MA 63: Poster II (Surface Magnetism/ Magnetic Imaging/ Topological Insulators/ Spin Structures and Magnetic Phase Transitions/ Graphene/ Magnetic Thin Films/ Magnetic Semiconductors/ Magnetic Half-metals and Oxides/ Spin-dependent Transport/ Spin Excitations and Spin Torque/ Spin Injection and Spin Currents in Heterostructures/ Spintronics/ Magnetic Storage and Applications)

Time: Friday 11:00–14:00 Location: P2

MA 63.1 Fri 11:00 P2

Spin-resolved microspectroscopy of Co thin films on Cu(100) using one- and two-photon photoemission — •Martin Ellguth, Christian Tusche, Cheng-Tien Chiang, A. Akin Ünal, Aimo Winkelmann, and Jürgen Kirschner — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany

We measure spin-polarized photoelectron emission microscopy images of Co films with a thickness of 8 to 12 monolayers grown on Cu(100), using one- and two-photon (1PPE, 2PPE) photoemission (photon energy = 6.0 eV and 3.1 eV, respectively). Our photoelectron emission microscope (PEEM) is equipped with both a double hemispherical energy analyzer and an imaging spin-detector. Spin filtering of the full PEEM image is achieved by low-energy scattering of the photoelectrons at a W(100) crystal under specular reflection by 90 degrees. Compared to classical spin-resolved electron spectrometers, the two-dimensional detection scheme offers the simultaneous measurement of an entire spatial image and recording of the magnetic domain structure of the Co film at a selected energy.

Final-state energy spectra of the Co films in 1PPE and 2PPE show a positive spin-polarization background arising from the Co electronic structure. We find a superimposed reversal of the spin polarization due to the contribution of the surface resonance state of Co with minority spin character. In comparison, the unoccupied quantum well state of the Co thin film causes enhanced spin polarization in 2PPE, in a thickness-dependent energy range.

MA 63.2 Fri 11:00 P2

Vortex states in magnetic nanodisks in presence of a screw dislocation — •Anna B. Butenko, Ulrich K. Rössler, and Alexei N. Bogdanov — IFW Dresden

Defect structures in magnetic crystalline materials may locally change magnetic properties and can considerably influence the magnetic behavior of magnetic nanostructures. As an example, dislocations in magnets result in additional magnetic anisotropy [1] and break inversion symmetry of crystals which leads to chiral Dzyaloshinskii-Moriya (DM) couplings [2]. It was shown that similar surface-induced DM interactions can strongly affect vortex structures in magnetic nanodisks causing a chirality selection [3]. We present a phenomenological approach for dislocation-induced DM couplings and investigate effects of a screw dislocation at the center of a magnetic nanodisk with a vortex state. By numerical calculations on vortex profiles we analyze equilibrium parameters (the size, shape and stability) of the vortices as functions of applied magnetic field and the material and geometrical parameters.

[1] A.B. Dichenko et al., J. Magn. Magn. Mater. **53** (1985) 71.

[2] A. Arrott, J. Appl. Phys. **34** (1963) 1108; S.V. Maleev, Phys. Uspekhi **45** (2002) 569.

[3] A.B. Butenko et al., Phys. Rev. B **80** (2009) 134410.

MA 63.3 Fri 11:00 P2

Structure and magnetic properties of metal-TCNQ charge transfer networks on Ag(100) and Au(111) — •Nasiba Abdurakhmanova, TzuChun Tseng, Nan Jiang, Alexander Langner, Sebastian Stepanow, and Klaus Kern — MPI for Solid State Research, Stuttgart, Germany

Charge transfer networks of TCNQ with Ni and Mn on Ag(100) and Au(111) were investigated using Scanning Tunneling Microscopy (STM) and X-Ray Magnetic Circular Dichroism. STM reveals a diversity of structures for both Ni(TCNQ)x and Mn(TCNQ)x networks on Ag(100) that can be tuned by the x=TCNQ:Metal ratio, whereas on Au(111) only one type of network with x=1 was found. The fourfold coordinated Mn exhibits a high-spin d5 configuration and shows potential antiferromagnetic coupling between the Mn atoms. In contrast to Mn, Ni centers couple ferromagnetically. The electronic state is ascribed to a high-spin d8 configuration on Au(111), whereas Ni has predominant d9 character in the networks on Ag(100). The results are related to the different charge transfer modes of TCNQ present on the Ag and Au substrates.

MA 63.4 Fri 11:00 P2

Spin-structure of the Mn double layer on W(110) — •Silke Schröder, Paolo Ferriani, and Stefan Heinze — Institute of Theoretical Physics and Astrophysics, CAU Kiel, Germany

In ultrathin magnetic films Heisenberg exchange, Dzyaloshinskii-Moriya interaction (DMI) and magnetic anisotropy can compete and thus span a vast magnetic phase space containing also two- and three-dimensional complex magnetic structures [1]. Recent spin-polarized scanning tunneling microscopy measurements of the double layer of Mn on W(110) [2] suggest a short period ferromagnetic spin-spiral propagating along the [001] direction for an out-of-plane tip magnetization. However, an antiferromagnetic (AFM) contrast along the [1-10] direction is found for an in-plane tip magnetization which hints at a complex spin-structure. We studied the magnetic properties of this system by means of density functional theory calculation using the full-potential linearized augmented plane wave (FLAPW) method. We found a strong AFM nearest neighbour exchange and performed spin-spiral calculations resulting in a non-collinear ground state. Including spin-orbit coupling (SOC) in our calculations we determined the preferred magnetization direction due to magnetocrystalline anisotropy and studied the effects of the DMI. We finally considered three-dimensional spin-structures as possible explanations for the experimental results.

[1] Heide *et al.*: www.psi-k.org/newsletters/News_78/Highlight_78.pdf (2006)

[2] Y. Yoshida, K. von Bergmann, private communication

MA 63.5 Fri 11:00 P2

A New Highly Efficient Spin Detector for Electron Spectroscopy — •Matthias Escher[1], Nils B. Weber[1], Michael Merkel[1], Claus Michael Schneider[2], and Lukasz Plucinski[2] — [1]Focus GmbH, Hünstetten, Germany — [2]Peter Grünberg Institut, FZ Jülich, Germany

In order to overcome the restrictions in efficiency of conventional spin-detectors, e.g. Mott or SPLEED detectors, low energy electron scattering at a Fe(100)-p(1x1)O surface was first proposed by Bertacco et al. [1] as a system for highly efficient spin detection.

A new instrument based on that scheme is described here. It can be adapted to a spherical or a cylinder sector analyzer. An optimized optics and non-magnetic design enable the operation at very low energies without sacrificing the performance. The iron film is prepared in-situ on a W(100) crystal [2] without the need for separate sample preparation and exchange when using a MgO substrate [3]. We find an optimum working point at 6.5eV scattering energy consistent with [1]. First results obtained with UPS on Fe and Co films are shown.

With a Sherman-function of approx. 30% and a reflectivity up to 10% the figure of merit of this detector is more than one magnitude higher than conventional detectors. The oxidized iron film shows no degradation over days in UHV.

[1] R. Bertacco and F. Ciccacci, Phys. Rev B 59, 4207 (1999)

[2] A. Winkelmann, D. Hartung, H. Engelhard, C.-T. Chiang and J. Kirschner, Rev. Sci. Instrum 79, 083303 (2008)

[3] T. Okuda et al., Rev. Sci. Instrum 79, 123117 (2008)

MA 63.6 Fri 11:00 P2

Modulation of magnetic anisotropy due to the quantization of Bloch states in ferromagnetic films on vicinal surfaces — Uwe Bauer, •Maciej Dabrowski, Marek Przybylski, and Jürgen Kirschner — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany

Oscillatory magnetic anisotropy is attributed to the quantization of Bloch states along the growth direction and the resulting formation of quantum well states (QWS). With varying film thickness, QWS lead to periodic changes in the electronic structure and therefore can modulate

magnetic anisotropy.

To determine magnetic anisotropy by magneto-optic Kerr effect (MOKE), Fe thin films were grown on vicinal surfaces of Ag(001) and Au(001). The mono-atomic steps on the substrates induce an in-plane uniaxial anisotropy which determines the easy magnetization axis. Moreover, the magnetization can be tilted out of the film plane and result in an additional polar component to the Kerr signal which can result in hysteresis loops with a very complex shape. We provide a model, verified by experimental studies of Fe on Au(1,1,13), which explains why even small uncertainties in the experimental MOKE geometry can have a significant influence on the measured hysteresis loops.

The largest oscillation amplitude of Hs we obtained for Fe films grown on Ag(1,1,6). This shows that the larger the distorted fraction of the film volume (i.e. the larger the step density), the larger the amplitude of the anisotropy oscillations.

MA 63.7 Fri 11:00 P2

Magnetic Properties of Nanowires and Nanocorrals at the Classical Level — •Nikolaos P. Konstantinidis[1] and Samir Lounis[2,3] — [1]Physikalisches Institut, Universität Freiburg, 79104 Freiburg, Germany — [2]Department of Physics and Astronomy, University of California Irvine, California, 92697 USA — [3]Institut für Festkörperforschung and Institute for Advanced Simulation, Forschungszentrum Jülich and JARA, 52425 Jülich, Germany

The bottom-up approach is one of the main focus research areas of nanoscience where various atomic structures, *e.g.* corrals of adatoms and nanowires, are engineered atom by atom with a scanning tunneling microscope [1,2]. Our contribution addresses the magnetic properties of such systems whereby one more or less adatom is crucial. We use a classical Heisenberg model for the spins of the nanostructures. If the magnetic exchange interaction between nearest neighbors is of antiferromagnetic type, complex magnetic textures can arise provided an external magnetic field is applied or a magnetic coupling to a ferromagnetic substrate exists. Within this model, the corral of adatoms forms an open or a closed chain. We show that the spin configuration of the system can be tuned to a non-collinear or to a ferromagnetic state by adjusting its number of sites, the location of the adatom or the strength of the coupling to the ferromagnetic substrate.

[1] Manoharan *et al.*, Nature **403**, 512 (2000).
[2] Gambardella *et al.*, Science **300**, 1130 (2003).

MA 63.8 Fri 11:00 P2

Preparation of bulk Chromium tips for SP-STM — •André Engel, Anika Schlenhoff, Andreas Sonntag, Stefan Krause, and Roland Wiesendanger — Institute of Applied Physics, University of Hamburg

Chromium has proven to be a very useful bulk tip material for spin-polarized scanning-tunneling-microscopy (SP-STM) [1,2]. Recent studies show that bulk Chromium tips allow for atomic resolution and are sensitive to both in-plane and out-of-plane sample magnetization. Compared to ferromagnetic Iron or Nickel, antiferromagnetic Chromium is expected to have a negligible magnetic stray field which otherwise may affect the sample magnetization. In contrast to coated tips, bulk tips do not require any in-situ evaporation or tip exchange mechanism.

Starting with the method and etching parameters proposed in [1,3] we enhanced the preparation of Chromium tips in order to get optimum results regarding tip sharpness and aspect ratio. We present scanning electron microscopy (SEM) images and chemical analysis by means of electron dispersive x-ray spectroscopy (EDX) of differently prepared tips. Influences of different etching solutions, applied voltages and the weight of the insulating polymer tube [3] which physically restricts the etching region to a small area will be discussed.

[1] Li Bassi *et al.*, Appl. Phys. Lett. **91**, 173120 (2007)
[2] Schlenhoff *et al.*, Appl. Phys. Lett. **97**, 083104 (2010)
[3] Ceballos *et al.*, Surface Science **523**, 131 (2003)

MA 63.9 Fri 11:00 P2

Thermal magnetization reversal of small Fe-nanoislands on W(110) — •Andreas Sonntag, Anika Schlenhoff, Gabriela Herzog, Stefan Krause, and Roland Wiesendanger — Institute of Applied Physics, University of Hamburg, Germany

Spin-polarized scanning tunneling microscopy (SP-STM) has been proven to be a powerful technique for investigating magnetic nanostructures [1]. Recently it has been applied to probe the thermal switching behavior of superparamagnetic Fe/W(110) nanoislands [2]. It turned out that the magnetization reversal of islands that consist of more than approx. 30 atoms takes place via the nucleation and propagation of a domain wall. The smallest island investigated in the study showed a significantly different behavior which could not be explained within this model.

In our experiments we studied very small iron islands using variable temperature SP-STM. The thermal switching of individual islands was characterized at various temperatures by measuring the mean lifetime between two consecutive switching events. The characteristic parameters as the energy barrier and attempt frequency can be calculated by matching the results with the Néel-Brown law. The results are discussed with regard to the elongation of the islands along special crystallographic axes in order to clarify what kind of processes play a role in the magnetization reversal.

[1] R. Wiesendanger, Rev. Mod. Phys. **81**, 1495 (2009).
[2] S. Krause *et al.*, Phys. Rev. Lett. **103**, 127202 (2009).

MA 63.10 Fri 11:00 P2

The application of a monopole-like probe for local magnetization measurements by means of Magnetic Force Microscopy — •Silvia Vock[1], Franziska Wolny[1], Thomas Mühl[1], Rainer Kaltofen[1], Ludwig Schultz[1], Bernd Büchner[1], Christoph Hassel[2], Jürgen Lindner[2], and Volker Neu[1] — [1]IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany — [2]Physik, Universität Duisburg-Essen, 47048 Duisburg, Germany

A local magnetization measurement was performed with a Magnetic Force Microscope (MFM) to determine magnetization in domains of an exchange coupled [Co/Pt]/Co/Ru multilayer with predominant perpendicular anisotropy. The basic requirement for quantitative evaluation of MFM data is the calibration of the used probes. For this purpose conventional and iron filled carbon nanotubes (Fe-CNT) were calibrated within the point probe approximations. The results show a monopole-like behavior for the Fe-CNT tips while the parameters of the conventional tip depend strongly on the calibration structure. Therefore the Fe-CNT tip was chosen for the local magnetization measurement. As a result we determined an additional in-plane magnetization component of the multilayer, which is explained by estimating the effective permeability of the sample within the μ^*-method.

MA 63.11 Fri 11:00 P2

Threshold photoemission magnetic circular dichroism of perpendicularly magnetized Ni films on Cu(001): theory and experiment — •Matthias Kronseder, Stefan Günther, Georg Woltersdorf, and Christian H. Back — Universität Regensburg, Regensburg, Deutschland

Threshold photoemission magnetic circular dichroism (TP-MCD) for perpendicularly magnetized Ni films on Cu(001) was measured with a total electron yield method. This dichroism was used to observe the magnetic domain structure of these samples in a photoemission electron microscope. A spin-polarized relativistic Korringa-Kohn-Rostoker Green's function calculation including a dynamical mean field theory approach within the one-step-photoemission model reproduces the measured asymmetry in the photocurrents for left and right circularly polarized light. In addition, a three-step photoemission model calculation based on the same ab-initio calculation is used to quantitatively explain the MCD effect near the photoemission threshold. Furthermore, the dependence of the MCD-asymmetry on the polarization state of the incoming photons is theoretically computed and experimentally verified.

MA 63.12 Fri 11:00 P2

X-ray holographic imaging of dot patterned perpendicular magnetic structures — •Felix Büttner[1,2,5], Christoforos Moutafis[1,2,3], Jan Rhensius[1,3], André Bisig[1,2,3], Bastian Pfau[5,6], Christian Günter[6], Carsten Tieg[6], Jyoti Mohanty[5], Stefan Schaffert[5], Samuel Flewett[5], Hermann Stoll[4], Laura Jane Heyderman[1], Mathias Kläui[1,2,3], and Stefan Eisebitt[5,6] — [1]Paul Scherrer Institut, 5232 Villigen, Switzerland — [2]LNSD, Ecole Polytechnique Fédérale de Lausanne, 1015 Lausanne, Switzerland — [3]Universität Konstanz, 78457 Konstanz, Germany — [4]MPI für Metallforschung, 70569 Stuttgart, Germany — [5]Technische Universität Berlin, 10623 Berlin, Germany — [6]HZB, 12489 Berlin, Germany

Dot patterned magnetic data storage media with perpendicular magnetic anisotropy (PMA) are among the most promising candidates for future storage technology that is threatened by the superparamagnetic limit in conventional hard disk media. There is therefore industrial and fundamental scientific interest for dynamic and static imaging of spin

structures in these materials. Of particular interest are domain wall movement and domain switching processes. X-ray holography is a well suited imaging technology due to the immunity to drift, the absence of any cross talk between the excitation system and the imaging system and due to the perspective to take single shot time resolved images at free electron lasers. We present first holographic images of PMA material disks. The image quality was considerably improved by an advanced reconstruction algorithm accounting for finite gaps in the path of the x-rays.

