MA 52: Poster II - Magnetic Heusler compounds, Magnetic shape memory alloys, Thin Films, Micro-/Nano-structured magnetic materials, Graphene, Spins in organics, Magnetic imaging, Surface Magnetism, Spin excitations/Torque, Spincaloric transport

Time: Friday 11:00–14:00 Location: Poster A

MA 52.1 Fri 11:00 Poster A

Inverse tunnel magnetoresistance with Mn_2VGa based magnetic tunnel junctions — •Christoph Klewe, Markus Meinert, Jan Schmalhorst, and Günter Reiss — Department of Physics, Thin Films and Physics of Nanostructures, Bielefeld University, 33501 Bielefeld, Germany

The ferrimagnetic Heusler compound Mn_2VGa is predicted to have a pseudo-gap in the majority carriers [1], which should lead to inverse tunnel magnetoresistance. We synthesized epitaxial Mn_2VGa thin films on MgO(001) substrates by dc magnetron co-sputtering, resulting in nearly stoichiometric films. XRD analysis revealed a mostly B2-ordered structure for the films deposited at substrate temperatures of 350°C, 450°C, and 550°C.

Magnetic tunnel junctions with MgO barrier and CoFe counterelectrodes were fabricated. After post-annealing at up to $T_a = 400°C$ negative TMR was obtained around zero bias, providing evidence for the inverted spin-polarization. Band structures of both electrodes were computed within the coherent potential approximation [2] and used to calculate the TMR vs. U characteristics, which are in good agreement with our experimental findings.

In addition, measurements on GMR-devices fabricated with Cu spacer layers were carried out. The current-in-plane GMR was negative as well, consistent with our TMR results.

[1] K. Özdogan, I. Galanakis, E. Sasioglu, B, Aktas, J. Phys.: Condens. Matter **18**, 2905 (2006). [2] H. Ebert, D. Ködderitzsch, J. Minar, Rep. Prog. Phys. **74**, 096501 (2011).

MA 52.2 Fri 11:00 Poster A

Magnetic properties of the full Heusler compounds $Mn_{2+x}V_{1-x}Si$ — •Christian Sterwerf, Markus Meinert, Jan-Michael Schmalhorst, and Günter Reiss — Dünne Schichten und Physik der Nanostrukturen, Fakultät für Physik, Universität Bielefeld, 33501 Bielefeld, Deutschland

Half-metallic Heusler compounds have attracted much interest in the recent years because of their possible applications in spintronic devices. They provide a high spin polarization of the electrons at the Fermi level. A fully compensated half metallic ferrimagnet is ideal for spintronic devices since a vanishing magnetization leads to low stray fields and a lower energy consumption.

Thin films of the ternary full Heusler compound $Mn_{2+x}V_{1-x}Si$ were prepared by DC and RF magnetron co-sputtering on MgO (001) substrates. At $x = 0.5$ the compound has 24 valence electrons per formula unit, resulting in complete magnetic compensation according to the Slater Pauling rule $m = N - 24$.

In this work we investigate the films by means of x-ray diffraction, x-ray reflectometry, magnetometry techniques and transport measurements, especially of the anomalous Hall effect.

MA 52.3 Fri 11:00 Poster A

Magneto-optical characterization of single crystalline $Co_2FeAl_{0.4}Si_{0.6}$ thin films on MgO substrates — •Ana Ruiz Calaforra[1], Andres Conca[1], Britta Leven[1], Tanja Graf[2,3], Frederick Casper[2], Claudia Felser[2,4], and Burkard Hillebrands[1] — [1]FB Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Institute of Inorganic and Analytical Chemistry, Johannes Gutenberg-University Mainz, 55099 Mainz, Germany — [3]Graduate School of Excellence - Material Science in Mainz, 55099 Mainz, Germany — [4]Max Planck Institute for Chemical Physics of Solids, 01187 Dresden, Germany

The full Heusler compound $Co_2FeAl_{0.4}Si_{0.6}$ (CFAS) has been predicted to provide a 100% spin polarization with an enhanced temperature stability due to the fact that the Fermi level lies in the middle of the energy gap. Therefore, this material is a promising candidate for TMR- and GMR-devices. For this, the understanding of the magnetic properties of these compounds is of great importance. We present magneto-optical investigations on epitaxial thin CFAS films deposited on MgO (100) substrates with different seed layer materials. A magneto-optical Kerr effect setup with a rotational stage was used to study the magnetocrystalline anisotropy of the sample. An overall uniaxial anisotropy with a biaxial contribution strongly depending on the nature of the used seed layer was observed.

Support by the BMBF project MultiMag (VDI-TZ 13N9913) is acknowledged.

MA 52.4 Fri 11:00 Poster A

Evolution of atomic order upon annealing in Co_2MnSi thin films probed by ^{59}Co and ^{55}Mn NMR — •Steven Rodan[1], Alexey Alfonsov[1], Sabine Wurmehl[1], Filippo Ferraro[2], Jürgen Kohlhepp[2], Bert Koopmans[2], Yuya Sakuraba[3], Bosu Subrojati[3], Koki Takanashi[3], and Bernd Büchner[1] — [1]Leibniz Institute for Solid State and Materials Research (IFW), 01171 Dresden, Germany — [2]Eindhoven University of Technology, 5600 MB Eindhoven, Netherlands — [3]Institute for Materials Research, Tohoku University, 980-8577 Sendai, Japan

Materials with high spin polarization at the Fermi level are highly desirable for spintronics applications. Many intermetallic Heusler compounds, such as Co_2MnSi, exhibit half-metallic ferromagnetism with such large spin polarization, but this tends to depend strongly on the ordering of the atoms in the crystal lattice. Pulsed nuclear magnetic resonance (NMR) proves to be essential for identifying the type(s) of disorder present by investigating the structure locally. We performed ^{59}Co and ^{55}Mn NMR experiments on several annealed and as-cast Co_2MnSi thin films, the results of which together reveal that the atomic ordering evolves with different annealing temperatures. We compare our results with previous structural analysis which used x-ray diffraction.

MA 52.5 Fri 11:00 Poster A

Direct investigation of the Co_2MnSi/MgO interface by spin-resolved photoemission — •R. Fetzer[1], J.-P. Wüstenberg[1], T. Taira[2], M. Yamamoto[2], M. Aeschlimann[1], and M. Cinchetti[1] — [1]Department of Physics and Research Center OPTIMAS, TU Kaiserslautern, Erwin-Schrödinger-Str. 46, D-67663 Kaiserslautern — [2]Graduate School of Information Science and Technology, Hokkaido University, Kita 14 Nishi 9, Sapporo 060-0814, Japan

State-of-the-art tunnelling magnetoresistance (TMR) devices based on magnetic full Heusler compounds (e.g. Co_2MnSi) as electrodes and insulating MgO as tunnelling barrier are very promising as advanced spintronic devices [1]. Understanding the spin-dependent electronic properties of Heusler/insulator interfaces is hereby of great importance for further improvement of these multilayer systems. We have studied the Co_2MnSi/MgO (100) interface by means of spin-resolved near-threshold photoemission spectroscopy. The excitation source was laser light with photon energy lower than the MgO band gap width. This allows to investigate directly the spin-dependent electronic properties of the interface as a function of the MgO thickness. We found that the interface spin polarization is positive and can be detected through MgO layers up to 20 ML. Furthermore distinct changes in crystal structure and chemical composition of the epitaxial MgO layer were observed by means of LEED and Auger electron spectroscopy when varying its thickness. We will discuss the connection between the quality of the MgO layer and the detected interface spin polarization.

[1] T.Ishikawa et al., J. Appl. Phys 103, 07A919 (2008)

MA 52.6 Fri 11:00 Poster A

Spin-wave propagation in a $Co_2Mn_{0.6}Fe_{0.4}Si$ Heusler waveguide — Thomas Sebastian[1,2], •Philipp Pirro[1], Thomas Brächer[1,2], Alexander A. Serga[1], Burkard Hillebrands[1], Yusuke Ohdaira[3], Hiroshi Naganuma[3], Mikihiko Oogane[3], and Yasuo Ando[3] — [1]FB Physik und Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Graduate School Material Science in Mainz, Staudinger Weg 9, 55128 Mainz, Germany — [3]Departement of Applied Physics, Tohoku University, Sendai, Japan

The class of Cobalt-based full Heusler compounds combines high Curie temperatures and spin polarizations with a lower Gilbert damping than most conventional 3d-ferromagnets [1]. These material parame-

ters make them promising candidates in the emerging field of *magnon spintronics*. In this concept, information is transferred and processed via magnons - the excitations of the magnetic system - without flow of electronic currents. Here we present the first observation of spin dynamics in a microstructured Heusler waveguide using Brillouin light scattering microscopy. The low magnetic losses estimated by FMR measurements [2] have been confirmed by the increase of the observed propagation distances (up to 80 μm, with an exponential decay length of at least 10 μm) compared to the commonly used $Ni_{81}Fe_{19}$.

We acknowledge financial support by the *DFG Research Unit 1464: ASPIMATT*.

[1] S. Trudel, J. Phys. D: Appl. Phys. **43**, 1930001 (2010).
[2] T. Kubota, Appl. Phys. Lett. **94**, 122504 (2009).

MA 52.7 Fri 11:00 Poster A

Electronic structure, magnetic and transport properties of Heusler compounds $Fe_{3-x}Mn_xSi(x = 0,..,3)$ — •Y. Shapiro[1], G. H. Fecher[1,2], S. Ouardi[1], A. Gloskovskii[1], B. Balke[1], S. Ueda[3], and C. Felser[1,2] — [1]Institute of Inorganic and Analytical Chemistry,Johannes Gutenberg - University, Mainz — [2]Max Planck Institute for Chemical Physics of Solids, Dresden — [3]NIMS Beamline Station at SPring-8, National Institute for Materials Science, Japan.

Heusler compounds are promising materials in many fields of contemporary research. The spectrum of their possible applications ranges from magnetic and magneto-mechanical materials from semiconductors, thermoelectrics to superconductors. The properties of these intermetallic compounds can be altered by changing the degree and kind of chemical order as well as by substituting one element by another.

The substitutional series of polycrystalline Heusler compounds $Fe_{3-x}Mn_xSi(x = 0,...,3)$ were synthesized and experimentally investigated with respect to their electronic and crystalline structure as well as magnetic and transport properties. The crystal structure was determined by means of x-ray diffraction. The temperature dependence of electrical resistivity, Seebeck coefficient, and thermal conductivity were investigated. Hard and soft X-ray photoelectron spectroscopy (HAXPES and MgK_α XPS) was carried out to study the details of the electronic structure and relate it to the transport properties.

MA 52.8 Fri 11:00 Poster A

Transport investigations on Mn_3Si — •Frank Steckel, Regina Hermann, Christian G. F. Blum, Steven Rodan, Sabine Wurmehl, Christian Hess, and Bernd Büchner — Leibniz-Institute for Solid State and Materials Research, Dresden, Germany

We investigate the electronic and thermal transport phenomena of the itinerant antiferromagnet Mn_3Si, which has been suggested to be a prototype material for realizing half-metallic ferromagnetism with a spin density wave below 26 K. We measured the resistivity, the Hall-effect as well as the thermal conductivity and the thermopower in the temperature range from 10 K up to 300 K using single crystals. In the vicinity of the antiferromagnetic transition temperature we found clear anomalies in the transport coefficients and a large fluctuation regime which extends to temperatures much higher (up to about 150 K) than the antiferromagnetic ordering temperature.

