DF 22: Poster II

Magnetic Measurement Methods, Magnetic Thin Films,Micro- and Nanostructured Materials, Magnetization Dynamics,Computational Magnetism,Spin-dependent Transport Phenomena,Spincaloric Transport, Spin-Injection and - Currents in Heterostructures,Spintronics

Time: Friday 10:30–13:30 Location: Poster D

DF 22.1 Fri 10:30 Poster D

Nanoscale sensing of a magnetic topology — •Alexander Gerstmayr[1], Raphael Bindel[2], Dominik Reitzle[3], Marcus Liebmann[2], Markus Morgenstern[2], Berndt Koslowski[3], and Fedor Jelezko[1] — [1]Institut für Quantenoptik, Universität Ulm, Deutschland — [2]Institut IIb, RWTH Aachen, Deutschland — [3]Festkörperphysik, Universität Ulm, Deutschland

For years, the nitrogen-vacancy (NV) center in diamond has been in the spotlight for studies of electron spin coupling. Also the coupling to other near color centers in diamond was studied recently. We will explore single atom control techniques for sensing external spins and imaging them using scanning probe microscopy. External magnetic fields cause a frequency shift of the electron spin resonance of our NV-center, which is detectable by Optically Detected Magnetic Resonance (ODMR). For even higher magnetic sensitivity (down to few nT of AC field), pulsed experiments are performed. One single NV-center located in a diamond tip is the main part of the future Atomic Force- and Magnetic Resonance Microscope (AFM/MRM). Due to the possibility of single-spin detection in NV-centers under ambient conditions, this combination of AFM and MRM is planned to work even at room temperature as well as also at low temperature (4 K). We will be able to locate single spins on the nanoscale.

DF 22.2 Fri 10:30 Poster D

Exploring the magnetization dynamics and interaction effects of single microparticles with Hall-magnetometry — •Martin Lonsky[1], Merlin Pohlit[1], Sven Heinz[1], Pintu Das[1], Natalija van Well[1], Yuzo Ohno[2], Hideo Ohno[2], and Jens Müller[1] — [1]Physikalisches Institut, Goethe-Universität, Frankfurt (M), Germany — [2]Laboratory for Nanoelectronics and Spintronics, Tohoku University, Sendai, Japan

Micro-Hall-magnetometry is a powerful technique for studying the magnetization dynamics of micrometer- and nanometer-scale particles. Our sensors are based on the two-dimensional electron gas in GaAs/AlGaAs heterostructures and allow for magnetic stray-field measurements of *individual* micron-sized particles positioned on one or several lithographically defined Hall crosses. Besides the standard experiment of measuring magnetization switching in ferromagnets, we extend the fields of application of this technique to susceptibility and static and dynamic magnetic flux measurements. In order to further optimize the compatibility with standard fabrication methods of nanotechnology we aim to establish planar contact geometries as opposed to In/Sn soldered contacts. We recently demonstrated the high resolution of our devices by tracking the domain wall dynamics in a single CrO_2 micro-grain that has been positioned with a micromanipulator [1]. A further step will be to study interaction effects between individual grains and the influence of intrinsic and extrinsic pinning on the domain wall dynamics.

[1] P. Das et al., APL 97, 042507 (2010).

DF 22.3 Fri 10:30 Poster D

Magnetometry on the nanometer scale using nanogranular tunnel resistors prepared by focused electron-beam-induced deposition — •Peter Gruszka, Marcel Winhold, Christian H. Schwalb, and Michael Huth — Physikalisches Institut, Goethe-Universität, Max-von-Laue-Str.1, 60438 Frankfurt am Main

By using conventional methods of magnetometry one can experience difficulties when having small amounts of sample materials. Our novel approach uses focused electron-beam-induced deposition (FEBID) for the realization of small magnetic structures using the precursor $Co_2(CO)_8$ (Dicobaltoctacarbonyl). The magnetic structures are deposited on thin cantilever structures that are equipped with nanogranular tunnel resistors (NTRs) at the bending edge of the cantilever also prepared by FEBID.[1] Applying an external magnetic field to the cantilever induces a magnetic torque resulting in a deflection of the cantilever that can be measured due to a resistance change of the NTR sensor elements. The all-electric measurement enables us to measure precisely the temperature dependent magnetic properties of sample volumes as small as $1\mu m^3$.

[1] Schwalb et al., Sensors 2010, 10, 9847-9856

DF 22.4 Fri 10:30 Poster D

Treshold magnetic circular dichroism as a contrast mechanism for imaging magnetization dynamics of thin films — •Maximilian Staab, Hans-Joachim Elmers, Mathias Kläui, and Gerd Schönhense — Johannes Gutenberg-Universität, 55099 Mainz, Germany

Investigations of thin magnetic films like Co/Pt or Co/Au promise novel findings to overcome existing limits of data storage devices. Threshold magnetic circular dichroism (MCD) in photoemission is a phenomenon which allows gathering information about the details of the electronic structure near E_F [1]. Photons generated from a femtosecond laser excite electrons at the magnetic surface and eject them from the material. The yield of electrons is directly influenced by the relative orientation of the magnetization direction of the surface layer and the helicity of the incoming photons. By changing the helicity one obtains yield asymmetries of the order of 10% and more, making threshold MCD a great contrast mechanism for imaging dynamical processes in magnetic materials.

The combination of photoemission electron microscopy with MCD sensitivity and a femtosecond laser setup is capable of investigating magnetization dynamics with great spatial and time resolution. The process of ultrafast demagnetization and the current-induced domain wall motion by spin torque transfer are two very interesting phenomena which will be explored.

Project funded by DFG EL172/15.

[1] K. Hild et al., Phys. Rev. B 82, 195430 (2010)

DF 22.5 Fri 10:30 Poster D

Manipulating the Heat Conductivity of $La_{0.67}Ca_{0.33}MnO_3$ using External Magnetic Fields — •Christoph Euler, Christian Mix, Tino Jäger, Ramudu Machavarapu, Mathias Kläui, and Gerhard Jakob — University of Mainz, Germany

Recently research has been conducted on the interaction between electron spin and heat conduction. It was shown that heat currents can generate spin currents in magnetic nanostructures, which in turn can manipulate the magnetization [1]. Such spin-caloric mechanisms are frequently studied in thin films.

$La_{0.67}Ca_{0.33}MnO_3$ (LCMO) is a doped manganese oxide displaying huge magnetoresistivity (CMR)[2]. LCMO is a paramagnetic insulator above $T_C \approx 230\,K$ and ferromagnetic and semiconducting below. LCMO films ($d \approx 200\,nm$) are deposited on $SrTiO_3$ substrates using pulsed laser deposition in an O_2 atmosphere. The samples are characterized using XRD, AFM and VSM. A 3ω method is then used to determine the out-of-plane thermal conductivity.

The transport properties of LCMO have been studied previously [3]. In a material displaying CMR, by virtue of the Wiedemann-Franz law it should also be possible to modify the heat conductivity of a sample by applying external magnetic fields in a low-temperature magnetic cryostat. First results of the thermal conductivity are presented.

[1] K. Uchida et al., Nature 455, 778 (2008).
[2] R. von Helmolt et al., Phys. Rev. Lett. 71 (1993) 2331.
[3] G. Jakob et al., Phys. Rev. B58 (1998) 14966.

DF 22.6 Fri 10:30 Poster D

Effects of mechanical stress to GMR/TMR elements — •Stefan Niehörster, Andy Thomas, and Günter Reiss — Universität Bielefeld, Germany

By applying a mechanical stress to thin film giant magnetoresistance (GMR) and tunnel magnetoresistance (TMR) elements, it is possible to influence their resistive behavior because of the inverse magnetostriction. Dependent on the direction between the applied mechanical stress and the magnetic field, it is possible to increase/decrease the GMR/TMR ratio and to influence the shape of their hysteresis. With the applied stress perpendicular to the magnetic field, the TMR

ratio decreased from 192% to 151%. A parallel stress increased the TMR ratio from 193% to 208%. In this case, the applied stress was just limited by the mechanical breakdown of the wafer. Otherwise, the changes in the ratios and the shape of the hysteresis were reversible.

DF 22.7 Fri 10:30 Poster D

Development of a maganite-film-based AMR sensor for low magnetic fields using the planar Hall effect — •Camillo Ballani, Sebastian Hühn, Markus Jungbauer, Markus Michelmann, and Vasily Moshnyaga — I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

The anisotropic magnetoresistance (AMR) is widely used for sensing of both direction and absolute value of magnetic fields. Besides conventionally used ferromagnetic metallic materials, like permalloy ($Ni_{80}Fe_{20}$), thin epitaxial manganite films, e.g. $La_{0.7}(Sr_{1-y}Ca_y)_{0.3}MnO_3$, show large AMR ratios at temperatures slightly below T_C, which can be tuned close to room temperature by changing the Sr/Ca ratio.[1] For a special AMR geometry, called "planar Hall effect", the measured transverse voltage is directly proportional to the sample magnetization, M, thus allowing one to obtain very high field sensitivity at low fields $H \lesssim H_C$. With the goal to achieve low H_C and high AMR ratios, we have grown thin manganite films on $SrTiO_3$ substrates with different orientations by metalorganic aerosol deposition technique and studied the dependence of planar Hall effect on the temperature and applied magnetic field. Using the optimized films, we developed a prototype of a manganite-film-based magnetic field sensor. Financial support from EU FP 7 Project IFOX (interfacing oxides) is acknowledged.

[1] J. Appl. Phys. 93, 6354 (2003)

DF 22.8 Fri 10:30 Poster D

Magnetic and transport properties of MnSi thin films — •Josefin Engelke[1], Niklas van Elten[1], Tommy Reimann[1,2], Dirk Menzel[1], and Stefan Süllow[1] — [1]Inst. für Physik d. Kond. Materie, TU Braunschweig, Germany — [2]Forschungs-Neutronenquelle Heinz Maier-Leibnitz (FRM II), TU München, Germany

The ferromagnetic compound MnSi has recently aroused great interest since a variety of different phases is observed in the magnetic phase diagram. Besides a helical spin structure a topologically stable skyrmion phase occurs in a small temperature region close to the ordering temperature. By reducing the dimensionality from bulk to thin films it is expected that the skyrmions are present over a larger temperature regime. Using molecular beam epitaxy we have grown MnSi thin films by simultaneous deposition of Mn and Si. Magnetization and magnetoresistivity measurements have been carried out and related to the magnetic phase diagram. We observe a thickness dependence of the ordering temperature, which can be explained by the reduction of spin-spin interactions in the vicinity of the film surface. In comparison to bulk MnSi critical magnetic fields are enhanced, which is interpreted in terms of the reorientation of the helix affected by the film anisotropy.

DF 22.9 Fri 10:30 Poster D

Towards novel functionality with metal and complex oxide thin films prepared with molecular beam epitaxy — •Alexander Weber[1], Markus Waschk[1], Alexandra Steffen[2], Sabine Pütter[2], and Thomas Brückel[1] — [1]Jülich Centre for Neutron Science JCNS-2 und Peter Grünberg Institut PGI-4: Streumethoden, Forschungszentrum Jülich GmbH — [2]Jülich Centre for Neutron Science JCNS, Forschungszentrum Jülich GmbH, Außenstelle am FRM II, Garching

At the Jülich Centre for Neutron Science two state of the art Oxide Molecular Beam Epitaxy systems were commissioned in 2010. Up to now we managed to produce thin metal and oxide films in single layers as well as multilayers, like Fe/Cr, LaSrMnO3 a.s.f. with high crystalline quality and very low roughness. Here we present the results on LaMnO3/SrMnO3 (LMO/SMO) multilayers grown on SrTiO3 with inter layer roughness of one mono layer. The multilayers show an interface induced ferromagnetic behavior within the LMO in contrast to the antiferromagnetic behavior of the single layers. The structural analysis concerning layer thickness and unit cell size was done with X-ray reflectometry and X-ray diffraction. We carried out a thickness dependent study of the magnetic moment induced by the interfaces with SQUID magnetometry. Here we observed a raise in the net magnetic moment of the LMO with decreasing layer thickness. To study the depth resolved magnetization profile within the LMO we measured several multilayers with varying layer thickness on D17 at the ILL. The results fit well to our simple model for the magnetic profile.

DF 22.10 Fri 10:30 Poster D

Conical Spin-Spiral State in an Ultrathin Film — •N. Romming[1], Y. Yoshida[1], S. Schröder[2], P. Ferriani[2], D. Serrate[1], A. Kubetzka[1], K. von Bergmann[1], S. Heinze[2], and R. Wiesendanger[1] — [1]Institute of Applied Physics, University of Hamburg, Jungiusstrasse 11, D-20355 Hamburg, Germany — [2]Institute for Theoretical Physics and Astrophysics, Christian-Albrechts-Universität zu Kiel, D-24098 Kiel, Germany

We report a transverse conical spin spiral as the magnetic ground state of a double-layer Mn on a W(110) surface. Using spin-polarized scanning tunnelling microscopy, we find a long-range modulation along the [001] direction with a periodicity of 2.4 nm coexisting with a local row-wise antiferromagnetic contrast. First-principles calculations reveal a transverse conical spin-spiral ground state of this system which explains the observed magnetic contrast. The canting of the spins is induced by higher-order exchange interactions, while the spiralling along the [001] direction is due to frustrated Heisenberg exchange and Dzyaloshinskii-Moriya interaction. In addition, we show how the spin spiral's cone angle can be determined experimentally and how this sample can be used as a reference system to fully characterize the spin direction of SP-STM tips.

DF 22.11 Fri 10:30 Poster D

Growth of thin $La_{0.7}Sr_{0.3}MnO_3$ films on $SrTiO_3$ substrates with different orientations — •Danny Schwarzbach, Markus Jungbauer, Sebastian Hühn, Markus Michelmann, and Vasily Moshnyaga — I. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Thin film peculiarities like oxygen vacancies, epitaxial strain, orbital reconstruction at the interface and especially the polar catastrophe are of great interest for the physics and technology of correlated oxide films. We studied the growth and preparation of epitaxial films of $La_{0.7}Sr_{0.3}MnO_3$ with a thickness $d = 5-120$ nm on $SrTiO_3$ substrates with (100), (110) and (111) orientations, to get more insight on the above effects.