MA 63.13 Fri 11:00 P2

A Scanning X-ray Microscope for Time-resolved and Surface-sensitive Measurements — •Markus Weigand[1], Daniela Nolle[1], Bartel van Waeyenberge[2], Michael Bechtel[1], and Eberhard Goering[1] — [1]MPI für Metallforschung, Stuttgart — [2]Ghent University, Belgium

MAXYMUS, an new UHV Scanning Transmission X-ray Microscope (STXM), has recently finished commissioning and became open for external users at HZB/Bessy II, Berlin, placed at a newly commissioned helical undulator Beamline. Activities up to now focused on magnetic measurements using XMCD as a contrast mechanism.

Key features of the microscope design are alternate acquisition methods: A fast APD detector with a custom FPGA system allows time resolved measurements with time resolutions below 50 ps and up to 100 time channels. Total electron yield, on the other hand, allows surface sensitive imaging on both transparent and bulk samples using the full range of soft x-ray spectroscopic methods. This is facilitated by a fully UHV compatible, bakeable microscope design with hot-pluggable sample transfer and UHV preparation chamber.

We will present and overview of current and near future capabilities as well as fist users and commissioning results with a focus of the above mentioned areas.

MA 63.14 Fri 11:00 P2

Quantifying magnetic moments $\vec{\mu}$ in magnetic force microscopy (MFM) tips — •Denny Köhler, Peter Milde, Ulrich Zerweck-Trogisch, and Lukas M. Eng — Institut für Angewandte Photophysik, TU Dresden, Deutschland

Measuring quantitative magnetic moments becomes one of the major tasks in nanomagnetic research. Here, we present a novel way to characterize magnetic force microscopy (MFM) tips in homogeneous external magnetic fields. Our methods basis on the deflection of the cantilever caused by the mechanical torque [1] as it is induced by an external magnetic field.

Low temperature measurements of the frequency-shift and static deflection of the cantilever in a variable external magnetic field are used to access the different vectorial components of the magnetic moment $\vec{\mu}$ of the tip. This allows to quantify both the magnitude and 3D spatial orientation of $\vec{\mu}$. Experimental results are compared with the theoretical behaviour of the magnetic dipole moment of the cantilever as calculated by combining a harmonic oscillator model with the minimization of the magnetic energy.

MA 63.15 Fri 11:00 P2

Bulk vs. surface effects in ARPES experiments on the topological insulator Bi_2Se_3 — •Richard C. Hatch[1], Marco Bianchi[1], Dandan Guan[1,2], Shining Bao[2], Jianli Mi[3], Bo Brummerstedt Iversen[3], and Philip Hofmann[1] — [1]Department of Physics and Astronomy, Interdisciplinary Nanoscience Center Århus University, 8000 Århus C, Denmark — [2]Department of Physics, Zhejiang University, Hangzhou, 310027 China — [3]Department of Chemistry, Interdisciplinary Nanoscience Center, Århus University, 8000 Århus C, Denmark

While the bulk of a topological insulator is insulating, fundamental symmetry considerations require the surfaces to be metallic. The dimensionality of states in the topological insulator Bi_2Se_3 were probed directly by performing ARPES measurements at different photon energies along $\bar{\Gamma}\bar{K}$ and $\bar{\Gamma}\bar{M}$. It was found that both the topological surface state and the state attributed to a two-dimensional electron gas [1] do not disperse with respect to the wave vector perpendicular to the surface k_z—thus confirming their two-dimensional nature. In contrast, strong k_z dispersions of the bulk conduction and valence bands are evident. From the experimental data, we derive the bulk band structure in the two high-symmetry slices throughout the Brillouin zone. Finally, we observe a state at a binding energy of 750 meV which does not disperse with k_z and is interpreted to be another surface state situated in a projected bulk band gap below the upper valence band.

[1] M. Bianchi *et al.* Nat. Communications 2010, DOI 10.1038/NComms1131.

MA 63.16 Fri 11:00 P2

Edge states in a spin-triplet multi-band superconductor — •Yoshiki Imai[1,2] and Manfred Sigrist[1] — [1]Institute for Theoretical Physics, ETH Zurich, Zurich, Switzerland — [2]Department of Physics, Saitama University, Saitama, Japan

Motivated by the multi-band spin triplet superconductor Sr_2RuO_4 we investigate the properties of a 2D two-band system with an electron- and hole-like Fermi surfaces within a tight-binding model including inter-orbital hybridization and spin-orbit coupling effects. The band structure is chosen as to support spontaneous spin currents flowing along edges in the normal state. In our study we focus on helical and chiral spin-triplet pairing states and their influence on the states at the edge. Both states have topological character and yield, despite a full quasiparticle excitation gap in the bulk, gapless edge states with contributions to spontaneous spin and/or charge currents. We elucidate how electron- and hole-like particles interfere with each other in the formation of these edge states and edge currents. In this context multi-orbital and topological properties are discussed.

MA 63.17 Fri 11:00 P2

Magneto-acoustic study of single crystalline $UCu_{0.95}Ge$ — •S. Yasin[1], A.V. Andreev[2], Y. Skourski[1], J. Wosnitza[1,3], S. Zherlitsyn[1], and A.A. Zvyagin[3,4] — [1]Hochfeld-Magnetlabor Dresden (HLD), Forschungszentrum Dresden-Rossendorf, 01314 Dresden, Germany — [2]Institute of Physics ASCR, Na Slovance 2, 18221 Prague 8, The Czech Republic — [3]Institut für Festkörperphysik, Technische Universität Dresden, 01069 Dresden, Germany — [4]B.I. Verkin Institute for Low Temperature Physics and Engineering of the National Academy of Sciences of Ukraine, Kharkov, 61103, Ukraine

We present results of a magneto-acoustic study on a $UCu_{0.95}Ge$ single crystal. This compound exhibits antiferromagnetic ordering at 48 K and shows a first-order metamagnetic phase transition at 38 T to a spin-polarized state, i.e., when the magnetic field is applied along the c direction a sharp jump in the magnetization appears. The sound velocity and sound attenuation demonstrate pronounced anomalies in the vicinity of both magnetic phase transitions proving the important role of magneto-elastic interactions in the physics of this actinide compound. Above T_N, the acoustic characteristics show some unusual frequency-dependent features which presumably can be related to the dynamics of Cu vacancies in $UCu_{0.95}Ge$. Our results are discussed in frame of a phenomenological model, which describes qualitatively the main experimental observations.

MA 63.18 Fri 11:00 P2

Investigation of spin- lattice interactions in Ho2Ti2O7 and Dy2Ti2O7 — •Salim Erfanifam[1], Sergei Zherlytsin[1], Joachim Wosnitza[1], and Oleg Petrenko[2] — [1]Dresden High Magnetic Field Laboratory, Forschungszentrum Dresden-Rossendorf, Germany — [2]University of Warwick, Department of Physics, Coventry, CV47AL, United Kingdom

Ho2Ti2O7 and Dy2Ti2O7 belong to the family of rare-earth titanates with pyrochlore structure which have attracted much interest in recent years because of their spin-ice ground state and unusual magnetic excitations. Ultrasound experiments have been carried out on Ho2Ti2O7 and Dy2Ti2O7 at low temperatures down to 0.3 K and applied magnetic fields of up to 17.5 T. The temperature as well as field dependences of the relative change of the sound velocity demonstrate some pronounced anomalies below 2 K for the acoustic modes c11 and cL. In addition we have performed magnetization measurements of these two compounds. The observed anomalies and features in the sound velocity and magnetization provide additional information about the spin-lattice interactions in these spin-ice compounds. The role of the lattice degrees of freedom in connection with the emergent quasiparticles (magnetic monopoles) is discussed.

Part of this work was supported by EuroMagNET II under EU contract 228043.

MA 63.19 Fri 11:00 P2

Magnetic properties and configuration of $Fe_{50}Pt_{50*x}Rh_x$ films — •Jochen Fenske[1], Dieter Lott[1], Wolfgang Schmidt[2], Karin Schmalzl[2], Gary J. Mankey[3], Frank Klose[4], Helena Tartakowskaya[5], and Andreas Schreyer[1] — [1]Helmholt-Zentrum Geesthacht, Germany — [2]IFF Forschungszentrum Juelich, JCNS at ILL, France — [3]MINT Center, University of Alabama, USA — [4]Ansto,

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Ordered FePt alloys with $L1_0$ structure are known as materials with FM order and a high magnetic moment of Fe providing a large mangetization. The large atomic number of Pt on the other hand results in a high magnetic anisotropy. If grown in thin films, the high anisotropy often results in perpendicular magnetization which is the preferred orientation for current magnetic recording media. One way to control the magnetic properties in these materials is through the introduction of a third element into the crystal matrix e.g. Rh. When Rh is added to replace Pt in the equiatomic alloy, new magnetic phases emerge. Here we present neutron diffraction studies on the magnetic properties of different 200nm thick $Fe_{50}Pt_{50*x}Rh_x$ films in dependce of the temperature and external magnetic fields. Additional resonant x-ray measurements on the Fe and Pt absorption edges provide additional information about the magnetic moments on these sites.

MA 63.20 Fri 11:00 P2

Spin transport in graphene nanostructures — •Sebastian Schweitzer[1], Ajit Kumar Patra[1], Yenny Hernandez[2], Jan Rhensius[3], Jakoba Heidler[3], Matthias Eltschka[1], Mathias Kläui[1,3], Xinliang Feng[2], Laura Heyderman[4], and Klaus Müllen[2] — [1]FB Physik, Uni Konstanz, Universitätsstr. 10, D-78457 Konstanz, Germany — [2]MPI for Polymer Research, Ackermannweg 10, D-55128 Mainz, Germany — [3]SwissFEL, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland & Laboratory for Nanomagnetism and Spin Dynamics, Ecole Polytechnique Fédérale de Lausanne (EPFL), 1015 Lausanne, Switzerland — [4]Laboratory for Micro- and Nanotechnology, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland

Graphene, a monolayer of carbon atoms packed into a two-dimensional honeycomb lattice, is an exciting and promising material for spintronic applications. Due to its high mobility [1] it has a long spin diffusion length λ up to 2 μm [2]. However, λ is currently limited by the strong interaction between graphene and the substrate and by the corrugation in the graphene sheet, respectively. This can be overcome by using more robust turbostratic graphene (TG), a multilayer graphene stack without the usual Bernal stacking [3]. Therefore, enhancements in the mobility and the spin lifetime in TG are expected. Our recent results on spin-injection experiments using graphene as well as TG will be presented.

[1] A. K. Geim et al., Nature Materials **6**, 183 (2007), Science **324**, 1530 (2009). [2] N. Tombros et al., Nature **448**, 571 (2007). [3] M. Orlita et al., Phys. Rev. Lett. **101**, 267601 (2008).

MA 63.21 Fri 11:00 P2

Ab initio treatment of spin relaxation in Graphene caused by adatoms — Martin Gradhand[1], •Dmitry Fedorov[2], Sergey Ostanin[1], Igor Maznichenko[2], Arthur Ernst[1], Peter Zahn[2], Ingrid Mertig[1,2], and Jaroslav Fabian[3] — [1]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany — [2]Martin-Luther-Universität Halle, Institut für Physik, 06099 Halle, Germany — [3]Institut für Theoretische Physik, Universität Regensburg, 93040 Regensburg, Germany

The fast spin relaxation of conduction electrons in Graphene [1,2] is still an intriguing problem, since different experimental and theoretical investigations favour either the Elliott-Yafet or the Dyakonov-Perel spin relaxation mechanism. Nevertheless, it started to be a common opinion that the spin relaxation times obtained in experiments are due to the scattering of conduction electrons on adatoms which increase an effective spin-orbit interaction. However, in the theory the magnitude of the spin relaxation time is usually estimated using models where only a few parameters are taken from first principles calculations.

Here we present results of a consistent ab initio calculation of the spin relaxation time due to the Elliott-Yafet mechanism induced by adatoms. Our study is based on a recently developed fully relativistic approach for the spin-flip scattering at impurities [3]. We consider C and Si atoms as possible adatoms in the experiments.

[1] N. Tombros et al., Nature 448, 571 (2007) [2] N. Tombros et al., Phys. Rev. Lett. 101, 046601 (2008) [3] M. Gradhand et al., Phys. Rev. B 81, 020403(R) (2010)

MA 63.22 Fri 11:00 P2

Role of hybridization for the emergence of a giant Rashba effect in graphene — •Dmitry Marchenko[1], Andrei Varykhalov[1], Markus R. Scholz[1], Oliver Rader[1], Gustav Bihlmayer[2], Artem Rybkin[3], Anna Popova[3], Alexander M. Shikin[3], Emmanuel I. Rashba[4], and Thomas Seyller[5] — [1]Helmholtz-Zentrum Berlin — [2]Forschungszentrum Jülich — [3]St. Petersburg State University — [4]Harvard University — [5]Universität Erlangen-Nürnberg

We have recently created a giant Rashba splitting (100 meV) [1] of the Dirac fermions at the Fermi energy of graphene by intercalation of Au and attributed it to the high spin-orbit interaction in Au. Ab initio calculations and spin- and angle-resolved photoemission spectra of the interaction of graphene π with Au d states show a delicate dependence on the details of the hybridization which are not present in other systems. A giant Rashba splitting (200 meV) reported recently for graphene grown on SiC [2] is not confirmed by our measurements giving an upper limit of ~ 10 meV. Moreover, we compare to the intercalation system graphene/Au/SiC.

[1] D. Marchenko, A. Varykhalov, M. R. Scholz, E. I. Rashba, G. Bihlmayer, A. Rybkin, M. A. Shikin, O. Rader, unpublished [2] I. Gierz et al., arXiv:1004.1573v1

MA 63.23 Fri 11:00 P2

X-ray absorption and magnetic circular dichroism of $LaCoO_3$, $La_{0.7}Ce_{0.3}CoO_3$, and $La_{0.7}Sr_{0.3}CoO_3$ films: Evidence for Co valency-dependent magnetism — •Michael Merz[1], Peter Nagel[1], Andrea Assmann[1,2], Stephan Uebe[1,2], Markus Wissinger[1,2], Hilbert von Löhneysen[1,3], Dirk Fuchs[1], and Stefan Schuppler[1] — [1]Institut für Festkörperphysik, Karlsruhe Institute of Technology, 76021 Karlsruhe, Germany — [2]Fakultät für Physik, Karlsruhe Institute of Technology, 76031 Karlsruhe, Germany — [3]Physikalisches Institut, Karlsruhe Institute of Technology, 76031 Karlsruhe, Germany

Epitaxial thin films of undoped $LaCoO_3$, of electron-doped $La_{0.7}Ce_{0.3}CoO_3$, and of hole-doped $La_{0.7}Sr_{0.3}CoO_3$ exhibit ferromagnetic order with a transition temperature $T_C \approx 84$ K, 23 K, and 194 K, respectively. The spin-state structure for these compounds was studied by soft x-ray magnetic circular dichroism and by near-edge x-ray absorption fine structure at the Co $L_{2,3}$ and O K edges. It turns out that superexchange between Co^{3+} high-spin and Co^{3+} low-spin states is responsible for the ferromagnetism in $LaCoO_3$. For $La_{0.7}Ce_{0.3}CoO_3$ a spin blockade between Co^{3+} low-spin and Co^{2+} high-spin ions naturally explains the low transition temperature and the insulating characteristics of $La_{0.7}Ce_{0.3}CoO_3$. For $La_{0.7}Sr_{0.3}CoO_3$, ferromagnetism and metallicity is induced by t_{2g} double exchange between Co^{3+} and Co^{4+} high-spin states. For all systems, a strong magnetic anisotropy is observed, with the magnetic moments essentially oriented within the film plane.