MA 52.9 Fri 11:00 Poster A

Spin calorics in ferromagnetic Heusler alloys on semiconductors — •Yori Manzke, Farshchi Rouin, Ramsteiner Manfred, and Jens Herfort — Paul-Drude-Institut für Festkörperelektronik, Hausvogteiplatz 5-7, 10117 Berlin, Germany

Recently, a spin-based counterpart to the Seebeck effect (SE) has been discovered in various ferromagnetic systems, which can potentially serve to generate spins from waste heat in future spintronic devices. In contrast to the SE, where a temperature gradient leads to a charge potential difference across a material, in the spin-based version (or SSE) a thermal gradient induces a "spin voltage", i.e. a chemical potential difference due to a spin imbalance in the material. However, the SSE is difficult to isolate due to other magnetothermal effects, and special experimental criteria must be met to eliminate such artifacts. Here, we report clear evidence of spin-induced voltages across Pt strips deposited on epitaxially grown Fe_3Si/GaAs hybrid structures. The Pt strips are intended to convert spin currents from the Fe_3Si layer into measurable voltages via the inverse spin Hall effect, while also eliminating magnetothermal artifacts. These voltages depend on the magnetization of the Fe_3Si layer and appear as a consequence of thermal gradients across the sample. Nonetheless, the spatial and temperature dependences of the spin voltages observed in our samples fundamentally differ from those of other materials systems for which the SSE has been reported. Therefore, these findings may be crucial for the understanding of the SSE.

MA 52.10 Fri 11:00 Poster A

Pulsed laser deposition of thin film Heusler compounds — •Mirko Emmel, Christian Mix, and Gerhard Jakob — Institut für Physik, Johannes Gutenberg-Universität Mainz, Deutschland

Pulsed laser deposition (PLD) is a versatile technique to deposit thin films of one or more targets illuminated by a focused pulsed-laser beam. Since the energy source is located outside the chamber, the use of ultra-high vacuum is possible. Due to a stoichiometric transfer between target and substrate, PLD allows depositing all kinds of multicomponent materials. We optimized the optical elements, which resulted in higher transmission of the laser energy and a more defined laser spot on the target. At a base pressure of about 10^{-9} mbar we successfully deposited thin films of different Heusler compounds. A further advantage of a PLD system is the capability to use relatively small targets, which are not suitable for other deposition methods like sputtering. The minimum diameter of a PLD-target is defined by the spot size of the laser on the target in order to avoid ablating other material. Hysteresis loops of Co_2FeSi and Rh_2MnGe thin film showed the expected magnetic saturation values. Ellipsometry measurements of Co_2FeSi thin films were performed to determine the permittivity. This work is supported by the DFG research group ASPIMATT and the Stiftung Rheinland-Pfalz für Innovation.

MA 52.11 Fri 11:00 Poster A

Magnetic resonance study of highly spin polarized compounds — •A. Alfonsov[1], S. Rodan[1], M. E. Belesi[1], S. Wurmehl[1], V. Kataev[1], F. Ferraro[2], J. T. Kohlhepp[2], H. J. M. Swagten[2], B. Koopmans[2], K. Takanashi[3], B. Subrojati[3], Y. Sakuraba[3], and B. Büchner[1] — [1]IFW Dresden, D-01169 Dresden, Germany — [2]Eindhoven University of Technology, 5600 MB Eindhoven, Netherlands — [3]Institute for Materials Research, Tohoku University, 980-8577 Sendai, Japan

Heusler alloys have attracted a considerable attention in recent years since these compounds can be halfmetallic ferromagnets. Such materials have a theoretical 100% spin polarization at the Fermi level at low temperatures, which gives them a significant potential for spintronics applications. The halfmetallicity strongly depends on the local atomic ordering. Therefore, a precise knowledge of the structural and magnetic ordering also on a local scale is crucial to control the macroscopic physical properties. To obtain this knowledge one has to call for local probe techniques. In this work we present recent nuclear magnetic resonance and electron spin resonance study of various Co-, Mn- and Fe-based Heusler compounds exhibiting different structural disorders and different magnetic ground states.

MA 52.12 Fri 11:00 Poster A

Elastic properties and stability of Heusler compounds — •S. -C. Wu[1,2], S. S. Naghavi[1], G. H. Fecher[1,2], and C. Felser[1,2] — [1]Institute of Inorganic Chemistry and Analytical Chemistry, Johannes Gutenberg - University, Mainz — [2]Max Planck Institute for Chemical Physics of Solids, Dresden

The properties of Heusler compounds which are the promising thermoelectric materials are important. Various Heusler compounds are investigated with respect to their malleability and stability. By applying isotropic strain in different ways to the cubic crystal could calculate the elastic constants. The result of the cubic elastic anisotropy can be used to decide the structural stability. The behavior that Young's modulus is largest in the ⟨111⟩-type directions whereas the rigidity modulus is largest in the ⟨100⟩-type directions shows a direct consequence of $A_e > 1$. Zener's ratios of the most stable compounds are in the range of $1.9 < A_e < 2.7$. $A_e < 0$ is not stable and $A_e = 0$ is isotropic. More physical properties could be derived from the calculated elastic constants.

MA 52.13 Fri 11:00 Poster A

Antisite disordering in new Fe-based tetragonal Heusler compounds characterised by 57Fe-Mössbauer spectroscopy — •Teuta Gasi, Vadim Ksenoofontov, Jürgen Winterlik, and Claudia Felser — Institut für Anorganische und Analytische Chemie, Johannes Gutenberg Universität, Staudinger Weg 9, 55099 Mainz, Germany

We report on magnetic properties and antisite disordering in tetragonal Heusler Compounds investigated by 57Fe-Mössbauer Spectroscopy.

These materials are important because of their potential application in spintronic especially for STT (spin-transfer torque) technology, magnetocaloric or STO etc. New tetragonal Heusler compounds based on Fe and Mn were synthesized by arc-melting and characterized. 57Fe transmission and conversion electron Mössbauer spectroscopy (CEMS) was applied to explore magnetism and local surrounding of Fe atoms in bulk samples. Measurements reveal that the magnetic moments of Fe atoms in these compounds are almost vanishing, whereas in the cubic ones magnetic moments are much higher. Taking into account magnetic susceptibility measurements of Mn based compounds, one can conclude that magnetic moments of Mn atoms are mainly responsible for the bulk magnetization. The Mössbauer data support this observation.

MA 52.14 Fri 11:00 Poster A

A General Phase-field Model for the Martensite Rearrangement in Ni_2MnGa — •Christian Mennerich[1], Frank Wendler[1], Marcus Jainta[1], Anna Weisshaar[1], and Britta Nestler[1,2] — [1]Karlsruhe University of Applied Sciences — [2]Karlsruhe Institute of Technology

Ferromagnetic shape memory alloys have gained major interest in the last 15 years as components in actuators and dampers, as they provide large recoverable strains at low operation cost. A multi-phase field model of Allen-Cahn type has been successfully applied to describe the microstructure rearrangement in Ni_2MnGa in the martensitic state, induced by external magnetic or strain fields. The model is based on a Helmholtz free energy density formulation and includes magnetic and elastic energy contributions. With order parameters that are related to the different eigenstrains of the twin variants and the spontaneous magnetization, the time-spatial evolution of the system is described by a set of partial differential equations. The evolution of the order parameters depends on energy contributions for twin interfaces and bulk phase states. To make the complex boundary value problem treatable, different techniques (staggered grids, geometric integration methods, Fast Fourier methods etc) are combined. In this contribution we describe the model, the discretization and numerical implementation. We present simulation results to show the general applicability of the model to the magnetic shape memory effect and stress induced martensite microstructure rearrangement.

MA 52.15 Fri 11:00 Poster A

Structural and magnetic properties of zinc ferrite thin films grown by pulsed-laser deposition — •Kerstin Brachwitz[1], Marcus Jenderka[1], Andrey Timopheev[2], Alexandre Azevedo[2], Nikolai Sobolev[2], Annette Setzer[1], Pablo Esquinazi[1], Michael Lorenz[1], and Marius Grundmann[1] — [1]Institut für Experimentelle Physik II, Universität Leipzig, Germany — [2]Departamento de Fisíca and I3N, Universidade de Aveiro, Portugal

Zinc ferrite ($ZnFe_2O_4$) is a promising candidate for the application in magnetic tunnel junctions due to its ferrimagnetic properties. In this regard, we investigated the structural and magnetic properties of $ZnFe_2O_4$ thin films grown by pulsed-laser deposition on different substrates at various substrate temperatures (T_S).

X-ray diffraction measurements reveal an increasing crystalline quality of the films with increasing T_S. Epitaxial single phase $ZnFe_2O_4$ (100) thin films were observed on $SrTiO_3$ (100) substrates, whereas no symmetric $ZnFe_2O_4$ reflexes were observed for thin films deposited on r-plane sapphire independent of T_S.

Magnetic properties were studied by static magnetization and ferromagnetic resonance (FMR) measurements. All films show a strong magnetic ordering, even if the zinc ferrite spinel phase has not been detected. However, energy dispersive X-ray spectroscopy studies reveal a stoichiometric Zn/Fe ratio. FMR measurements revealed fourfold cubic magnetic anisotropy of $ZnFe_2O_4$ thin films grown on $SrTiO_3$. The values of effective magnetization and cubic anisotropy have been determined from a detailed study of the FMR spectra.

MA 52.16 Fri 11:00 Poster A

Theoretical and experimental investigation of ultrathin iron fcc films — •Michael Vogel, Matthias Kronseder, Florian Freund, Georg Woltersdorf, and Christian Back — Universität Regensburg

The magnetic properties of ultrathin films are determined in essence by the magnetic anisotropy constant, magnetic moment and the exchange interaction integral. Due to the challenging experimental accessibility of these parameters and the fact that none of these parameters can be obtained separately, the combination of experimental and theoretical methods can be used [1]. Optical (MOKE) and photoemission (MCD) measurements combined with ab initio calculations (DFT-VASP) [2] leads to a full understanding of the magnetic behavior of this system. For the theoretical investigation of the interatomic exchange interactions and the magnetic moment we have modeled those as a function of the involved strain in thin films. Assuming a ferromagnetic state of thin films as demonstrated experimentally in [3], we have calculated the exchange interaction from first principles by rotating moments within specially constructed supercells, based on structural data achieved by I(V)-LEED measurements also done in [3]. In addition the exchange interactions have also been determined using a "spin-spiral" technique [4].

[1] H. L. Meyerheim et al., PRL 103, 267202 (2009) [2] G. Kresse et al., Comp. Mater. Sci. 6, 15 (1996). [3] S. Müller et al., Phys. Rev. Lett. 74, 765 (1995). [4] L.M. Sandratskii, J. Phys. Condens. Matter 3, 8565 (1993); J. Phys. Condens. Matter 3, 8587 (1993).

MA 52.17 Fri 11:00 Poster A

Magnetic properties of thin iron films on strontium titanate substrates — •Armin Haase, Kay Potzger, Oskar Maciej Liedke, and Rantej Bali — Institut für Ionenstrahlphysik und Materialforschung, Helmholtz-Zentrum Dresden-Rossendorf

In this study, the magnetic moment of thin iron films will be investigated. The methods of preparing the strontium titanate substrate surfaces for layer growth, creating near-surface defects, and growing thin iron films will be described. A procedure for surface preparation using a sequence of etching and annealing steps in an oxygen-rich environment will be introduced. The defects were created using ion implantation, and the samples were tested for defect magnetism. A magnetic moment was determined for hydrogen with the fluency of $2 \times 10^{17}\ \frac{1}{\mathrm{cm}^2}$ and the energy of 1,2 keV. Nitrogen implantation did not produce defect magnetism. In a separate process, iron layers of varying thicknesses were grown and investigated for their groth modes and magnetic properties. Finally, the steps described above were combined and repeated.

