MA 17: Poster Session I

Magnetic Materials, Thin Films, Nano- und Mikrostruktured Materials, Magnetic Imaging and Measurement Techniques, Particles and Bio- and Molecular Magnetism, Magnetic Heuslers, Half-metals, Semi-conductors and Oxydes, Exchange bias and magnetic coupling phenomena.

Time: Tuesday 9:30–12:30 Location: Poster B1

MA 17.1 Tue 9:30 Poster B1

How to accomplish (quasi) in-situ neutron reflectivity measurements on ultrathin magnetic films — •Sabine Pütter, Amir Syed Mohd, Stefan Mattauch, Alexandros Koutsioubas, Harald Schneider, and Thomas Brückel — Jülich Centre for Neutron Science JCNS, Forschungszentrum Jülich GmbH, Outstation at MLZ, Garching, Germany

The investigation of ultrathin films which are sensitive to ambient air at large scale instruments is a challenge as the capabilities for on-site growth UHV chambers to measure in-situ are often limited, mostly due to lacking space. A common solution is the use of protecting cap layers on top of the films. However they might change the physical properties of the sample.

Our solution is a handy mini UHV-chamber which is used for sample transfer and quasi in-situ measurements at the neutron reflectivity instrument MARIA of the Jülich Centre for Neutron Science at MLZ in Garching. The samples are prepared in the adjacent thin film laboratory by molecular beam epitaxy and moved into the compact chamber for transfer. It is equipped with sapphire windows, an SAES getter pump and a wobble stick, which serves also as a sample holder for samples of up to 1.4 cm^2. The pressure in the transfer chamber is kept below 10^{-9} mbar. Neutron reflectivity measurements can be performed at room temperature in magnetic fields of up to 600 mT.

We present first polarized neutron reflectivity measurements on Co thin films at room temperature in a magnetic field of 300 mT in the Q-range up to 0.2 $Å^{-1}$.

MA 17.2 Tue 9:30 Poster B1

VEKMAG - a new vector magnet beamline in BESSY II — •Chen Luo[1], Hanjo Ryll[2], Florin Radu[2], Steffen Rudorff[2], Olive Rader[2], Tino Noll[3], D. A. Tennant[4], Andrew James Britton[5], Lucas Arruda[5], Yin Ming Chang[5], Jorge Miguel[5], Wolfgang Kuch[5], Radu-Marius Abrudan[6], Hartmut Zabel[6], Georg Woltersdorf[7], Markus Hollnberger[1], and Christian Back[1] — [1]Universität Regensburg — [2]Helmholtz-Zentrum Berlin — [3]Technische Universität Berlin — [4]Oak Ridge National Laboratory, USA — [5]Freie Universität Berlin — [6]Ruhr-Universität Bochum — [7]Martin-Luther-Universität Halle-Wittenberg

VEKMAG is a vector superconducting magnet station, which is being jointly developed by Regensburg University, Free University Berlin, Ruhr University Bochum, and Helmholtz Zentrum Berlin. The instrument is installed at the PM2 dipole beamline of the synchrotron facility BESSY II.

The instrument is designed for XAS/XMCD/XMLD measurements, as well as for ferromagnetic resonance (FMR) and electron paramagnetic resonance (EPR) measurements using XMCD. Its 3D vector magnet can provide 9 T field in the x-ray beam direction, 2 T field anywhere in the horizontal plane, and 1 T field in all directions. It has two variable temperature inserts (VTI) - the low temperature VTI and the FMR VTI which allow measurements with a temperature range of 2 K-400 K and 4 K-500 K respectively.

The VEKMAG project is funded by the German Federal Ministry for Education and Research (BMBF).

MA 17.3 Tue 9:30 Poster B1

Resonant Soft X-Ray Diffraction on Chiral Multiferroic Ba3TaFe3Si2O14 — •Mahesh Ramakrishnan[1], Yoav William Windsor[1], Laurenz Rettig[1], Aurora Alberca[1], Elisabeth Bothschafter[1], Yves Joly[2], Rafik Ballou[2], Virginie Simonet[2], Pascal Lejay[2], Valerio Scagnoli[1], and Urs Staub[1] — [1]Swiss Light Source, Paul Scherrer Institut, Villigen PSI, Switzerland — [2]Institut Neel, CNRS and Universite Grenoble Alpes, Grenoble Cedex 9, France

We study the incommensurate spin structure of the multiferroic helical butterfly Ba3TaFe3Si2O14 using resonant soft x-ray diffraction. We investigate the role of the out-of-plane spin moments in the magnetically induced lattice modifications resulting in ferroelectric polarization. We also combine ab initio calculations and results from recent neutron scattering measurements to re-examine the symmetry of the low temperature crystal structure.