MA 63.24 Fri 11:00 P2

Electric, magnetic and THz optical properties of $La_{1-x}Ca_xMnO_3$ $(0.45 < x < 0.7)$ and $(La_{1-y}Pr_y)_{0.33}Ca_{0.66}MnO_3$ $(0 < y < 1)$ thin films — •S. Hühn[1], F. Fischgrabe[1], V. Moshnyaga[1], K. Samwer[1], M. Dressel[2], L. S. Kadyrov[3], A.A. Voronkov[3], E.S. Zhukova[3], and B.P. Gorshunov[3] — [1]I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]1. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70550 Stuttgart, Germany — [3]A. M. Prokhorov Institute of General Physics, Russian Academy of Science, 119991 Moscow, Russia

Multiferroic behaviour has been paid a lot of attention due to the rich physics and great potential for technological applications. Recent studies indicate a close correlation between charge ordering (CO) and the ferroelectricity. For this reason we investigate $La_{1-x}Ca_xMnO_3$ $(0.45 < x < 0.7)$ and $(La_{1-y}Pr_y)_{0.33}Ca_{0.66}MnO_3$ $(0 < y < 1)$, which both show competing ferromagnetic metallic and charge ordering insulating phases. The films were grown by metalorganic aerosol deposition technique on MgO(100) substrates. D.c. and a.c. transport $(f = 0-40MHz)$, magnetization and optical conductivity, in the THz range of the electromagnetic spectrum, were studied as a function of temperature $(5-350K)$ and magnetic field $(0-7T)$. THz spectroscopy provides a clear sign for the CO transition at $220-280K$, depending on Ca-doping x. Moreover an indication for possible ferroelectricity in half-doped LCMO was observed from d.c. and a.c. transport measurements. Financial support via SFB 602 TP A2 is acknowledged.

MA 63.25 Fri 11:00 P2

Characterisation of magnetic thin films on MgO(100) — •Hendrik Bettermann, Wolfgang Rosellen, and Mathias Getzlaff — Institute of Applied Physics,University Duesseldorf

Nanoparticles on surfaces become more and more interesting from a

technological point of view like storage technology due to their size dependent electronic and magnetic properties. Therefore it is important to have access to the structure of deposited particles at different magnetic substrates. In the past it was shown that the interaction between surface and nanoparticle plays a predominant role for the particle shape and morphology. Both are influenced by the landing process and the interface and therefore on the substrate.

The focus of our investigation is on magnetic particles consisting of Fe, Co, and their alloys preformed with an Arc Cluster Ion Source (ACIS) and subsequently deposited on magnetic thin films. MgO(100) substrates are used for quick and easy access to clean, well-defined and single crystalline Fe, Co, and Ni thin films. These ultrathin films are investigated and characterised by the means of LEED (low energy electron defraction), AES (Auger electron spectoscopy) and STM (scanning tunneling microscopy).

MA 63.26 Fri 11:00 P2

Micromagnetic investigation of domain walls in $NdCo_5$ thin films — •Marietta Seifert, Ludwig Schultz, and Volker Neu — IFW Dresden, Helmholtzstr. 20, 01069 Dresden, Germany

$NdCo_5$ is a highly anisotropic magnetic material in which a spin reorientation takes place from a magnetic easy *c*-axis above a temperature of 310 K via an easy cone to a magnetic easy plane in the basal plane of the hexagonal crystal at temperatures below 255 K. This transition was experimentally investigated in thin epitaxial $NdCo_5$ films grown on Cr buffered MgO (110) substrates [1]. For a further understanding of the domain processes during this transition, micromagnetic simulations have been performed to elucidate the spin structure within the domain walls in all three regimes of magnetic anisotropy. In addition the evolution of the domain structure while cooling down through the spin reorientation transition was simulated by a sequence of micromagnetic simulations with varying anisotropy constants.

[1] M. Seifert, L. Schultz, V. Neu, JAP 106, 073915 (2009)

MA 63.27 Fri 11:00 P2

Ferrimagnetism and disorder in epitaxial $(Mn_{1-x}Co_x)_2VAl$ thin films — •Markus Meinert[1], Jan-Michael Schmalhorst[1], Günter Reiss[1], and Elke Arenholz[2] — [1]Dünne Schichten und Physik der Nanostrukturen, Fakultät für Physik, Universität Bielefeld, 33501 Bielefeld, Deutschland — [2]Advanced Light Source, Lawrence Berkeley National Laboratory, CA 94720, USA

Thin films of the quarternary full Heusler compound $(Mn_{1-x}Co_x)_2VAl$ were prepared by DC and RF magnetron co-sputtering on heated MgO (001) substrates. The magnetic structure was examined by x-ray magnetic circular dichroism and the chemical disorder was characterized by x-ray diffraction. For $x = 0.5$ a full compensation of the magnetic moments is expected according to the Slater-Pauling rule $m = N_V - 24$. Ferrimagnetic coupling of V to Mn was observed for Mn_2VAl ($x = 0$) and $x = 0.25$. For $x = 0.25$, we also found ferrimagnetic order with V and Co antiparallel to Mn. The experimental results are interpreted with the help of band structure calculations. The total magnetic moment is strongly reduced in Mn_2VAl because of preferential $D0_3$-like Mn-Al disorder. Co_2VAl is only B2 ordered and has reduced magnetization. In the cases with $x \geq 0.45$ conventional ferromagnetism was observed, closely related to the atomic disorder in these compounds.

MA 63.28 Fri 11:00 P2

Ultrathin continuous CoPt films with perpendicular anisotropy — •Ludwig Reichel, Karin Leistner, Sebastian Fähler, and Ludwig Schultz — IFW Dresden, PF 270116, 01171 Dresden

The change of magnetic properties of ferromagnetic ultrathin films by an electric field would be an easy and fast way to control their behaviour in nanosized devices. Among the ordered L10 phases, DFT calculations [1] predict the highest E-field induced change of anisotropy for the CoPt phase. Experimentally, the application of the electric field can be achieved by using a film as electrode in an electrochemical cell. For this, continuous, conducting films are required.

In the present investigation, 2-10 nm thick continuous CoPt films were deposited by pulsed laser deposition on MgO(001) substrates with Cr and Pt(001) buffer layers. Magnetic hysteresis curves with the magnetic field applied perpendicular to the film plane were obtained by anomalous Hall effect measurements. For films deposited at low temperatures, the A1 CoPt phase is present and shape anisotropy in the film plane dominates. On the other hand, temperatures above 500°C lead to interdiffusion and a lower degree of texture. Optimum (001)-textured L10 phase formation occurs for deposition temperatures of 450°C to 500°C. In these films, perpendicular anisotropy and switching of magnetization is achieved. We will present first results on electrolyte-CoPt interactions and electrolytic charging of these films.

[1] Zhang et al.: New J. Phys. 11 (2009) 043007

MA 63.29 Fri 11:00 P2

Charge-induced reversible change of magnetic properties in ultrathin FePt films — •Norman Lange, Karin Leistner, Steffen Oswald, Sebastian Fähler, and Ludwig Schultz — IFW Dresden, Helmholtzstraße 20, 01069 Dresden

FePt has attracted a lot of interest as hard magnetic material due its high magnetocrystalline anisotropy. For applications, e.g. in NEMS, fast and reversible changes of magnetic properties induced by an electric field would be ideal.Weisheit et al. [Science 315 (2007) 349] showed that the coercivity of ultrathin FePt films can be changed by 4 % by electronic charging. Larger E-field induced effects are expected at critical points. We study continuous FePt(001) films where perpendicular magnetocrystalline anisotropy competes with shape anisotropy. The 2 nm ultrathin FePt(001) films are prepared by pulsed laser deposition. The films are charged in a non-aqueous electrolyte by applying an electric voltage. In-situ magnetic hysteresis curves are measured using the anomalous Hall effect. We observe a large reversible change of anisotropy (up to 20 %) and of the magnitude of the anomalous Hall effect as a measure for the moment (up to 4 %) for a potential range of 2 - 3 V vs. Li/Li+. As XPS studies reveal an iron oxide layer on top of FePt, we suggest that the moment increase at lower potentials results from electrochemical reduction of surface iron oxide species to metallic iron. The perpendicular anisotropy of the composite film decreases when a soft magnetic Fe layer is exchange coupled to FePt. We conclude that the anisotropy of exchange coupled FePt/iron oxide composite films can be tuned reversibly by electrical charging.

MA 63.30 Fri 11:00 P2

An oxide MBE system for quasi *in-situ* neutron reflectometry studies — •Sabine Pütter[1], Alexander Weber[2], Alfred Richter[1], Ulrich Rücker[2], Stefan Mattauch[1], Aleander Ioffe[1], and Thomas Brückel[1,2] — [1]Jülich Centre for Neutron Science am FRM II, Forschungszentrum Jülich GmbH, Lichtenbergstr. 1, 85747 Garching — [2]Institut für Festkörperforschung, Forschungszentrum Jülich GmbH, 52425 Jülich

A state-of-the-art oxide-MBE (Molecular Beam Epitaxy) system has been commissioned at the Jülich Centre for Neutron Science (JCNS) in 2010. It is designed to create high quality epitaxial thin films and heterostructures of complex oxides utilizing co-deposition and *in-situ* oxidation for quasi *in-situ* neutron scattering studies at the new dedicated MAgnetism Reflectometer with high Incident Angle (MARIA) of the JCNS by transferring the sample in a UHV transport chamber to the neutron beam.

We report on progress in the fabrication of systems of metal and complex oxide thin films like $[Cr/Fe]_x/GaAs$ and $La_{1-x}Sr_xMnO_3/SrTiO_3$, respectively, with the fine control of stoichiometry, morphology, and thickness. We have carried out careful calibration of the deposition rates of the constituent elements by reflective high energy electron diffraction intensity oscillations, Auger intensity analysis and *ex-situ* X-Ray diffraction. Annealing steps have been optimized to obtain atomically smooth films which have been checked with atomic force microscopy.

MA 63.31 Fri 11:00 P2

Magnetic structure of one monolayer Fe on Ir(001)-(1$\times$1) — •yiqi zhang, zhen tian, kuntala bhattacharjee, masaki takada, dirk sander, and jürgen kirschner — Max-Planck-Institut für Mikrostrukturphysik,06120 Halle, Germany

The morphology and the magnetic structure of a Fe monolayer (ML) on Ir(001)-(1$\times$1) were investigated using a low-temperature scanning tunneling microscope (STM) operating in the constant-current mode with nonmagnetic and magnetic tips, respectively. Our STM studies with atomic resolution confirm pseudomorphic growth of Fe in the first layer [1,2], where our spin-resolved measurements identify a spin contrast with a 3 $\times$ 3 superstructure. As the magneto-optical Kerr-effect study [2] and the first-principles calculations [3] indicate that the first ML of Fe on Ir(001)-(1$\times$1) tends to order antiferromagnetically, we propose a noncollinear antiferromagnetic spin configuration of the Fe ML based on the spin contrast mapping.

\begin{flushleft} [1] V. Martin, W. Meyer, C. Giovanardi, L. Hammer, K. Heinz, Z. Tian, D. Sander, and J. Kirschner, Phys. Rev. B 76, 205418 (2007). [2] Z. Tian, D. Sander, and J. Kirschner, Phys. Rev.

B 79, 024432 (2009).

[3] J. Kudrnovsk\'{y}, F. M\'{a}ca., I. Turek, and J. Redinger, Phys. Rev. B 80, 064405 (2009). \end{flushleft}

MA 63.32 Fri 11:00 P2

Magnetic properties of $Mn_{2.6}Ga$ thin films with perpendicular anisotropy — •Daniel Ebke, Manuel Glas, Patrick Thomas, and Günter Reiss — Thin Films and Physics of Nanostructures, Physics Department, Bielefeld University, Germany

Spintronic devices have found a lot of attraction in the recent years due to possible new applications. To reach high storage densities and low spin transfer writing current densities it is essential to utilize magnetic tunnel junctions (MTJs) with perpendicular magnetic anisotropy. Materials with a high spin polarization like Heusler compounds are eligible to realize high tunneling magnetoresistance (TMR) ratios. The Heusler compound $Mn_{3-x}Ga$ is predicted to show a high spin polarization and a perpendicular magnetic anisotropie. In this work we have investigated the magnetic properties of Heusler $Mn_{2.6}Ga$ thin films. The results will be discussed with respect to the choice of substrate, deposition temperature and film thickness.

MA 63.33 Fri 11:00 P2

Preparation of $Mn_{3-x}Ga$ Heusler thin films with perpendicular magnetic anisotropy — •Manuel Glas, Daniel Ebke, Patrick Thomas, and Günter Reiss — Thin Films and Physics of Nanostructures, Physics Department, Bielefeld University, Germany

Recently, the integration of materials with perpendicular magnetic anisotropy into magnetic tunnel junctions (MTJs) has found a lot of attraction due to the predicted lowered current densities for spin transfer switching and a higher thermal stability. Because of the predicted high spin polarization and the low magnetic moment Mn_3Ga is a promising material for future spin torque transfer (STT) magnetic switching devices. For this work, we have fabricated $Mn_{3-x}Ga$ Heusler thin films with varying stoichiometries into half magnetic tunnel junctions. The effect of Heusler film composition will be discussed with respect to the magnetic and crystal properties.

MA 63.34 Fri 11:00 P2

In-Situ STM, LEED and MOKE Measurements of Ultrathin Epitaxially Flat Grown Fe Films on the GaAs(110) Surface — •Tim Iffländer, Martin Wenderoth, Thomas Druga, Lars Winking, and Rainer G. Ulbrich — IV. Phys. Inst., Georg-August-Universität Göttingen

Fe films of up to 8 ML thickness were deposited on in-situ cleaved n-, p-, and i-GaAs(110) in a two-step process combining low-temperature deposition at 130 K with a subsequent annealing to room temperature. LEED and STM measurements suggest an abrupt interface without any considerable amount of compound formation.

In-situ longitudinal MOKE measurements at RT were conducted for different in-plane orientations of the applied magnetic field with respect to the sample. In contrast to RT grown Fe films of 2-3 ML thickness, the easy and hard axes are interchanged, now parallel to [001] and [110], respectively. The hysteresis loop of films thicker than or equal to 5 ML is equivalent to magnetization curves observed in the case of RT grown films.

Furthermore, we observe a new phenomenon in the 2-3 ML thickness regime: the sense of the hysteresis loops for steep angles of incidence is not determined by the orientation of the magnetic field but linked to the crystallographic orientation of our substrate. From that we conclude a polar magnetization component induced by the epitaxially grown interface.

This work was supported by the DFG SFB 602 TP A7 and SPP 1285.

MA 63.35 Fri 11:00 P2

(001)-textured growth of $L1_0$-FePt thin films on MgO and Cr seed layers — •Patrick Matthes, Christoph Brombacher, Marcus Daniel, Gunther Beddies, and Manfred Albrecht — Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz - Germany

Chemically ordered FePt has a high uniaxial anisotropy with the easy axis in (001)-direction. It has been shown that (001)-textured MgO [1] and Cr [2] seed layers can be used to stabilize the (001)-texture of $L1_0$-chemically ordered FePt on amorphous substrates. In this study the growth of MgO and Cr seed layers was optimized by varying the process parameters (deposition temperature and rate as well as Ar pressure) and their influence on the magnetic properties of epitaxially grown FePt films have been analyzed. In addition, reference samples on MgO(100) single crystals were prepared. XRD measurements revealed a high degree of chemical order leading to a K_{eff} of $(8.5 \pm 1.3) \times 10^6$ erg/cm^3 after FePt deposition at 350 °C. The low deposition temperature results in a smooth film morphology and a reversal behaviour which is dominated by domain wall propagation.

[1] T.Shima et al., APL **81**, 1050 (2002)

[2] A.-C. Sun et al., JAP **88**, 076109 (2005)

MA 63.36 Fri 11:00 P2

UHV-chamber for broadband magneto-optical reflection and polarisation experiments — •Marc Tesch[1], Markus Gilbert[1], Hans-Christoph Mertins[1], Roman Adam[2], Herbert Feilbach[2], and Claus Michael Schneider[2] — [1]FH Münster, Stegerwaldstr.39, 48565 Steinfurt — [2]FZ Jülich, IFF-9, 52425Jülich

A new UHV-chamber for magneto-optical reflectometry and polarimetry experiments is presented. It enables measurements from the VIS to the soft X-ray range, using xenon- and deuterium-lamps or synchrotron radiation. The samplemagnetisation is generated by a quadrupolmagnetometer via rotating 8 NdFeB-permanentmagnets. The magnetic field is tunable from -500 mT to +500 mT in longitudinal or tranversal geometry. This device avoids thermal load, sophisticated UHV-compatible water cooling and offers reflection- and scattering experiments in a wide angular range. The presented 5-axes-polarimeter allows simple intensity measurements as well as polarisation analysis of the light after interaction with the magnetized sample in L- and T-MOKE-geometry. Practical features are in-situ sample transfer, easy chamber alignment and compatibility to synchrotron radiation beamlines as well as to light sources in the laboratory.