All films were found to be coherently strained and show qualitatively similar ferromagnetic and metallic behaviour. However, the orientation of substrates influences significantly the values of Curie point T_C, metal-to-insulator transition temperature T_{MI}, coercive field H_C and magnetic anisotropy.

Especially the (111) films show the highest T_C and T_{MI} as well as the lowest H_C. For example, the film with $d = 30$ nm reveals $T_C = 362$ K and $H_C(5\text{ K})$ less than 2 - 5 Oe, which indicates practically the absence of magnetic anisotropy. The results are discussed within the orbital reconstruction and polar catastrophe, which both depend on the crystal orientations.

Support of EU Seventh Framework Programme via IFOX is acknowledged.

DF 22.12 Fri 10:30 Poster D

Exchange bias in DyCo/NiFe bilayer — •Kai Chen[1], Dieter Lott[1], Andreas Schreyer[1], R.S Iskhakov[2,3], S.V Stolyar[2,3], and V.Yu Yakovchuk[2] — [1]Institute for Materials Research, Helmholtz-Zentrum Geesthacht, 21502 Geesthacht , Germany — [2]Kirensky Institute of Physics SB RAS, Krasnoyarsk, 660036,Russia — [3]Siberian Federal University, Krasnoyarsk, 660041, Russia

High in-plane exchange bias up to 40 mT at room temperature was found through-out the whole hard ferrimagnetic layer of DyCo which is coupled to NiFe layer. The exchange bias effects can be achieved here by magnetizing the DyCo in perpendicu-lar direction in respect to the film plane. The direction of the shifts of the in-plane hysteresis is dependent on the direction of the pre-magnetization in the one or other direction. Results from magnetic optical Kerr effect (MOKE), X-ray magnetic cir-cular dichorism (XMCD) and Polarized Neutron Reflectometry (PNR) are discussed to investigate the mechanism behind.

DF 22.13 Fri 10:30 Poster D

Magnetization reversal analysis of thin magnetic films studied by magnetooptic Kerr effect including superimposed uniaxial and cubic magnetic anisotropy — •Timo Kuschel[1], Jaroslav Hamrle[2], Jaromir Pistora[2], Kesami Saito[3], Subrojati Bosu[3], Yuya Sakuraba[3], Koki Takanashi[3], Henrik Wilkens[4], and Joachim Wollschläger[4] — [1]University of Bielefeld, Germany — [2]Technical University of Ostrava, Czech Republic — [3]Tohoku University of Sendai, Japan — [4]University of Osnabrück, Germany

Fe and $Co_{50}Fe_{50}$ films on MgO(001) are investigated by vectorial magnetometry via magnetooptic Kerr effect (MOKE). Measurements using s- and p-polarized incident light and an external magnetic field either parallel or perpendicular to the incidence plane of light are performed. Additionally, different in-plane orientations of the crystalline samples with respect to the external magnetic field are analyzed.
The observed magnetic reversal processes reveal two in-plane magnetic easy axes (MEAs) of different strength which are not orthogonal. Atypical magnetization curves including multidomain states with some magnetic moments providing antiparallel alignment to the external field (if projected to the direction of the external field) confirm the appearance of differently strong MEAs. This magnetic structure can be explained by a cubic magnetic anisotropy (CMA) induced by the crystalline film structure superimposed by an additional uniaxial magnetic anisotropy (UMA) which is not parallel to one of the MEAs of the CMA. The results are compared with regular magnetic films having a UMA parallel to one of the MEAs of the CMA.

DF 22.14 Fri 10:30 Poster D

Raman spectroscopy on thin manganite films — •Sebastian Merten[1], Sebastian Hühn[1], Antje Krüger[1], Christin Kalkert[1], Burkhard Schmidt[2], and Vasily Moshnyaga[1] — [1]I. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Abteilung Mineralogie, Geowissenschaftliches Zentrum, Georg-August-Universität Göttingen, Goldschmidtstraße 1, 37077 Göttingen, Germany

A commonly believed picture is the colossal magnetoresistance effect in thin manganite films is related to a first order magnetic phase transition which can be also coupled to a structural phase transition from an orthorhombic (Pnma) to a rhombohedral ($R\bar{3}c$) structure. This structural change can be reflected in Raman spectra which provide information of the phonon modes specific to the structural phases involved. Here we report on the Raman spectroscopy of epitaxial manganite films of $La_{0.7}Sr_{0.3}MnO_3$, $La_{0.7}Ca_{0.3}MnO_3$ and $(La_{65}Pr_{45})_{0.7}Ca_{0.3}MnO_3$ grown on MgO (100)-substrates. We observed the known Raman peaks characteristic for both structures as was identified in previous works. Moreover, the details of the phase transition and phase competition could be obtained from the temperature behaviour of the Raman peaks. In addition first results of Surface-enhanced Raman spectroscopy (SERS) will be presented on $La_{0.7}Ca_{0.3}MnO_3$. We covered the surface of the films with commercially available gold nanoparticles with the dimensions of 25x60 nm and detected an enhancement of 2-3 orders of magnitude. SFB 602(TPA2) is acknowledged.

DF 22.15 Fri 10:30 Poster D

Magnetocaloric effect in layered thin film Heusler-type materials — •Anna Möhn[1,2], Anja Waske[1], Niclas Teichert[3], Andreas Hütten[3], and Jürgen Eckert[1,4] — [1]IFW Dresden, Institute for Complex Materials, Dresden, Germany — [2]TU Dresden, Institut für Festkörperphysik, Dresden, Germany — [3]Universität Bielefeld, Fakultät für Physik, Bielefeld, Germany — [4]TU Dresden, Institut für Werkstoffwissenschaft, Dresden, Germany

The magnetocaloric effect (MCE) is the increase of temperature of a material upon the application of a magnetic field and decrease when it is removed [1]. Materials which exhibit a giant MCE have a strong coupling between crystallographic structure and magnetism [2]. However, the abrupt structural change that is the origin of "giant" magnetocaloric effects, also leads to significant strain occuring in the material. The effect of strain on the magnetocaloric performance is yet unclear. To systematically study the influence of strain, we investigate a bilayer model system which introduces strain by a lattice mismatch at the interface of two different magnetocaloric materials. Experimentally we investigated sputtered thin film samples of different NiMnGa, NiMnSn and NiCoMnSn composition which show regular and inverse MCE, respectively. We determined the magnetic properties of the thin films as a function of temperature and applied magnetic field. Furthermore we determined the magnetic properties of multilayered samples which are consist of different NiMnGa and NiMnSn alloys.

[1] Giauque et. al., Phys. Rev., 43, 768 (1933)
[2] Liu et. al., Nature Mater., 11, 620 (2012)

DF 22.16 Fri 10:30 Poster D

Magnetic Properties of the Fe-GaAs(110) Interface with ultrathin films investigated by In-Situ MOKE Measurements — Tim Iffländer, Martin Wenderoth, •Steffen Rolf-Pissarczyk, Steffen Weikert, Lars Winking, and Rainer G. Ulbrich — IV. Phys. Inst., Georg-August-Universität Göttingen

We have investigated the magnetic properties of ultrathin Fe Films epitaxially grown on the GaAs(110) and the InAs(110) surface. The films were deposited in a two-step process at 130 K to avoid any interface mixing. In-situ STM and LEED measurements proved an abrupt interface and an epitaxial growth of the Fe-GaAs system. In-situ magneto-optical kerr effect (MOKE) measurements at RT were conducted for different longitudinal, transversal and polar orientations of the applied magnetic field with respect to the (110) surface of the GaAs sample. For the 2-3 ML thickness regime deposited at low-temperature an interchange of the easy-axis from the [110] to the [001]-axis was in contrast to at RT grown Fe films observed. Moreover, we found a magnetic anisotropy along the [001]-axis which is connected to a polar magnetization component.

In addition, several MOKE hysteresis loops for different magnetic field directions and a fixed laser beam were taken to distinguish easy-axis from hard-axis behaviour. Hence we were able to show that in comparison to the in-plane [001]-axis the out-of plane direction is not a magnetic easy-axis. These results indicate a strong spin-orbit coupling in these compound systems. This work was supported by the Deutsche Forschungsgemeinschaft SFB 602 TP A7 and SPP 1285.

DF 22.17 Fri 10:30 Poster D

Domain formation in laminated FeCoBSi films for ME sensor applications — •Necdet Onur Urs[1], Christine Kirchhof[1], Dirk Meyners[1], Robert Jahns[2], Eckhard Quandt[1], Reinhard Knöchel[2], and Jeffrey McCord[1] — [1]Institute for Materials Science, Kiel University, Germany — [2]Institute of Electrical and Information Engineering, Kiel University, Germany

Magnetic domain activities in magnetoelectric (ME) sensors severely limit the sensor sensitivity, which can be solved by laminating the magnetic layers with non-magnetic materials. Magnetron-sputtered FeCoBSi/Ta multilayer thin films of different thicknesses and their single layer counterparts with the same total thickness are investigated by magneto-optical Kerr microscopy. All samples are annealed under a magnetic field to obtain a well defined uniaxial anisotropy. The domain structure changes depending on the FeCoBSi layer thickness [1]. The coupling between the domains of the adjacent magnetic layers through magneto-static interaction causes the domain walls to align themselves to their peers in the neighboring layers eliminating the magnetic charges from the interior of the films [1]. Magnetic hysteresis loops show a significant drop in coercivity [2]. In patterned samples, the magnetic closure domains display a transition from a modified spike domain to a closure domain structure and the domain rotation starts to become dominant in the magnetization reversal process. As a result Barkhausen noise in ME-sensors is reduced considerably. [1] J. C. Slonczewski, B. Petek, B. E. Argyle, IEEE Transactions on Magnetics (1988) [2] J. McCord and J. Westwood, J. Appl. Phys. 87, 6592 (2000)

DF 22.18 Fri 10:30 Poster D

FMR and MOKE characterization of $Co_{40}Fe_{40}B_{20}$ thin films — •Andres Conca, Jochen Greser, Thomas Sebastian, Stefan Klingler, Britta Leven, and Burkard Hillebrands — FB Physik und Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

Magnetic tunneling junctions are being widely used for read heads in hard discs, sensors in robotics or machine controllers. A major breakthrough was provided by the introduction of the alloy CoFeB. With a control of the exact stack composition and of the annealing conditions tunelling magnetoresistance ratios (TMR) as large as 604% [1] have been reported.

Here, we report on the characterization of $Co_{40}Fe_{40}B_{20}$ thin films deposited by magnetron rf-sputtering on SiO_x substrates. The dynamic properties and material parameters were studied by measuring the ferromagnetic resonance using a stripline-vector network analyzer (VNA-FMR). The quasi-static anisotropic switching properties were measured with a magneto-optical Kerr effect setup in longitudinal geometry with a rotational sample stage. A discussion of the values of the saturation magnetization, the Gilbert damping parameter and the exchange constant is presented.

Financial support by the MBWWK of Rhineland-Palatinate and the EFRE programm in the frame of the Spin Technology Platform (STeP) is gratefully acknowledged.

[1] S. Ikeda, *et al*, Appl. Phys. Lett. **93**, 082508 (2006).

DF 22.19 Fri 10:30 Poster D

Post-annealing effects in the Heusler compound Co_2MnSi revealed by magnetoresistance and anomalous Hall effect measurements — •Inga-Mareen Imort, Patrick Thomas, Savio Fabretti, and Andy Thomas — Thin Films and Physics of Nanostructures, Bielefeld University, Germany

Co-based Heusler compounds are prominent candidates for spintronic application due to the predicted half-metallic behavior, i.e. 100% spin polarization at the Fermi level, and the required high Curie temperatures. The degree of structural disorder can affect the spin polarization, and therefore, the electrical and magnetic transport properties. Local disorder as well as crystallographic quality of thin films can be influenced by post-annealing. The Co_2MnSi layers were deposited using dc/rf-magnetron sputtering on single-crystal MgO (001) substrates, and ex-situ annealed at temperatures in the range from 350°C to 500°C. The structural quality of our samples, especially the crossover from amorphous to crystalline structure, was tested by X-ray diffraction scans. After etching typical Hall bar structures, we measured the temperature and field dependent evolution of the anomalous Hall resistance ρ_{AHE} and the longitudinal resistance ρ_{xx} with the sample annealing temperature, in order to investigate the influence of defects, i.e. dislocations and grain boundaries, and atomic disorder on the magnetoresistance and the anomalous Hall effect in Co_2MnSi. This work has been supported by the NRW MIFW.

DF 22.20 Fri 10:30 Poster D

On the micromagnetic origin of the spin-reorientation transition in Ni_xPd_{1-x} alloys — •Daniel Gottlob[1,2], Ingo Krug[1], Florian Nickel[1], Hatice Doganay[1], Stefan Cramm[1], and Claus M. Schneider[1,2] — [1]Peter-Gruenberg Institut 6, Forschungszentrum Juelich, 52425 — [2]Fakultaet fuer Physik, Universitaet Duisburg-Essen, 47057 Duisburg

We chose the model system Ni_xPd_{1-x} to investigate different mechanisms involved in inverse spin-reorientation transitions (iSRTs). The 3d-4d hybridization between Ni and Pd and the strain variation by composition offer a way to tune magnetic anisotropy. Aberration-corrected LEEM-PEEM with its high spatial resolution is the ideal tool to investigate the magnetic domain-structure and do temperature- and composition-gradient dependent studies on microwedges and thin films. By alloying Paladium into Nickel the epitaxial strain of a thin film may be varied and the critical film thickness at which an iSRT occurs can be controlled. Close to the critical thickness the iSRT can also be induced by variation of the temperature. We present first results imaging the iSRT in NiPd by aberration corrected PEEM at the FZ Jülich Beamline UE56/1-sgm at BESSY. We prepared NiPd thin films in situ in a microwedged structure by molecular beam epitaxy. Both elements have been co-deposited using an aperture-shadowing technique to create a thickness wedge on the sample. On this poster we present LEEM and PEEM data mapping the wedge in terms of structural and magnetic properties.