MA 52.18 Fri 11:00 Poster A

Magnetic and structural properties of $Fe_{1-x}Tb_x$ and $Fe_{0.82-x}Co_{0.18}Tb_x$ thin films — •Birgit Hebler[1], Christian Schubert[1], Herbert Schletter[1], Florin Radu[2], Andreas Liebig[1], and Manfred Albrecht[1] — [1]Institute of Physics, Chemnitz University of Technology, D-09107 Chemnitz, Germany — [2]Hemholtz-Zentrum Berlin für Materialen und Energie, Albert-Einstein-Str.15, D-12489 Berlin, Germany

Amorphous rare earth-transition metal alloys with perpendicular magnetic anisotropy exhibit a versatile magnetic configuration making them interesting materials for exchange coupled heterostructures used in spintronic devices. We present an investigation of $Fe_{1-x}Tb_x$ and $Fe_{0.82-x}Co_{0.18}Tb_x$ thin films with a varying content of terbium (16 at. % $<$ x $<$ 30 at. %). The 20 nm thin films were prepared by magnetron co-sputtering in a UHV-chamber at room temperature. X-ray diffraction measurements and transmission electron microscopy imaging in cross-section geometry show an interdiffusion of the platinum protecting layers into the amorphous films at the interface. The temperature dependence of the magnetization reversal process was obtained by SQUID-VSM measurements in a maximum applied field of 7 T from 4 K to 400 K. Around the compensation temperature an anomalous reversal behavior was observed at higher fields, which may be assigned to a spin flop transition in the sperimagnetic configuration.

MA 52.19 Fri 11:00 Poster A

Investigations of magnetism in multiferroic layer systems — •Martin Welke[1], Joachim Gräfe[1], Vasili Hari Babu[1], Remya Kunjuveettil Govind[2], Martin Trautmann[2], Francis Bern[3], Michael Ziese[3], Karl-Michael Schindler[2], and Reinhard Denecke[1] — [1]Wilhelm-Ostwald-Institut für Physikalische und Theoretische Chemie, Universität Leipzig — [2]Institut für Physik, Universität Halle — [3]Institut für Physik, Universität Leipzig

Systems with multiferroic properties are of interest for research since the 60s of the 20th century. In the starting time single crystal multiferroics were in the focus of research. Nowadays layer systems with ferroelectric and ferromagnetic components are also studied.

The work presented deals with different ferrite layers - namely Nickelferrite and Cobaltferrite - on Bariumtitanate (001). Preparation of the ferrite films was done by PLD in UHV. Subsequently they were measured by SQUID in order to obtain magnetization loops. From temperature-dependend data, there seems to be an influence of the

phase transitions of Bariumtitanate on the magnetic response of the ferrite films. Altogether Nickelferrite and Cobaltferrite appear to have a small remanent magnetization.

In order to additionally characterize these materials XPS measurements were carried out. Especially the Iron to Oxygen ratio is of interest.

Furthermore XAS measurements of thick ferrite layers were taken into account.

MA 52.20 Fri 11:00 Poster A

Magnetic anisotropy of strained $La_{0.7}Sr_{0.3}CoO_3$ thin films probed by XMCD — •Felix Eilers[1,2], Michael Merz[1], Dirk Fuchs[1], Hilbert von Löhneysen[1,3], Peter Nagel[1], and Stefan Schuppler[1] — [1]KIT, Institut für Festkörperphysik — [2]KIT, Fakultät für Physik — [3]KIT, Physikalisches Institut, Karlsruhe, Germany

The magnetic properties of perovskite-type $La_{1-x}Sr_xCoO_3$ have their origin in the variety of possible valence and spin states of the Co ion and in strong electronic correlations. Bulk $La_{0.7}Sr_{0.3}CoO_3$ is known to be a ferromagnetic metal below $T_C \approx 240\,K$ and to exhibit large Joule magnetostriction. This motivated us to investigate a complementary magnetoelastic effect: the effect of biaxial strain on the magnetization.

$La_{0.7}Sr_{0.3}CoO_3$ thin films were grown on lattice-mismatched substrates ($LaAlO_3$ and LSAT) by pulsed laser deposition. X-ray diffraction confirmed the films to be subjected to compressive or tensile strain, respectively. Near-edge x-ray absorption fine structure (NEXAFS) and x-ray magnetic circular dichroism (XMCD) at the Co $L_{2,3}$ edge and the O K edge provided spectroscopic information on the electronic and magnetic structure. Sum rules were used to extract magnetic moments from the XMCD spectra. The difference between in-plane and out-of-plane magnetic moments was found to vary with the biaxial strain.

We gratefully acknowledge the Max Planck Institute for Intelligent Systems (E. Goering, T. Tietze, G. Schütz) for the use of their XMCD end station and the synchrotron light source ANKA for the provision of beam time.

MA 52.21 Fri 11:00 Poster A

Temperature and thickness dependent sign change of the Anomalous Hall Effect in Co/Pd multilayers — •Vedat Keskin[1,2], Bekir Aktas[2], Zoe Kugler[1], Jan-Michael Schmalhorst[1], and Günter Reiss[1] — [1]Thin Films & Physics of Nanostructures, Bielefeld University, Germany — [2]Gebze Institute of Technology, Izmit, Turkey

The anomalous Hall effect (AHE) [1] was studied on ultra-thin Co/Pd multilayers, which might be a promising material for AHE based perpendicular magnetic recording technology [2]. The Co/Pd multilayers were grown on Si wafers by using conventional dc magnetron sputtering techniques. We focused on the Co thickness and temperature dependence of the AHE and the longitudinal resistivity, whereas the Pd thickness was kept constant at 1.8nm. The Co thickness was incrementally increased from 0.20nm to 0.55 nm. The AHE measurements were carried out in the temperature range of 14-330 K.Uniquely, we have observed that for a fixed temperature the polarity of the AHE changes at a certain Co thickness, the critical Co thickness decreases with increasing temperature. This behavior will be discussed with respect to the influence of extrinsic skew scattering [3]. [1] E. H. Hall, Philos. Mag. 10, 301 (1880) [2] D. Rosenblatt, M. Karpovski, and A. Gerber, Appl. Phys. Lett. 96, 022512 (2010) [3] J. Smit, Physica (Amsterdam) 24, 39 (1958).

MA 52.22 Fri 11:00 Poster A

X-ray absorption and magnetic circular dichroism of perpendicular $Mn_{3-x}Ga$ thin films — •Daniel Ebke, Manuel Glas, Jan Schmalhorst, Markus Meinert, Patrick Thomas, and Günter Reiss — Thin Films and Physic of Nanostructures, Bielefeld University, 33615 Bielefeld, 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 lower current densities for spin torque switching and higher thermal stability. Especially, the interface of the electrodes to the tunnel barrier play a key role for the realization of MTJs with high tunneling magneto resistance (TMR) ratios. In this work, we have investigated the chemical and magnetic interface properties of perpendicular magnetized $Mn_{3-x}Ga$ (x=0-1) thin films for MgO based MTJs as a function of deposition temperature and stoichiometry. The results will be compared to the corresponding magnetic bulk properties and the crystallographic ordering.

MA 52.23 Fri 11:00 Poster A

Hall effect studies in ultrathin LSMO/SRO superlattices — •Francis Bern[1], Michael Ziese[1], and Ionela Vrejoiu[2] — [1]Division of Superconductivity and Magnetism, University of Leipzig, 04103 Leipzig, Germany — [2]Max Planck Institute of Microstructure Physics, 06120 Halle, Germany

A variety of ultrathin multilayer films have been produced by pulsed laser deposition. The itinerant ferromagnet $SrRuO_3$ (SRO) and the double-exchange ferromagnet $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) were grown on $SrTiO_3$ (STO), both in single layers as well as in superlattices. Characterization by magnetotransport measurements indicate a structural transition due to strain in the ultrathin layers. The complex temperature dependence of the anomalous Hall coefficient suggests changes in the electronic structure and/or a conducting interfacial layer at the LSMO/SRO interface.

MA 52.24 Fri 11:00 Poster A

CPP – GMR using the Heusler alloy $Co_2FeAl_{0.4}Si_{0.6}$. — •F. Casper[1], K. Rott[2], G. Reiss[2], and C. Felser[1,3] — [1]Institute of Inorganic Chemistry and Analytical Chemistry, Johannes Gutenberg - University, Mainz, Germany — [2]Department of Physics, Bielefeld University, Bielefeld, Germany — [3]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany

Large tunneling magneto resistance (TMR) values were reported from magnetic tunneling junctions (MTJs) using Heusler alloys, which indicates a high spin polarization of the electrode materials. These high spin polarized materials should also enhance current-perpendicular-to-plane giant magneto resistance (CPP GMR). Most of these experiments were performed on small MgO-substrates which are not suitable for an industrial application. We implemented the Heusler compound $Co_2FeAl_{0.4}Si_{0.6}$ (CFAS) into an industrial production. A twelve inch target is used to sputter a Cr(10)/Ag(50)/CFAS(10)/Ag(5)/CFAS(10)/Ru(8) spin valve structure on silicon and MgO wafers. The structure of the films was determined by x-ray diffraction. The film was microfabricated to form a pillars with the size of 0.2 X 0.1 μm^2 up to 1.0 X 0.4 μm^2 for the measurement of CPP-GMR. Depending on the annealing temperature the TMR ratio reaches values of 7% on MgO and 1.2% on Si wafers at room temperature. This work is supported by the Federal Ministry for Education and Research BMBF, project "'Multimag"'.

MA 52.25 Fri 11:00 Poster A

Slow Relaxation Effects in CMR Manganite Films and Superlattices — •Markus Jungbauer, Felix Koeth, Sebastian Hühn, Markus Michelmann, and Vasily Moshnyaga — I. Physikalisches Institut, Universität Göttingen

Colossal magnetoresistance (CMR) and complex magnetic/electric state close to the I. order phase (metal-insulator) transition in ferromagnetic perovskite manganites are still puzzling phenomena. We studied epitaxial films of $(La_{1-y}Pr_y)_{0.7}\,Ca_{0.3}MnO_3$/MgO(100) (y=0.4-0.6) with respect to their magnetotransport and magnetooptic properties with special focus on the relaxation effects. Close to the metal-to-insulator transition temperature, T_{MI}, application of magnetic field, $B = 0 - 1\,T$, leads to a relaxation of the electrical resistivity on a timescale, $\tau \approx 100\,s$. Considering the observed temperature hysteresis of resistance and magnetization close to T_C as well as an anomalous increase of coercive field and low-field CMR in the vicinity of T_{MI} a following semi-quantitative picture of the complex magnetic state close to the phase transition was developed: the nanoscopic single-domain ferromagnetic clusters are coupled antiferromagnetically by a short-range-ordered correlated polaronic phase with a thickness of few monolayers. By growing digital $(FMM/AFMCOI)_N$ superlattices with $FMM = La_{0.7}(Ca,Sr)_{0.3}MnO_3$ and $AFMCOI = Pr_{1-x}Ca_xMnO_3$ (x=0.3-0.7) we try to reproduce and to tune this unique magnetic state with the main aim to obtain the enhanced low-field CMR close to room temperature. A financial support from EU FP7 via the Project IFOX (interfacing oxides) is acknowledged.