MA 63.37 Fri 11:00 P2

Ab initio study of MnSi thin films on the Si(111) surface — •Benjamin Geisler and Peter Kratzer — Fakultät für Physik, Universität Duisburg-Essen

One of the challenges in the field of spintronics is the injection of a spin-polarized electric current into a semiconductor. This can be achieved by combining the semiconducting material with a ferromagnetic one, e. g., by growing thin films of a transition metal like Mn on top of a Si(111) surface. Due to the high reactivity of Mn and Si, thin films of MnSi will form instead of pure Mn films.

We perform density functional theory calculations for thin films of MnSi on Si(111) in their ground state crystal structure, the B20 structure. This structure lacks inversion symmetry, and the (111) films show a periodicity of 12 layers, which can be decomposed into three groups, each consisting of four different layers: a dense Si, a sparse Mn, a sparse Si and a dense Mn layer. Changing the number of layers, the orientation and termination of the layer stack alters the thin film properties, resulting in different magnetic ordering, STM pattern or STM contrast. The calculated formation energies or surface energies can be used to compare the thermodynamic stability and / or probability of different film terminations. STM images are calculated in order to improve the understanding of recently observed experimental STM images. Furthermore, the question of ferro- vs. antiferromagnetism is addressed.

MA 63.38 Fri 11:00 P2

Proper Scaling of the Anomalous Hall Effect in Heusler Compounds — •Inga-Mareen Imort[1], Patrick Thomas[1], Günter Reiss[1], Andy Thomas[1], Franz D. Czeschka[2], Matthias Althammer[2], Alexander T. Krupp[2], Rudolf Gross[2], and Sebastian T. B. Goennenwein[2] — [1]Fakultät für Physik, Universität Bielefeld, Bielefeld, Germany — [2]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany

The anomalous Hall effect (AHE) is a fundamental but controversially discussed physical phenomenon in ferromagnets. We have studied the AHE in thin films of the Heusler compound Co_2FeAl, at temperatures between 3 K and 300 K, with magnetic fields of up to 4 T perpendicular to the film plane. The Co_2FeAl layers were deposited using rf-magnetron sputtering on single-crystal MgO (001) substrates, and annealed at different temperatures ex-situ. The structural quality of our samples was tested by X-ray diffraction scans. After etching Hall-bar mesa structures, we measured the evolution of the anomalous Hall resistance ρ_{AHE} and the longitudinal resistance ρ_{xx} with the sample annealing temperature, in order to investigate the contribution of the different microscopic mechanisms to the anomalous Hall effect. For comparison, we also have measured the AHE in iron and cobalt thin

films. All our AHE data of the Heusler compound Co_2FeAl show the typical behavior of an itinerant ferromagnet, with skew scattering and side-jump terms.

This work was supported by the NRW MIWF.

MA 63.39 Fri 11:00 P2

vector magneto-optical generalized ellipsometry (VMOGE) — •Kahming Mok, Nan Du, and Heidemarie Schmidt — Institute of Ion-Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Bautzner Landstrasse 400, 01328 Dresden, Germany

Numerous techniques have been utilized as experimental tools for magneto-optical (MO) characterization and the Kerr effect (MOKE) has been the most widely used method for this purpose so far. Recently, magneto-optical generalized ellipsometry (MOGE) has been developed to study layer systems with optical anisotropy induced by an external magnetic field. In our work, we setup a Vector-Magneto-Optical Generalized Ellipsometer (VMOGE) with a generalized spectroscopic ellipsometer and an octupole magnet. Not only measuring the MOKE of a sample, VMOGE also allows to perform generalized Mueller matrix ellipsometry in a magnetic field of arbitrary orientation and magnitude up to 0.4 T at room temperature, which provides a more general analysis for arbitrarily anisotropic and depolarizing materials. The VMOGE features a new "field orbit" measurement that can be performed without physically moving the sample, which is important for the analysis of MO thin films and layered nanostructure samples to study, e.g., exchange phenomena in multilayer samples, confinement, and collective magnetism. We discuss here exemplarily the investigation of a Cr_2O_3/Co/sapphire multilayer sample prepared by molecular beam epitaxy (MBE) by means of VMOGE. This optically isotropic sample system is chosen due to the well-known ferromagnetic properties of Co.

MA 63.40 Fri 11:00 P2

Electronic and magnetic structure of (Ca,Sr)RuO_3 thin films — •Andrea Assmann[1,2], Stephan Uebe[1,2], Michael Merz[1], Markus Wissinger[1,2], Hilbert von Löhneysen[1,3], Dirk Fuchs[1], Peter Nagel[1], and Stefan Schuppler[1] — [1]Karlsruhe Institute of Technology, Institut für Festkörperphysik, Germany — [2]Karlsruhe Institute of Technology, Fakultät für Physik, Germany — [3]Karlsruhe Institute of Technology, Physikalisches Institut, Germany

The 4*d* transition metal oxide (Ca,Sr)RuO_3 exhibits ferromagnetic order in the doping range $0.4 \leq x \leq 1$ while it is a paramagnetic metal for $x < 0.4$. Since (Ca,Sr)RuO_3 remains essentially isostructural and has a similar electronic configuration throughout the doping series, the differences in the magnetic properties might be attributed to chemical pressure effects. To verify a possible dependence of direction and/or magnitude of the magnetic moments on pressure, (Ca,Sr)RuO_3 films were deposited on different substrates (LSAT, STO, $DyScO_3$=DSO). The magnetic and electronic structure of the samples was studied by soft x-ray absorption and magnetic circular dichroism at the Ru $M_{2,3}$ and O K edges. In addition, depth-dependent information on element-specific core levels was obtained by varying the photon energy in soft x-ray photoemission spectroscopy. Various implications will be discussed.

MA 63.41 Fri 11:00 P2

High quality electrodeposited $Fe_{100-x}Ga_x$ films for magnetostrictive applications — •Diana Iselt[1,2], Heike Schlörb[1], Sebastian Fähler[1], and Ludwig Schultz[1,2] — [1]IFW Dresden, Institute for Metallic Materials, P.O. Box 270116, 01171 Dresden, Germany — [2]TU Dresden, Faculty of Mechanical Engineering, 01062 Dresden

Magnetostrictive materials can be used to build electromagnetic sensing and actuating devices. A promising candidate to overcome the mechanical limitations of Terfenol-D is $Fe_{100-x}Ga_x$ with 15 to 25 at.% Ga, which exhibits high mechanical strength and low saturation fields. For sensor application an efficient, scalable preparation way is required for thin film and nanowire fabrication. In this study FeGa alloy films with a desired composition close to $Fe_{80}Ga_{20}$ have been fabricated electrochemically on Pt substrates. For a conventional deposition at constant potentials strong interactions of the electrolyte with the platinum coated substrate are identified to cause low reproducibility and high oxygen content. The use of optimised pre-treatment and pulsed potential conditions resulted in dense and homogeneous films with a (110) $\alpha - Fe_3Ga$ fibre texture. Oxygen content was reduced below 1 at.% and the saturation magnetization reaches up to 1.7 T, confirming the high quality of these films. In order to understand the influence of the substrate on morphology and oxygen content deposition on gold and copper coated substrates have been carried out.

MA 63.42 Fri 11:00 P2

Fabrication and characterisation of ferromagnetic layers for CEO Spin LEDs — Wera Fehl[1], Carsten Godde[1], Sani Noor[1], Arne Ludwig[2], Henning Soldat[3], Andreas Wieck[2], •Martin Hofmann[3], and Ulrich Köhler[1] — [1]Institut für Experimentalphysik IV, AG Oberflächen, Ruhr-Universität Bochum — [2]Lehrstuhl für angewandte Festkörperphysik, Ruhr-Universität Bochum — [3]Lehrstuhl für Photonik und Terahertztechnologie, Ruhr-Universität Bochum

The purpose of this project is the spin injection via Fe and Fe/MgO on GaAs(110). We employ cleaved edge overgrowth (CEO) which means cleaving of the samples with an LED structure in UHV and in situ deposition of the ferromagnetic layers under variable angles with respect to the cleaved surface. This geometry allows us to use thin films with an in plane magnetization. Due to the sample structure we can produce spin injection lenghts in the μm range. The optically active region consists of quantum dots embedded in intrinsic GaAs. Polarization dependent electroluminescense measurements have been made in order to determine the degree of circular polarization as a function of the applied magnetic field. Furthermore, we made micromagnetic simulations using OOMMF to get information about possible effects of the ferromagnetic film boundary on the domain structure.

MA 63.43 Fri 11:00 P2

Orbital Ordering at the Interfaces in Transition Metal Oxide Heterostructures — •Alexandra Steffen, Artur Glavic, Daniel Schumacher, Jörg Voigt, Alexander Weber, Emmanuel Kentzinger, Ulrich Rücker, and Thomas Brückel — IFF-4, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany

In heterostructures of oxide perovskites with the structure ABO_3 orbital ordering can be induced by Jahn-Teller distortions or strain-induced change of the lattice constants, influencing for example the Curie temperature of the compound [1]. The aim of this work is the investigation of orbital ordering in ultrathin layered structures with layer thicknesses below 2 nm.

We prepare multilayers consisting of $La_{1-x}Sr_xMnO_3$ or $La_{1-x}Ca_xMnO_3$ ($0.2<x<0.5$) and $SrTiO_3$ or $BaTiO_3$ by high pressure sputtering using an oxygen plasma. Combining ferromagnetic and dielectric resp. ferroelectric layers we expect strong magnetoelectric effects. The structural quality of the layered structures has been confirmed using the x-ray reflectometer and 4-circle diffractometer. With AFM and SQUID magnetometry we have investigated inhomogeneities and magnetization behaviour. In near future, we expect to gain further insights in the ordering phenomena and the interaction between the layers with resonant x-ray diffraction experiments giving access to orbital ordering phenomena and lattice distortions on an atomic length scale.

[1] A. Sadoc *et al.*, Phys. Rev. Lett. **104** 046804 (2010)

MA 63.44 Fri 11:00 P2

Semiconducting (Half-Metallic) Ferromagnetism in Mn(Fe) Substituted Pt and Pd Nitrides — •Abdeslam Houari[1], Samir Matar[2], and Volker Eyert[3] — [1]Theoretical Physics Laboratory, Department of Physics, University of Bejaia, Bejaia 06000. Algeria — [2]ICMCB, CNRS, Université de Bordeaux 1, 87 avenue du Docteur Albert Schweitzer, 33600, Pessac, France — [3]Center for Electronic Correlations and Magnetism, Institut Fur Physik, Universitat Augsburg, 86135 Augsburg, Germany

Using first principles calculations as based on density functional theory, we propose a class of so far unexplored diluted ferromagnetic semiconductors and half-metals. Here, we study the electronic properties of recently synthesized 4*d* and 5*d* transition metal dinitrides. In particular, we address Mn- and Fe-substitution in PtN_2 and PdN_2. Structural relaxation shows that the resulting ordered compounds, $Pt_{0.75}(Mn,Fe)_{0.25}N_2$ and $Pd_{0.75}(Mn,Fe)_{0.25}N_2$, maintain the cubic crystal symmetry of the parent compounds. On substitution, all compounds exhibit long-range ferromagnetic order. While both $Pt_{0.75}Mn_{0.25}N_2$ and $Pd_{0.75}Mn_{0.25}N_2$ are semiconducting, Fe-substitution causes half-metallic behavior for both parent materials.

MA 63.45 Fri 11:00 P2

Defect-induced ferromagnetism in crystalline SrTiO3 — •Julia Osten[1], Kay Potzger[1], Alexander. A. Levin[2], Artem Shalimov[1], Georg Talut[1], Helfried Reuther[1], Seda Arpaci[1],

Danilo Bürger[1], Heidemarie Schmidt[1], Tina Nestler[3], and Dirk C. Meyer[3] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstrasse 400, 01328 Dresden, Germany — [2]Institut für Strukturphysik, Technische Universität Dresden, 01062 Germany — [3]Institut für Experimentelle Physik, Technische Universität Bergakademie Freiberg, 09596 Freiberg

Ion irradiation of high-quality SrTiO3 single crystals leads to room-temperature ferromagnetism. Structural analysis revealed oxygen deficient (polycrystalline) SrTiO3, Sr2Ti6O13, or Ruddlesden-Popper like secondary phases at the sample surface induced by the irradiation. The lack of potentially ferromagnetic secondary phases suggests defects to be the origin of the observed ferromagnetic signal.

MA 63.46 Fri 11:00 P2

Magnetic coupling in Fe/(Ga,Mn)As based heterostructures — •M. Sperl[1], P. Torelli[2], M. Soda[1], F. Eigenmann[1], M. Utz[1], S. Polesya[3], G. Woltersdorf[1], G. Panaccione[2], D. Bougeard[1], and C. H. Back[1] — [1]Institut für Experimentelle Physik, Universität Regensburg, D-93040 Regensburg, Germany — [2]Laboratorio Nazionale TASC, INFM-CNR, in Area Science Park, S.S. 14, Km 163.5, I-34012 Trieste, Italy — [3]Department of Chemistry, Ludwig-Maximilians University Munich, Germany

(Ga,Mn)As is one of the most promising diluted magnetic semiconductors (DMS) for spintronics due to the compatibility with the GaAs MBE technology. Despite the promising features (Ga,Mn)As has a Curie temperature well below room temperature limiting its possible applications. One potential direction to tailor novel properties of DMS thus making integration in real devices feasible is to exploit interface effects in highly controlled heterostructures (HS). Following this route FM behaviour of Mn at room temperature in both epitaxial and non-epitaxial Fe/(Ga,Mn)As interfaces has been demonstrated [1].

We report results obtained with Synchrotron Radiation techniques, where we were able to monitor the evolution of the magnetic coupling between Fe and Mn as a function of Mn doping, temperature and thickness. In particular, XMCD experiments show a peculiar thickness dependence of the room temperature magnetic coupling between Fe and Mn, namely a switching from antiparallel to parallel, thus opening the possibility of controlling the magnetization state of the interface.

[1] F. Maccherozzi et al. Phys. Rev. Lett. 101 (2008) 267201.

MA 63.47 Fri 11:00 P2

Transparent field effect transistors with spin-polarized electrons — Tim Kaspar, Danilo Bürger, Ilona Skorupa, Vicki Kühn, Artur Erbe, Manfred Helm, and •Heidemarie Schmidt — Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstraße 400, 01328 Dresden

We focus our research on possible semiconductor spintronics devices. Our work is motivated by magnetoresistance effects in magnetic ZnO thin films that have been detected below 50 K and are due to spin-polarized electrons [1]. Our aim is to control the characteristics of a ZnO-based Junction Field Effect Transistor (J- FET) by manipulating spin polarized electrons in the magnetic channel of the J-FET by external electrical and magnetic fields. The magnetic channel layers have been deposited by pulsed laser deposition on Al_2O_3 and ZnO substrates. The gate, source and drain contact was structured by electron beam lithography. The gate contact was fabricated by reactive sputtering of Ag [2]. The main characteristics of the ZnO-based J-FET with magnetic channel will be presented.

[1] Qingyu Xu, H. Schmidt et al. , Phys. Rev. Lett. **101**, 076601(2008)

[2] H.Frenzel et al., Appl. Phy. Lett. **92**, 192108 (2008)

MA 63.48 Fri 11:00 P2

Spin precession and modulation in ballistic cylindrical nanowires due to Rashba effect — Andreas Bringer[1] and •Thomas Schaepers[2] — [1]Institute of Solid State Research and JARA-Fundamentals of Future Information Technology, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany — [2]Institute of Bio- and Nanosystems (IBN-1) and JARA-Fundamentals of Future Information Technology, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany

The spin precession in a cylindrical semiconductor nanowire due toRashba spin-orbit coupling is theoretically investigated. We employed an InAs nanowire containing a surface two-dimensional electron gas as a model system. By solving the Schrödinger equation in a cylindrical symmetry the corresponding eigenstates, the energy-momentum dispersion, and the energy-magnetic field dispersion relation are determined. The combination of states with the same total angular momentum but opposite spin orientation results in a periodic modulation of the axial spin component along the wire axis. Spin-precession about the wires axis is achieved by interference of two states with different total angular momentum. Due to the fact that at zero magnetic field a superposition state with exact opposite spin precession exists an oscillation of the spin orientation can be obtained. In case that an axially oriented magnetic field is applied the spin gains a precessing component in addition.

Various injection and detection methods are studied to demonstrate the functionality of these modes in spin electronic devices.