DF 22.21 Fri 10:30 Poster D

Magnetic anisotropy of strained La0.7Sr0.3CoO3 thin films probed by XMCD — •Peter Nagel[1], Michael Merz[1], Felix Eilers[1,2], Dirk Fuchs[1], Hilbert von Löhneysen[1,3], 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 La1-xSrxCoO3 have their origin in the variety of possible valence and spin states of the Co ion and in strong electronic correlations. Bulk La0.7Sr0.3CoO3 is known to be a ferromagnetic metal below Tc=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. La0.7Sr0.3CoO3 thin films were grown on lattice-mismatched substrates (LaAlO3 , SrTiO3, MgO 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 L2,3 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.

DF 22.22 Fri 10:30 Poster D

Correlations between the surface morphology and the atomic structure of thin layers of Fe_3Si on GaAs(001) and their magnetic properties — •Sani Noor[1], Igor Barsukov[2], M. Samet Özkan[1], Lina Elbers[1], Benjamin Geisler[2], Peter Kratzer[2], Michael Farle[2], and Ulrich Köhler[1] — [1]Experimentalphysik IV, AG Oberflächen, Ruhr-Universität Bochum — [2]Fakultät für Physik and Center for Nanointegration (CeNIDE) Universität Duisburg-Essen

Among the FM/SC combinations that represent one possible approach necessary for the realization of spintronic devices Fe_3Si/GaAs is an interesting choice due to its properties like a low lattice mismatch, half-metallic behaviour and high thermal stability.

In this contribution we consider the structural and magnetic properties of thin near-stoichiometric Fe_3Si layers on GaAs(001) with varying thicknesses. Methods employed include STM, LEED, in situ MOKE, SQUID magnetometry and FMR. Emphasis is laid on the correlations between these properties such the nucleation at low coverage and its superparamagnetic behaviour and the layer morphology at higher coverage and magnetic anisotropies. Furthermore, atomic scale STM data is compared with STM simulations.

DF 22.23 Fri 10:30 Poster D

Pattern formation and transformation in a magnetic model system — •Matthias Kronseder, Martin Buchner, and Christian Back — Universität Regensburg, Deutschland

Magnetic phase transitions in ultra thin films have been subject to intensive studies in the last decade. Particular interest has been dedicated to the spin reorientation transition (SRT) found in some ultra thin magnetic films with a strong perpendicular anisotropy. In addition, the magnetic domain pattern exhibits a distinct evolution, i.e. a transformation between individual phases of those patterns, while approaching the SRT. Here, we concentrate on the dynamics near phase transitions. We use a laboratory based imaging technique with high spatial resolution, which is threshold photoemission magnetic circular dichroism (TP-MCD) in combination with photoemission electron microscopy (PEEM). The magnetic phase transitions of the system Fe/Ni/Cu(001) has been investigated with respect to its temporal and temperature dependence. Furthermore we investigate its behavior in external magnetic fields.

DF 22.24 Fri 10:30 Poster D

Preparation and characterization of ultrathin Ni films on W(110): electronic structure and magnetism — •Henry Wortelen[1], Anke B. Schmidt[1], Martin Weinelt[2], and Markus Donath[1] — [1]Physikalisches Institut, Westfälische Wilhelms-Universität Münster, 48149 Münster — [2]Fachbereich Physik, Freie Universität Berlin, 14195 Berlin

An effective way to study the electronic structure of the band ferromagnet nickel at the magnetic phase transition is to lower the Curie temperture by going from bulk samples to ultrathin films.

In this contribution, we present a comprehensive investigation of ultrathin nickel films grown on W(110), as the film thickness is reduced from 10 to 1 monolayer. A combined study with scanning tunneling microscopy, low-energy electron diffraction, magneto-optic Kerr effect, and spin-resolved inverse photoemission reveals the close relation between film thickness, morphology, electronic structure, and magnetism. Our results indicate changes in coercivity, spin asymmetry, and spectral intensity of surface states as a function of film thickness and quality.

DF 22.25 Fri 10:30 Poster D

An oxide MBE system as a user instrument for quasi *in-situ* neutron reflectometry studies — •Sabine Pütter[1], Alexandra Steffen[1], Stefan Mattauch[1], and Thomas Brückel[1,2] — [1]Jülich Centre for Neutron Science JCNS, Forschungszentrum Jülich GmbH, Outstation at FRM II, Lichtenbergstr. 1, 85747 Garching — [2]Jülich Centre for Neutron Science JCNS and Peter Grünberg Institute, JCNS-2, PGI-4: Scattering methods, Forschungszentrum Jülich GmbH, 52425 Jülich

Molecular Beam Epitaxy (MBE) is a fascinating method to deposit high quality epitaxial thin films. The Jülich Centre for Neutron Science (JCNS) opens its state-of-the-art MBE system at the FRM II in Garching to friendly users who are interested in preparing tailored samples for the investigation with the JCNS neutron reflectometer MARIA (magnetic reflectometer with high incident angle) or other methods.

The MBE is equipped with 6 effusion cells, two electron guns for electron-beam evaporation with 4 crucibles each and an oxygen plasma

source. Standard in-situ surface analysis tools like reflection high and low energy electron diffraction, Auger electron spectroscopy analysis are also available.

We will give examples for high quality metal and complex oxide thin film systems like e.g. $La_{1-x}Sr_xMnO_3/SrTiO_3$ with focus on stoichiometry, morphology and thickness and give detailed information about what kind of samples we can provide to you.

DF 22.26 Fri 10:30 Poster D

Roughness investigations of a CoFeB-MgO nanowire — •Tim Zacke[1], Tomek Schulz[1], Su Jung Noh[1], Benjamin Krüger[1], Capucine Burrowes[1], Dafiné Ravelosona[2], and Matthias Kläui[2] — [1]Institut of physics, University of Mainz, Mainz, 55128, Germany — [2]Institut d'Elecronique Fondamentale, Univerité Paris Sud, Orsay, 91405, France

We have investigated the impact of roughness on the domain wall dynamics in a nanowire, consisting of the multilayer stack CoFeB/MgO, which exhibits a high magnetic perpendicular anisotropy. These investigations were carried out by numerical simulations using the object oriented micro magnetic framework (OOMMF) based on the Landau-Lifshitz-Gilbert (LLG) - equation and the micromagnetic model. By varying the key roughness parameters (correlation length and amplitude), we determine the dependence on the pinning strength (wall propagation field) on these parameters and correlate the wall width with these. To compare with experimental results, we nucleate a DW in a CoFeB/MgO by an Oersted field generated by a gold wire on top of the magnetic wire. We then measure the wall propagation field at variable temperature down to 4K. This allows us to determine by comparison between experimental and theoretical results the effective magnetic roughness of the wire. Comparison to high resolution microscopy images allows us to ascertain to what extent the visible roughness and the magnetic roughness correlate yielding insights on the homogeneity of the magnetic properties at the wire edge.

DF 22.27 Fri 10:30 Poster D

Investigations of magnetic properties of thin (Mn,Zn)Fe2O4 films on SrTiO3 — •Martin Welke[1], Stephan Borek[2], Kerstin Brachwitz[3], Annette Setzer[3], Michael Lorenz[3], Pablo Esquinazi[3], Marius Grundmann[3], Karl-Michael Schindler[2], Angelika Chassé[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 Experimentelle Physik II, Universität Leipzig

The work presented deals with Mn-Zn ferrite (Mn0.5Zn0.5Fe2O4) film on Strontiumtitanate (SrTiO3) as preparative studies towards multiferroic layer systems. The ferrite film was prepared by PLD in 6*10-5 mbar O2 at a substrate temperature of 620 °C. XRD phi scans reveal an in plane epitaxial relationship of [100](Mn,Zn)Fe2O4 || [100]SrTiO3. Subsequently SQUID magnetometry measurements are planned in order to obtain magnetization loops. Furthermore, angular dependent XMCD measurements at remanent magnetization have been carried out. There was no remanent out-of-plane magnetization observed in XMCD. In addition, XMLD measurements have been performed in order to proof the antiferromagnetic coupling between Fe atoms. While the measured Mn L2,3 spectra corresponded well to bulk spectra published in literature [1], the Fe L2,3 spectra proof to exhibit defect induced magnetism in XMCD. Theoretical simulations are performed to obtain a detailed understanding. [2]

[1] M. Magnuson et al., Phys. Rev. B, 2006, 74, 172409
[2] E. Stavinski and F.M.F. de Groot, Micron, 2010, 687

DF 22.28 Fri 10:30 Poster D

Synthesis and properties of ultrahtin, epitaxial, B2 ordered FeRh thin films — •Ralf Witte[1,2], Richard Brand[1], Robert Kruk[1], and Horst Hahn[1,2] — [1]Institute of Nanotechnology, Karlsruhe Institute of Technology — [2]Joint Laboratory Nanomaterials, Materials Science Departement, TU Darmstadt

The B2 ordered phase (CsCl structure) of equiatomic FeRh alloys possess interesting magnetic properties. It is antiferromagnetically (AFM) coupled at room temperature and shows a transition to a ferromagnetic phase (FM) at about 400 K. This behavior has been observed in bulk material and as well in thin films. Generally, stabilization of the FM phase is associated with the Rh spin state; in the AFM phase the magnetic moment on the Rh atom is zero, while it gets polarized in the FM state. It has been calculated [1] that the FM state can be stabilized at room temperature in (freestanding, single crystalline) films with a thickness below a critically value of nine atomic layers. This effect is attributed to the increased polarizability of the Rh atoms at the surface, which in turn stabilizes the FM state in the entire film. We present results on the synthesis and properties of such ultra thin, epitaxial FeRh films on MgO substrates prepared by electron beam evaporation. The samples are characterized using e.g. high-resolution X-ray diffraction, atomic force microscopy, SQUID magnetometry, X-ray photo electron spectroscopy and Fe Moessbauer spectroscopy. [1] S. Lounis, Phys. Rev. B 67, 094432 (2003)

DF 22.29 Fri 10:30 Poster D

Magnetization reversal of percolated ferrimagnetic Fe-Tb nanodot arrays — •Christian Schubert[1], Phani Arekapudi[1], Birgit Hebler[1], Florin Radu[2], Marcus Daniel[1], and Manfred Albrecht[1] — [1]Institute of Physics, Chemnitz University of Technology, D-09107 Chemnitz, Germany — [2]Department for Magnetization Dynamics, Helmholtz Zentrum Berlin, Germany

Amorphous ferrimagnetic rare earth-transition metal alloys with high perpendicular magnetic anisotropy are suitable in hard disk drives to overcome the superparamagnetic limit. In particular for thermally assisted bit patterned recording media [1] amorphous Fe-Tb is a promising functional layer providing good adjustability of anisotropy, Curie temperature, and saturation magnetization [2].

We present an investigation of structural and magnetic properties of percolated amorphous Fe-Tb nanodots produced by co-deposition on pre-patterned substrates with pillar diameters of 30 nm and a period of 60 nm. The magnetic films follow closely the morphology of the pre-pattern forming exchange coupled nanodots and trench material. Despite the exchange interaction the nanodots reveal a single domain magnetization state and reverse via a more coherent rotation process as deduced from in-field MFM and angular MOKE measurements. Contrary to this the reversal of the continuous trench material is dominated by domain wall motion and the coercive field is enhanced due to pinning effects caused by the nanodot array.

[1] Akagi et al., J. Magn. Magn. Mater. 324, 309 (2012)
[2] Mimura et al., IEEE Trans. Magn. 12, 779 (1976)

DF 22.30 Fri 10:30 Poster D

Investigation of Domain Pattern and Magnetisation Reversal Process in Hexagonal Nano-Scaled Antidot Lattices — •Joachim Gräfe[1], Felix Häring[2], Ulf Wiedwald[2], Paul Ziemann[2], Ulrich Nowak[3], Gisela Schütz[1], and Eberhard Goering[1] — [1]Max Planck Institute for Intelligent Systems, Stuttgart, Germany — [2]Department of Solid State Physics, Ulm, Germany — [3]Department of Physics, Konstanz, Germany

Antidot lattices in magnetic materials can be a way to form artificial magnonic lattices as an approach towards spin-wave filters for spintronics [1]. Furthermore, the introduction of an antidot lattice provides a significant modification of static properties of the samples like the coercivity and magnetic anisotropy [2]. In this work we present results from investigations into the static regime of antidot lattice properties of in-plane (Fe) and out-of-plane (GdFe) systems. Results from x-ray microscopy indicate control over the formation and propagation of magnetic domains by the antidot pattern. Angular and spatially resolved MOKE measurements prove that the easy axes orientation is governed by the antidot lattice geometry, resulting in a six-fold symmetry of preferential magnetic axes. We present two distinct magnetisation reversal mechanisms occurring along the easy and hard axes in the antidot lattice.

[1] B. Lenk et al., Phys. Rep. 507 (2011) 107-136
[2] G. Ctistis et al., Nano Lett. 9 (2009) 1-6

DF 22.31 Fri 10:30 Poster D

Magnetic properties of Co/Pt multilevel systems — •Patrick Matthes, Benno Oehme, Robert Rückriem, and Manfred Albrecht — Chemnitz University of Technology, Chemnitz, Germany

For both fundamental and technological reasons multilevel film systems with perpendicular magnetic anisotropy has gained importance in recent research. These structures may have applications as storage devices [1], pseudo spin valves or magnetic field sensors [2, 3]. In this study ferromagnetic layers of Co/Pt multilayer stacks with various coercivities separated by a non magnetic Pt-spacer which ensures exchange decoupling have been prepared by dc-magnetron sputtering at room temperature. These flat films have been investigated by Vibrating Sample Magnetometer, Magnetic Force Microscopy and Magnetoresistance measurements to analyze the magnetic switching behaviour and magnetoresistance effect. Furthermore patterned samples with periods below 100 nm have been prepared to investigate the in-

fluence of reduced dimensions on the switching behaviour and thermal stability. This study is further supported by micromagnetic simulations.