MA 52.26 Fri 11:00 Poster A

Tailoring perpendicular anisotropy in Co/Pd multilayers by ion irradiation — •Julia Osten[1], Peter Greene[2], Tamio Endo[3], Nobuyuki Iwata[4], Kilian Lenz[1], Kai Liu[2], and Jürgen Fassbender[1] — [1]Institute of Ion Beam Physics and Materials Research HZDR, Dresden, Germany — [2]U.C. Davis Physics Department, Davis, CA, USA — [3]Mie University, Tsu, Mie, Japan — [4]Nihon University, Funabashi, Chiba, Japan

A major obstacle towards the increase in areal magnetic recording density and the decrease in bit size is the retention of thermal stability while maintaining reasonable write fields. Materials with graded magnetic anisotropy are promising candidates to solve this problem. Here we demonstrate the approach of using post-deposition Ar-ion irradiation to tailor the perpendicular anisotropy in Co/Pd multilayer thin films. The films, with uniform as well as graded perpendicular anisotropy, were synthesized by magnetron sputtering. Based on TRIDYN simulations, different primary ion energies (1-25 keV) are chosen to achieve varying penetration depths of the ions creating a depth dependent anisotropy grading. Before and after ion irradiation, MOKE as well as magnetometry measurements were employed to detect the changes of the magnetic properties. Upon ion irradiation, the Co/Pd films exhibit reduced coercivity and remanence with increasing fluence. Higher ion energies have a more pronounced effect on reducing the perpendicular anisotropy.

The work at UCD was supported by the US NSF (DMR-1008791 & ECCS-0925626).

MA 52.27 Fri 11:00 Poster A

Method to separate the anomalous Hall signal of different Co/Pt nanodots — •Carsten Thönnissen[1], Alexander Neumann[1], Simon Hesse[1], Andreas Meyer[2], and Hans Peter Oepen[1] — [1]Institut für Angewandte Physik, Universität Hamburg, Germany — [2]Institut für Physikalische Chemie, Universität Hamburg, Germany

On nanosized Hall crosses (<100nm) made via electron beam lithography (EBL) nanodots are created, which can be magnetically investigated with single dot sensitivity via anomalous Hall effect (AHE). The nanodots were fabricated from thin Co/Pt films using SiO_2 particles as shadow mask for Ar^+ ion milling at 150eV [1]. Due to the fact that the number of nanodots in the sensitive area of the cross varies between one and five it is necessary to separate the signals of the different nanodots. For that purpose we use a measurement setup similar to the van der Pauw method. The DC current is sent through adjoining legs of the Hall cross and a voltage drop is measured across the other legs. The obtained signal is proportional to the current through the dot and depends on the local current direction at the position of the dot. By cyclic permutation we obtain different signal ratios which allow us to identify the individual particles. By means of micrographs taken by scanning electron microscopy we identify the position and arrangement of the dots, which is used to simulate the voltage that has to be expected for the different geometries.

[1] H. Stillrich *et al.* Adv. Funct. Mat. **18**, p76-81, (2008).

MA 52.28 Fri 11:00 Poster A

Single wire and ensemble measurements on NixCo1-x nanowires for the determination of switching field distributions — •Philip Sergelius[1], Tim Böhnert[1], Stephan Martens[1], Victor Vega Martinez[2], Kornelius Nielsch[1], and Detlef Görlitz[1] — [1]Institute of Applied Physics, University of Hamburg, Hamburg, Germany. — [2]Depto. Física, Universidad de Oviedo, Oviedo, Spain.

NixCo1-x nanowires with x varying between 0.05 and 0.77 have been synthesized by potentiostatic electrodeposition into self ordered Al2O3 Membranes (AAO) by hard anodization. The variation of the Ni:Co composition in the alloyed nanowires of appr. 20μm length, 150nm diameter and 305 nm spacing allows for a tuning of the switching field along the wire axes between 190 Oe and 400 Oe.

We performed First Order Reversal Curve (FORC) measurements on the nanowire ensembles in a VSM (Quantum Design VersaLab). The FORC analysis yields the distribution of the coercive fields for all nanowires in the membrane and the distribution of their interaction fields. Additionally, MOKE analyses utilizing a NanoMOKE2TM (Durham Magneto Optics Ltd) were performed on up to 100 singular wires of each ensamble in order to have adequate statistics for the distribution of coercivities ranging from 150 Oe to 450 Oe. The obtained coercivity distributions with widths of appr. 18 % from the FORC and MOKE measurements are discussed and compared revealing the impact of different interaction fields in the investigated templates.

MA 52.29 Fri 11:00 Poster A

Investigation of the influence of dipolar interactions on the magnetic behavior of Ni nanorods — •Florian Krämer, Philipp Bender, Andreas Tschöpe, and Rainer Birringer — Universität des Saarlandes, Saarbrücken

Ni nanorods with diameters < 42nm are expected to be uniaxial ferromagnetic single domain particles. In recent years, the magnetic properties of Ni nanorods in porous alumina templates were extensively studied. However, the investigation of characteristic magnetic properties was hampered by the large dipolar interactions (DI) due to the dense packing of the rods in the template. We synthesized Ni nanorods (D =19 nm) by current-pulsed electrodeposition of Ni into ordered porous alumina templates. The filled templates were characterized by static magnetization measurements (SMM) as a modelsystem of uniaxial ferromagnets with significant DI. Then, the nanorods were released from the templates by dissolution of the alumina in aqueous NaOH, dispersed in 20 wt% gelatine solutions @60°C and aligned paralell by an external homogenous magnetic field during gelation. These gels were also characterized by SMM as an corresponding system of uniaxial ferromagnets with negligible DI. The objective of this work was to study the influence of DI on the magnetic properties of such uniaxial ferromagnetic particles. We measured the remanence and the coercivity as a function of the angle between the rodaxis and the external field, the switching field distribution, the shape anisotropy constant and the activation volume.

MA 52.30 Fri 11:00 Poster A

Magnonic modes in rectangular antidot lattices — •Jelena Panke, Benjamin Lenk, Nils Abeling, and Markus Münzenberg — I. Physikalisches Institut, Georg-August-Universität Göttingen

On the way towards spin-wave logic devices an understanding of mechanisms for the manipulation and guiding of spin waves is of crucial importance. Femtosecond laser pulses are used to optically excite (pump) and subsequently measure (probe) magnetization dynamics on timescales as long as nanoseconds. Two-dimensional arrays of antidots in a ferromagnetic film provide a periodic "potential" to the excited spin waves and induce drastic changes in the magnetization dynamics.

In the spin wave spectra of rectangular CoFeB antidot lattices different modes are observed which are influenced by the variation of material parameters (filling fraction, antidot diameter, lattice parameter). We focus on these Bloch-like modes and investigate the spin-wave population for different directions of the external field. By applying the external field along the long or short axis $a_{1,2}$ of the rectangular lattice a magnonic mode appears with a wave vector $k = \pi/a_{1,2}$ at the boundary of the first Brillouin zone for each respective direction. Therefore it is possible to tune the Bloch modes only by rotating the external field. Furthermore, band structure calculations are used to investigate the changed dispersion on the patterned media as compared to the continuous film. The periodic lattice structure induces band gaps at the zone boundary that are also sensitive to the field direction and can explain the prefered population of the magnonic modes.

MA 52.31 Fri 11:00 Poster A

Influence of the dipolar interaction on the quasi-static magnetic properties of elliptical microstructures in dense packed arrays — •Andres Conca, Thomas Sebastian, Georg Wolf, Britta Leven, and Burkard Hillebrands — FB Physik und Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

Elliptical magnetic structures with dimensions of a few micrometers play a crucial role in the design of magnetic field sensors and in data storage applications such as MRAM cells. The magnetic properties of such structures are mostly controlled via the shape anisotropy. In many cases, a high packing density is required. However the effect of dipolar interaction between the individual elements within the array due to stray fields can be very strong when the distances are of only a few micrometers.

We present measurements of the influence of the packing density on the coercive field H_C of elliptical elements in arrays. For this purpose, 5×5 arrays of elliptical elements were prepared with varying interelement distances. The arrays were structured using e-beam lithography from a 5 nm thick polycrystalline CoFeB thin film deposited on a Si substrate. The measurements were performed with a μMOKE setup equipped with a micro-focused HeNe-laser beam with a spotsize of 1 μm.

MA 52.32 Fri 11:00 Poster A

Magnetic Films on Nanoperforated Substrates — •Carsten Schulze[1], Marco Faustini[2], Michael Grobis[3], Denys Makarov[4], David Grosso[2], and Manfred Albrecht[1] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]Laboratoire de Chimie de la Matière Condensée de Paris, Université Pierre et Marie Curie-Paris 6, CNRS, 75252 Paris Cedex

05, France — [3]San Jose Research Center, Hitachi GST, San Jose, CA 95135, USA — [4]IFW Dresden, Helmholtzstr. 20, 01069 Dresden, Germany

A study of the magnetization reversal in ferromagnetic thin films with perpendicular magnetic anisotropy deposited onto substrates with densely distributed nanoperforations is presented. The nanoperforated substrates are fabricated by a wet-chemical evaporation induced self-assembly process of block-copolymer micelles, Co/Pt multilayers are used as ferromagnetic thin films. The pinning of magnetic domain walls on the substrate-induced defects has been shown earlier [1, 2], as well as the possible application of such a system as a percolated perpendicular recording medium [3, 4].

Here, the dependence of the pinning strength on the interplay between saturation magnetization, anisotropy, domain wall width and perforation size will be discussed.

[1] D. Makarov *et al.*, *IEEE Trans. Magn.* **45** (2009) 3515.
[2] C. Schulze *et al.*, *Nanotechnology* **21** (2010) 495701.
[3] D. Suess *et al.*, *J. Appl. Phys.* **99** (2006) 08G905.
[4] M. Grobis *et al.*, *Appl. Phys. Lett.* **98** (2011) 192504.

MA 52.33 Fri 11:00 Poster A

Ion beam irradiation of interlayer exchange coupled trilayers in the sub-micron regime — •Roland Neb[1], Thomas Sebastian[1], Philipp Pirro[1], Stefan Pofahl[2], Rudolf Schäfer[2], Bernhard Reuscher[3], and Burkard Hillebrands[1] — [1]TU Kaiserslautern, Landesforschungszentrum Optimas, 67663 Kaiserslautern, Germany — [2]IFW Dresden, 01069 Dresden, Germany — [3]IFOS Kaiserslautern, 67663 Kaiserslautern, Germany

Focused ion beam irradiation is a well known tool for patterning thin film media. We use this tool to pattern an antiferromagnetically coupled Fe/Cr/Fe trilayer in the micron and sub-micron regime. The irradiated areas become ferromagnetic, allowing for the creation of well-defined ferromagnetic areas in an antiferromagnetically coupled environment. The suitability of such irradiated elements for information storage was investigated. We found that if certain conditions for the patterning process are met, sub-micron elements are able not only to store information but also to be overwritten by a sufficiently high magnetic field. The resulting bit density is strongly dependent on the applied ion dose, changing by a factor of 100 in the regime of 10^{14} to 10^{16} ions/cm^2.