MA 63.49 Fri 11:00 P2

ZnO thin films with (Li,Ni)-codoping — Senthil Kumar[1], Matthias Althammer[2], Deepak Venkateshvaran[2], Eva Karrer-Müller[2], Sebastian T.B. Goennenwein[2], M.S. Ramachandra Rao[1], •Matthias Opel[2], and Rudolf Gross[2] — [1]Materials Science Research Centre, Indian Institute of Technology Madras, Chennai, India — [2]Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany

The wide bandgap II-VI semiconductor ZnO is controversially discussed with regard to both dilute magnetic doping and stable p-type conductivity. Following a recent report [APL **96**, 232504 (2010)], we investigated (Li,Ni)-codoping to establish ferromagnetism together with p-type conduction. Using laser-MBE, we deposited thin films from stoichiometric targets with compositions $Zn_{0.98-x}Li_xNi_{0.02}O$ ($x = 0, 0.02, 0.05, 0.09$). High-resolution x-ray diffraction reveals excellent structural quality and nearly perfect in-plane orientation. Magnetization measurements show an "S"-shaped behavior in $M(H)$ at room temperature and a clear difference after field cooling or zero-field cooling in $M(T)$ which is reminiscent of superparamagnetism. The saturation magnetic moment is around $0.7\,\mu_B$ per Ni and, hence, very close to the bulk value of Ni metal ($0.6\,\mu_B$). From thermopower measurements, we obtained negative Seebeck coefficients between $-400\,\mu$V/K and $-900\,\mu$V/K, with smaller absolute values corresponding to lower Li concentrations. In summary, we could not confirm p-type conductivity or ferromagnetism in (Li,Ni)-substituted ZnO thin films.

This work was supported by the DAAD and the DFG via SPP 1285.

MA 63.50 Fri 11:00 P2

The effects of short-range order and clustering in dilute magnetic semiconductors: a non-local, multi-sublattice CPA investigation — •Alberto Marmodoro[1,2], Julie Staunton[1], and Arthur Ernst[2] — [1]University of Warwick, Department of Physics, CV4 7AL Coventry, United Kingdom — [2]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany

The compound $(Ga, TM)As$, for TM transition metals such as Mn, represents a prototypical diluted magnetic semiconductor in which different magnetic coupling mechanisms coexist and are differently affected by dopant concentration, the nature of impurity states, formation of complexes etc.

We propose that the recently developed multi-sublattice, non-local coherent potential approximation (MS-NL-CPA) for a fully parameters-free multiple scattering investigation of disorder and short range ordering is well-suited to describe these effects beyond a single-site treatment. Our preliminary results demonstrate the enhanced accuracy of this generalized approach, and its potential to provide useful insights into the roles of Zener's $p-d$ and double-exchange effective interactions between the TM impurities, and the influence of other possible sources of defects such as co-dopants or interstitial and anti-site substitutions.

MA 63.51 Fri 11:00 P2

Optical and magnetic properties of Cr-implanted indium oxides thin films — •Scarlat Camelia, Shengqiang Zhou, Mykola Vinnichenko, Andreas Kolitsch, Manfred Helm, and Heidemarie Schmidt — Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstraße 400, 01328 Dresden, Germany

Dilute magnetic oxides using the electron spin rather than its charge as information carrier are expected to play a key role in the development of spinelectronics. As it has been shown recently, indium oxide (IO), a transparent conducting material, is of potential importance also as a material for spintronics [1]. Polycrystalline and amorphous (ca. 300 nm thick) n-type conductive IO films were grown on SiO_2/Si substrates using reactive magnetron sputtering. The films were implanted with 120 keV Cr^+ ions in order to reach Cr concentrations of 1, 2, 3, 4 and 5

at%. Cr is chosen as a dopant because of its large magnetic moment in the ionic state, and the antiferomagnetic nature of Cr metal segregations. Highly oxygen deficient 2%Cr:IO co-evaporated films revealed ferromagnetism. Here we study the effect of the post-growth treatment on the structural, electrical, magnetic, and optical properties of Cr-implanted IO films. It is shown that only the 2%Cr:IO implanted film is weakly ferromagnetic at 5 K. A reasonable model for the Cr:IO implanted films has been developed to extract optical constants from spectroscopic ellipsometry data below 3 eV in dependence on the Cr concentration. [1] C. Scarlat et al., Nuclear Instruments and Methods in Physics Research B 267 (2009) 1616.

MA 63.52 Fri 11:00 P2

Ferromagnetic Heusler alloy Co_2FeSi films on GaAs(110) substrates — •Thomas Hentschel, Bernd Jenichen, Achim Trampert, and Jens Herfort — Paul-Drude-Institut Berlin, Hausvogteiplatz 5-7, 10117 Berlin, Germany

Ferromagnetic Heusler alloys may be promising material candidates for spintronic devices due to a theoretically full spin polarization at the Fermi edge. We have investigated the Heusler alloy Co_2FeSi grown by molecular beam epitaxy on GaAs(110) for different substrate temperatures T_S with respect to the structural and magnetic properties. The (110) ferromagnet/semiconductor (FM/SC) interface is predicted to maintain the half-metallic behaviour. Furthermore the (110) orientation reveals a significantly higher spin-lifetime in the semiconductor than its (001) counterpart.

We found ferromagnetic films entirely free of dislocations and an interface roughness below 1 nm up to $T_S = 225$ °C. The films exhibit an in-plane uniaxial magnetic anisotropy with an easy axis along the $[\bar{1}10]$ and a hard one along the [001] direction. With increasing T_S the hard [001] axis shifts into an intermediate one, while the easy axis remains stable but shows higher coercitive fields, indicating the formation of crystal defects. X-ray diffraction measurements reveal the lattice parameter expected for the correct composition. If the film thickness is continuously reduced from 40 to 4 nm, the uniaxial contribution increases. This gives evidence that the FM/SC interface plays an important role in the magnetic behaviour.

MA 63.53 Fri 11:00 P2

Inverse interface Cr magnetization at the CrO2/RuO2 interface: The origin for unexpected small GMR effects — •Khalid Zafahr[2], Manjit Pathak[1], Arunava Guptha[1], Patrik Audehm[2], and Eberhard Goering[2] — [1]MINT Center, University of Alabama, Tuscaloosa, Alabama 35487, USA — [2]MPI-MF, Heisenbergstraße 3, 70569 Stuttgart

Due to the 100% spin polarization in CrO2 and the good epitaxy CrO2/RuO2/CrO2 trilayers have been proposed to provide extraordinary magnetoresitive effects (GMR), but only very small GMR has been observed so far. We will provide soft X-ray resonant reflectivity results at the Cr L2,3 edges performed on a CrO2/RuO2 -bilayer. By the use of linear and circular polarized light this method is able to determine the chemical and the magnetic profiles including roughness or diffusion length. On one hand, we can clearly exclude the presence of an induced Ru magnetization at the CrO2/RuO2 interface as an origin for the reduced GMR effect. On the other hand we found instability to an antiparallel oriented CrO2 magnetization top layer at the RuO2 interface. No tendency of a dead layer could be found. This unexpected result directly explains the rather small GMR observed in this system.

MA 63.54 Fri 11:00 P2

Structural and magnetic properties of $Zn_{1-x}Fe_xO_4$ thin films grown by pulsed laser deposition — •Kerstin Brachwitz[1], Katja Mexner[1], Tammo Böntgen[1], Michael Lorenz[1], Jörg Lenzner[1], Kartik C. Ghosh[2], and Grundmann Marius[1] — [1]Institut für Experimentelle Physik II, Universität Leipzig, Linnéstraße 5, 04103 Leipzig, Germany — [2]Physics, Astronomy, and Materials Science Department, Missouri State University, Springfield, 901 South National Avenue, MO 65804, USA

Zinc ferrite ($ZnFe_2O_4$) is a semitransparent magnetic semiconductor with various potential applications, e.g. in magnetic tunnel junctions and spin filters. Using pulsed laser deposition $Zn_{1-x}Fe_xO_4$ thin films with target compositions $0 \leq x \leq 0.66$ were grown on a-plane sapphire substrates. Besides the target stoichiometry the oxygen partial pressure $p(O_2)$ applied during growth was varied. By increasing x the intensity of the ZnO (0001) reflex decreases while that of $ZnFe_2O_4$ (111) increases. For $x > 0.4$ single phase $ZnFe_2O_4$ layers are obtained. For these thin films energy dispersive X-ray spectroscopy shows an excess of iron for $p(O_2) = 5 \cdot 10^{-5}$ mbar and a strong influence of $p(O_2)$ on the thin film stoichiometry.
Further, the magnetic properties depend on $p(O_2)$ and x. The saturation magnetization ranges up to 30 emu/cm^3 for $x = 0.66$. Indications for an in-plane magnetization were found by magnetic force microscopy and magnetization measurements. The latter revealed that the coercive field increases with increasing Fe content.

MA 63.55 Fri 11:00 P2

Investigations of the ordering in $Co_2Mn(Si,Ge)$ and Co_2FeSi via transport, magnetization, XRD and Mößbauer measurements — •Britta Willenberg[1], Dirk Schulze Grachtrup[1], Jochen Litterst[1], Stefan Süllow[1], Jens Röder[2], and Dirk Menzel[1] — [1]Institut für Pysik der Kondensierten Materie, TU Braunschweig, Germany — [2]Physikalische und Theoretische Chemie, TU Braunschweig, Germany

Heusler alloys like Co_2MnSi, Co_2MnGe and Co_2FeSi have attracted interest, because some theoretical works predicted half-metallicity with 100 % spin polarization. So far, this high value has not been observed experimentally. Some calculations indicate that the lack of total spin polarization should be due to structural defects, which destroy the half-metallicity. We have investigated the effect of annealing on the quality of these compounds via transport, magnetization, XRD and Mößbauer measurements. Thermal annealing of Co_2MnSi and Co_2MnGe leads to an increase of the residual resistivity ratio. Furthermore, powder x-ray measurements on Co_2MnSi showed that a second phase occurs in the annealed sample due to a phase segregation during annealing. In contrast to this behavior the residual resistivity ratio for Co_2FeSi decreases during annealing. Moreover, by means of Mößbauer studies we found out that the disorder between some atomic sites increased during annealing and additionally a second phase arises. Thus, thermal annealing of this compound degrades the quality of the crystal.

MA 63.56 Fri 11:00 P2

The interface of the ferromagnetic metal CoS_2 and the nonmagnetic semiconductor FeS_2 — •Udo Schwingenschlögl and Safdar Nazir — PSE Division, KAUST, Thuwal 23955-6900, Kingdom of Saudi Arabia

The electronic and magnetic properties of the cubic pyrite CoS_2/FeS_2 interface are studied using the all-electron full-potential linearized augmented plane wave method. We find that this contact between a ferromagnetic metal and a nonmagnetic semiconductor shows a metallic character. The CoS_2 stays close to half-metallicity at the interface, while the FeS_2 becomes metallic. The magnetic moment of the Co atoms at the interface slightly decreases as compared to the bulk value and a small moment is induced on the Fe atoms. Furthermore, at the interface ferromagnetic ordering is found to be energetically favorable as compared to antiferromagnetic ordering.

Reference: Appl. Phys. Lett. 97, 183113 (2010)

MA 63.57 Fri 11:00 P2

The importance of the on-site electron-electron interaction for the magnetic coupling in the zigzag spin-chain compound In_2VO_5 — •Udo Schwingenschlögl and Hao Wang — PSE Division, KAUST, 23955-6900 Thuwal, Kingdom of Saudi Arabia

We present first-principles electronic structure calculations for the zigzag spin-chain compound In_2VO_5 using the generalized gradient approximation both with and without inclusion of an on-site Coulomb interaction. It has been proposed that In_2VO_5 is characterized by itinerant V 3d electrons at high temperature and localized electrons at low temperature. Consequently, it is to be expected that electronic correlations play an important role for the magnetic transition from ferromagnetic to antiferromagnetic exchange around 120 K. In this context, we study the electronic and magnetic properties of a set of possible spin configurations. Our calculations show that inclusion of an on-site Coulomb interaction in fact changes the ground state from ferromagnetic to antiferromagnetic.

Reference: J. Phys.: Cond. Matter 22, 416002 (2010)

MA 63.58 Fri 11:00 P2

Element specific magnetic moments and spin-resolved DOS of the half-metallic compounds CoFeMnZ (Z = Al, Ga; Si, Ge) — •Peter Klaer[1], Alijani Vajiheh[2], Benjamin Balke[2], Gerhard H. Fecher[2], Claudia Felser[2], and Hans-Joachim Elmers[1] — [1]Institut für Physik, Johannes Gutenberg-Universität, D-55099 Mainz, Germany — [2]Institut für Anorganische Chemie und Analytis-

che Chemie, Johannes Gutenberg-Universität Mainz, D-55099 Mainz, Germany

A new class of materials based on the $L2_1$ Heusler crystal structure are quaternary CoFeMnZ (Z = Al, Ga; Si, Ge) alloys. CoFeMnSi with the LiMgPdSb-type structure is predicted to be a half-metallic ferromagnet[1].

We used circular dichroism in x-ray absorption spectroscopy (XMCD) to evaluate the magnetic moments for Co, Fe, and Mn. A comparison with calculations clearly allows to distinguish between various structure models confirming the proposed LiMgPdSb-type structure with predicted half-metallicity. Moreover, we show the element specific spin-resolved unoccupied density of states (DOS) for Co, Fe, and Mn evaluated from XMCD spectra. Exchange of the main group elements from group III (Al, Ga) by those from group IV (Si, Ge) fills majority states and shifts the Fermi energy with respect to the half-metallic band gap in the minority states. The authors are thankful for financial support from the DFG (Grant No. FOR 559).

[1] X. Dai, G. Liu, G. H. Fecher, C. Felser, Y. Li, and H. Liu, J. Appl. Phys., 105, 07E901 (2009).

MA 63.59 Fri 11:00 P2

AC electric transport in CMR-manganite thin films — •Florian Fischgrabe, Sebastian Hühn, Jon-Olaf Krisponeit, Konrad Samwer, and Vasily Moshnyaga — I. Physikalisches Institut, Göttingen

We report ac measurements on $(La_{0.6}Pr_{0.4})_{0.7}Ca_{0.3}MnO_3$ and $La_{1-x}Ca_xMnO_3$ thin films prepared by metalorganic aerosol deposition technique. The measurements were carried out for temperatures, T=10-300 K, frequencies, f=10 Hz-1 MHz and applied magnetic field ,B=0-1 T,to get a detailed view on the electric properties close to the phase transition. While the dc resistance as a function of temperature shows a well-known metal-insulator-transition behaviour, the other features appear when varying frequency. The imaginary part of the impedance demonstrates a strong phase shift near the metal insulator transition and even changes its sign directly after the metal insulator transition. Furthermore in a half-doped $LaCaMnO_3$ ($x \approx 0.5$) we observed a pronounced difference between ac and dc measurements for temperatures T<100 K. The influence of FM/AFM coexistence as well as of charge ordering on the ac electric transport will be discussed.

MA 63.60 Fri 11:00 P2

Sputtering deposition and characterization of epitaxial LSMO thin films — •Philipp M. Leufke, Ajay K. Mishra, Robert Kruk, and Horst Hahn — Karlsruher Institut für Technologie, Institut für Nanotechnologie, D-76344 Eggenstein-Leopoldshafen, Germany

We report on the heteroepitaxial deposition of $La_{1-x}Sr_xMnO_3$ (LSMO) thin films using RF and DC magnetron sputtering. Co-deposition from the two different LSMO targets with $x = 0.25$ and $x = 0.35$ was used to tailor the desired composition to control ferromagnetic Curie temperature of the films. The influence of different single crystalline substrates as well as the effect of varying the oxygen partial pressure on magnetic and structure properties during deposition was investigated. The chemical stoichiometry was determined by Rutherford backscattering spectroscopy (RBS). Transmission electron microscopy and high resolution X-ray diffractometry (HRXRD) confirmed epitaxial growth for substrates with low in-plane lattice mismatch. The temperature dependence of the electric resistance agrees with the T_{Curie} determined by (zero) field-cooling (FC/ZFC) superconductive quantum interference device SQUID measurements.