[1] M. Albrecht al., J. Appl. Phys. **97**, 103910 (2005)
[2] J.F. Feng et al., J. Magn. Magn. Mater. **324**, 2298 (2012)
[3] L. You et al., Appl. Phys. Lett. **100**, 172411 (2012)

DF 22.32 Fri 10:30 Poster D

Artificial spin-ice systems prepared by focused electron beam induced deposition. — •Evgeniya Begun, Fabrizio Porrati, and Michael Huth — Physikalisches Institut, Goethe-Universität, D-60438 Frankfurt am Main, Germany

Spin-ice systems are interesting for the study of fundamental aspects of magnetic monopoles, as well as for magnetic information processing. Besides of the rather narrow class of materials with ice-type magnetic disorder, there exists the possibility of artificial spin-ice creation. Here we present first results on the preparation of cobalt-based artificial spin-ice structures of different configurations grown by focused electron beam induced deposition (FEBID) using the precursor dicobaltoctacarbonyl $Co_2(CO)_8$. The obtained spin-ice structures are in the form of two-dimensional regular arrays of elongated magnetic cobalt islands, which have a metal content of about 70-85 at.%. For the optimization of a one-domain state in each individual Co element the length (from 100 to 500 nm), the width (from 30 to 50 nm), the thickness (from 25 to 50 nm) and the lattice constant (from 200 to 400 nm) have been varied. The arrays have been grown to cover areas from 1 to 10 μm^2 in order to exclude edge effects. First results of magnetic force microscopy measurements done at room-temperature are presented.

DF 22.33 Fri 10:30 Poster D

Spin structure manipulation in nickel nanostructures by magneto-elastic coupling to piezoelectric PMN-PT substrates — •Simone Finizio[1], Michael Foerster[1], Carlos A. F. Vaz[1,2], Tetsuya Miyawaki[3], Joshua L. Hockel[4], Gregory P. Carman[4], and Mathias Kläui[1] — [1]Institut für Physik, Johannes Gutenberg Universität, Mainz, Germany — [2]SwissFEL, Paul Scherrer Institut, Villigen PSI, Switzerland — [3]Department of Crystalline Materials Science, University of Nagoya, Nagoya, Japan — [4]Department of Mechanical and Aerospace Engineering, University of California, Los Angeles, USA

In recent years, there has been an increasing interest in current-less control of magnetization for reduced energy consumption in memory devices. One possible route to achieve such goal is given by the magneto-elastic coupling, through the exploitation of voltage-driven piezoelectric effects to manipulate the magnetization of a ferromagnetic thin film grown on a piezo-substrate. Here, we report XMCD-PEEM imaging of Ni ring-shaped nanostructures grown on PMN-PT. By applying an out-of-plane electric field, a piezoelectric strain is induced in the plane of the film, leading to reproducible modifications of the spin structure due to strain-induced anisotropy in Ni. The characterization shows a clear influence of the piezoelectric strain on the magnetization of the Ni nanostructures, where the nucleation of magnetic domains to 45° with respect to the applied strain direction is observed.

DF 22.34 Fri 10:30 Poster D

Magnetic vortices in permalloy cap structures in confined geometry — •Dennis Nissen[1], Mi-Young Im[2], Peter Fischer[2], and Manfred Albrecht[1] — [1]Institute of Physics, Chemnitz University of Technology, D-09126 Chemnitz, Germany — [2]Center for X-ray Optics, Lawrence Berkeley National Laboratory, California 94720, USA

Vortex states, which are characterized by the chirality of the in-plane magnetization and the out-of-plane component of the vortex core[1], are of great fundamental importance and relevant for application. One approach to realize such magnetic vortex states is to manufacture large arrays of spherical SiO_2-particle monolayers followed by film deposition of permalloy. In this way, it is possible to obtain magnetic cap structures on the particles forming vortex states[2].
We will present the fabrication process of spherical SiO_2-particle monolayers with a particle diameter in the range between 50 nm and 4,5 μm, which act as templates for further film deposition, and furthermore the possibility to create particular particle arrangements using additional pre-patterns. Moreover, we will show investigations of the magnetic properties studied by magnetic force microscopy and magneto-optic Kerr effect magnetometry. In this context particular attention is paid to the magnetic reversal mechanism of a vortex as a function of external field. In addition, recent studies on the formation process of vortex states in large arrays of cap structures using magnetic transmission X-ray microscopy will be presented. [1]T. Shinjo et al. Science 289 (2000) 930. [2]R. Streubel et al. Phys. Rev. B 85, (2012) 174429.

DF 22.35 Fri 10:30 Poster D

Dynamic response of periodic magnetic domain patterns in submicron sized Co2MnGe-Heusler wires — •Katherine Gross, Frank Brüssing, Kurt Westerholt, and Hartmut Zabel — Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, D-44780 Bochum,Germany

We have investigated the dynamic response of periodic magnetic domain patterns in submicron sized Co2MnGe-Heusler ferromagnetic wires by measuring the in-phase and out-of phase magnetic susceptibility via the magneto-optical Kerr effect with an ac-magnetic field applied parallel or perpendicular to the wire axis. In magnetic remanence the magnetization in the Co2MnGe wires aligns along the growth induced uniaxial anisotropy axis transverse to the wire axis, forming highly regular domain patterns with 180° domain walls. The application of an ac-field perpendicular to the wire axis results in a oscillating motion of the domain walls (DW) along the wire axis. For small field amplitudes just above the depinning field the DW dynamics can be described by a slide-like motion and an analytical expression can be used to extract the depinning field and the domain wall mobility. When applying the ac-magnetic field along the wire axis the magnetization in the perpendicular domains responses by coherent rotation towards the direction of the wire axis. In both configurations the complex ac-susceptibilty is described by a Cole-Cole type of relaxation time approach.

DF 22.36 Fri 10:30 Poster D

Domain wall magnetoresistance and depinning in $La_{0.66}Sr_{0.33}MnO_3$ nanowires — Michael Foerster[1], Luis Peña[1], •Simone Finizio[1], Laurence Mechin[2], Felix Büttner[1,3], André Bisig[4], Stefan Eisebitt[3], and Mathias Kläui[1] — [1]Institut für Physik, Johannes Gutenberg Universität, Mainz, Germany — [2]GREYC, UMR 6072, CNRS-ENSICAEN-UCBN, Caen Cedex, France — [3]Institut für Optik und Atomare Physik, Technische Universität Berlin, Berlin, Germany — [4]SwissFEL, Paul Scherrer Institut, Villigen PSI, Switzerland

Magnetic domain walls (DWs) and their reliable displacements are key ingredients for novel magnetic memory and sensing devices with switching by domain wall motion. $La_{0.66}Sr_{0.33}MnO_3$ (LSMO) is a ferromagnetic metal with a high spin polarization, which promises large spin transfer torque (STT) effects, and a T_c close to room temperature (370K) that allows for the investigation of magnetotransport and STT effects with tuneable parameters. We have measured the magnetoresistance of LSMO nanostructures at 4.3K, observing the magnetoresistance associated with DWs in an LSMO wire by comparing hysteresis loops with fields along different directions. Depinning of DWs was observed as function of the applied magnetic field along the wire, with good quantitative agreement with simulations. The injection of current pulses leads to changes in the signal that are probably due to local changes in the magnetization, which occur due to Joule heating combined with the low T_c.

DF 22.37 Fri 10:30 Poster D

Magnetization Reversal Mechanisms in Co-Antidot Arrays — Manuel Langer[1], •Rantej Bali[1], Ewa Kowalska[1], Andreas Neudert[1], Kilian Lenz[1], Kay Potzger[1], Mikhail Kostylev[2], Adekunle Adeyeye[3], Jürgen Fassbender[1], and Jürgen Lindner[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf e.V., 01328 Dresden, Germany — [2]School of Physics, University of Western Australia, Crawley 6009, Australia — [3]Department of Electrical and Computer Engineering, National University of Singapore, 117576 Singapore

Co-antidots with holes arranged in the form of a square lattice, with lattice parameter of 415 nm and hole diameter $d = 145$ to 255 nm were fabricated using DUV photolithography. For arrays with film thickness of 50 nm, the angular dependence of the saturation field (H_s) shows presence of four-fold anisotropy with the hard axes along the <01> directions and easy axes was along the diagonal <11> directions. Spikes in the H_s were measured along the intermediate <12> directions. Kerr microscopy suggests that the reversal mechanism along the <01> is domain-wall (DW) depinning followed by propagation within the continuous channels along the <01>, whereas along the <11> the mechanism tends towards nucleation and growth. We postulate that the H_s-spikes occur because DW-propagation requires domino-like spin-reorientations through the continuous channels, whereas nucleation can only occur when a coherent region is formed with the spins ori-

ented along the applied field. The frustration caused by the two possible spin-reorientation paths results in the larger H_s. We attempt to model these mechanisms using OOMMF and investigate the influence of varying d.

DF 22.38 Fri 10:30 Poster D

All-optical switching in CoTb alloys: composition and thickness dependent studies — •Ute Bierbrauer[1], Sabine Alebrand[1], Michel Hehn[2], Matthias Gottwald[2,3], Daniel Steil[1], Daniel Lacour[2], Mirko Cinchetti[1], Martin Aeschlimann[1], Eric E. Fullerton[3], and Stéphane Mangin[2] — [1]Dep. of Physics and Research Center OPTIMAS, TU Kaiserslautern, Germany — [2]IJL, Université de Lorraine, Nancy, France — [3]University of California, San Diego, USA

All-optical switching (AOS), i.e. switching of magnetic domains by means of circularly polarized fs laser pulses, has been demonstrated up to now only in GdFeCo [1]. However, it is still not clear if AOS is related to the specific properties of GdFeCo or if it also occurs in other materials.

We focus on AOS in high anisotropy CoTb alloys [2], demonstrating that AOS is possible for a certain Tb concentration range. Interestingly this concentration range corresponds to the one where the compensation point is above room temperature. We further investigate the dependence of AOS on the film thickness. Overall we discuss possible influences of the material specific magnetic properties, like e.g. the coercive field and the saturation magnetization. We find indications that such properties cannot be ignored, when trying to get a deeper understanding of AOS.

[1] C.D. Stanciu et al., PRL 99, 047601 (2007) [2] S. Alebrand et al., APL 101, 162408 (2012)

DF 22.39 Fri 10:30 Poster D

Control of Magnetic Domains and Domain Walls by Thermal Gradients — •Martin Stärk, Johannes Boneberg, Mikhail Fonin, and Elke Scheer — Department of Physics, University of Konstanz, Germany

Investigation and control of domains and domain walls in magnetic materials is very important for the understanding of the magnetism in thin films and nanostructures as well as for the development of future spintronic devices. Recently, the interaction between spin-currents or magnetic fields and domain configurations attracted considerable attention. With respect to new data storage media techniques as heat assisted magnetic recording, thermal effects in spin-polarized materials and nanostructures might get important.

From the theoretical point of view, nanometer-sized domain walls can be moved with a speed of 50 m/s by temperature gradients of around 50 K/μm (D. Hinzke et al., Phys. Rev. Lett. 107, 027205 (2011)). In order to investigate this behavior experimentally, we use ns-pulsed laser interference to generate temperature patterns with variable periods between 200 nm and 20 μm and thermal gradients of up to several hundred K/μm on thin films of ferromagnetic metals.

Using this technique, we study the effects on out-of-plane Co/Pd multilayer systems with magnetic force microscopy before and after the illumination. Thereby, a change in the domain distribution is observed.

DF 22.40 Fri 10:30 Poster D

investigation of magnetic domain structure and domain wall in Co2Mn0.6Fe0.4Si — •tomohiro koyama[1], phillip pirro[1], thomas bräcker[1], thomas sebastian[1], ikhtiar i[2], yusuke ohdaira[2], takahide kubota[3], hiroshi naganuma[2], mikihiko oogane[2], yasuo ando[2], and burkard hillebrands[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Department of Applied Physics, Graduate School of Engineering, Tohoku University, 980-8579, Sendai, Japan — [3]WPI Advanced Institute for Materials Research, Tohoku University, 980-8577, Sendai, Japan

The interaction between magnetic domain walls (DW) and spin waves is much attractive from the viewpoint of physical interests and applications. The full Heusler compound Co2Mn0.6Fe0.4Si (CMFS) is one of the suitable materials to investigate it because of its long decay length of spin waves. For the advance of the research, we have characterized domain structures and DWs in CMFS. The micro structures were fabricated from CMFS film with 30 nm thickness sputtered on MgO substrate by electron beam lithography and ion etching. The magnetic domain structure and DWs in CMFS were directly observed by using magnetic force microscopy. We found that in a square pad the Landau closure domain was formed by oscillatory reducing the external field to zero. In addition, the creation of a single DW in an L-shaped wire was performed. The effect of excited spin waves on these domain structures will be discussed. T.K. gratefully acknowledges the Alexander von Humboldt foundation for a postdoctoral fellowship.

DF 22.41 Fri 10:30 Poster D

Brillouin light scattering investigations of perpendicular standing spin waves at Au and Ag nanoparticles on top of a $Ni_{81}Fe_{19}$ film — •Thomas Meyer, Björn Obry, and Burkard Hillebrands — FB Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

In the last decades localized plasmons excited in metallic nanoparticles providing a local field enhancement were used to increase the signal strength and spatial resolution like in the case of surface enhanced Raman spectroscopy. We present Brillouin light scattering (BLS) studies of perpendicular standing spin waves in a thin $Ni_{81}Fe_{19}$ film with single Au and Ag nanoparticles on top. An increase of the BLS signal as well as a frequency shift of the spin waves due to the metal nanoparticles is observed. To describe this, and besides their plasmonic properties, other influences of the nanoparticles on the magnetization dynamics have to be taken into account. In order to identify the contributions to the observed signal changes, investigations using different materials, sizes and shapes of the structures have been performed.