Financial support by the Deutsche Forschungsgemeinschaft, the Graduate School *Material Science in Mainz* and the Graduiertenkolleg 792 is gratefully acknowledged.

MA 52.34 Fri 11:00 Poster A

Mechanical deformation of Dy nanocontacts in magnetic field — Marc Müller[1], •Oliver Berg[1], Christoph Sürgers[1], and Hilbert v. Löhneysen[1,2] — [1]Karlsruhe Institute of Technology, Physikalisches Institut and Center for Functional Nanostructures, D-76049 Karlsruhe — [2]Karlsruhe Institute of Technology, Institut für Festkörperphysik, D-76021 Karlsruhe

Recently, we demonstrated the reproducible tuning of the electrical conductance of Dy nanocontacts in a magnetic field by exploiting the large magnetostriction of Dy [1]. Here we report on the dependence of the contact shape on an applied magnetic field. The nanocontacts were obtained from Dy wires by the mechanically controlled break-junction technique. In zero magnetic field we find the usual variation of the conductance G vs. electrode distance x while breaking the wire mechanically, with a sequence of steps and more or less prominent conductance plateaus. From the behavior $G(x)$ we estimate the shape of the nanocontact after several cycles of mechanical deformation of the wire. We find that the final shape of the nanocontact depends on the strength and orientation of an applied magnetic field. This shaping under alternating tensile and compressive stress is attributed to the rearrangement of magnetic domains in magnetic field during formation of the nanocontact by magnetoelastic coupling.

[1] M. Müller et al., Nano Letters **11**, 547 (2011)

MA 52.35 Fri 11:00 Poster A

Rolled-up tubes and cantilevers from magnetic $SrRuO_3$-$Pr_{0.7}Ca_{0.3}MnO_3$ films — Christoph Deneke[1,4], •Kathrin Dörr[2], Elisabeth Wild[3], Stefan Baunack[3], Angelo Malachias[4], and Oliver Schmidt[3] — [1]Laboratorio Nacional de Nanotecnologia, Caixa Postal 6192, Campinas, S.P., Brazil — [2]MLU Halle-Wittenberg, Halle, Germany — [3]Institute for Integrative Nanosciences, IFW Dresden, Dresden, Germany — [4]Laboratorio Nacional de Luz Sincrotron, Caixa Postal 6192, Campinas, S.P., Brazil

Three-dimensional microobjects are fabricated by the controlled release of inherently strained $SrRuO_3/Pr_{0.7}Ca_{0.3}MnO_3/SrRuO_3$ trilayers from $SrTiO_3(001)$ substrates. Cantilevers and rolled-up microtubes with a diameter of 6-8 μm are demonstrated. The etching behavior of the $SrRuO_3$ film is investigated and a selectivity of 1:9100 with respect to the $SrTiO_3$ substrate is found. The initial and final strain states of the rolled-up oxide layers are studied by x-ray diffraction on an ensemble of tubes. Relaxation of the sandwiched $Pr_{0.7}Ca_{0.3}MnO_3$ layer towards its bulk lattice parameter is observed as the major driving force for the roll-up of the trilayers. Finally, microdiffraction experiments reveal that a single object can represent the ensemble proving a good homogeneity of the rolled-up tubes.

MA 52.36 Fri 11:00 Poster A

Interaction of Josephson and magnetic oscillations in Josephson tunnel junctions with a ferromagnetic layer — •Sebastian Mai, Ervand Kandelaki, Anatoly Volkov, and Konstantin Efetov — Theoretische Physik III, Ruhr-Universität Bochum, 44780 Bochum, Deutschland

We studied the dynamics of Josephson junctions with a thin ferromagnetic layer F (SFIFS junctions). In such junctions, the phase difference ϕ of the superconductors and magnetization M in the F layer are two dynamic parameters coupled to each other. We derived equations describing the dynamics of these two parameters and calculated the modified current-voltage (I-V) characteristics in the presence of a weak magnetic field (Fiske steps). We showed that the magnetic degree of freedom not only changes the form of the Fiske steps but also the overall view of the I-V curve (new peaks related to the magnetic resonance appear). We also calculated the power P absorbed in the system if a microwave radiation with an ac in-plane magnetic field is applied (magnetic resonance). The obtained formula for the power P essentially differs from the one which describes the power absorption in an isolated ferromagnetic film. In particular, this formula describes the peaks related to the excitation of standing plasma waves as well as the peak associated with the magnetic resonance.

MA 52.37 Fri 11:00 Poster A

Molecular Dynamic Simulation of atomic deposition between MnAs cluster — •Andreas Rühl and Christian Heiliger — I. Physikalisches Institut, Justus Liebig University Giessen, D-35392, Germany

MnAs is a promising ferromagnetic material for magnetoelectronic devices, in particular as nano-scaled clusters, providing a great tunability concerning the shape and position. We investigate hexagonal MnAs clusters which are separated by a metal. Such structures could be produced by using a FIB (focused ion beam) two disconnect two touching MnAs clusters and to deposit a metal between them. We succesfully implemented a molecular dynamic program to simulate the atomic deposition of the metal atoms on the surface of the MnAs cluster. The necessary effective interaction potentials between the simulation participants are gained by means of a force matching method, where the effective potentials are fitted to ab initio data.

MA 52.38 Fri 11:00 Poster A

Spin-resolved photoemission study of Bis(phthalocyaninato) terbium(III) ($TbPc_2$) deposited on Co/Cu(001) — •Nicolas Grossmann[1], Sabine Steil[1], Norman Haag[1], Mirko Cinchetti[1], Mario Ruben[2], and Martin Aeschlimann[1] — [1]Department of Physics and Resarch Center OPTIMAS, University of Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Institut of Nanotechnology, Karlsruhe Institute of Technology, 76344 Eggenstein-Leopoldshafen

We have studied the formation of the electronic structure of the interface between an epitaxially grown Co(001) thin film and the single molecular magnet Bis(phthalocyaninato)terbium(III) ($TbPc_2$). The organic semiconductor was progressively grown on the cobalt substrate. The grown interfaces have been characterized by means of spin-resolved ultraviolet photoemission. For every growth step we have monitored the changes in the work function, the energetic position of the occupied molecular orbitals and interface states, and the changes in the cobalt spin polarization induced by interface formation. The most striking result is the presence of an occupied spin polarized hybrid interface state with a negative spin polarization, lying 0,7 eV below the Fermi level. The spin polarization of this state shows a pronounced temperature dependency. Our results agree with the recent observation of an antiferromagnetic coupling between $TbPc_2$ and a ferromagnetic metal substrate reported in [1].

[1] Gambardella et al., Phys. Rev. Lett. 107, 177205 (2011)

MA 52.39 Fri 11:00 Poster A

Organic molecular beam deposition of a paramagnetic organic magnet — Sabine-Antonia Savu[1], •Reza Kakavandi[1], Indro Biswas[1], Mathias Glaser[1], Lorenzo Sorace[2], Matteo Mannini[2], Andrea Caneschi[2], Thomas Chassé[1], and Maria Benedetta Casu[1] — [1]IPTC, University of Tübingen, Tübingen, Germany — [2]LAMM, University of Florence, Florence, Italy

Nitronyl nitroxide radicals are an interesting class of organic compounds because of their magnetic properties. In this work we present a soft X-ray investigation of thin films of a pyrene derivative of the nitronyl nitroxide radical (nitpyrene), deposited onto well characterized single crystals surfaces, using strictly controlled evaporation conditions. We approach the deposition of nitpyrene using the knowledge obtained during the last years on thin film processes of organic molecules. The electronic structure and the interaction with the surface are discussed. By analyzing the attenuation of the XPS substrate signal, we find indications for island plus layer growth mode, supported by AFM measurements. We have also investigated the molecular orientation of the pyrene part versus film thickness, identifying the strength of molecule-molecule interactions versus molecule-substrate interactions by using X-ray absorption and photoemission spectroscopies.

MA 52.40 Fri 11:00 Poster A

Electron Localization in a Charge Transfer Salt on Au(111) — Tobias R. Umbach[1], Isabel Fernandez-Torrente[1], •Michael H. Kleinert[1], Ricardo Rurali[2], Mats Persson[3], Jose I. Pascual[1], and Katharina J. Franke[1] — [1]Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany — [2]Institut de Ciencia de Materials de Barcelona, Campus de Bellaterra, 08193 Bellaterra (Barcelona), Spain — [3]The Surface Science Research Center, The University of Liverpool, L69 3BX, United Kingdom

Alkali metals are perfect candidates for varying the electronic structure in molecular environments. Acting as electron donors with a low ionization potential, they easily build charge transfer complexes under the presence of an acceptor molecule. We investigated such a charge transfer process in a monolayer of the acceptor molecule 7,7,8,8,-tetracyanoquinodimethane (TCNQ) doped with Na on a Au(111) surface, using low-temperature scanning tunneling microscopy and spectroscopy. The self-assembled Na-TCNQ phase shows a Kondo resonance centered on the cyano-terminations of the TCNQ molecules, which proves the presence of an unpaired electron in the complex. Ab initio calculations corroborate the transfer of the Na's 3s electron to the organic acceptor and reveal its localization at the cyano groups.

MA 52.41 Fri 11:00 Poster A

Transport properties of novel Anthraquinone based molecular switches — •Simon Liebing[1], Torsten Hahn[1], Nadine Seidel[2], Tim Ludwig[3], and Jens Kortus[1] — [1]Institut for Theoretical Physics, TU Bergakademie Freiberg, 09596 Freiberg, Germany — [2]Institut for Organic Chemistry, TU Bergakademie Freiberg, 09596 Freiberg, Germany — [3]Institute for Theoretical Physics, TU Dresden, 01062 Dresden, Germany

Anthraquinone derivatives were recently reported to be good candidates for application as molecular switches [1]. We present a novel molecular system based on the anthraquinone-core π conjugated spacers and linkers units. The influence on the transport properties of model junctions by chemical modifications of the anthraqunine-core as well as the impact of difficult linker units is discussed. The authors show how chemical modifications can be used for Fermi level and band gap engineering. The theoretical results based on DFT [2] and NEGF [3] calculations are used to suggest further optimizations of the molecular system.

[1] Elisabeth H. van Dijk et al., Synthesis and Properties of an Anthraquinone-Based Redox Switch for Molecular Electronics, Org. Lett. 8, no. 11 (November 30, 2011): 2333-2336. [2] M. Pederson, D. Porezag, J. Kortus, and D. Patton, Phys. Status Solidi b - Basic Res., 2000,217, 197. [3] S. Datta, Nanotechnology, 2004, 15, 433.

MA 52.42 Fri 11:00 Poster A

Simulation of STM images and STS spectra of Metal-Phthalocyanine molecules on different substrates - comparing the DFT/NEGF and QME approach — •Torsten Hahn[1] and Tim Ludwig[2] — [1]Institute of Theoretical Physics, TU Bergakademie Freiberg, Freiberg, Germany — [2]Institute of Theoretical Physics, TU Dresden, Dresden, Germany

STM (scanning tunneling microscopy) and STS (scanning tunneling spectroscopy) experiments are the methods of choice to study the transport characteristics of single molecules in an well defined environment [1]. Metal Phthalocyanines are known to be promising candidates for applications in molecular spintronics. The interpretation of measured STM/STS data is crucial for the understanding of material properties. We compare theoretical results obtained from DFT - NEGF (density functional theory - non equilibrium green functions formalism) [2] and QME (quantum master equation) [3] investigations and discuss their impact on the interpretation of experimental data.