MA 63.61 Fri 11:00 P2

Temperature dependent antisymmetric Planar Hall effects in $Co_2FeAl_xSi_y$ Heusler alloys — •Jan Heinen[1], Jan Rhensius[2], Mathias Kläui[1,2], Tanja Graf[3], and Claudia Felser[3] — [1]Fachbereich Physik, Universität Konstanz, 78457 Konstanz, Germany — [2]SwissFEL, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland and Laboratory for Nanomagnetism and Spin Dynamics, Ecole Polytechnique Fédérale de Lausanne (EPFL), 1015 Lausanne, Switzerland — [3]Institut für Anorganische Chemie und Analytische Chemie, Universität Mainz, 55128 Mainz, Germany

Very promising candidates for future spintronic devices are Co-based Heusler alloys like $Co_2FeAl_xSi_y$, which generally possess a high Curie temperature and a high spin polarization (>0.5) [1]. Here we report on magnetoresistance measurements of μm-wide nanowires using contacts in longitudinal magnetoresistance (AMR) and Hall geometry (planar Hall effect (PHE)) [2]. For the AMR we observe an overall decrease in resistance with increasing field, whilst first results indicate an antisymmetric contribution in the PHE, whose origin is still under debate. A correlation to crystal symmetry was suggested for semiconductors [3]. We therefore study its dependence on applied field, field angle, temperature and the direction of growth on the substrate to gain further insight into this effect. References: [1] T. M. Nakatani et al., J. Appl. Phys. 102, 033916 (2007). [2] P. K. Muduli et al., Phys. Rev. B 72, 104430 (2005). [3] H. T. He et al., J. Appl. Phys. 107, 063902 (2010).

MA 63.62 Fri 11:00 P2

***Ab initio* calculations of the magnetic properties of mixed-valence perovskite** — •Igor Maznichenko[1], Arthur Ernst[2], and Ingrid Mertig[1,2] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, D-06099 Halle (Saale), Germany — [2]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle (Saale), Germany

Materials with perovskite and perovskite-like structures demonstrate a broad spectrum of physical properties. Colossal magnetoresistance, ferroelectricity, multiferroicity, superconductivity, charge ordering, metal-insulator transition, Jahn-Teller and other effects are observed in perovskites. These properties of the mentioned materials with the common formula ABO_3 are very sensitive to the type of the cations A and B. Manganites $La_{1-x}Sr_xMnO_3$ are strongly correlated 3d transition-metal oxides with different types of magnetic ordering (depending on the La/Sr ratio).

Here we perform *ab initio* calculations for the above mentioned manganites in different structural phases. We try to analyze the magnetic properties of mixed-valence mangatines depending on charge ordering in the system.

MA 63.63 Fri 11:00 P2

Optical tuning of manganese valence and conductivity in Ce-doped lanthanum manganite films — •Andreas Thiessen[1], Elke Beyreuther[1], Stefan Grafström[1], Kathrin Dörr[2], and Lukas M. Eng[1] — [1]Institut für Angewandte Photophysik, Technische Universität Dresden, D-01062 Dresden — [2]Institut für Metallische Werkstoffe, IFW Dresden, D-01171 Dresden

The preparation of epitaxial $La_{0.7}Ce_{0.3}MnO_3$ (LCeMO) films by pulsed-laser deposition is very challenging [1] – especially the oxygen partial pressure during deposition plays a crucial role to suppress the presence of a CeO_2 secondary phase [2]. As-prepared films typically suffer from overoxygenation and concomitant hole doping instead of the nominal and desired electron-doping. Post-deposition annealing however, using a reducing atmosphere seems to solve this problem [3]. These samples though are insulating and do not exhibit a phase transition from a paramagnetic insulating to a ferromagnetic metallic phase any more [4,5].

Here, we show the possibility to drive the Mn valence towards 2+ by photoexcitation, which renders LCeMO thin films conductive and recovers their phase transition [5]. Possible mechanisms behind the photoconductivity effect are presented, especially the role of the $SrTiO_3$ substrate and the influence of interface defect states.

[1] C. Mitra et al., J. Appl. Phys. 89, 524 (2001). [2] R. Werner et al., Phys. Rev. B 79, 054416 (2009). [3] E. Beyreuther et al., Phys. Rev. B 73, 155425 (2006). [4] D. J. Wang et al., Phys. Rev. B 73, 144403 (2006). [5] E. Beyreuther et al., Phys. Rev. B 80, 075106 (2009).

MA 63.64 Fri 11:00 P2

HIGH ENERGY X-RAY DIFFRACTION MEASUREMENTS ON $Gd_{0.5}Sr_{0.5}MnO_3$ — •Dinesh Kumar Shukla[1], Sonia Francoual[1], Martin von Zimmermann[1], Jörg Strempfer[1], Aditya Avinash Wagh[2], P S Anil Kumar[2], Suja Elizabeth[2], and H L Bhat[2] — [1]Deutsches Elektronen-Synchrotron DESY, Notkestrasse 85, Hamburg, 22603, Germany — [2]Department of Physics, Indian Institute of Science, Bangalore, 560012, India

We report on high-energy (100 keV) x-ray diffraction measurements in high magnetic fields on $Gd_{0.5}Sr_{0.5}MnO_3$. This system is reported to have a charge ordered state below 90 K and a spin glass behaviour below 42 K. The experiment was performed at the high energy x-ray diffraction beamline BW5 at DORIS. A cryo cooled 10 T magnet was used with temperatures reaching down to 2 K. Superstructure peaks at (h±1/2, k±1/2, 0) and (0, 2k+1, 0) positions are observed. There is no evidence of magnetic peaks along (0 1 0) or (1 0 0), down to 1.7 K as observed for $GdMnO_3$. At 35 K, integrated intensity of the superstructure peaks increases with increasing field above the critical

field of 8.5 T. The exact origin of the superstructure peaks is under investigations.

MA 63.65 Fri 11:00 P2

Bulk ordering and surface segregation for defects in NiO — •Martin Hoffmann[1], Eero Nurmi[2], Kalevi Kokko[2], Arthur Ernst[3], and Wolfram Hergert[1] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, Betty-Heimann-Str. 7, D-06120 Halle, Germany — [2]Department of Physics and Astronomy, University of Turku, FIN-20014 Turku, Finland — [3]Max-Planck-Institut für Mikrostrukturphysik,Weinberg 2, D-06120 Halle, Germany

Ordering of structural defects in NiO oxide has been studied using a combination of ab initio calculations and Monte Carlo simulations. In the framework of the general perturbation method a Korringa-Kohn-Rostoker method is used to obtain for the defects the effective cluster interactions (ECI's) which are mapped on an Ising Model. With this model a Monte Carlo method is applied to simulate the ordering behaviour and obtain the thermodynamic properties. Due to the magnetic moment of the defects in NiO the magnetic properties are derived via a Heisenberg model.

MA 63.66 Fri 11:00 P2

Magneto-electrical properties of $LaSrMnO_4$ epitaxial thin films — •Mehran Vafaee Khanjani, Philipp Komissinskiy, and Lambert Alff — Institut für Materialwissenschaft, Technische Universität Darmstadt, Petersenstraße 23, 64287 Darmstadt, Germany

The single layer manganite $LaSrMnO_4$ as an antiferromagnetic insulator was under numerous investigations in the last decade. Due to its layered structure, $LaSrMnO_4$ shows anisotropic electrical resistivity. Epitaxial thin films with extremely smooth surfaces were deposited on different substrates such as $NdGaO_3$ and $NdAlO_3$ by pulsed laser deposition (PLD) to reveal the influence of strain on the magneto-electrical properties. The authors would like to thank DFG GK 1035.

MA 63.67 Fri 11:00 P2

Using symmetry breaking for the directed transport of paramagnetic colloids on garnet films — •Saeedeh Aliaskarisohi[1], Tom.H Johansen[2], and Thomas.M Fischer[1] — [1]Institut für Experimentalphysik, Universität Bayreuth, 95440 Bayreuth, Germany — [2]Department of Physics, University of Oslo, P.O.Box 1048, Blindern, 0316 Oslo, Norway

The transport behavior of paramagnetic particles on top of a ferrimagnetic garnet film is investigated in a modulated external magnetic field. Broken symmetries are required to direct the transport of the particles. We provide such symmetry breaking by tilting the external field modulation with respect to the garnet film normal and by the intrinsic geometrical symmetry breaking of the garnet film magnetic pattern. The interplay of both symmetry breaking mechanisms cause a rich variety in transport behavior and direction. We corroborate our experimetal transport directions by comparing experimental with theoretical transport phase diagrams. Directing the transport of paramagnetic colloids will be useful when they are loaded with biomedical cargo on a magnetic lab-on-a-chip device.

MA 63.68 Fri 11:00 P2

E-beam patterning of CoFeB/MgO/CoFeB-based magnetic tunneljunctions — •Johannes Christian Leutenantsmeyer[1], Marvin Walter[1], Vladyslav Zbarsky[1], Henning Schuhmann[2], Michael Seibt[2], and Markus Münzenberg[1] — [1]I. Physikalisches Institut, Georg-August-Universität Göttingen, 37077 Göttingen — [2]IV. Physikalisches Institut, Georg-August-Universität Göttingen, 37077 Göttingen

The tunnel magnetoresistance (TMR) in magnetic tunnel junctions (MTJs) is suitable for various applications such as next generation RAM-Cells, the MRAM. Our MTJs are fabricated by magnetron sputtered CoFeB and Ta and further e-beam evaporated material such as the MgO-barrier. After patterning, the samples are characterized by $R(H)$ measurements and optical hysteresis loop measurements. The samples show up to 200% TMR.
Since spin-transfer torque requires smaller dimensions we investigate downscaling of the junction size. We expect this to improve the switching behavior and increase the TMR-ratio of our MTJs. Thus we present a study of e-beam lithography, which gives us the capability to produce MTJs below $1\,\mu m$ edge length. We also aquire the ability to produce different shaped structures, with the aim to investigate the MTJs' structural anisotropy to optimize magnetic switching.
Research is supported by the DFG through SFB 602.

MA 63.69 Fri 11:00 P2

Influence of the buffer-layer on the tunnel barrier quality in CoFeB/MgO/CoFeB magnetic tunnel junctions on the tunnel magneto resistance (TMR). — •Vladyslav Zbarsky[1], Marvin Walter[1], Gerrit Eilers[1], Johannes Christian Leutenantsmeyer[1], Patrick Peretzki[2], Michael Seibt[2], and Markus Münzenberg[1] — [1]I. Physikalisches Institut, Georg-August-Universität Göttingen, 37077 Göttingen — [2]IV. Physikalisches Institut, Georg-August-Universität Göttingen, 37077 Göttingen

The optimization of MTJs is necessary for increasing of TMR and therefore is very important for the production of MRAM devices. The quality of the tunnel barrier of our CoFeB/MgO/CoFeB MTJs is essential for getting high TMR. For this reason we investigate the influence of roughness of the MgO layer on the TMR. Another important parameter which we could optimize is the choice and preparation of the buffer-layer. For example we compared two sorts of Ta buffer-layers: prepared via magnetron sputtering and via e-beam evaporation. Already by optimizing these two parameters we increase the TMR from 80% to above 200%. In addition we show the investigations of the influence of the annealing temperatures and annealing duration on the TMR. Fast annealing time prevents diffusion, however for short annealing time no full crystallization is observed.
We thank the DFG for funding the research through SFB 602.

MA 63.70 Fri 11:00 P2

Boltzmann equation for charged particles with spin — •Katarina Tauber[1,2], Martin Gradhand[1,2], Dmitry V. Fedorov[2], Ingrid Mertig[1,2], and Balazs Gyorffy[3] — [1]Max Planck Institute of Microstructure Physics — [2]Martin Luther University Halle-Wittenberg — [3]University of Bristol

The ordinary Boltzmann equation describes the transport of charge carriers in solids via distribution function f.

$$\frac{\partial f(\vec{r},\vec{k},t)}{\partial t}+\dot{\vec{r}}\cdot\frac{\partial f(\vec{r},\vec{k},t)}{\partial \vec{r}}-\frac{e}{\hbar}(\vec{E}+\dot{\vec{r}}\times\vec{B})\cdot\frac{\partial f(\vec{r},\vec{k},t)}{\partial \vec{k}}=\left(\frac{\partial f(\vec{r},\vec{k},t)}{\partial t}\right)_{scatt.}$$

In the era of spintronics it is desirable to investigate the change of charge and magnetic moment of an electron under the influence of external fields on the same footing by a Boltzmann theory. Therefore, we extended the Boltzmann equation to a 2×2 matrix form for the distribution function. The components describe the scalar distribution function for the charge and 3 components of the magnetic moment. Furthermore, we added a precession term to allow the change of the direction of the magnetic moments. We solved the modified Boltzmann equation for general, simple cases analytically with a relaxation time approximation for the scattering term. Thereby, we analyzed the effect of the different terms in the Boltzmann equation separately to investigate the influence of the electric and magnetic field.

MA 63.71 Fri 11:00 P2

Optical detection of spin transport in non-magnetic metals — Frederik Fohr[1], Steffen Kaltenborn[1], Jaroslav Hamrle[1], Helmut Schultheiss[1], •Alexander A. Serga[1], Hans Christian Schneider[1], Burkard Hillebrands[1], Yasuhiro Fukuma[2], Le Wang[2], and YoshiChika Otani[2] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany. — [2]ASI RIKEN, and ISSP, University of Tokyo, Japan.

We detect the dynamic magnetization in non-magnetic metal wedges, composed of silver, copper and platinum and grown on top of a $Ni_{80}Fe_{20}$ layer. The $Ni_{80}Fe_{20}$ layer is excited externally by the RF field of a coplanar waveguide (CPW), and generates the dynamic magnetization in the wedge layer via the spin pumping effect. The inelastically scattered light is collected as a function of the local wedge thickness and analysed by Brillouin light scattering (BLS) microscopy. The BLS signal originates from the metal wedges due to inelastic scattering from the spin polarization as well as from the magnetic layer below the wedge. To separate both contributions of the signal experimentally, reference samples are prepared with an interlayer between $Ni_{81}Fe_{19}$ and the respective metal wedge to block the spin pumping. By comparing the experimental results to a macroscopic spin-transport model we determine the transverse relaxation time of the pumped spin current which is much smaller than the longitudinal relaxation time.

Support by the DFG within the project JST-DFG Hi380/21-1 is acknowledged.

MA 63.72 Fri 11:00 P2

Spintransport through magnetically doped Quantum Dots — •Christoph Hübner, Daniel Becker, and Daniela Pfannkuche — I. Institut für Theoretische Physik, Universität Hamburg, 20355 Hamburg.

Spin transport between two non-polarized electron reservoirs via an idealized single level quantum dot with an incorporated magnetic impurity is investigated. A real time diagrammatic transport theory, based on the Keldysh formalism, is used to determine the current between the leads and the non-equilibrium occupation of quantum dot states in stationary limit [1]. In the weak coupling regime one can derive a master equation for diagonal elements of the density matrix by perturbatively expanding to second order in hybridization. This formalism gives insight into sequential and coherent transport in the stationary limit. Up to first order the electron impurity interaction leads to differently pronounced signals of sequential transport channels visible in the differential conductivity. Also a new type of spin blockade is found which is tunable by the coupling strength between electron and impurity spin. In second order spin flip processes occur, which depend on the interaction strength and lead to a spin excitation in the quantum dot. Research is supported by GRK 1286,DFG-CH265/4-1 as well as by the Hamburg's Excellence Cluster Spintronik.

[1] M. Leijnse, M.R. Wegewijs, *Phys. Rev. B* 78, 235424 2008

MA 63.73 Fri 11:00 P2

Anisotropic magneto-resistance as a measure for the phase coexistence in Co_2FeSi layers — •Pawel Bruski, Klaus-Jürgen Friedland, Rouin Farshchi, Jens Herfort, and Manfred Ramsteiner — Paul-Drude-Institut für Festkörperelektronik, Hausvogteiplatz 5-7, 10117 Berlin, Germany

The ferromagnetic Heusler alloy Co_2FeSi is closely lattice matched to GaAs but epitaxially grown layers exhibit, in general, the coexistence of the well-ordered $L2_1$ phase and the Fe-Si disordered $B2$ phase depending on the substrate temperature T_S. The former one is predicted to be half-metallic, i.e. to be 100 % spin polarized at the Fermi-energy whereas the latter one is not only expected to lack half-metallicity but also to compete with the $L2_1$ phase by injecting spins of opposite sign. Since the degree of anisotropy is larger in the well-ordered $L2_1$ phase, the admixture of the disordered $B2$ phase should reflect itself in anisotropic magnetoresistance (AMR) measurements.