DF 22.42 Fri 10:30 Poster D

Magnetoresistance of an individual ferromagnetic nanotube under microwave irradiation — •Tobias Stückler[1], Florian Heimbach[1], Rupert Huber[1], Daniel Rüffer[2], Eleonora Russo-Averchi[2], Martin Heiss[2], Anna Fontcuberta i Morral[2], and Dirk Grundler[1,3] — [1]Physik-Dep. E10, TU München, D-85748 Garching — [2]LMSCX, IMX, EPF Lausanne, CH-1015 Lausanne — [3]STI, EPF Lausanne, CH-1015 Lausanne

The magnetic states predicted for ferromagnetic nanotubes have generated great interest in both theoretical and experimental nanomagnetism research. Using atomic layer deposition, we have prepared 40 nm thick Ni nanotubes by conformal coating of single-crystalline GaAs nanowires with a diameter of about 300 nm. Subsequently, we position a several-μm-long nanotube on a Si substrate and integrate four metallic contacts. At room temperature, we measure the magnetic field dependent resistance under microwave irradiation using a neighboring antenna. We report on characteristic resonance features which we attribute to excited spin waves. Financial support by the EC (FP7/2007-2013) under Grant Agreement No. 228673 (MAGNONICS), the DFG via NIM, the SNF, and QSIT is gratefully acknowledged.

DF 22.43 Fri 10:30 Poster D

Azimuthal Spin-Wave Modes in Permalloy Coated Glass Fibers — •Lukas Nagrodzki, Felix Balhorn, Wolfgang Hansen, and Stefan Mendach — Institut für Angewandte Physik, Universität Hamburg, Germany

We show by means of broadband microwave spectroscopy that Permalloy cylinders with micron-sized diameters exhibit pronounced azimuthal spin-wave modes, which can be tuned over several GHz by an external magnetic field. For the preparation of these devices we have deposited thin layers of Permalloy on glass fibers with diameters of a few microns by thermal evaporation. They show resonant behavior with multiple resonances when magnetized along the fiber axis. We interpret those resonances as interfering spin waves propagating in azimuthal direction. The data can be well reproduced using an analytical model for spin waves in thin films employing periodic boundary conditions as also used for rolled-up Permalloy spin-wave resonators previously introduced by our group [1, 2].

Financial support by the Deutsche Forschungsgemeinschaft via SFB668 is acknowledged.

[1] F. Balhorn et al., PRL **104**, 037205 (2010); [2] F. Balhorn et al., APL **100**, 222402 (2012)

DF 22.44 Fri 10:30 Poster D

Time-Resolved Magnetic Imaging in an Energy-Filtered, Aberration-Corrected Photoemission Electron Microscope — •Florian Nickel[1], Daniel Gottlob[1], Ingo Krug[1], Alexander M. Kaiser[2], Denys Makarov[3], Gungun Lin[3], Stefan Cramm[1], Hatice Doganay[1], Oliver G. Schmidt[3], and Claus M. Schneider[1,4] — [1]Peter Grünberg Institut 6, Research Center Jülich, 52425 Jülich — [2]SPECS Surface Nano Analysis GmbH, 13355 Berlin — [3]Institute for Integrative Nanosciences, IFW Dresden,

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Information technology relies on reliable storage and fast switching of material states. These states can be governed either by magnetic or electrical degrees of freedom, which offers a wide variety of design concepts. Common to all storage concepts is that manipulation of the information state takes place on a characteristic time and length scale, which is in the picosecond respective nanometer range. All requirements are combined in the method of time-resolved photoemission microscopy (TR-PEEM). Recently, we installed a state-of-the-art PEEM with energy-filtering system and aberration corrector (FE LEEM-P90 AC by SPECS) at the FZ-Jülich Beamline UE56/1-SGM @ BESSY. In this poster we present the extension of the microscope setup for synchrotron pump-probe measurements. We will present details about the technical performance of the setup as well as first results on magnetization dynamics in ferromagnetic nanoelements.

DF 22.45 Fri 10:30 Poster D

Supercritical parametric generation in a $Ni_{81}Fe_{19}$ microstripe — •Thomas Brächer[1,2], Philipp Pirro[1], Alexander A. Serga[1] und Burkard Hillebrands[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Graduate School Materials Science in Mainz, Gottlieb-Daimler-Straße 47, 67663 Kaiserslautern, Germany

Parallel parametric amplification [1] is an alternative method to excite spin-wave dynamics in microstructured elements, as recent experiments have shown the applicability of the technique to micron-sized $Ni_{81}Fe_{19}$ structures.[2,3]

We report on the supercritical evolution of parametrically generated spin-wave modes as a function of applied microwave power in a $Ni_{81}Fe_{19}$ microstripe employing parallel parametric amplification. The experimental observation is carried out using Brillouin light scattering microscopy. We find that depending on the applied external magnetic field, different transitions of the observed spin-wave mode profiles, like a transition from the first to the second transverse mode at low magnetic fields, can be found.

Thomas Brächer is supported by a fellowship of the Graduate School Materials Science in Mainz (MAINZ) through DFG-funding of the Excellence Initiative (GSC 266).

[1] E. Schlömann et al., J. Appl. Phys. 31, 386S (1960)
[2] T. Brächer et al., Appl. Phys. Lett. 99, 162501 (2011)
[3] H. Ulrichs et al., Phys. Rev. B 84, 094401 (2011)

DF 22.46 Fri 10:30 Poster D

Spin pumping in YIG/Pt bilayer — •Markus Härtinger[1], Sibylle Meyer[2], Stephan Geprägs[2], Matthias Opel[2], Hans Huebl[2], Sebastian T.B. Goennenwein[2], Christian Back[1], and Georg Woltersdorf[1] — [1]Department of Physics, Universität Regensburg, 93040 Regensburg, Germany — [2]Walter-Meißner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany

Spin pumping adds an additional damping mechanism to the instinsic damping propierties of a magnetization precession by emission of an angular momentum flow. When the latter is relaxed, e.g. in a material with large spin orbit scattering like Pt, the spin current is efficiently damped, resulting in an increased FMR linewidth. Here we report on this effect in a bilayer of the insulating ferrimagnet Yttrium Iron Garnet (YIG) and platinum (Pt). The samples consist of ultrathin epitaxial YIG layers grown by pulsed laser deposition on GGG(111) (Gadolinium Gallium Garnet) substrates. The platinum capping layers are deposited in-situ. We have determined the magnetic properties by performing ferromagnetic resonance (FMR) measurements on YIG layers as well as on bilayer YIG/Pt samples in a frequency range from 2 to 20 GHz. In the pure YIG samples we find very narrow resonance lines corresponding to a Gilbert damping constant of approximately $\alpha = 0.001$. Due to the spin pumping an additional platinum layer on top of the YIG samples results in a significant broadening of the FMR linewidth proportional to the microwave frequency. In order to substantiate this we measured the platinum and YIG thickness dependence of this additional damping.

DF 22.47 Fri 10:30 Poster D

Inverse Spin Hall Effect in $Ni_{80}Fe_{20}$ / Normal Metal Bilayers — •Martin Obstbaum, Markus Härtinger, Thomas Meier, Fabian Swientek, Christian H. Back, and Georg Woltersdorf — Institut für Experimentelle und Angewandte Physik, Universität Regensburg,93040 Regensburg, Germany

We investigate the inverse spin Hall effect in $Ni_{80}Fe_{20}$/normal metal bilayers. Pure spin currents are generated by spin pumping at ferromagnetic resonance and a dc-voltage is measured in the plane of the bilayer system. For Pt and Au as normal metals the observed inverse spin Hall effect and the corresponding spin Hall angle are consistent with literature values. In the case of $Ni_{80}Fe_{20}$/Ta - bilayers a giant spin Hall angle has recently been reported [1], however, we do not detect a measurable voltage due to the inverse spin Hall effect in $Ni_{80}Fe_{20}$/Ta bilayers. In fact, from our angle and temperature dependent measurements we conclude that for $Ni_{80}Fe_{20}$/Ta bilayers the voltage generated at ferromagnetic resonance is solely a consequence of the anisotropic magnetoresistance.

[1] Liu et al. Science 336, 555 (2012)

DF 22.48 Fri 10:30 Poster D

Femtosecond spin dynamic in ferromagnetic Fe/Ru/Ni nanopillars — •Jorge Martin[1,2], Marco Battiato[4], Roman Adam[1,2], Dennis Rudolf[1,2], Chan La-o-vorakiat[3], Justin M. Shaw[5], Emrah Turgut[3], Pablo Maldonado[4], Stefan Mathias[3,6], Patryk Grychtol[3], Hans T. Nembach[5], Thomas J. Silva[5], Martin Aeschlimann[6], Henry C. Kapteyn[3], Margaret M. Murnane[3], Peter M. Oppeneer[4], and Claus M. Schneider[1,2] — [1]Peter Grünberg Institut PGI-6 ,Forschungszentrum Jülich, 52425 Jülich, Germany — [2]JARA, Fundamentals of Information Technology — [3]Department of Physics and JILA, University of Colorado and NIST, Boulder, CO, USA — [4]Department of Physics and Astronomy, Uppsala University, SE-75120 Uppsala, Sweden — [5]Electromagnetics Division, National Institute of Standards and Technology, Boulder, CO, USA — [6]University of Kaiserslautern and Research Center OPTIMAS, 67663 Kaiserslautern, Germany

High harmonics generation, driven by a femtosecond pulsed laser, has provided a unique insight into the spin dynamics in ferromagnetic multilayered samples, due to the development of ultrafast probing techniques that combine femtosecond time resolution with element selectivity. We patterned Fe/Ru/Ni layers into an array of equally spaced nanopillars. Following optical pump, we employed the resonant transversal magneto optical Kerr effect for tracing the response of Fe and Ni layers separately, to gain deeper comprehension of the interplay of optically induced demagnetization-magnetization processes.

DF 22.49 Fri 10:30 Poster D

Ultrafast Demagnetization in a Kondo-Lattice System — •Alexander Baral and Hans-Christian Schneider — University of Kaiserslautern

We present theoretical results on the magnetization dynamics after ultrashort pulse excitation in a Kondo-lattice model, i.e., a system of 2D carriers coupled by an exchange interaction to a virtual lattice of localized spins. For the itinierant carriers, we include a spin-orbit coupling of the Rashba type as well as carrier-carrier and carrier-phonon scattering. In the framework of this model and starting from a mean-field description and using a dynamical exchange splitting, we investigate the magnetization dynamics after ultrashort-pulse excitation. Such an excitation leads to a demagnetization dynamics reminiscent of that found in 3d- and 4f-ferromagnetic metals.[1] We compute time- and momentum-dependent carrier distribution functions from carrier-carrier and carrier-phonon Boltzmann scattering integrals. In addtion, in our model, the exchange splitting is time-dependent, so that also the spin-mixing changes with time. It is shown that the dynamical exchange splitting and also the dynamical change of the spin mixing hava an important qualitative and quantitative influence on the demagnetization and remagnetization dynamics. [1] Koopmans, B. et al., Nature Mater. 9, 259*265 (2010).

DF 22.50 Fri 10:30 Poster D

Influence of hot electrons on the ultrafast quench of magnetization in Ni and FePt — •Martin Lüttich[1], Jakob Walowski[1], Andreas Mann[1], Johannes Mendil[1], Markus Münzenberg[1], Unai Atxitia[2], and Oksana Chubykalo-Fesenko[2] — [1]I. Physikalisches Institut Georg-August-Universität Göttingen, Göttingen, Germany — [2]Instituto de Ciencia de Materiales de Madrid, Madrid, Spain

Since the first investigation of ultrafast magnetization dynamics in 1996, the question on driving mechanism(s) is still not resolved entirely. According to the predicted superdiffusive spin transport, we investigate the influence of hot electrons on the relative demagnetization.

Magnetization dynamics of an in-plane magnetized Ni film and an

out-of-plane magnetized FePt film is measured using the all-optical pump-probe technique for various pump pulse fluences. To clarify the influence of hot electrons on the relative demagnetization, experiments with temporarily stretched pump pulses from 50 fs up to 2.5 ps are performed. These results are compared to simulations based on the Landau-Lifshitz-Bloch equation, which is based on the thermal model, and featured by the consideration of two spin temperature dependent relaxation times $\tau_{||}$ and $\tau_{\perp}$. The electron temperature needed as input for the simulations is obtained from independent experiments on reflectivity dynamics. Compared to experiments, using ultrashort 80 fs pump pulses containing same energy per pulse, a lower maximum electron temperature is reached, but it is maintained for a longer time with the longer pump pulses.

DF 22.51 Fri 10:30 Poster D

Femtosecond spin dynamics in ferromagnet/metal bi-layers — •Daniel Simon[1,2], Roman Adam[1,2], Moritz Plötzing[1,2], Christian Weier[1,2], Dennis Rudolf[1,2], and Claus M. Schneider[1,2] — [1]Peter Grünberg Institut (PGI-6), Forschungszentrum Jülich, 52425 Jülich, Gemany — [2]JARA - Fundamentals of Future Information Technologies

Laser-induced demagnetization of ferromagnetic films is known to be an effect on the timescale of a few hundred femtoseconds. Among many proposed mechanisms, spin-flip processes [1] and spin-superdiffusion [2, 3] have been proposed to explain these ultrafast developments. In the presented work, we investigate spin dynamics of ferromagnet (4nm)/metal (20nm) bi-layers in a backside-pump/frontside-probe setup using infrared (800nm) pump and blue (400nm) probe laser pulses. This geometry allows us to probe the magnetization dynamics spatially separated from the pumping. Our measurements show an influence of the pump pulse on the magnetization even though a direct pumping is suppressed by the metal layer, giving rise to an interpretation based on a non-local effect, namely spin currents.