[1] C. Iacovita et. al., Phys. Rev. Lett. 101, 116602 (2008)
[2] C. Toher, I. Rungger, S. Sanvito, Phys. Rev. B 79, 205427 (2009)
[3] Timm, Phys. Rev. B 77, 195416 (2008)

MA 52.43 Fri 11:00 Poster A

Quantitative MFM on superconducting thin films — •Henry Stopfel[1], Silvia Vock[1], Tetyana Shapoval[1], Volker Neu[1], Ulrike Wolff[1], Dmytro S. Inosov[2], Silvia Haindl[1], Jan Engelmann[1], Rudolf Schäfer[1], Bernhard Holzapfel[1], and Ludwig Schultz[1] — [1]IFW Dresden, Institute for Metallic Materials, P.O. Box 270116, 01171 Dresden, Germany — [2]Max Planck Institute for Solid State Research, Heisenbergstraße 1, 70569 Stuttgart, Germany

Quantitative interpretation of magnetic force microscopy (MFM) data is a challenge, because the measured signal is a convolution between the magnetization of the tip and the stray field emanated by the sample. It was established theoretically that the field distribution just above the surface of the superconductor can be well approximated by the stray field of a magnetic monopole [1]. The description of the MFM tip, however, needs a second approximation. The temperature-dependent vortex-distribution images on a NbN thin film were fitted using two different tip models. Firstly, the magnetic tip was assumed to be a monopole that leads to the simple monopole-monopole model for the tip-sample interaction force. Performing a 2D fitting of the data with this model, we extracted λ, Δ and the vortex pinning force [2]. Secondly, a geometrical model was applied to calculate the tip-transfer-function of the MFM tip using the numerical BEM method [3].

[1] G. Carneiro and E. H. Brandt, PRB 61, 6370 (2000)
[2] Shapoval T. et al., PRB 83, 214517 (2011)
[3] Vock S. et al., IEEE Transactions on Magnetics 47, 2352 (2011)

MA 52.44 Fri 11:00 Poster A

Observation of antiferromagnetic domains using magneto-optical microscopy. — •Anna Möhn, Ingolf Mönch, Denys Makarov, Rudolf Schäfer, Oliver G. Schmidt, and Ludwig Schultz — IFW Dresden, Institute for Metallic Materials Dresden, Germany

Two different exchange biased systems were studied. Both antiferromagnetic/ferromagnetic-bilayer systems contain Py as ferromagnetic material, but one with IrMn and the other one with CoO as antiferromagnetic layer. Through the different Néel-temperatures of the antiferromagntic materials the systems show the exchange bias effect under different temperature conditions. The exchange bias effect can be used to imprint a well-defined domain pattern into the antiferromagnetic layer. To observe those imprinted antiferromagnetic domains directly we will use the Voigt effect. This quadratic magneto-optical effect is a birefringence of linearly polarized light which we observe in reflection with a wide-field Kerr microscope. Using the Voigt effect on a ferromagnet, we can see domains which differ by 90° in the axis of the magnetic moments independent of their net magnetization. The same effect is expected to be seen in an antiferromagnet if the antiferromagnetic domains are magnetized along orthogonal easy axes [1]. The required 90° domains are firstly generated as a Landau pattern in the (structured) ferromagnetic film of our bilayer systems and then imprinted to the antiferromagnetic film by cooling below the blocking temperature.

[1] Peter Oppeneer, University Uppsalla, private communication

MA 52.45 Fri 11:00 Poster A

Direct Imaging of Precessional Domain Wall Propagation in Ferromagnetic Rings Induced by Circular Magnetic Fields — A. Bisig[1,2,3], •M. A. Mawass[1,4], M. Stärk[1,3], C. Moutafis[1,3], J. Rhensius[3,5], J. Heidler[2], M. Curcic[2], E. Prabu[2], M. Noske[2], M. Weigand[2], T. Tyliszczak[5], B. Van Waeyenberge[6], H. Stoll[2], G. Schütz[2], and M. Kläui[1,3,4] — [1]Paul Scherrer Institut, Villigen, Switzerland — [2]Max-Planck-Institut für Intelligente Systeme,

Stuttgart, Germany — [3]Universität Konstanz, Konstanz, Germany — [4]Johannes Gutenberg-Universität Mainz, Mainz, Germany — [5]Advanced Light Source, LBNL, Berkeley, USA — [6]Ghent University, Ghent, Belgium

The controlled displacement of magnetic domain walls (DW) along magnetic nanostructures is a key prerequisite to memory storage or DW logic devices. Depending on the strength of the driving force (magnetic field or spin-polarized currents), the propagation of DW changes from simple translation to more complex precessional modes, i.e. periodic transformations of vortex DWs into transverse DWs and back during propagation. We present direct experimental visualization of the precessional motion of vortex DWs in permalloy nanorings controlled by circular fields. Employing scanning transmission x-ray microscopy (STXM) we image the propagation of a pair of vortex DWs in a stroboscopic measurement scheme. We find that the DW velocity strongly varies during the transformation processes and that the propagation and DW spin structures are highly reproducible indicating the direct observation of the Walker breakdown.

MA 52.46 Fri 11:00 Poster A

Magnetic resonant scattering with Laser generated higher harmonic radiation — •Christian Weier[1], Dennis Rudolf[1], Roman Adam[1], Claus M. Schneider[1], André Kobs[2], Gerrit Winkler[2], Robert Frömter[2], Hans P. Oepen[2], Margaret M. Murnane[3], and Henry C. Kapteyn[3] — [1]Peter Grünberg Institut, Research Center Jülich, 52425, Jülich, Germany — [2]Institut für Angewandte Physik, University of Hamburg, 20355, Hamburg, Germany — [3]JILA, University of Colorado, Boulder, CO 80309-0440, USA

Laser driven higher harmonic generation has recently been used to generate extreme ultraviolet (EUV) radiation for probing magnetization dynamics of ferromagnets, element selectively, with a time resolution of few femtoseconds. EUV photons with energies of 52 eV, 61 eV and 67 eV can reach M-absorption edges of Fe, Co and Ni, respectively, what leads to a resonantly enhanced magneto-optical signal. On the other hand, there is a strong progress in imaging techniques using laser generated EUV radiation due to its low divergence and high coherence. In our experiment, we resonantly scatter EUV light from Co/Pt-multilayers forming a magnetic domain pattern. As a consequence of the magnetization dependent scattering, the amplitude of the resulting image in k-space is directly related to the average domain size. Exploring advantage of the femtosecond coherent EUV radiation, our scattering experiment gives the possibility to probe magnetization dynamics with a high temporal and spatial resolution.

MA 52.47 Fri 11:00 Poster A

Switching the magnetization of nanomagnets using SP-STM — •Benjamin Ehlers, Gabriela Herzog, Johannes Friedlein, Stefan Krause, and Roland Wiesendanger — University of Hamburg, Institute of Applied Physics, Jungiusstraße 11A, 20355 Hamburg, Germany

With spin-polarized scanning tunneling microscopy (SP-STM) it is possible to manipulate the switching behavior of atomic-scale superparamagnets, using a high spin current generated between a magnetic tip and a magnetic sample. [1]

Here, current-induced magnetization switching of thermally quasistable magnetic nanoislands with a state lifetime on the order of several hours is demonstrated using SP-STM. The magnetization of an individual Fe nanoisland consisting of about 40 atoms on a W(110) surface is reversibly switched between two states by the application of short spin-polarized tunnel current pulses in the μA regime [2]. The combined action of Joule heating and spin-transfer torque during the pulse leads to a controlled reversal of the magnetization. The switching efficiency is evaluated as a function of different current pulse parameters, i.e. pulse length and amplitude, bias polarity and bias value.

[1] S. Krause, L. Berbil-Bautista, G. Herzog, M. Bode, and R. Wiesendanger, Science **317**, 1537 (2007).
[2] G. Herzog, S. Krause, and R. Wiesendanger, Appl. Phys. Lett. **96**, 102505 (2010).

MA 52.48 Fri 11:00 Poster A

Complex magnetic ground states observed in Fe nanostructures on different Ir surfaces — •Matthias Menzel[1], Kirsten von Bergmann[1], Stefan Heinze[2], Yuriy Mokrousov[3], Gustav Bihlmayer[3], Jessica Bickel[1], Jens Brede[1], Robert Wieser[1], Elena Vedmedenko[1], Stefan Blügel[3], André Kubetzka[1], and Roland Wiesendanger[1] — [1]Institut für Angewandte Physik, Universität Hamburg, 20355 Hamburg — [2]Institut für Theoretische Physik und Astrophysik, Universität Kiel, 24098 Kiel — [3]Institut für Festkörperforschung, Forschungszentrum Jülich, 52425 Jülich

The reduced symmetry and large spin-orbit interaction can give rise to complex magnetic ground states in 3*d*-transition metal nanostructures on heavy element surfaces, e.g. [1]. Especially, Fe nanostructures on an Ir surface are promising candidates for non-collinear magnetic states, due to an extremely weak Heisenberg exchange [2].

Here, we present SP-STM measurements of Fe chains on the (5×1)-Ir(001) surface as well as the Fe monolayer on Ir(111) which reveal atomic-scale, non-collinear magnetic ground states in both systems [3,4]. Density functional theory calculations show that the weak Heisenberg exchange allows other interactions, as the Dzyaloshinskii-Moriya exchange or higher-order interactions, to dominate the energy landscape.

[1] M. Bode *et al.*, Nature **447**, 190 (2007).
[2] B. Hardrat *et al.*, PRB **79**, 094411 (2009).
[3] S. Heinze *et al.*, Nature Physics **7**, 713 (2011).
[4] M. Menzel *et al.*, submitted.

MA 52.49 Fri 11:00 Poster A

Quantum-Mechanical Model of Spin Polarized STM — •Kolja Them, Thim Stapelfeldt, Elena Y. Vedmedenko, and Roland Wiesendanger — Institute for Applied Physics University of Hamburg Jungiusstr. 11 20355 Hamburg

Spin sensitive studies of individual magnetic ad-atoms and atomic ensembles on surfaces with spin-polarized scanning tunneling microscopy (SP-STM) have raised the necessity of a quantum-mechanical description of spin dynamics during SP-STM experiments. The quantum-mechanical treatments of STM experiments typically deal with the expectation values of observables using Gibbs ensemble averages. An SP-STM measurement, however, is a time-average of the expectation values. The lack of the time-averaging might be a reason for the fact that the theoretically predicted relaxation time on the nanosecond scale for a single spin of a magnetic adatom is at odd with the femtosecond rates measured for Fe adatoms on semiconductor surfaces. Another still unexplained finding is the extremely high switching frequency of Co atoms on Pt(111) at zero magnetic field. In the present paper we use the algebraic formulation of quantum statistical mechanics to clearly separate the thermal equilibrium Gibbs states and the time evolution of the system during SP-STM experiments. Using elaborated techniques we calculate dynamics of single quantum spins as well as magnetic ensembles at finite temperatures. We demonstrate that the relaxation times of those quantum objects on different substrates lie in the femto- or pico-second regime.