[1] Scagnoli V. et al., Phys. Rev. B 88 104417 (2013)
[2] Chaix L. et al., arXiv:1506.06491 (2015)

MA 17.4 Tue 9:30 Poster B1

Research and cost-saving production of size-selected magnetic nanoparticles from toners — •Miriam Leifels, Paula Weber, and Mathias Getzlaff — Heinrich-Heine-Universität Düsseldorf

The investigation of laser printer toners proves that they often contain magnetic nanoparticles. The aim is to isolate them from the nonmagnetic ones as a cost-saving method for production. There are many constructive characterization methods like energy dispersive x-ray spectroscopy, dynamic light scattering, x-ray diffraction, scanning electron microscopy and transmission electron microscopy to analyze particles which are part of toners. Thus, we obtain information about the element composition, size and shape of the particles. It shows that all the toners which contain magnetic particles have a bimodal size distribution. It is possible to isolate the magnetic particles from the nonmagnetic ones. For that process we solve the toner powder in a suitable solvent. Subsequently, we use a little magnet to isolate all the magnetic particles out of solution. This enables to make measurements only with the magnetic particles and independently only with the nonmagnetic ones, exemplarily by dynamic light scattering. After separation we are able to measure the size of the magnetic particles and nonmagnetic particles separately. It shows that the magnetic particles have a different size as the nonmagnetic particles. One peak of the bimodal size distribution only represents magnetic and the other peak only nonmagnetic particles.

MA 17.5 Tue 9:30 Poster B1

Magnetic and structural propertiesof small binary Fe_mGe_n, Ni_mGe_n clusters — •A. Ziane[1,2], A. Mokrani[3], M. Zemirli[2], and M. Benakki[2] — [1]Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich and JARA, D-52425 Jülich, Germany — [2]Laboratoire de Physique et Chimie Quantique, Université Mouloud Mammeri de Tizi-Ouzou, B.P. N°17 RP, Algeria — [3]Institut des Matériaux Jean Rouxel, BP 32229, 2 rue de la Houssinière, F-44322 Nantes cedex, France

Transition metal germanides clusters could be considered as an ideal system for studying how the localized *d* electrons interact with the *sp* quasi-free electrons gas to enhance the transition metal (TM) magnetic moments, and then explain the unusual large moments observed when TM are adsorbed on *sp* metal surfaces [1]. Here we investigate from first-principles the magnetic and structural properties of small binary Fe_mGe_n, Ni_mGe_n clusters. We show that the clusters prefer the 3D closed structures with interatomic distances that are dependent on the clusters sizes. The binding energy increases with the cluster size and the addition of an atom, regardless of its nature, strengthens the stability of the system. Interestingly, the Germanium induced moments are negligible but couple antiferromagnetically to the TM moments. All of non magnetic Ni_mGe_n clusters have a low HOMO-LUMO gap in contrast to Fe_mGe_n clusters, which present a relatively large gap in only one spin channel revealing thereby their semi-metallic nature.

[1] Qun Jin *et al.*, The Journal of Chemical Physics **128**, 124319 (2008)

MA 17.6 Tue 9:30 Poster B1

Carbon nanotube encapsulated magnetic particles: Insights from statistical analysis — •Markus Gellesch[1], Marcel Haft[1], Silke Hampel[1], Sabine Wurmehl[1,2], and Bernd Büchner[1,2] — [1]IFW Dresden, Institute for Solid State Research, PF 270116, 01171 Dresden, Germany — [2]Institute for Solid State Physics, Dresden Technical University, TU Dresden, 01062

We report investigations of assemblies of carbon nanotube encapsulated intermetallic magnetic nanoparticles. As a result from annealing treatments with various durations, the evolution of particle size and,

likewise, of magnetic properties with progressing annealing duration could be observed. Here, we present a thorough statistical analysis of particle samples which yielded a multimodal size distribution. The investigation of this size distribution as function of annealing time provided the grounds to formulate a model for formation and growth of metallic particles inside confined geometries (here: the inner cavity of the carbon nanotubes). The derived average particle size well-described known magnetic behavior of ferromagnetic nanoparticles. In detail, a multi- to single domain transition, as well as indications for a transition to the superparamagnetic state, were found in coercivity data as function of the characteristic nanoscale length of the considered nanoparticulate systems. Our study emphasizes the advantage of a detailed statistical analysis of assemblies of magnetic nanoparticles in order to obtain insights on particle formation and growth and, subsequently, on related physical properties, such as magnetism.