[1] B. Koopmans, et al. Nature Materials 9, 259 (2010).
[2] D. Rudolf, et al. Nature Communications 3, 1037 (2012).
[3] M. Battiato, et al. Phys. Rev. Lett. 105, 027203 (2010).

DF 22.52 Fri 10:30 Poster D

Comparing the ultrafast demagnetization of Gadolinium and Terbium — •Martin Teichmann[1,2], Robert Carley[1,2], Björn Frietsch[1,2], Kristian Döbrich[1,2], Jan Wolter[1,2], John Bowlan[1,2], and Martin Weinelt[1,2] — [1]Freie Universität Berlin — [2]Max-Born-Institut Berlin

The laser-driven ultrafast demagnetization dynamics of the rare earths gadolinium and terbium show distinct behavior. We performed time- and angle-resolved photoemission experiments using high-order harmonics on Gd and Tb, revealing the occupied band structure in the 3rd Brillouin zone. By following the time evolution of the spin-split valence bands individually, we are able to separate the different effects acting during demagnetization, namely spin transport and electron-phonon scattering, while simultaneously monitoring the magnetization via the exchange splitting.

We see that the dynamics of the electron-phonon scattering is very similar in Gd and Tb, while the spin transport accounts for their differences.

DF 22.53 Fri 10:30 Poster D

A Non-Equilibrium Band-Structure View of Ultrafast Magnetization Dynamics — •Robert Carley[1,2], John Bowlan[1], Kristian Döbrich[2], Björn Frietsch[1,2], Martin Teichmann[1,2], Jan Wolter[1], and Martin Weinelt[1] — [1]Freie Universität Berlin, Germany — [2]Max-Born-Institut, Berlin, Germany

We present recent results from ultrafast laser-driven magnetization dynamics experiments on the rare-earth local-moment ferromagnet Gadolinium. Our experiment combines angle-resolved photoemission spectroscopy (ARPES) with the VUV photon energies and time resolution made possible by high-order harmonic generation to scrutinize the non-equilibrium band structure following excitation of the ferromagnet by a short infrared pulse. On the timescale of a few picoseconds, transient changes of the minority and majority components of the exchange-split valence band reveal significant insight into the underlying microscopic processes. Furthermore, linear magnetic dichroism in photoemission allows us to directly follow the magnetic response of the localized 4f electrons, from which the magnetic moment arises.

DF 22.54 Fri 10:30 Poster D

Spin motive force induced by moving vortex in magnetic nanostructures — •Ajay Gangwar[1], Hans G. Bauer[1], Matthias Noske[2], Markus Weigand[2], Hermann Stoll[2], Gisela Schütz[2], Georg Woltersdorf[1], and Christian H. Back[1] — [1]University of Regensburg, Regensburg, Germany — [2]Max Planck Institute for Intelligent Systems Stuttgart, Germany

Recently, voltage signals due to spin motive force (SMF) have been observed in magnetic elements with a moving magnetic vortex core [1]. However a moving vortex core also represents a change of the magnetic inductance and therefore also leads to a large electro motive force (EMF). An unambiguous separation of EMF and SMF signals is necessary for the interpretation of the SMF voltage. For this reason we simultaneously measure the voltage signal and the position of the moving magnetic texture in a sub-micron permalloy (Py) disk with high temporal and spatial resolution in a scanning X-ray transmission microscope (STXM). In this way we determine directly the phase relation between the obtained voltage signals and the position of the vortex core with respect to the nanoscale voltage probes. This technique allows us to unambiguously separate contributions from EMF (due to the change of magnetic induction) and SMF (due to the moving magnetic texture). We separate EMF and SMF by performing measurements in various configurations and by reversing the vortex core polarity.

[1] K. Tanabe et al., Nature Communications 3, 845 (2012).

DF 22.55 Fri 10:30 Poster D

Dynamic vortex core reversal studied with micromagnetic simulations — •Hans G. Bauer, Georg Woltersdorf, and Christian H. Back — Universität, Regensburg, Germany

Thin discs of soft magnetic material can have non-trivial ground states of the magnetization. When the demagnetization energy forces the magnetization to lie in the plane of the disc, ground states of curling magnetization (vortex) exist with the magnetization in the middle pointing out-of-plane (vortex core). The ground state is degenerate with respect to the vortex core pointing either up or down (polarity) and the rotation sense of the in-plane magnetization (chirality).

While both are in principle capable of representing a bit in data storage we study two cases of polarity switching, where the vortex core polarity is reversed by a) a short rotating field pulse and b) a combination of sub-GHz and GHz excitations.

First we address the problem of the minimal time required to selectively switch the vortex core with short pulses. In the second study we investigate the threshold amplitude needed for switching at GHz-frequencies when the vortex core is already displaced from its equilibrium position by a low frequency excitation of the vortex, the so-called gyro-frequency. Both results are finally compared to the experimental findings in [1] and [2].

[1] M. Kammerer et al., Phys. Rev. B 86, 134426 (2012)
[2] M. Sproll et al. (to be published)

DF 22.56 Fri 10:30 Poster D

Collective Switching of Nanoparticles in Magnetic Arrays — •David Altwein, Elena Vedmedenko, Robert Wieser, and Roland Wiesendanger — Institute of Applied Physics, University of Hamburg, Jungiusstr. 11, 20355 Hamburg, Germany

Numerical simulations of the switching of ensembles of superparamagnetic nanoparticles in the framework of the Langevin Spin Dynamics as well as the path integral formalism are reported and compared with experimental results. The particles have been coupled via dipolar or RKKY interactions. In the case of a strong coupling a collective switching of particles has been observed. The continuous decrease of the coupling's strength leads to a continuous decrease in the coherency of the switching. The phase shift of the switching as a function of the interaction strength shows a gradual change similar to that of the order parameter in the second order phase transition. This dynamical phase transition is discussed and compared with existing theoretical models.

DF 22.57 Fri 10:30 Poster D

Synchronization between two pointcontact spin torque nano-oscillators — •Thomas Kendziorczyk and Tilmann Kuhn — Institut für Festkörpertheorie, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster

It has been predicted theoretically and observed experimentally that a direct current traversing a magnetic multilayer exerts a spin torque on the magnetic system which can compensate the natural damping and lead to self-sustaining magnetic oscillations in the GHz range. Due

to the easy frequency tunability of the spin torque nano-oscillators (STNOs) this effect has great potential for the construction of nano-sized microwave generators. The main problem which has to be solved for future applications is the low output power of a single STNO. Some experiments have already been performed which show that it is possible to synchronize two STNOs. The output power for N synchronized STNOs could in principle scale with N^2. However, in order to construct larger arrays of STNOs a good knowledge about the interaction mechanism between them is indispensable. We will show by means of micromagnetic simulations, that there can exist several different synchronized states for two STNOs depending on the inter-contact distance and the initial phase difference of the free running oscillators. The multistability can be explained by the dispersion of the involved spin waves, which provide the main mechanism for the synchronization.

DF 22.58 Fri 10:30 Poster D

Temperature dependent spin transport and precession in non-local spin valves with transparent interfaces — •Björn Burkhardt[1], Nils Motzko[1], Piotr Laczkowski[2], and Laurent Vila[2] — [1]Institut für Physik, Johannes Gutenberg Universität Mainz, 50099 Mainz, Germany — [2]Laboratoire Nanostructure et Magnetisme, CEA/INAC, 38054 Grenoble, France

In magnetic memory applications and spintronic devices a controlled switching of the magnetization is necessary. One possibility to manipulate the magnetization is to employ pure spin currents, for example in non-local spin valve (NLSV) configurations [1]. Here, the spin diffusion length and the spin flip time of the non-magnetic spin conduit material between two ferromagnetic wires play crucial roles for the efficiency of the resulting pure spin currents. We use aluminum and copper as non-magnetic spin conduits between two Permalloy stripes. Measuring the non-local spin signal as a function of temperature, we found a non-monotonous dependence and a maximum of the non-local signal and spin diffusion length at 23 K for Al and 38 K for Cu. These effects can be explained by different scattering mechanisms and probabilities at various temperatures. To determine this for Al-NLSVs we use Hanle measurements [2]. These show a small periodic effect caused by the spin precession which allowing us to deduce the spin diffusion parameters.

[1] D. Ilgaz et al., Phys. Rev. Lett. 105, 076601 (2010)
[2] G. Mihajlovic et al., Phys. Rev. Lett. 104, 237202 (2010)

DF 22.59 Fri 10:30 Poster D

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

We present an ab initio study of the spin Hall as well as the spin Nernst effect. Both refer to the creation of a transverse spin current caused by an applied electric field or a temperature gradient, respectively. For the considered Cu-based dilute alloys, the dominant skew scattering mechanism was analysed for several pairs of impurities. We investigated the dependence of the transport properties of ternary alloys on the relative concentration of the two types of impurities. The efficiency of all systems with respect to the spin current generation is discussed in detail. All calculations are based on a fully relativistic Korringa-Kohn-Rostoker method and solution of a linearized Boltzmann equation, successfully applied to the SHE [1] and SNE [2] in binary alloys. The considered ternary alloys appeared to be well described by Matthiessen's rule. However, for the Hall resistivity deviations from Matthiessen's rule can have both signs in contrast to the longitudinal resistivity with only positive deviations.

[1] M. Gradhand et al., Phys. Rev. Lett. 104, 186403 (2010).
[2] K. Tauber et al., Phys. Rev. Lett. 109, 026601 (2012).

DF 22.60 Fri 10:30 Poster D

Magneto-resistance in electromigrated magnetic nanocontacts — •André Loescher[1], Mohamad-Assaad Mawass[1,5], Robert M. Reeve[1], Jakoba Heidler[2], Jan Rhensius[2,3], Laura J. Heyderman[2], Regina Hoffmann[4], and Mathias Kläui[1,2,3] — [1]Johannes Gutenberg-Universität Mainz, Germany — [2]Paul Scherrer Institut, Villigen, Switzerland — [3]Universität Konstanz, Germany — [4]Physikalisches Institut and DFG-Center for Functional Nanostructures, Karlsruhe Institute of Technology, Germany — [5]Max-Planck-Institut für Intelligente Systeme, Stuttgart, Germany

Magnetotransport measurements on magnetic nanocontacts have been performed with the aim to understand the interactions between spin-polarized charge carriers and magnetization on the nanoscale. Here, we study the evolution of magnetoresistance (MR) in electromigrated ferromagnetic junctions obtained in clean ultra-high vacuum (UHV) conditions. While previously Permalloy ($Ni_{80}Fe_{20}$) nanocontacts with variable constriction width have been investigated, the fundamental behaviour of magnetization in such nanocontacts is not fully understood, with measurement artifacts often complicating the interpretation of results. *In-situ* controlled electromigration of notched half ring structures was performed in order to tailor the size of the contact. The MR was measured as a function of the constriction width in order to study the magnetic properties and characterize the strength and extent of the domain wall pinning potential. Furthermore, the MR ratio at remanence is observed to reach 50% and exhibit a previously unobserved sign change in contacts that approach the atomic limit.

DF 22.61 Fri 10:30 Poster D

Spin Seebeck effect in FM/NM/NM hybrid structures — •Michael Schreier[1], Kathrin Ganzhorn[1], Mathias Weiler[1], Matthias Althammer[1,2], Sibylle Meyer[1], Rudolf Gross[1], and Sebastian T.B. Goennenwein[1] — [1]Walther-Meißner-Institut, Garching, Germany — [2]Univeristy of Alabama, Center for Materials for Information Technology MINT, Tuscaloosa, AL, USA

In the spin Seebeck effect thermally excited magnetic moments in a ferromagnet (FM) give rise to a pure spin current which is then detected in a normal metal (NM), usually platinum. Platinum, however, can be subject to a pronounced magnetic proximity effect, which induces a static magnetic polarization adjacent to the interface to the FM. This could eventually give rise to additional contributions by the anomalous Nernst effect in the longitudinal spin Seebeck geometry [1]. Therefore, we have conducted a series of measurements and simulations on YIG/Pt, YIG/Au/Pt, YIG/Cu/Pt, YIG/Au and YIG/Cu samples to verify whether recent spin Seebeck experiments have to be reevaluated on these terms. We find that contributions by the anomalous Nernst effect to the measured voltage signals [2] are much smaller, likely entirely negligible, than those from the spin Seebeck effect. Furthermore, the reported [1] inverse relation between the platinum film thickness and the spin Seebeck voltage can be explained by taking the spin diffusion in the NM into account. This work is supported by the DFG via SPP1538.

[1] S. Y. Huang et al., Phys. Rev. Lett. 109, 107204 (2012)
[2] M. Weiler et al., Phys. Rev. Lett. 108, 106602 (2012)

DF 22.62 Fri 10:30 Poster D

Efficient integration method for the intrinsic anomalous Hall conductivity — •Alexander Mook[1], Falko Pientka[1,2], Ingrid Mertig[1,3], and Peter Zahn[1,4] — [1]Institut für Physik, Martin-Luther-Universität, Von-Seckendorff-Platz 1, D-06120 Halle — [2]Fachbereich Physik, Freie Universität, D-14195 Berlin — [3]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle — [4]Helmholtz-Zentrum Dresden-Rossendorf, D-01314 Dresden

Haldane has already presented the expression of the intrinsic anomalous Hall conductivity as an integral over the Fermi surface as expected for Fermi-liquid theory [1] replacing the volume integral of the occupied states in the Brillouin zone.

We implemented both integration methods and applied them to a 4-band (sp^3) tight-binding Hamiltonian including both exchange splitting and spin-orbit coupling. Furthermore, we used an adaptive tetrahedral mesh refinement being based on the 8-tetrahedra-shortest-interior-edge method [2] to obtain convergence when integration over avoided crossings is necessary. Our investigations show that the results of both methods agree very well.