MA 52.50 Fri 11:00 Poster A

Spin-transfer torque experiments on Co2MnSi/Ag/Co2MnSi (001) nanopillars — •Şaban Tırpancı[1,2], Daniel E. Bürgler[1], Yuya Sakuraba[3], Subrojati Bosu[3], Koki Takanashi[3], and Claus M. Schneider[1] — [1]Electronic Properties (PGI-6) and JARA-FIT, Forschungszentrum Jülich, Jülich, Germany — [2]GIT, Gebze, Turkey — [3]IMR, Tohoku University, Sendai, Japan

The Heusler alloy Co2MnSi (CMS) is a half-metallic ferromagnet with a Curie temperature above room temperature (RT) and high spin polarization, which in combination with Ag spacer layers yields large GMR ratios of up to 36 percent at RT [1]. Therefore, CMS is a very promising material for new spintronic devices. Fully epitaxial CMS/Ag /CMS(001) thin films are prepared by UHV magnetron sputtering [1]. Ellipsoidal nanopillars with diameters between 120 nm to 300 nm are fabricated by e-beam lithography and ion-beam etching for spin-torque measurements in current-perpendicular-plane (CPP) geometry. The two CMS layers of 20 and 5 nm thickness act as fixed and free layer, respectively, and are separated by 8 nm Ag. Previous work [1,2] is extended by performing DC and HF measurements at low temperatures in order to study the influence of the increased polarization on critical currents for current-induced switching and magnetic excitation as well as the efficiency of injection locking [3] as a prerequisite for synchronization of several spin-torque oscillators.

[1] Y. Sakuraba et al.,. Phys. Rev. B 82, 094444 (2010)
[2] R. Okura et al., Appl. Phys. Lett. 99, 052510 (2011)
[3] R. Lehndorff et al., Appl. Phys. Lett. 97, 142503 (2010)

MA 52.51 Fri 11:00 Poster A

Determination and characterization of spin torque in perpendicular magnetized multilayer materials — •Tomek Schulz[1], Jan Heinen[1,2], Mathias Kläui[1,2,7], Olivier Boulle[3], Gregory

Malinowsky[4], Christian Ulysse[6], Giancarlo Faini[6], Denise Hinzke[2], Henk Swagten[5], Bert Koopmans[5], and Berthold Ocker[8] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, Germany — [2]Fachbereich für Physik, Universität Konstanz, Germany — [3]Spintec, UMR CEA/CNRS/UJF-Grenoble 1/Grenoble-INP, France — [4]Laboratoire de physique des solides, Universite Paris-sud, France — [5]Department of Applied Physics, Eindhoven University of Technology, The Netherlands — [6]CNRS, Phynano team, Laboratoire de Phtonique et de Nanostructures, Marcoussis, France — [7]SwissFEL, Paul Scherrer Institut, Villigen PSI, Switzerland — [8]Singulus Technologies AG, Kahl am Main, Germany

We report on measurements to deduce the spin torque contribution of current induced domain wall motion in out-of-plane magnetized multilayer materials. Using complementary measurement techniques such as the current-field equivalency and thermally activated domain wall hopping allow us not only to separate the torque terms on the same material, but also to gauge their accuracy and validity. The extension of these techniques to characterize novel materials reveals not only the predicted dominant non-adiabatic spin torque as in the Co/Pt multilayer nanowires, but also a dominant adiabatic torque in Co/Ni multilayer nanowires highlighting the importance of the materials composition for the acting torques.

MA 52.52 Fri 11:00 Poster A

Dynamical magnetic susceptibility of nanostructures with spin–orbit coupling — •Manuel dos Santos Dias, Stefan Blügel, and Samir Lounis — Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich and JARA, D-52425 Jülich, Germany

We outline a real–space linear response theory of the dynamical spin susceptibility of nanostructures, accounting for the spin–orbit interaction. The starting point is the existing formalism of time–dependent Density Functional Theory, in the Korringa–Kohn–Rostoker Green function method [1,2]. The linear response to an external time-dependent applied magnetic field transverse to the orientation of the magnetisation generates both transverse and longitudinal time-dependent spin susceptibilities, while the induced charge fluctuations introduce the screened Coulomb interaction in the problem. The breaking of the spin rotational invariance due to the spin–orbit interaction is explored, and the roles of the familiar magnetocrystalline anisotropy and the coupled spin–charge fluctuations are compared, and some examples for adatoms on simple non–magnetic surfaces are given.

Work supported by the HGF-YIG Programme FunSiLab – Functional Nanoscale Structure Probe and Simulation Laboratory (VH-NG-717).

[1] S. Lounis, A. T. Costa, R. B. Muniz and D. L. Mills, Phys. Rev. Lett. **105**, 187205 (2010)
[2] S. Lounis, A. T. Costa, R. B. Muniz and D. L. Mills, Phys. Rev. B **83**, 035109 (2011)

MA 52.53 Fri 11:00 Poster A

Imaging of magnetization reversal by spin transfer torque — •Matthias Buhl[1], Artur Erbe[1], Sebastian Wintz[1], Jörg Raabe[2], Jochen Grebing[1], Kay Potzger[1], and Jürgen Fassbender[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf — [2]Swiss Light Source, Paul-Scherrer Institut

The magnetic moment of nanosized magnets is widely used for data storage in modern electronics. Integration of such magnets into larger circuits can be possible, if the read-out and the storage of data can be performed electrically. This can, for example, be achieved by using spin transfer torque for the definition of magnetic moment of a nanomagnet. Here, we demonstrate switching of a single magnetic pillar in a so-called current in plane geometry. The pillar structures are fabricated from CoFe layers using electron beam lithography on SiN membranes. The magnetization direction of the pillar is imaged using scanning transmission x-ray microscopy (STXM).

MA 52.54 Fri 11:00 Poster A

Magnon dispersion relation in adiabatic spin approximation — •Christian Franz and Christian Heiliger — I. Physikalisches Institut, Justus-Liebig-Universität, Gießen, Deutschland

The adiabatic approximation is used to separate the fast electronic degrees of freedom from the slow magnetic ones. A single magnetic moment is assigned to each atom in an itinerant ferromagnet. The interaction of these moments can be described by an effective Heisenberg model.

$$H = -\sum_{i,j} J_{i,j} \vec{S}_i \cdot \vec{S}_j - \frac{g\mu_b B_0}{\hbar} \sum_{i,j} S_i^z \qquad (1)$$

The exchange parameters of this model are obtained from *ab initio* calculations by applying the magnetic force theorem. The magnon dispersion and various physical parameters as the spin-wave stiffness and the Curie temperature can be determined within this model. We perform this calculations several systems and find result in good agreement with experimental and other theoretical results. This is the first step in including magnons and the electron-magnon interaction in transport calculations.

MA 52.55 Fri 11:00 Poster A

Influence of pure diffusive spin currents on magnetic switching in non-local spin valves — •Björn Burkhardt[1], Helmut Körner[2,3], Piotr Laczkowski[4], Laurent Vila[4], and Mathias Kläui[1,2,3] — [1]Institut für Physik, Johannes Gutenberg Universität Mainz, 50099 Mainz, Germany — [2]Fachbereich Physik, Universität Konstanz, 78457 Konstanz, Germany — [3]SwissFEL, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland — [4]Laboratoire Nanostructure et Magnetisme, CEA/INAC, 38054 Grenoble, France

We analyzed magnetic switching processes in Permalloy stripes during injection of pure diffusive spin currents. These spin currents are created via a non-local spin valve design with aluminium as the non-magnetic spin conduit between the stripes. By measuring the non-local spin signals as a function of temperature we find a non-montonous behavior. To determine the spin diffusion length in the aluminium conduit the distance between injection and detection stripe was varied. The depinning of domain walls assisted by pulsed pure spin currents is further studied and the spin-torque and the Joule heating effect are separated, by using the underlying symmetries of the effect.

MA 52.56 Fri 11:00 Poster A

Domain Wall Manipulation with a Magnetic Tip — •Thim Stapelfeldt, Robert Wieser, Elena Y. Vedmedenko, and Roland Wiesendanger — Institute of Applied Physics and Microstructure Advanced Research Center

A theoretical concept of local manipulation of magnetic domain walls is introduced. In the proposed procedure, a domain wall is driven by a spin-polarized current induced by a magnetic tip, as used in a scanning tunneling microscope, placed above a magnetic nanostripe and then moved along its long axis with a current flowing through the vacuum barrier. The angular momentum from the spin-polarized current exerts a torque on the magnetic moments underneath the tip and leads to a displacement of the domain wall. Particularly, the manipulation of a ferromagnetic 180° transverse domain wall has been studied by means of Monte Carlo simulations. The coercivity created by defects as well as tailord pinning centers is presented as a function of the change of the exchange constant and the pinning center size, respectively.

MA 52.57 Fri 11:00 Poster A

Spin caloric transport: Investigation of out-of-plane thermal gradient effects in thin film geometries — •Andreas Kehlberger, Enrique Vilanova Vidal, Gerhard Jakob, and Mathias Kläui — Johannes Gutenberg University of Mainz, Institute of Physics, Mainz

Spin caloric transport is expected to open new avenues towards low energy nanoscale spin sources. The measurement of the spin-Seebeck effect has drawn much attention to the research of thermally induced spin currents in thin film structures. In order to explain the observed amplification of signal due to the temperature of the environment, phonon enhancement of the spin caloric effect has been suggested. This magnon-phonon interaction calls for an understanding of the underlying effects of the thermal behavior of the used substrates in thin film experiments. Many thin film studies assume in-plane thermal gradients along the substrate neglecting perpendicular thermal gradients. We present studies of different measurement geometries revealing the importance of out-plane gradients, which can often not be avoided. These unexpected temperature differences lead to asymmetric thermally induced effects such as the anomalous Nernst effect, which have to be taken into account. Measurements of these effects are compared to measurements in a new optimized setup, which focuses on the minimization of the out-of-plane gradient to reveal the spin-Seebeck contribution to the signal. This work is supported by the DFG priority program SPP 1538 Spin Caloric Transport.

MA 52.58 Fri 11:00 Poster A

Experimental Study of the Anisotropic Magneto-Thermopower in (113) oriented (Ga,Mn)As Thin Films — •Sibylle Meyer[1], Matthias Althammer[1], Lukas Dreher[2], Wladimir Schoch[3], Sebastian T. B. Goennenwein[1], and Rudolf Gross[1] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Walter Schottky Institut, Technische Universität München, Garching, Germany — [3]Institut für Quantenmaterie, Universität Ulm, Ulm, Germany

In analogy to the anisotropic magnetoresistance (AMR), the thermopower of ferromagnetic materials also characteristically depends on the orientation of the magnetization vector. This anisotropic magnetothermopower (AMTP) has only scarcely been studied to date. Taking the ferromagnetic semiconductor (Ga,Mn)As with its large magneto-resistive effects as a prototype example, we have measured the evolution of both the AMR and the AMTP effects at liquid He temperatures as a function of both the orientation and the magnitude of an externally applied magnetic field. Our data show that the AMTP effect can be adequately modeled only if the symmetry of the (Ga,Mn)As crystal is explicitly taken into account. We will quantitatively compare AMR and AMTP data taken on the same (113) - oriented (Ga,Mn)As thin film with corresponding model calculations, and address the differences between the magneto-resistance and the magneto-thermopower coefficients. Financial support by DFG via SPP 1538 is gratefully acknowledged.