We investigated a series of spin light emitting GaAs/(Al,Ga)As diodes with Co_2FeSi injection layers as well as Co_2FeSi layers on GaAs grown by molecular beam epitaxy at different T_S. The AMR amplitude reveals a monotonic dependence on T_S indicating the coexistence of both phases. The sign reversal of an additional anisotropy constant Δ, which takes into account the deviation from an isotropic structure, gives further evidence for the phase coexistence. Both the AMR amplitude as well as the anisotropy constant Δ can be utilized as a sensitive measure for the phase composition in Co_2FeSi layers.

MA 63.74 Fri 11:00 P2

Spin filter contacts to Silicon using magnetic insulators: EuS/Si(001) — •Martina Müller, Reinert Schreiber, and Claus M Schneider — Forschungszentrum Jülich, Institut für Festkörperforschung (IFF-9), 52425 Jülich, Germany

Efficient spin filtering through magnetic insulators has been envisioned for sensitive spin injection and -detection in semiconductors. In our work, focus is put on establishing spin filter functionality of ultrathin films of the magnetic insulator EuS grown directly on silicon. We investigate EuS tunnel barriers combined with nonmagnetic NM and ferromagnetic FM electrodes in the light of their possible application as dedicated spin tunnel contacts to silicon. Our study of the electrical transport across Si(001)/EuS/NM and Si(001)/EuS/FM tunnel contacts, which is supported by a detailed magnetic characterization of the samples, evidences the influence of the work function of the NM and FM electrodes on the bias dependent tunnel current. We assigned the temperature-dependent electrical transport mechanisms in our systems and addressed the question, how a Schottky barrier formation can be reduced in order to enhance the EuS spin filter effect. We finally could show, that tunnel magnetoresistance effects, though still moderate, arise in both Si(001)/EuS/FM spin valves and estimated a EuS spin filter efficiency of about 20%, which coincides very well for both systems. In general, our experimental findings point encouraging towards the successful implementation of spin filter tunnel contacts into silicon heterostructures.

MA 63.75 Fri 11:00 P2

Simulation of spin-polarized scanning tunneling microscopy and spectroscopy on magnetic nanostructures — •Krisztian Palotas[1], Werner Hofer[2], and Laszlo Szunyogh[1] — [1]Budapest University of Technology and Economics, Department of Theoretical Physics, Budapest, Hungary — [2]University of Liverpool, Surface Science Research Centre, Liverpool, UK

We developed a method for simulating spin-polarized scanning tunneling microscopy (SP-STM) and spectroscopy (STS) from first principles. It is based on the work of Heinze [Appl. Phys. A 85, 407 (2006)], where we made the following developments: (1) treatment of chemically inequivalent surface atoms is included, thus, enabling imaging of complex magnetism in supported atomic clusters. (2) We take into account local electron workfunction variations on the surface, which becomes particularly important in the vicinity of atomic steps. (3) Tip electronic structure is considered going beyond the Tersoff-Hamann model. (4) By including bias voltage in our model differential tunneling (dI/dV) spectra and other bias dependent properties can be calculated.

The main advantage of the presented method is that it can be applied based on results obtained by any ab initio electronic structure code. We present simulation results on a few magnetic surface structures and compare them to experiments, e.g. considering a Cr monolayer or island with noncollinear spin structure on Au(111).

Acknowledgements: Magyary Foundation, EEA and Norway Grants, Hungarian Scientific Research Fund (OTKA-K77771, OTKA-IN83114).

MA 63.76 Fri 11:00 P2

Effect of film roughness in Fe/MgO/Fe magnetic tunnel junctions: model calculations — •Saeideh Edalati Boostan[1], Hosein Moradi[2], and Christian Heiliger[1] — [1]I. Physikalisches Institut, Justus Liebig University Giessen, D-35392, Germany — [2]Department of Physics,Faculty of sciences, Ferdowsi University of Mashhad, Mashhad, Iran

We calculate how interface roughness affects the tunneling magnetoresistance (TMR) in Fe/MgO/Fe (100) junctions. The used method is based on a single-band tight-binding (SBTB) approximation [1] employing the Green's function formalism. We investigate the influence of disorder at the TMR ratio. Thereby, the disorder is modeled by considering different occupation probabilities of Fe and MgO at interface sites. We calculate the current densities for parallel and antiparallel configurations for different disorders. The results show that the roughness decreases the TMR that match well with experimental observations.

[1] H. Itoh, J. Phys. D: Appl. Phys. 40 1228.1233 (2007).

MA 63.77 Fri 11:00 P2

Calculations of spin dependent transport in MnAs — •Michael Czerner and Christian Heiliger — I. Physikalisches Institut, Justus Liebig University Giessen, D-35392, Germany

Magnetic MnAs nanoclusters can be grown on a GaAs substrate in a controlled manner [1]. Such structures can be used to construct planar magnetic devices for spintronic applications. We perform ab initio calculations by means of the non-equilibrium Keldysh formalism implemented in the Korringa-Kohn-Rostoker Green's function method [2]. We study the spindependent transport of MnAs in the hexagonal NiAs structure along different crystallographic directions. Furthermore we discuss in detail the transport through interfaces formed by two MnAs clusters with different magnetic domains. We found a very large magnetoresistance ratio above 200% while the spin polarization is low, which is originated by the different Fermi surface topologies of the two spin channels. Furthermore we study the transport properties in a tunnel junction geometry with MnAs as lead material.

[1] S. Ito, S. Hara, T. Wakatsuki and T. Fukui, Appl. Phys. Lett. 94, 243117 (2009) [2] C. Heiliger, M. Czerner, B. Yu. Yavorsky, I. Mertig, M. D. Stiles, J. Appl. Phys. 103, 07A709 (2008)

MA 63.78 Fri 11:00 P2

Temperature and bias voltage dependence of Co/Pd multilayer-based magnetic tunnel junctions with perpendicular magnetic anisotropy — •Zoë Kugler, Volker Drewello, Markus Schäfers, Jan Schmalhorst, Günter Reiss, and Andy Thomas — Bielefeld University, Department of Physics, Universitätsstr. 25, 33615 Bielefeld, Germany

Temperature- and bias voltage-dependent transport measurements of magnetic tunnel junctions (MTJs) with perpendicularly magnetized Co/Pd electrodes are presented. Magnetization measurements of the

Co/Pd multilayers are performed to characterize the electrodes. The effects of the Co layer thickness in the Co/Pd bilayers, the annealing temperature, the Co thickness at the MgO barrier interface, and the number of bilayers on the tunneling magneto resistance (TMR) effect are investigated. TMR-ratios of about 11% at room temperature and 18.5% at 13 K are measured and two well-defined switching fields are observed. The results are compared to measurements of MTJs with Co-Fe-B electrodes and in-plane anisotropy.

MA 63.79 Fri 11:00 P2

The influence of multi-layer structure of Heusler compound electrodes on transport properties and magnon excitation of magnetic tunnel junctions — •Volker Drewello, Daniel Ebke, Markus Schäfers, Günter Reiss, and Andy Thomas — Bielefeld University, Bielefeld, Germany

Magnetic tunnel junctions with single layers and multilayers of the Heusler compounds Co_2FeAl, Co_2FeSi, and Co_2MnSi as the soft magnetic electrode are prepared. Pinned Co-Fe is used as the hard reference electrode. The junctions show a high tunnel magnetoresistance ratio up to 331 % at 13 K. The electronic transport characteristics are investigated by tunneling spectroscopy. The spectra of the different samples are compared by normalized IETS. The multilayered electrodes show unique influence on the spectra in the parallel state, and when tunneling out of the Heusler. In the other cases (antiparallel state, or tunneling into the Heusler) a hugh contribution prevails, which we identify as magnon excitation. A comparison to the temperature dependence of the TMR ratio is drawn.

MA 63.80 Fri 11:00 P2

Controlling the resistance of a micro-/nanostructured GMR device with current induced domain wall motion — •Jana Münchenberger, Jonathan Fetting, Patryk Krzysteczko, Günter Reiss, and Andy Thomas — Bielefeld University, Department of Thin Films and Physics of Nanostructures, Universitätsstr. 25 33615 Bielefeld

We investigated the possibility to control the resistance of a structured Giant Magnetoresistance (GMR) system via current induced domain wall motion. For a narrow spin valve structure current induced domain wall motion in the free layer is predicted as soon as the current density reaches a critical threshold. The resistance of the device then depends on the position of the domain wall. The GMR systems we investigated were kindly provided by Infineon and show a GMR ratio of 10% as prepared. They were structured with e-beam lithography and ion beam etching. We fabricated narrow stripes of varying length (between 100 and 25μm) and a width of 200nm with a diamond shaped domain wall nucleation pad. The samples were measured with four-point-method and a constant current source. We measure GMR ratios up to 8% in the stripes. The GMR curves also showed steps indicating the existence of domain walls. To switch the sample between the different resistance states a current is applied to the device at a small magnetic field.

MA 63.81 Fri 11:00 P2

Highly efficient spin-current assisted domain wall depinning — •Helmut Körner[1,2], Emil Tafra[2], Jakoba Heidler[2], Jan Rhensius[2,3], Laura Heyderman[3], and Mathias Kläui[2] — [1]Universität Konstanz, 78457 Konstanz, Germany — [2]SwissFEL, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland & Laboratory for Nanomagnetism and Spin Dynamics, Ecole Polytechnique Fédérale de Lausanne (EPFL), 1015 Lausanne, Switzerland — [3]Laboratory for Micro- and Nanotechnology, Paul Scherrer Institut, 5323 Villingen, Switzerland

We have recently shown, that the depinning of domain walls can be very efficiently assisted by pure diffusive spin currents in a non-local spin valve consisting of a Permalloy wire and a Permalloy halfring with Copper as a non-magnetic spin conduit. We have now further improved the sample design by replacing the ferromagnetic wire used for spin injection by an additional halfring to study the effect of different spin directions for the injected spin current. Spin diffusion length and spin polarization are deduced from the measurements and for the chosen geometry simulations of the angular dependence of the spin torque are determined.

[1] D. Ilgaz et al., Phys. Rev. Lett. 105, 076601 (2010)

MA 63.82 Fri 11:00 P2

Preparation and Characterization of Magnetic Tunnel Junctions with Spin Transfer Torque — •Marcel Höwler[1], Kerstin Bernert[1], Jeffrey McCord[1], Kay Potzger[1], Monika Fritzsche[1], Arndt Mücklich[1], Jürgen Fassbender[1], Konstantin Kirsch[2], Roland Mattheis[2], and Stefan Slesazeck[3] — [1]Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf (HZDR), P.O. Box 51 01 19, 01314 Dresden, Germany — [2]Institut für Photonische Technologien e.V. (IPHT), Postfach 10 02 39, 07702 Jena, Germany — [3]NaMLab gGmbH, Nöthnitzer Str. 64, 01187 Dresden, Germany

Current-perpendicular-to-plane (CPP) magnetic tunnel junctions (MgO-MTJ) have been prepared using electron beam lithography as well as argon ion beam etching. A tantalum hardmask was utilized for pattern transfer. The size of the elliptical nanopillars could be decreased down to 90nm x 150 nm while preserving a TMR ratio of 92.5 %. TEM images proof the absence of redepositions at the MgO layer edge and give an insight into the interface quality.

Magnetization switching was performed using either static magnetic fields and/or dc current (spin torque). The nanopillars could be characterized at temperatures ranging from 5 K to 150 K and room temperature. The analysis of magnetization dynamics included single-shot time-resolved magnetoresistance measurements as well as dc current induced oscillations of the free-layer magnetization.

MA 63.83 Fri 11:00 P2

Magnetic polarizability of Rh atoms and spin-waves in FeRh. — •Leonid Sandratskii, Pawel Buczek, and Arthur Ernst — Max Planck Institute of Microstructure Physics, Halle, Germany

Recent femtomagnetic experiments revealed a sub-picosecond generation of the magnetisation after laser irradiation of antiferromagnetic FeRh. This strongly enhanced the interest in the magnetic dynamics and thermodynamics of this system. The available first-principles theories of the properties of FeRh outside the ground state differ cardinally in the treatment of magnetic excitations. This, in particular, concerns the account for the appearance of the induced Rh moment in the antiferromagnetic phase and the variable value of the Rh moment in the ferromagnetic phase. We report the calculation of the spin-waves in the antiferromagnetic and ferromagnetic FeRh with account for the specific properties of the Rh moment. The study is performed within both frozen magnon and dynamic susceptibility approaches. The comparison of the results of two approaches is given.

MA 63.84 Fri 11:00 P2

Higher-order corrections to the magnon dispersion in the Heisenberg model — •Julian Hüser, Thomas Kendziorczyk, and Tilmann Kuhn — Institut für Festkörpertheorie, Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster

It is well known that in thin magnetic films the magnon energy spectrum exhibits a minimum at nonzero wavevectors where Bose-Einstein condensation can take place. The main mechanism which leads to this minimum is a competition between exchange and dipole-dipole interactions. Most fundamental work is based on the Heisenberg model in the spirit of the 1/S-approximation which is able to explain this complex dispersion relation. Because of the nonlinearity of the Holstein-Primakoff transformation higher-order terms react on the linear terms and thus modify the dispersion relation. However this correction has been neglected so far and barely investigations were made to confirm the validity of the 1/S-approximation. The present work provides an analysis of the higher-order terms and shows in which cases the corrections are negligible or not.

MA 63.85 Fri 11:00 P2

Anisotropic Spin wave propagation in ferromagnetic layers with an inplane magnetic field — •Thomas Kendziorczyk, Julian Hüser, and Tilmann Kuhn — Institut für Festkörpertheorie, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster

Spin waves are a quickly developing topic and have great potential in application for magnetic nanodevices because of their remarkable property, that the dispersion relation can be very easily tuned by an external magnetic field. In a ferromagnetic layer spin waves can be generated by a spin polarized current through a nanocontact which gives rise to a spin-torque on the spin system in the layer. The propagation process of the spin waves can be theoretically described by the Landau-Lifschitz equation taking into account exchange and dipole interaction for a finite layer thickness. If an external inplane magnetic field is applied the spin waves align themselves perpendicular to the direction of the field. We will show analytical calculations of the dispersion re-

lation and group velocity, that explain this anisotropic behavior, and compare these with micromagnetic simulations.

MA 63.86 Fri 11:00 P2

Spin excitations in Dy/Y and Gd/Y superlattices — •Alexander Grünwald[1], Elena Tartakovskaya[2], Andrew Wildes[3], Wolfgang Schmidt[4], Peter Link[5], Astrid Schneidewind[6], Gregor Nowak[7], Katharina Theis-Bröhl[8], Roger Ward[9], and Andreas Schreyer[1] — [1]Helmholtz-Zentrum Geesthacht, Germany — [2]Institute for Magnetism of National Ukrainian Academy of Science, Ukraine — [3]Institut Laue-Langevin, France — [4]IFF, Forschungszentrum Jülich, JCNS at ILL, France — [5]Forschungs-Neutronenquelle Heinz Maier-Leibnitz, Germany — [6]Helmholtz-Zentrum Berlin / TU Dresden, Germany — [7]Ruhr-Universität Bochum, Germany — [8]Hochschule Bremerhaven, University of Apllied Sciences, Germany — [9]Oxford University, Clarendon Laboratory, United Kingdom

Neutron inelastic measurements of magnetic excitations propagating normal to the interfaces in rare-earth multilayers are presented. The measurements show multiple peak features at different energies for a given momentum transfer, indicating discrete energy modes, and a renormalization of the spin waves with an applied magnetic field on Dy/Y [1] and Gd/Y [2] superlattices, respectively. The results can be quantitatively explained with long-range intralayer and interlayer RKKY exchanges and a significant contribution of the Dzyaloshinsky-Moriya interaction in Dy/Y.

[1] A. T. D. Grünwald et al., Phys. Rev. B, 82, 014426 (2010)
[2] A. T. D. Grünwald et al., Appl. Phys. Lett., 96, 192505 (2010)

MA 63.87 Fri 11:00 P2

Ab initio calculations of spin dynamics in magnetic tunnel junctions — •Michael Czerner and Christian Heiliger — I. Physikalisches Institut, Justus Liebig University Giessen, D-35392, Germany

Magnetic tunnel junctions are widely used in spintronics. A key issue is a deep understanding of the physical mechanisms of spin dynamics in these systems. In particular, it is useful to have a theoretical model that can calculate the spin transfer torque as well as the magnetic damping in tunnel junctions. For this purpose we extend our non-equilibrium Keldysh formalism implemented in the Korringa-Kohn-Rostoker Green's function method [1] to treat the system full relativistically. In addition, we extend our implementation to a full potential description to investigate the role of exact cell treatment. The full relativistic treatment as well as the full potential description are compared to our previous results [2]. We will discuss different magnetic lead materials including Fe, Co, and FeCo alloys. These different materials are discussed with respect to their applicability for storage elements in magnetic memory. For this purpose a high spin-transfer torque but a low magnetic damping is desired. We calculate the spin-transfer torque for the whole tunnel junction whereas for the damping we use the bulk material neglecting interface effects.