The adaptive integration method is applicable to advanced ab initio electronic structure schemes which provide besides the band energies also the Berry curvature.

[1] F. D. M. Haldane, *Phys. Rev. Lett.* **93**, 206602 (2004). [2] S. Zhang, *Houston J. Math.* **21** (3), 541-556 (1995).

DF 22.63 Fri 10:30 Poster D

Spin Nernst Angle: Definition and qualitative Estimation for Cu Alloys — •Peter Zahn and Sibylle Gemming — Helmholtz-Zentrum Dresden-Rossendorf, D-01314 Dresden, Germany

The spin Nernst effect describes the occurrence of a spin current perpendicular to an applied thermal gradient and the spin quantization axis in a non-magnetic material. To quantify the effect, the spin Nernst

angle will be defined in a more general way than in ref. [1]. This allows for a clear separation of the transverse spin current into two opposite contributions proportional to the spin Hall angle and the spin Nernst angle, respectively. Qualitative trends for Cu alloys with 3d, 4d, and 5d defects extending a resonant scattering model by Fert and Levy [2] will be presented.

The work was supported by the Initiative and Networking Fund of the German Helmholtz Association, Helmholtz Virtual Institute MEMRIOX (VH-VI-442).

[1] K. Tauber et al., Phys. Rev. Lett. **109**, 026601 (2012)
[2] A. Fert and P.M. Levy, Phys. Rev. Lett. **106**, 157208 (2011)

DF 22.64 Fri 10:30 Poster D

Zinc ferrite, an oxide for spintronics? — •Michael Bonholzer, Kerstin Brachwitz, Annette Setzer, Pablo Esquinazi, Michael Lorenz, and Marius Grundmann — Universität Leipzig, Institut für Experimentelle Physik II, Linnéstr. 5, 04103 Leipzig

Bulk zinc ferrite is known as an antiferromagnetic insulator with normal spinel structure [1, 2]. But in thin films grown by pulsed laser deposition, semiconducting behaviour of the conductivity is found [1, 3]. The conductivity can be tuned over several orders of magnitude by changing the growth conditions [3]. Magnetism in thin films is also affected by growth conditions and shows different properties compared to bulk as well. Zinc ferrite thin films have a ferrimagnetic magnetisation curve with a high saturation magnetisation and a coercive field of about 10 mT at room temperature. Curie temperature is expected to be well above 800 K [2, 3]. The unexpected properties can be explained by disorder caused by oxygen vacancies [3]. Also theoretical calculations show the semiconducting and ferrimagnetic behaviour of slightly distorted zinc ferrite. They also predict a high spin polarisation [4]. The properties make zinc ferrite a promising material for spintronic applications. First results on magnetic tunnel junctions consisting of a zinc ferrite bottom electrode, a magnesium oxide barrier and a cobalt top electrode show a tunnel magnetoresistance up to 25%.

[1] A. Marcu et al., J. Appl. Phys. **102**, 023713 (2007)
[2] C.E. Rodríguez Torres et al., Phys. Rev. B **84**, 064404 (2011)
[3] M. Lorenz et al., Phys. Status Solidi RRL **5**, 438 (2011)
[4] S. Soliman et al., Phys. Rev. B **83**, 085205 (2011)

DF 22.65 Fri 10:30 Poster D

Quantitative analysis of the spin Hall magnetoresistance in normal metal/ferromagnetic insulator hybrids — •F. Witek[1], S. Meyer[1], M. Althammer[2], S. Geprägs[1], M. Opel[1], R. Gross[1,3], A. Gupta[2], Y.-T. Chen[4], G.E.W. Bauer[4,5], H. Nakayama[5], E. Saitoh[5,6], and S.T.B. Goennenwein[1] — [1]Walther-Meißner-Institut, BAdW, Garching, Germany — [2]MINT Center, U. of Alabama, Tuscaloosa, USA — [3]Fakultät für Physik, TU München, Germany — [4]Kavli Institute of NanoScience, Delft, The Netherlands — [5]Institute for Materials Research, Tohoku U., Sendai, Japan — [6]The Advanced Science Research Center, JAEA, Tokai, Japan

Pure spin currents are a fascinating manifestation of spin physics in the solid state. We here report on a recently discovered magnetoresistance effect, arising from spin current flow across NM/FM interfaces. We observe this so-called spin Hall magnetoresistance (SMR) in $Pt/Y_3Fe_5O_{12}$ (Pt/YIG), Pt/nonferromagnetic metal/YIG, and Pt/Fe_3O_4 hybrid structures. The SMR effect stems from non-equilibrium spin transfer from the magnetic insulator into the Pt, in combination with spin Hall/inverse spin Hall effect. The SMR therefore characteristically depends on the orientation of the magnetization in the adjacent ferromagnet as observed in experiment. We show that the SMR is qualitatively different from the conventional anisotropic magnetoresistance effect arising in magnetic metals, and utilize the SMR to quantify the spin Hall angle and the spin diffusion length in the Pt layers. Financial support by the DFG via SPP 1538 SpinCAT and Nanoinitiative Munich (NIM) is gratefully acknowledged.

DF 22.66 Fri 10:30 Poster D

Determination of the magnetic depth profile of high-quality Fe_3O_4/ZnO heterostructures by polarized neutron reflectometry — •Michael Zapf[1], Ozan Kirilmaz[1], Sebastian Brück[1], Nina-Juliane Steinke[2], Nadezda Tarakina[3], Martin Kamp[3], Eberhard Goering[4], Michael Sing[1], and Ralph Claessen[1] — [1]Physikalisches Institut, Universität Würzburg, Germany — [2]Rutherford Appleton Laboratory, Chilton, UK — [3]Technische Physik, Universität Würzburg, Germany — [4]Max Planck Institute for Intelligent Systems, Stuttgart, Germany

Magnetite (Fe_3O_4) is one of the most promising materials for use as a spin injector into a semiconducting host. We demonstrate epitaxial growth of Fe_3O_4 films on the polar surfaces of ZnO single crystals. X-ray photoelectron spectroscopy evidences that the MBE-grown samples are phase-pure and nearly stoichiometric. The growth mechanism, the surface and film structure, the chemical profile and magnetic properties have been investigated in our previous publications.

To gain detailed information on the magnetic profile, polarized neutron reflectometry measurements were performed. Values for film thickness, roughness and magnetic moment were obtained from the reflectivity curves and checked against X-ray reflectometry, transmission electron microscopy and magnetometry data. A several nanometer thick region of reduced magnetization in the strained Fe_3O_4 layers near the heterointerface could be resolved. Thereby the efficiency of spininjection into ZnO could be strongly affected.

DF 22.67 Fri 10:30 Poster D

Exploring spin-filter tunneling in magnetic oxide hybrids — •Bernardus Zijlstra[1], Christian Caspers[1], Sebastian Flade[1], Michael Voigt[1], Jürgen Schubert[2], Claus M. Schneider[1], and Martina Müller[1] — [1]Peter-Grünberg-Institut (PGI-6), Forschungszentrum Jülich — [2]Peter-Grünberg-Institut (PGI-9), Forschungszentrum Jülich

A key requirement for the development of spintronic devices is the ability to electrically generate highly spin-polarized currents. Magnetic oxides that posses a spin-filter functionality are an interesting route for achieving this. In order to study the spin-filter tunneling mechanism, EuO was utilized as a representative of this magnetic oxide class.

With regard to studying the influence of band structure on the spin-filtering effect, a model-system was realized. Single-crystalline, ultrathin layers of EuO(100) were grown on lattice-matched Sn-doped In_2O_3(100) and characterized by RHEED, XRD and TEM. Moreover, the electrical behavior in this system was studied by spin-filter tunneling experiments.

Furthermore, single-crystalline EuO(100) was epitaxially grown on Si(100) with the final aim of studying spin injection through a magnetic tunnel barrier into a semiconductor. Contrary to earlier predictions of thermodynamic stability of EuO on silicon, formation of an intermediate silicide-layer was observed. To overcome this problem, the silicon surface was passivated by an ultrathin SiO_x layer and magnetotransport experiments were performed on such $EuO/SiO_x/Si$ heterostructures.

DF 22.68 Fri 10:30 Poster D

FMR measurements: Thickness dependence of YIG film investigated by spin pumping — •René Röser[1], Andreas Kehlberger[1], Gerhard Jakob[1], Benjamin Jungfleisch[2], Burkard Hillebrands[2], Ulrike Ritzmann[3], Denise Hinzke[3], Dong Hun Kim[4], Caroline Ross[4], Ulrich Nowak[3], and Mathias Kläui[1] — [1]Institute of Physics, Johannes Gutenberg-University Mainz, 55099 Mainz, Germany — [2]Department of Physics, Institute of Technology Kaiserslautern, 67663 Kaiserslautern, Germany — [3]Department of Physics, University of Konstanz, 78457 Konstanz, Germany — [4]Department of Materials Science and Engineering, MIT, Cambridge, MA 02139, USA

The production method pulsed laser deposition (PLD) offers the opportunity to study high quality YIG ($Y_3Fe_5O_{12}$) films in the sub micrometer thickness regime (Yiyan Sun et al., Appl. Phys. Lett. 101, 152405 (2012)). Especially thin bilayer systems consisting of YIG coated with materials with high spin orbit coupling became focus of the general interest. These systems turned out to be an important mechanism for the generation of a spin current in nonmagnetic conductors by spin pumping (C.W. Sandweg et al., Phys. Rev. Lett. 106, 216601 (2011)). We present studies of a variety of YIG films produced by PLD. The films are characterized by the thickness, surface roughness and crystalline order. Furthermore the intrinsic magnetic properties are investigated by a SQUID and a Vector Network Analyzer-FMR setup. In order to determine the spin wave excitation spectrum in thin YIG films, which are coated with platinum, we compare films of thicknesses up to 300nm.

DF 22.69 Fri 10:30 Poster D

Nernst vs. spin-Seebeck effects in Py thin films — •M. Schmid[1], S. Srichandan[1], M. Vogel[1], C. Strunk[1], C. Back[1], D. Meier[2], T. Kuschel[2], J.M. Schmalhorst[2], and G. Reiss[2] — [1]1Physics department University of Regensburg, Regensburg, Germany — [2]Thin Films and Physics of Nanostructures, Department of

Physics, University of Bielefeld, Germany

Magneto-thermal effects are investigated in Permalloy (Py) films deposited on different substrates (MgO and GaAs). The transverse voltage V_y is measured with attached Pt stripes on the Py. The measurements are taken with different in plane temperature gradients (along x) up to 50 K and an applied in plane magnetic field at various angles. The obtained signals can be identified as a combination of the anomalous (ANE) and the planar (PNE) Nernst effects. The PNE follows a $\cos(\Theta)\sin(\Theta)M\nabla T$ dependence, with M the magnetization, ∇T the temperature gradient and Θ being the angle between the two. The PNE voltage is of the order of μV which is consistent with the literature [1]. The ANE exhibits a $\cos(\Theta)$ relation with an amplitude of about 100 nV and is connected to an out of plane temperature gradient. Additionally, a small, but non-negligible contribution of the spin-Seebeck effect is considered but its magnitude is orders smaller than reported in the literature [2]. A COMSOL simulation of the temperature distribution supplements our interpretation. Finally, we studied Nernst effects in Py films deposited SiN membranes.

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DF 22.70 Fri 10:30 Poster D

In search of spin caloric effects in thin permalloy films using different setups for transverse spin Seebeck effect measurements — •Timo Kuschel[1], Daniel Meier[1], Takashi Kikkawa[2], Ken-ichi Uchida[2], Eiji Saitoh[2], Jan-Michael Schmalhorst[1], and Günter Reiss[1] — [1]University of Bielefeld, Germany — [2]Tohoku University of Sendai, Japan

In spin caloritronics the spin Seebeck effect (SSE) (generation of a spin current by a temperature gradient) plays an important role. After the original observation in thin permalloy films on sapphire substrates in the transverse geometry (TSSE) in 2008 many scientific groups tried to measure the TSSE on different materials. Often an additional out-of-plane temperature gradient generates an anomalous Nernst effect (ANE) which contributes to the measured signal.
We built up a setup for TSSE measurements and investigated thin permalloy films on sapphire and MgO substrates. While our measurements reveal a symmetric contribution concerning the external magnetic field due to the anisotropic thermopower (planar Nernst effect), an additional asymmetric contribution due to the TSSE or ANE is not observed in most cases. For comparison we used the original setup in Japan and obtained different results for the same samples. An asymmetric contribution due to the TSSE or ANE is now contributing for nearly every sample. This inconsistency is discussed in the context of setup differences and probable out-of-plane temperature gradients.

DF 22.71 Fri 10:30 Poster D

Anisotropic magneto-thermopower and control of temperature gradients in (113) oriented (Ga,Mn)As thin films — •Mathias Frank[1], Sibylle Meyer[1], Lukas Dreher[2], Wladimir Schoch[3], Rudolf Gross[1,4], and Sebastian T. B. Goennenwein[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 — [4]Physik-Department, Technische Universität München, Garching, Germany

For caloritronic experiments, it is of crucial importance to control the direction and amplitude of temperature gradients within a given sample. We have implemented and compared different methods to apply and measure longitudinal and transverse temperature gradients in a (Ga,Mn)As thin film. We further studied the anisotropic magneto-thermopower (AMTP), i.e. the characteristic dependence of the thermopower with respect to the orientation of the magnetization vector. Our data show that the AMTP can be adequately modeled only if the symmetry of the (Ga,Mn)As crystal is explicitly taken into account. We quantitatively compare the AMTP data with the anisotropic magnetoresistance (AMR) data taken on the same (113) - oriented (Ga,Mn)As thin film and with corresponding model calculations. Moreover, we address the differences between the magnetoresistance and the magneto-thermopower coefficients. Financial support by DFG via SPP 1538 is gratefully acknowledged.