MA 52.59 Fri 11:00 Poster A

Experimental determination of the spin mixing conductance in YIG/Pt bilayers — •Philipp Ross[1], Johannes Lotze[1], Franz D. Czeschka[1], Matthias W. Althammer[1], Mathias Weiler[1], Thomas Brenninger[1], Rudolf Gross[1,2], and Sebastian T. B. Goennenwein[1] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Physik-Department, Technische Universität München, Garching, Germany

A spin current is a directed flow of angular momentum. Since spin currents are independent of charge motion, they can also propagate in electrical insulators. One elegant way to generate a spin current is the process of spin pumping: the magnetization of a ferromagnet is driven into resonant precession, and relaxes by emitting a spin current into an adjacent normal metal. The efficiency of the spin pumping process is dependent on the spin-mixing conductance which is in the order of 1×10^{19} m^{-2} in a variety of conducting ferromagnets [1]. We have grown insulating yttrium iron garnet (YIG) thin films on gadolinium gallium garnet substrates by pulsed laser deposition, and covered them in situ with a Pt layer. On these samples, we simulaneously recorded ferromagnetic resonance and the DC voltage generated by the inverse spin Hall effect, at different fixed temperatures between room temperature and 3 K. We find the spin-mixing conductance to be in the range from 1.2×10^{18} m^{-2} to 8×10^{19} m^{-2}, which is consistent with values measured on conductive ferromagnet/Pt interfaces. Financial support by DFG SPP 1538 is gratefully acknowledged.

[1] F. D. Czeschka *et al.*, Phys. Rev. Lett. **107**, 046601 (2011)

MA 52.60 Fri 11:00 Poster A

Local charge and spin currents in magnetothermal landscapes — •Michael Schreier, Mathias Weiler, Hans Huebl, Matthias Althammer, Martin S. Wagner, Rudolf Gross, and Sebastian T. B. Goennenwein — Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany

The interplay of spin currents and phonons is currently vigorously investigated, e.g., in spin Seebeck effect measurements. In such spin caloritronic experiments, homogenous temperature gradients were used to date for spin current generation. However, for a detailed understanding of the magnon-phonon interaction, a spatially resolved study of spin currents in magnetothermal landscapes appears mandatory.

We use a focused, scannable laser beam to generate a local thermal gradient along the surface normal of a thin insulating $Y_3Fe_5O_{12}$ (YIG) film grown on $Gd_3Ga_5O_{12}$. This thermal gradient gives rise to a local spin current that we electrically detect by means of the inverse spin Hall effect in a Pt thin film deposited on top of the YIG. In our room temperature experiments, we demonstrate all-electrical detection [1] and thermal manipulation of the YIG magnetic texture. We furthermore discuss the interplay of local temperature gradients, charge currents and magnetic domains also in conductive ferromagnetic thin films. Taken together, our findings open the path for local magnetothermal generation and control of spin and charge currents in ferromagnetic thin films.

This work is supported by DFG via SPP1538.

[1] M. Weiler *et al.* (2011) arXiv:1110.3981v1

MA 52.61 Fri 11:00 Poster A

Realization of an experimental setup for temperature dependent measurements of the Spin Seebeck Effect — •Daniel Meier, Hanno Meyer zu Theenhausen, Jan-Michael Schmalhorst, and Günter Reiss — Thin Films and Physics of Nanostructures, Physics Department, Bielefeld University, Germany

Spin caloritronics is a growing field of research in the branch of spintronics, which combines spin, charge and heat currents. The discovery of the spin Seebeck effect (SSE) [1] gives a method for a thermal spin generator. The effect was first studied in Permalloy (Py) thin films on Sapphire substrates [1], which were partly covered by thin Pt stripes. When an in-plane temperature gradient is applied perpendicular to the Pt stripes a spin current into the Pt can be generated, which can be converted into an electromotive force via the inverse spin Hall effect. As a consequence one can measure a voltage between the ends of the Pt stripe in a range of a few μV. The voltage size and sign depends on the position of the Pt stripe on the Py film and on the size of the temperature gradient [1].

This work presents a setup for SSE measurements at variable temperatures. It was tested on various Py/Pt samples grown on MgO and Sapphire substrates utilizing conventional photo lithography or shadow mask techniques. A high resolution of about 50nV was achieved when measuring the planar Nernst effect in the different samples.

[1] K. Uchida et al., Nature Vol. 455, 2008, 778–781

MA 52.62 Fri 11:00 Poster A

Dependence of the magneto-Seebeck effect on the CoFe distribution in MgO tunnel junctions — •Jakob Walowski[1], Marvin Walter[1], Vladyslav Zbarsky[1], Anissa Zeghuzi[1], Christian Leutenantsmeyer[1], Mirco Marahrens[1], Markus Münzenberg[1], Markus Schäfers[2], Daniel Ebke[2], Günter Reiss[2], Andy Thomas[2], Patrick Peretzki[3], Michael Seibt[3], Michael Czerner[4], Michael Bachmann[4], and Christian Heiliger[4] — [1]I. Phys. Inst., Universität Göttingen — [2]Dept. of Physics, Bielefeld University — [3]IV. Phys. Inst., Universität Göttingen — [4]I. Phys. Inst., Universität Gießen

Thermally driven techniques gain more importance, as ever smaller element sizes in electronics reach exorbitantly high current densities, threatening with a breakdown of Moore's Law. Currently magnetic tunnel junctions attract a lot of attention, because they are interesting from the spinelectronic and the spincaloritronic point of view. Spin-transfer torque magnetic RAM, as well as thermal-spin-transfer torque elements are in the current discussion as future technologies.

The magneto-thermal effects in CoFeB|MgO|CoFeB tunnel junctions strongly depend on the distribution of the Co and Fe atoms within layers at the interface to the MgO barrier. Supported by theoretical calculations using the energy dependent transmission function, we present the temperature dependent Seebeck coefficients in parallel and antiparallel magnetization alignment, and the magneto-Seebeck ratio for tunnel junctions with different Co and Fe distributions.

We acknowledge the funding by the DFG through the SFB 602.

MA 52.63 Fri 11:00 Poster A

Barrier thickness dependence of the Magneto Seebeck effect in magnetic tunnel junctions: Ab initio studies — •Michael Czerner and Christian Heiliger — I. Physikalisches Institut, Justus Liebig Universität Giessen, D-35392, Germany

The magneto Seebeck effect is the dependence of the thermopower in a magnetic tunnel junction on the relative orientation of both magnetic layers [1]. First calculations show that there is a non-trivial barrier thickness dependence of this effect [1]. Therefore, we systematically investigate the thermopower for parallel and antiparallel alignment of the magnetic leads in MgO based tunnel junctions. We show that the actual dependence on the MgO thickness also depends on the magnetic material of the leads. Our theoretical investigations are ab initio calculations based on density functional theory. In particular, we used the Korringa-Kohn-Rostoker and the non-equilibrium Green's function method to obtain the transmission function T(E). Using T(E), we calculated in linear response the transport coefficients, e.g. conductance, Seebeck coefficient, thermal conductance (electronic contribution) [2]. Additionally we study the thermopower as a function of the tilting angle between the magnetization of the two ferromagnetic leads.

[1] M. Walter, J. Walowski, V. Zbarsky, M. Münzenberg, M. Schäfers, D. Ebke, G. Reiss, A. Thomas, P. Peretzki, M. Seibt, J. S. Moodera, M. Czerner, M. Bachmann, C. Heiliger, Nature Materials

10, 742 (2011)
[2] M. Czerner, M. Bachmann, C. Heiliger, Phys. Rev. B 83, 132405 (2011)

MA 52.64 Fri 11:00 Poster A

Scanning laser setup for local heat gradients in ferromagnetic micro- and nanostructures — •Florian Brandl, Haiming Yu, Thomas Rapp, and Dirk Grundler — Lehrstuhl für Physik funktionaler Schichtsysteme, Technische Universität München, Physik Department, James-Franck-Straße 1, 85748 Garching b. München, Germany

We report on the development of a scanning laser setup that allows us to generate temperature gradients locally in ferromagnetic devices. With our system we position a focused laser beam on a sample with a translation stage offering nm resolution. A pair of crossed coils provides magnetic fields in the plane of the sample of up to 100 mT. The local heating will be tested using magnetoresistance measurements on ferromagnetic micro- and nanostructures. We also plan to combine the setup with ferromagnetic resonance measurements. We acknowledge financial support through the German priority program SPP 1538 "spin caloric transport" and the German excellence cluster "Nanosystems Initiative Munich".

MA 52.65 Fri 11:00 Poster A

Thermomagnetic properties improved by self-organized flower-like phase separation of ferromagnetic $Co_2Dy_{0.5}Mn_{0.5}Sn$. — •Michael Schwall[1], Peter Klaer[2], Hans-Joachim Elmers[2], and Benjamin Balke[1] — [1]Institute of Inorganic Chemistry and Analytical Chemistry, Johannes Gutenberg - University, Mainz — [2]Institute of Physics, Johannes Gutenberg - University, Mainz

A thermodynamically stable phase separation of $Co_2Dy_{0.5}Mn_{0.5}Sn$ into the Heusler compound Co_2MnSn and $Co_8Dy_3Sn_4$ is induced by rapid cooling from the liquid phase. The phase separation forms an ordered flower-like structure on the microscale. The increased scattering of phonons at the phase boundaries reduces thermal conductivity and thus improves thermoelectric and spincaloric properties.

MA 52.66 Fri 11:00 Poster A

Extrinsic Spin Nernst effect from first principles — •Katarina Tauber[1,2], Martin Gradhand[3], Dmitry Fedorov[1,2], and Ingrid Mertig[1,2] — [1]Max-Planck-Institut für Mikrostrukturphysik, Halle, Germany — [2]Martin-Luther-Universität Halle-Wittenberg, Halle, Germany — [3]H.H. Wills Physics Laboratory, University of Bristol, United Kingdom

Recently, a new field *"Spin Caloritronics"* [1] arose, which relates the spin degree of freedom to a temperature gradient. Within an *ab initio* approach we present a study of the *spin Nernst effect*, which describes the creation of a transversal spin current or spin accumulation due to a longitudinal temperature gradient ∇T. This effect is similar to the intensively studied spin Hall effect, where instead of ∇T an electric field is applied. Here we investigate the extrinsic skew scattering mechanism, which is dominant in the limit of dilute concentrations of substitutional alloys. Our calculations are based on a fully relativistic Korringa-Kohn-Rostoker method and a solution of the linearized Boltzmann equation. As a first application, we consider a Cu host with different impurities.

[1] G.E. Bauer, A.H. MacDonald, and S. Maekawa, Solid State Commun. 150, 459 (2010).

MA 52.67 Fri 11:00 Poster A

Observation of Spin Seebeck Effect in Magnetic Semiconductor — •Ivan Soldatov, Christian Hess, Ludwig Schultz, and Rudolf Schaefer — IFW Dresden, Helmholtzstraße 20, 01069 Dresden

If a temperature gradient is applied along or perpendicular to a ferromagnetic /nonmagnetic metal interface, one can observe a pure spin current injected into the normal metal in direction perpendicular to the interface. This effect, called Spin Seebeck Effect (SSE), occupies a central role in the field of spin caloritronics, which explores the possibility of controlling spin currents by means of heat currents. In this work we investigate the SSE in a semiconducting ferromagnetic layer in Pt/GaMnAs/GaAs structures in conventional setup, purposed in pioneering work by Uchida (K. Uchida et al. Nature 455, 778 (2008)). The results include the absolute temperature dependence of the SSE dependence on the applied temperature gradient and the direction of applied magnetic field. The work is supported by the DFG-priority program Spin Caloric Transport