[1] C. Heiliger, M. Czerner, B. Yu. Yavorsky, I. Mertig, M. D. Stiles, J. Appl. Phys. 103, 07A709 (2008)
[2] C. Heiliger and M.D. Stiles, Phys. Rev. Lett. 100, 186805 (2008).

MA 63.88 Fri 11:00 P2

Optical Investigation of Spin Injection from (Ga,Mn)As into n-GaAs — •Bernhard Endres, Matthias Sperl, Martin Utz, Dieter Schuh, Andreas Einwanger, Mariusz Ciorga, Christian Back, and Günther Bayreuther — Universität Regensburg

Spin injection from a Ga(Mn,As) contact into a n-GaAs channel through an Esaki diode structure was investigated. Details of the layer structure are described in Ref 1. After lithographic patterning the spin polarization in the GaAs was measured by p-MOKE at low temperatures across a cleaved edge as described in Ref. 2. From the distribution of the spin polarization below the injecting contact the spin diffusion length and the drift dependent spin decay length can be estimated, which are important parameters for the calculation of the spin lifetime from Hanle-measurements. However, several contributions to the Hanle curves as the stray field, dynamic nuclear polarization and a tilted magnetization of the injector make the calculation of the spin lifetime more complex. In this contribution the different parameters of the sample are characterized by fitting experimental data with a one-dimensional drift-diffusion equation. A spin diffusion length of about 5 μm and a spin lifetime of 10 ns was observed.

[1] M. Ciorga et al., Phys. Rev. B, 79(16):165321 (2009)
[2] P. Kotissek et al., Nature Phys. 3, 872 (2007)

MA 63.89 Fri 11:00 P2

Modification of the interface in Co_2FeSi/(Al,Ga)As hybrid structures by insertion of ZnO barriers — •Yori Manzke, Rouin Farshchi, Abbes Tahraoui, Jens Herfort, and Manfred Ramsteiner — Paul-Drude-Institut Berlin, Hausvogteiplatz 5-7, 10117 Berlin, Germany

Thin ZnO layers of various thicknesses at the hybrid interface of Co_2FeSi/(Al,Ga)As spin light-emitting diodes (spin-LEDs) are being investigated, particularly regarding their usability as diffusion barriers for Co and Fe atoms, which have previously been found to strongly deteriorate the semiconductor (SC) material. The insertion of the ZnO layers is found to drastically alter the ferromagnetic injector layer properties, leading to a decrease in the saturation magnetization as well as a drastic increase in sheet resistance. Both of these findings indicate a strong intermixing of ZnO and Co_2FeSi. Consequently, electroluminescence from the LEDs containing ZnO is only observed close to contact rings, as opposed to the homogeneous emission over the entire LED mesa area observed for a reference sample prepared without any oxide layer. The diffusion of Co and Fe atoms which takes place during Co_2FeSi growth at 280 °C was studied by secondary ion mass spectrometry. Only thicker ZnO barriers were found to act as efficient diffusion barriers, while very thin ZnO layers even lead to an increase of the Co and Fe concentrations in the SC. From these findings it is concluded that ZnO appears not to be promising for the use as a barrier layer in ferromagnet/SC spin injection devices.

MA 63.90 Fri 11:00 P2

Detection of Spin-Wave Modes in Microscopic Magnetic Ellipses by Means of Dynamic Scanning Near-field Optical Microscopy — •Johann Jersch[1], Vladislav E. Demidov[1], Harald Fuchs[2], and Sergej O. Demokritov[1] — [1]WWU Münster, Institut für Angewandte Physik — [2]WWU Münster, Physikalisches Institut

Development of spintronic nano-devices demands a direct knowledge about spin dynamics in magnetic nanostructures. Recent achievements in nano-optics have allowed development of scanning near-field optical microsopes with a lateral resolution below 50 nm. Here we present a novel setup based on near-field Brillouin light scattering spectroscopy. This setup allows detection and mapping of spin-wave dynamics simultaneously with the imaging of the topography of the studied nanoelement. The lateral resolution achieved is of below 60 nm. The technique is also applicable for near-field Raman, acoustic and fluorescence spectroscopies. A mapping of spin-wave dynamic modes in in-plane magnetized permalloy micro-ellipses was carried out. Both center and strongly localized edge modes were observed and studied. The localization width of the edge modes depends on the applied magnetic field and reduces to about 85 nm for high fields.

MA 63.91 Fri 11:00 P2

Dr. — •Zhen Gang Zhu and Jamal Berakdar — Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, 06099 Halle, Germany

We propose a new efficient way to control the spin dynamics in a quantum wire with spin orbit interaction via the application of subpicosecond, linearly polarized electromagnetic pulses with appropriate shapes. If the electric field of the pulse is aligned along the direction of the wire, the carriers experience a momentum boost while keeping the spin coherence in the different spin channels. When the polarization of the pulse is perpendicular to the 2 dimensional plane in which the wire is engraved, a further dynamical spin precession is induced in addition to the static one. The former is comparable to the latter and can be tuned by changing the pulse field parameters, an effect utilizable for optically controlled spintronics devices

MA 63.92 Fri 11:00 P2

Interference of coherent spin waves in $Ni_{81}Fe_{19}$ microstripes — •Thomas Brächer, Philipp Pirro, Björn Obry, Helmut Schultheiss, Peter Andreas Beck, Britta Leven, and Burkard Hillebrands — FB Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

Propagating spin waves have attracted increasing interest during the past years due to their potential use in signal processing and in logical devices. The propagation in metallic ferromagnets like $Ni_{81}Fe_{19}$ is of particular interest because these materials offer the ability of microstructuring with industrial standard processes.

We report on the observation of interference of spin waves and their coherent propagation in $Ni_{81}Fe_{19}$ microstripes by using space-

and phase-resolved Brillouin light scattering microscopy (μBLS). By employing these techniques, we observe stationary interference patterns formed by counterpropagating spin-wave beams and the emerging phase profile. The spin waves are excited by two phase-locked microwave antennas on top of the $Ni_{81}Fe_{19}$ stripes.

The observed intensity and phase distributions along the stripe can be reconstructed with a simple model of interfering plane waves with sinusoidal transverse profiles. In addition, we were able to map a wide part of the spin-wave dispersion by extracting the spin-wave wavelength out of the interference patterns.

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MA 63.93 Fri 11:00 P2

Finite Element Model of Non-Local Spin Valves — •Xianzhong Zhou, Daniel E. Bürgler, and Claus M. Schneider — Peter Grünberg Institute, PGI-6, Research Center Jülich, D-52425 Jülich, Germany

We study lateral ferromagnetic/nonferromagnetic/ferromagneitc (F/N/F) non-local spin valve with transparent interfaces using the finite element model. The electrical injection and detection of spin accumulation in the non-local spin valve can be described by the diffusion theory of F/N/F junctions. We derive two equations, the diffusion equation and the Poisson equation, which we solve in three-dimensional case using a finite element differential equations analysis library. We obtain the spin up and down electrochemical potentials as well as the spin accumulation signal accessible in experiments. We assume the following parameter: conductivity of F and N $\sigma_F = 6.6 \cdot 10^6\,\mathrm{S/m}$, $\sigma_N = 3.5 \cdot 10^7\,\mathrm{S/m}$, spin diffusion lengths of F and N $\lambda_F = 5\,\mathrm{nm}$, $\lambda_N = 350\,\mathrm{nm}$, and the spin polarization is 30%. When both the width of spin injector and detector increase from 30 to 150 nm, the spin signal decreases from 313 to 82 $\mu\Omega$. However, if the widths of both injector and detector are fixed to 100 nm, but the thickness of the N increases from 50 to 250 nm, the spin signal first increases and then decreases. Therefore, there is a optimal thickness of the N yielding a maximum spin signal of 192 $\mu\Omega$.

MA 63.94 Fri 11:00 P2

Structural and magnetic properties of tetragonal Heusler compounds $Mn_{2-x}Fe_{1+x}Ga$ — •Teuta Gasi, Jürgen Winterlik, Benjamin Balke, Gerhard H. Fecher, and Claudia Felser — Institute of Inorganic and Analytical Chemistry, Johannes Gutenberg - University, 55099 Mainz

Heusler compounds such as tetragonal phase of $Mn_{3-x}Ga$ are currently receiving increased interest. These materials play an important role due to their multifunctional properties and high potential for applications in STT-MRAM technology. STT-MRAMs require high Curie temperatures, low Gilbert damping constants, and low magnetic moments. This contribution focuses on the structural and magnetic properties of tetragonal Heusler compounds $Mn_{2-x}Fe_{1+x}Ga$. These compounds are of exceptional importance due to their large diversity of adaptive magnetic properties and their tunability by variation of several physical parameters such as temperature, magnetic field, or electron-doping. The series of samples was successfully synthesized by arc-melting and characterized. The magnetic measurements show that all these materials show high T_Cs above 600 K and diverse magnetic hardness. Additionally, we found that the compound Fe_2MnGa shows magnetic shape memory behavior. This work is supported by the Deutsche Forschungsgemeinschaft through the ASPIMATT projects TP 1.2-A (CH 952/1-1) and TP 2.3-A (FE 633/11-1).

MA 63.95 Fri 11:00 P2

Extrinsic Spin Hall Effect in Metallic Slab Systems — •Christian Herschbach[1], Martin Gradhand[2], Dmitry V. Fedorov[1], Peter Zahn[1], and Ingrid Mertig[1,2] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, D-06099 Halle, Germany — [2]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany

After the first measurement of the *gigantic* spin Hall effect (SHE) in Au [1], a discussion about the responsible mechanism has been started [2-3]. Recently, a new experiment with Pt-doped Au films [4] showed a large spin Hall angle (SHA) as was reported before in Ref. [1].

Here we present *ab initio* calculations in order to describe the skew scattering mechanism of the spin Hall effect in free-standing Au slabs of different thicknesses. The computation is based on a fully relativistic Korringa-Kohn-Rostoker Green's function method [1]. The dependence of the SHA on the position of the substitutional Pt impurities in the slab is investigated.

[1] T. Seki et al., Nature Mater. **7**, 125 (2008)
[2] G. Guo et al., PRL **102**, 036401 (2009)
[3] M. Gradhand et al., PRL **104**, 186403 (2010)
[4] B. Gu et al., PRL **105**, 216401 (2010)

MA 63.96 Fri 11:00 P2

Non-Abelian Berry Curvature by the KKR method — •Martin Gradhand[1], Dmitry V. Fedorov[2], Falko Pientka[2], Peter Zahn[2], Ingrid Mertig[2,1], and Balazs L. Györffy[3] — [1]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany — [2]Martin-Luther-Universität Halle, Institut für Physik, 06099 Halle, Germany — [3]H.H.Wills Physics Laboratory, University of Bristol, United Kingdom

The existence of the geometrical phase, discovered by Michael Berry [1], for a quantum mechanical system with an adiabatically varied parameter is known since 25 years. However, its influence on many aspects of modern physics turned out during the last decade only. Nowadays the concept is used to describe transport phenomena as the anomalous and spin Hall effect as well as quantities such as the orbital magnetization and electrical polarization. In spite of the broad application of the Berry curvature, used for the description of these phenomena, a few *ab initio* methods only were developed for its calculation.

Here, within the Korringa-Kohn-Rostoker method, we present a new implementation of the Berry curvature calculation extended to the non-Abelian case where degenerate electron states exist. We discuss the method in detail and show results for metals as Cu, Ag, Au, and Pt.

[1] M.V. Berry, Proceedings of the Royal Society of London, A **392**, 45 (1984).

MA 63.97 Fri 11:00 P2

Gigantic spin Hall effect in Au caused by interstitial impurities — •Martin Gradhand[1], Dmitry V. Fedorov[2], Christian Herschbach[2], Peter Zahn[2], and Ingrid Mertig[2,1] — [1]Max-Planck-Institut fär Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany — [2]Martin-Luther-Universität Halle, Institut für Physik, 06099 Halle, Germany

The *gigantic* spin Hall effect (SHE) observed in Au [1] two years ago is still not fully understood. Several proposals such as a Kondo resonance on Fe impurities [2], a quantum renormalization of the SHE [3], Pt impurities on the thin Au [4] film were discussed in the literature. Among them, as was discussed in Ref. [3], the explanation with the Kondo resonance has been questioned already both theoretically and experimentally.

Meanwhile our fully relativistic *ab initio* calculation [5] showed that C and N substitutional impurities in Au should provide large spin Hall angle comparable to the experimentally found one. However, a practical realization of such stable substitutional alloys is quite questionable. Here we present a study of the skew scattering mechanism in gold caused by interstitial impurities such as C, N, and Ar. With this study we propose a new possibility for the gigantic SHE.

[1] T. Seki et al., Nature Mater. **7**, 125 (2008)
[2] G. Guo et al., PRL **102**, 036401 (2009)
[3] B. Gu et al., PRL **105**, 086401 (2010)
[4] B. Gu et al., PRL **105**, 216401 (2010)
[5] M. Gradhand et al., PRL **104**, 186403 (2010)

MA 63.98 Fri 11:00 P2

The Heusler compound $Co_2FeAl_{0.4}Si_{0.6}$ on its way to industry — •Frederick Casper[1], Tanja Graf[1], Gerhard Jakob[2], and Claudia Felser[1] — [1]Institute of Inorganic and Analytical Chemistry, Johannes Gutenberg - University, 55099 Mainz — [2]Institute of Physics, Johannes Gutenberg - University, 55099 Mainz

Half-metallic compounds Co-based Heusler compounds have been predicted to have a high spin polarization even at room temperature due to their high Curie temperature of around 1000 K. Recently, many different Heusler compounds were studied as potential candidates for TMR- and GMR-devices. High TMR-ratios of up to 220% at room temperature could be reached. On the other hand these experiments were performed on small MgO-substrates which are not suitable for an industrial application. We implemented the Heusler compound into an industrial production. A twelve inch target is used to sputter thin films of $Co_2FeAl_{0.4}Si_{0.6}$ (CFAS) on a five inch silicon wafer. Since the electronic structure of CFAS is very sensitive to its atomic order, the influence of the substrate, the buffer layer, and the annealing temper-

ature on the structure and the magnetic properties of the films were studied by X-ray diffraction, VSM measurements and TEM measurments, respectively. Diffetrent TMR-stags with a MgO barrier were deposited and show a TMR ratio up to 30 % at room temperature. This work is supported by the Federal Ministry for Education and Research BMBF, project "Multimag".

MA 63.99 Fri 11:00 P2

Magnetic tunnel junctions based on zinc ferrite and cobalt — •Michael Bonholzer, Kerstin Brachwitz, Katja Mexner, Jan Zippel, Michael Lorenz, and Marius Grundmann — Universität Leipzig, Institut für experimentelle Physik II, Linnéstraße 5, 04103 Leipzig, Germany

Magnetic tunnel junctions (MTJs) will play an important role in future computer architecture and spintronic systems. We have designed a magnetic tunnel junction out of zinc ferrite, magnesium oxide and cobalt. Zinc ferrite, acting as soft magnetic bottom electrode, was grown by pulsed laser deposition (PLD) on MgO and STO substrates. The thin films ($d \approx 200\,\mathrm{nm}$) were characterized by atomic force microscopy (AFM), X-ray diffraction (XRD), SQUID- and Hall-effect measurements and optimized in their conductivity ($\sigma \approx 50\,\mathrm{S/m}$) and surface roughness (rms $\approx 0.2\,\mathrm{nm}$). The thickness of the barrier material magnesium oxide was varied between 10 and 100 nm, the surface and stuctural properties have been measured by AFM and XRD. The cobalt top-electrode, which serves as hard electrode, was produced by thermal evaporation. The MTJ-structure was defined by multi-step photolitography with wet-chemical etching, using crossed-over masks in order to limit the contact area to 50×50 or $100 \times 100\,\mu\mathrm{m}^2$. Current-voltage measurements in dependence of an external magnetic field were performed.