin-orbit-scattering.

[1] R. Meservey, P.M. Tedrow, Phys. Rep. 238, No. 4 (1994), 173-243.

MA 5.6 Mon 11:30 H 0112

Investigation of MTJs with MgO / Al_2O_3 composite tunnel-barriers — •Oliver Schebaum, Andy Thomas, and Günter Reiss — Bielefeld University, Thin Films and Physics of Nanostructures, Universitätsstraße 25, 33615 Bielefeld

Recently, large tunneling magnetoresitances (TMR) ratios have been reported in magnetic tunnel junctions (MTJs) with cristalline MgO tunneling barriers. The TMR ratio of MTJs with tunneling barriers made of Al_2O_3 on the other side seems to be limited to a much lower value. This behavior is interpreted to be due to coherent tunneling in the case of MgO as the tunneling barrier.

We have investigated the TMR ratio of MTJs with tunneling barriers made of a MgO/Al_2O_3 bilayer system. The samples were fabricated using an automatic magnetron sputtering machine with a base pressure of 1×10^{-7}mbar. The MgO layers were formed by RF-sputtering MgO, whereas the Al_2O_3 layers were fabricated by sputtering metallic aluminum and post oxidization utilizing a electron cyclotron plasma oxidization in pure Oxygen.

The dependence of the TMR ratio of the thickness of the MgO and

Al_2O_3 layers has been investigeted and the results are compared to the highest TMR ratios with either single MgO or single Al_2O_3 tunneling barriers.

MA 5.7 Mon 11:45 H 0112

Reduction of the tunnel magnetoresistance in Fe/MgO/Fe by disorder — •Peter Bose[1], Jürgen Henk[2], and Ingrid Mertig[1] — [1]Martin Luther University Halle-Wittenberg, Halle, Germany — [2]Max Planck Institute of Microstructure Physics, Halle, Germany

Spin-dependent ballistic transport is usually computed for ideal tunnel junctions, leading to magnetoresistance (MR) ratios much larger than their experimental counterparts. Disorder at the interfaces is believed to reduce the MR ratios considerably. A proof of this assumption is hardly possible in experiments and very demanding for *ab initio* transport theory.

We report on a theoretical investigation of the MR in Fe/FeO/-MgO/Fe junctions with substitutional disorder. In particular, partially occupied O sites in the FeO layer—as found in experiments [1]—are addressed. Within our layer-KKR approach to Landauer-Büttiker theory, a supercell method is implemented and applied for selected O concentrations.

The MR ratio is significantly reduced for the disordered samples, thus improving essentially the agreement with experimental results. The decomposition of the conductance into a specular and a diffusive contribution allows to discuss the transport properties in detail.

[1] C. Tusche et al., Phys. Rev. Lett. **95** (2005) 176101.

MA 5.8 Mon 12:00 H 0112

Anisotropic tunnel magnetoresistance in Fe/MgO/Fe junctions — Mayukh Nilay Khan[1], •Jürgen Henk[2], and Patrick Bruno[2] — [1]Indian Institute of Technology, Kharagpur, India — [2]Max Planck Institute of Microstructure Physics, Halle, Germany

The tunnel magnetoresistance (TMR) of a magnetic tunnel junction is defined as the difference of the currents for the parallel and the antiparallel configuration. Due to spin-orbit coupling it becomes anisotropic, that is, dependent on the magnetization directions.

We report on a detailed theoretical investigation of the tunnel anisotropic magnetoresistance (TAMR) in Fe/MgO/Fe by means of relativistic first-principles electronic structure and transport calculations. The TAMR ratio can be as large as 30 %. It is shown that the anisotropy originates from both the Rashba spin-orbit interaction at the interfaces and from resonant tunnelling. Spin-orbit induced band gaps in the leads show no considerable effect.

MA 5.9 Mon 12:15 H 0112

Correlation effects in the magnetoresistance of Fe/FeO/-MgO/Fe tunnel junctions — •Hossein Mirhosseini[1], Kamal Krishna Saha[2], Arthur Ernst[1], Jürgen Henk[1], and Patrick Bruno[1] — [1]Max Planck Institute of Microstructure Physics, Halle, Germany — [2]Oak Ridge National Laboratory, Oak Ridge, U. S. A.

Localized electrons are rather badly described within the local spin density approximation (LSDA) to density functional theory because the LSDA electron interacts with itself. The local self-interaction correction (LSIC) improves the description of these electrons significantly, as was shown especially for transition metal oxides [1]. Since an FeO layer is formed in Fe/MgO/Fe tunnel junctions [2], a considerable effect on the theoretical magnetoresistances is expected if the LSIC is applied to that layer.

We report on first-principles electronic-structure and transport calculations of Fe/FeO/MgO/Fe tunnel junctions with an application of the LSIC in the FeO layers. The transmittances for the LSDA and the LSDA+LSIC cases are compared, thus highlighting a proper description of oxide layers.

[1] M. Lüders et al., Phys. Rev. B **71** (2005) 205109.
[2] H. L. Meyerheim et al., Phys. Rev. Lett. **78** (2001) 076102.

MA 5.10 Mon 12:30 H 0112

Inelastic electron tunneling spectra of MgO based tunnel junctions with various soft electrode materials — •Volker Drewello, Jan Schmalhorst, Andy Thomas, and Günter Reiss — Universität Bielefeld, Germany

We have prepared MgO based magnetic tunnel junctions which show up to 180% TMR ratio at room temperature and 250% at 12 K using a commonly used CoFeB/MgO/CoFeB layer stack. Several ferromagnetic materials were also used as the soft electrode and we have measured inelastic electron tunneling spectra for each of these systems. The spectra show the typical magnon and phonon features as well as additional features which are not known from amorphous Alumina barriers. We compare the spectra with respect to the different electrode materials and compare our findings to the Alumina based junctions.

MA 5.11 Mon 12:45 H 0112

Tunneling junctions with the Heusler electrode $Co_2Cr_{0.6}Fe_{0.4}Al$ — •Christian Herbort, Elena Arbelo, and Martin Jourdan — Institute of Physics, Johannes Gutenberg University, 55099 Mainz, Germany

Some ferromagnetic Heusler compounds are theoretically predicted to be half metallic materials, i. e. to be characterized by a huge spin polarization at the Fermi energy. We investigate the correlations between junction preparation conditions, morphology and transport properties of planar $MgO - Co_2Cr_{0.6}Fe_{0.4}Al - AlO_x - Co/CoO_x - Pt$ tunnelling junctions. Epitaxial $Co_2Cr_{0.6}Fe_{0.4}Al$ (CCFA) thin films were deposited by dc- and rf-sputtering on different buffer layers (Cr, Fe, MgO) on MgO (1,0,0) substrates. By RHEED, LEED and in-situ STM investigations very different surface morphologies were observed for the different preparation processes. With dc-sputtered CCFA films (island morphology) on Fe buffer layers we determined a maximum spin polarization of the Heusler compound of 54% (Jullière model, T=4K). Atomically flat surfaces with CCFA unit cell sized steps (B2 structure) were obtained by rf-sputtering on MgO substrates with e-beam evaporated MgO buffer layers. Considering that the TMR of the CCFA based junctions depends strongly on the interface at the tunneling barrier, the AlO_x layer needs to be optimized separately for the different CCFA morphologies. The barrier optimization process on the new atomically flat CCFA surfaces (rf-sputtered on MgO buffer) is in progress and current results of spectroscopic and TMR measurements will be shown.