DF 22.72 Fri 10:30 Poster D

Dynamical heating of ferrimagnetic structures in a wide range of magnetic fields — •Thomas Langner, Vitaliy Vasyuchka, Benjamin Jungfleisch, Andrii Chumak, Alexander Serga, and Burkard Hillebrands — Fachbereich Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, Erwin-Schroedinger-Str. 56, 67663 Kaiserslautern, Germany

Precessing magnetic moments can generate heat due to the decay of the precessional motion and the following transfer of energy into the phonon system. We placed a polycrystalline disc of yttrium iron garnet (YIG) in an external magnetic field and excited it with high power microwaves. The temperature of the disc was monitored with an infrared camera. Beside large heating at the ferromagnetic resonance (FMR) we show an unexpected heat generation with applied microwave frequencies around 3.5 GHz for magnetic fields between 0 and 200 Oe far below the FMR. In spite of practically the same absorption of microwaves the heating becomes smaller with higher magnetic field values in the mentioned range. The behavior can then be understood by resonant magnetic excitations of the grain structure inside the polycrystalline material. This assumption can be confirmed by a comparison to the behavior of a monocrystalline YIG structure and by an excitation of the polycrystalline sample by microwaves of higher frequencies.

Financial support by Deutsche Forschungsgemeinschaft within priority program SPP 1538 "Spin Caloric Transport" is gratefully acknowledged.

DF 22.73 Fri 10:30 Poster D

Structural and magnetic properties of $NiFe_2O_4$ thin films prepared by different deposition techniques — •Christoph Klewe[1], Timo Kuschel[1], Daniel Meier[1], Gerhard Götz[1], Liming Shen[2], Arunava Gupta[2], Karsten Küpper[3], Jan-Michael Schmalhorst[1], and Günter Reiss[1] — [1]Bielefeld University, Germany — [2]University of Alabama, Tuscaloosa, AL, USA — [3]University of Osnabrück, Germany

Recent advances in the field of spin caloritronics have urged the search for ferro- or ferrimagnetic, insulating materials in thin film form. One material which promises to be suitable for studies of the longitudinal Spin Seebeck effect is Nickelferrite ($NiFe_2O_4$). We fabricated $NiFe_2O_4$ thin films on $MgAl_2O_4$ (001) substrates by direct liquid injection chemical vapour deposition(DLI-CVD) and dc magnetron co-sputtering in a pure oxygen atmosphere. Stoichiometric measurements were performed using energy dispersive x-ray spectroscopy (EDX), x-ray fluorescence (XRF) and sputter x-ray photoelectron spectroscopy (XPS). Structural properties were investigated by x-ray diffraction analysis (XRD) and scanning electron microscopy (SEM). Magnetic properties were determined from magnetooptic Kerr effect (MOKE) and alternating gradient magnetometry (AGM) measurements. Temperature dependent measurements were carried out in order to investigate the resistivity and determine the bandgap. The results were compared to identify the best deposition technique and parameters with regard to the insulating properties of the ferromagnetic films.

DF 22.74 Fri 10:30 Poster D

Cooling Nanodevices by Spin Currents — •Jochen Brüggemann[1], Stephan Weiss[2], Peter Nalbach[1], and Michael Thorwart[1] — [1]1. Institut für theoretische Physik, Universität Hamburg, 20355 Hamburg, Deutschland — [2]Theoretische Physik, Universität Duisburg-Essen & CENIDE, 47048 Duisburg, Deutschland

In analogy to the demagnetization cooling for macroscopic devices, we aim to develop and analyze a magnetocaloric cooling cycle for nanodevices. For a proof of principle, a simple model consists of the following: First, an interacting quantum dot, which is tunnel coupled to ferromagnetic leads; second, dot electrons which can interact via exchange interaction with a localized impurity spin; and third, a Holstein phonon for the mechanical degrees of freedom. Using the real-time diagrammatic perturbation theory in lowest order in the hybridization of the leads, we determine the impurity spin dynamics as well as the mean energy of the mechanical oscillator as functions of the system parameters and the bias voltage. In agreement with previous findings, we reproduce an effective cooling of the impurity spin in the stationary limit. In the transient nonequilibrium regime, we realize a cooling cycle aiming at accumulating an increased ground state population of the phonon due to the cooling of the impurity spin as compared to the initial preparation.

DF 22.75 Fri 10:30 Poster D

Steady-state measurements of thermal effects in GaMnAs/GaAs/Pt systems — •Nadezda Panarina[1], Ivan Soldatov[1], Christian Hess[1], Rudolf Schäfer[1], Sibylle Meyer[2], Sebastian Gönnenwein[2], Wolfgang Limmer[3], and Wladimir Schoch[3] — [1]IFW Dresden, Dresden, Germany — [2]WMI, Garching, Germany — [3]Universität Ulm, Ulm, Germany

The steady-state measurements were performed on the GaAs/GaMnAs/ Pt system, where the so-called spin Seebeck effect is claimed to exist. The main principle of the steady-state technique lies in attaining and controlling thermal equilibrium and stable thermal gradient along the sample, which provides enhanced accuracy of the experimental data. It was possible to detect the transverse electric signal on the Pt strips deposited at different distances to the heater. The behavior of the detected signal (sign and value) depended strongly on the experimental details, such as position of the heater on the sample (on top or side), the range of the magnetic field sweep (varying from tens up to hundreds of mT) and temperature of measurement. Moreover, the transverse voltage was registered directly on the GaMnAs film in the same run of the experiments. This fact questions the role of Pt layers in detecting the thermal-gradient-induced signal and suggests the transverse thermopower, or planar Nernst, origin of the magneto-electric effects observed in the thin ferromagnetic film of GaMnAs.

DF 22.76 Fri 10:30 Poster D

Spin wave mediated heating in a magnetic insulator — •Vitaliy I. Vasyuchka, Alexander A. Serga, Andrii V. Chumak, and Burkard Hillebrands — FB Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

We present the results on spin wave mediated heating in films of a magnetic insulator using a thermography technique. The experiments were performed using a single-crystal yttrium iron garnet (YIG) film. We have found conditions when the direction of the heating of the sample can be controlled by an external magnetic field. In this case a large shift of the temperature maximum away from the excitation antenna of up to a few millimeters was observed. It was understood as a result of the interplay between the unidirectional heating and the diffusion of heat into the cold part of the YIG film. We found that the temperature maximum and its shift relative to the excitation antenna strongly depend on the speed of spin waves.

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DF 22.77 Fri 10:30 Poster D

Ground state, static vortices, and dynamic excitations in magnon Bose-Einstein condensates — •Patryk Nowik-Boltyk[1], Oleksandr Dzyapko[1], Vladislav Demidov[1], Natasha Berloff[2], and Sergej O. Demokritov[1] — [1]Universität Münster; Institut für Angewandte Physik — [2]University of Cambridge, Department of Applied Mathematics and Theoretical Physics

Although the basic properties of magnon Bose-Einstein condensates have been extensively studied during the last 5 years, details of the ground state, topological defects and induced dynamics of the condensate have not been addressed so far. Here we present a detailed study of the ground state of the condensate and static vortices as well as the dynamics of the condensate by means of space- and time-resolved Brillouin Light Scattering spectroscopy. We show that the intrinsic degeneracy of the condensate results in formation of a non-uniform ground state demonstrating a standing-wave of the condensate density. We also experimentally observed static defects in the condensate in a form of quantized vortices. The study of induced dynamics was performed using spatially and temporary non uniform external magnetic fields. For relatively slow field pulses we observe a quasi-adiabatical accommodation of the condensate density at the place of the field. If we use very short and fast field pulses, travelling density waves can be observed. If the field is varied periodically in the megahertz frequency range, traveling density waves are also observed. The dispersion relation of the newly observed waves is determined.

DF 22.78 Fri 10:30 Poster D

Nonlinear emission of spin-wave caustics from an edge mode of a micro-structured $Co_2Mn_{0.6}Fe_{0.4}Si$ waveguide — •Thomas Sebastian[1,2], Philipp Pirro[1], Thomas Brächer[1,2], Takahide Kubota[3], Hiroshi Naganuma[4], Alexander A. Serga[1], Mikihiko Oogane[4], Yasuo Ando[4], and Burkard Hillebrands[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Graduate School Materials Science in Mainz, 67663 Kaiserslautern, Germany — [3]WPI Advanced Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan — [4]Department of Applied Physics, Graduate School of Engineering, Tohoku University, Sendai 980-8579, Japan

The low Gilbert damping of the Heusler compound $Co_2Mn_{0.6}Fe_{0.4}Si$ (CMFS) makes the material a promising candidate for the utilization in perspective *magnon-spintronic* devices [1].

We present the nonlinear emission of spin-wave caustics [2] from a localized edge mode [3] in a CMFS waveguide at twice and three times the excitation frequency observed by Brillouin light scattering microscopy. The propagation characteristics of these strongly directed beams are confirmed by analytic modeling using the anisotropic dispersion for spin waves in magnetic thin films.

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DF 22.79 Fri 10:30 Poster D

Magnon temperature measurement: new insights into spin Seebeck effect — •Milan Agrawal[1], Vitaliy I. Vasyuchka[1], Alexander A. Serga[1], Alexy D. Karenowska[2], Gennadiy A. Melkov[3], and Burkard Hillebrands[1] — [1]Fachbereich Physik and Forschungszentrum OPTIMAS, Technische Universität Kaiserslautern, Kaiserslautern, 67663, Germany — [2]Department of Physics, University of Oxford, Oxford OX1 3PU, UK — [3]Faculty of Radiophysics, Taras Shevchenko National University of Kyiv, 03127 Kyiv, Ukraine

The study of magnon-phonon interaction is very important for the advancement of the emerging field of spin caloritronics [1]. The distribution of magnon and phonon temperatures in ferromagnets can explain the thermal spin-transport phenomena which have been observed electrically by measuring the induced inverse spin Hall voltage in normal metal placed over the ferromagnet [2-3]. Here, we report on the measurement of spatial distribution of magnon temperature in magnetic system imposed to a lateral thermal gradient by studying the variation of local magnetization. Our measurements reveal a strong correlation between magnons and phonons, and state that the contribution of magnons to the spin Seebeck effect in magnetic insulators is negligible or rather small. Furthermore, typical length scale of phonon-magnon interaction is calculated. Our results give new insights into the magnon contribution to the spin Seebeck effect.

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DF 22.80 Fri 10:30 Poster D

Heat-induced damping manipulation in YIG/Pt heterostructures — •Matthias Benjamin Jungfleisch[1], Toshu An[2], Kazuya Ando[2], Yosuke Kajiwara[2], Ken-ichi Uchida[2], Vitaliy I. Vasyuchka[1], Andrii V. Chumak[1], Alexander A. Serga[1], Eiji Saitoh[2], and Burkard Hillebrands[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, Technische Universität Kaiserslautern, D-67663 Kaiserslautern, Germany — [2]Institute for Material Research, Tohoku University, Sendai 980-8577, Japan.

One of the main objectives in the field of magnon spintronics is the control and manipulation of magnetization relaxation and the generation of spin waves.

Here, we show the manipulation of spin-wave damping utilizing a temperature difference across the thickness of an yttrium iron garnet (YIG)/platinum (Pt) multi-structure. This temperature difference ΔT gives rise to the longitudinal spin Seebeck effect: an imbalance between the effective magnon and the effective electron temperatures causes a spin current across the YIG/Pt interface. Since the created spin current transfers spin angular momentum, a torque is exerted on the magnetization. Consequently, the magnetization precession is either enhanced or suppressed depending on the sign of ΔT. This damping variation can be expressed as a change of the ferromagnetic resonance linewidth ΔH_{FMR} that is measured by spin pumping in the adjacent Pt layer as well as by microwave reflection.

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DF 22.81 Fri 10:30 Poster D

Correlation of Inverse Spin Hall Effect to the crystal growth of magnetic films — •Philipp Fuhrmann, Evangelos Papaioannou, and Burkard Hillebrands — Fachbereich Physik, Technische Universität Kaiserslautern, D-67663 Kaiserslautern, Germany

Spin transfer torque and spin pumping phenomena in magnetic hetero structures have attracted a lot of interest in the field of spintronics. Spin pumping and Inverse Spin Hall Effect (ISHE) in ferromagnetic

/ normal metal systems have been extensively investigated over the last years, covering dependencies on layer thickness and choice of material. However no systematic studies have been performed regarding the influence of the growth modes of the ferromagnetic / normal metal systems on spin pumping and ISHE.

In this work we present the correlation of crystal growth to ISHE. Structural properties of high quality epitaxial Fe films, covered with a Pt layer, are shown by Scanning Tunnel Microscopy and X-Ray Reflectivity. Characteristic roughness parameters are extracted by height-height correlation analysis. Magnetization properties are studied with the help of longitudinal Kerr effect. We show the dependence of ISHE on the crystal quality, and we correlate ISHE to surface roughness and magnetic anisotropies.

DF 22.82 Fri 10:30 Poster D

^{1}H-NMR in the heterometallic complex Mn_2Ni_3 — •Marco Günther[1], Liang Gong[1], Markus Brettschneider[1], Evgenia Vavilova[2], Vladislav Kataev[3], Animesh Das[4], Franc Meyer[4], and Hans-Henning Klauss[1] — [1]Institut für Festkörperphysik, TU Dresden — [2]Kazan Physical-Technical Institute — [3]Leibniz-Institute for Solid State and Materials Research IFW Dresden — [4]Institut für Inorganic Chemistry, Georg-August-University Göttingen

We studied the quasi-linear heterometallic complex Mn_2Ni_3, a recently synthesized single-molecule magnet by means of solid state proton NMR. The proton spectra is observed down to T=1.5 K where strong static hyperfine fields due to the $|S^z_{tot}$ =-7> ground state arise. The spectra is simulated with respect to the dipole summation of electronic moments at the local probe sites.

Proton T_1-relaxation rate probes the electronic dynamics in the paramagnetic regime down to the ground state formation within two orders of magnitude. For the lowest temperatures, we present our measurements of the field-depending relaxation experiments.