MA 17.7 Tue 9:30 Poster B1

magnetic hardening effect in self-assembled iron oxide nanoparticle films — •Xiao Sun, Oleg Petracic, and Thomas Brückel — Jülich Centre for Neutron Science JCNS and Peter Grünberg Institut PGI, JARA-FIT, Forschungszentrum Jülich GmbH, 52428 Jülich

By comparing the hysteresis loops of iron oxide nanoparticles (NPs) cooled at different magnetic fields, a hardening effect can be observed. The squareness and hardness of hysteresis loops is significantly enhanced with increasing the magnetic cooling field. Due to the antiferromagnetic (AF) wustite component, the spins of the ferrimagnetic magnetite/maghemite components are exchange biased and an anisotropy axis is induced. The influence of the induced anisotropy onto the magnetic correlations of the magnetic superspins was investigated. Self-assembled NP films have been fabricated using various methods (drop-casting, spin-coating, and liquid-air-interface) using 15 or 20nm iron oxide NPs. Large areas of self-assembled NPs has been achieved using the liquid-air interface method. The hardening effect of diluted iron oxide NPs is compared to self-assembled NP films.

MA 17.8 Tue 9:30 Poster B1

Magnetic force microcopy in the light of the pseudo-pole model — •Adrian Schillik[1], Matthias Stocker[1], Berndt Koslowski[1], Riedmüller Riedmüller[2], Runbang Shao[2], and Ulrich Herr[2] — [1]Institut für Festkörperphysik, Universität Ulm, D-89081 Ulm — [2]Institut für Mikro- und Nanomaterialien, Universität Ulm, D-89081 Ulm

Magnetic force microscopy (MFM) is a powerful and simple tool to analyze magnetic materials and structures down to the nano-meter scale. Though in use since almost 3 decades MFM suffers from a significant handicap: it is difficult to obtain quantitative results. This could be overcome by the recently proposed pseudo-pole model [1] assuming a cone which is covered homogeneously with dipoles pointing to the tip of the cones. The magnetic tip is then characterized by a single parameter and the field distribution is given by a simple analytic expression in the half-space in front of the tip. We tie in to the pseudo-pole model by verifying its general applicability and trying to uncover limitations. Here we report on the status of the resumed project. [1] Häberle, Thomas, et al. "Towards quantitative magnetic force microscopy: theory and experiment." New Journal of Physics 14.4 (2012): 043044.

MA 17.9 Tue 9:30 Poster B1

Exchange Bias in Granular Ferromagnet/Antiferromagnet Nanostructures — •Runbang Shao, Benjamin Riedmüller, Balati Kuerbanjiang, and Ulrich Herr — Institut für Mikro- und Nanomaterialien, Universität Ulm, Ulm, Deutschland

Exchange bias of ferromagnetic (FM) nanoparticles could be used to beat superparamagnetic limit, and the storage density of hard disk drive can be increased subsequently. For such application, a nanostructure with Ni nanoparticles embedded in an antiferromagnetic (AF) IrMn matrix is investigated. To determine the average size of the nanoparticles, the superparamagnetic m-H curve of Ni nanoparticles embedded in a diamagnetic matrix at room temperature is fitted using a superposition of Langevin functions. The fitted log-normal size distribution coincides with the result obtained by T-SEM analysis of unembedded Ni particles. After a field cooling procedure, exchange bias is observed for 10 nm Ni nanoparticles embedded in a IrMn matrix at 10 K. The exchange bias dependence on the Ni volume filling factor is studied. The exchange bias increases with the decreasing Ni volume filling factor up to a maximum of 650 Oe. By modeling the dependence of exchange bias on FM volume filling factor we conclude that a shell of AF material with a minimum thickness of 5.7 nm is needed around one Ni nanoparticle to achieve the largest exchange bias.

MA 17.10 Tue 9:30 Poster B1

Manipulation of Magnetic Nanoparticles for Lab-on-Chip systems — Shalini Easwardas, •Benjamin Riedmüller, Florian Ostermaier, and Ulrich Herr — Institut für Mikro- und Nanomaterialien, Ulm, Deutschland

Magnetic nanoparticles are widely used for Lab-on-chip systems. In such applications, biological analytes can be specifically bound to the surface of the magnetic particles. Many of these applications require a highly accurate and controlled manipulation of the particles. A common principle for manipulation is the application of magnetic field gradients by which a force on the particles is generated. Here we show a manipulation technique based on the superposition of field gradients generated by tapered conductor lines and an additional homogeneous magnetic field. By this technique we are able to position single superparamagnetic particles in two dimensions on length scales > 100 um with a precision of < 1 um. Our results show that the short-term fluctuations of the particle as quantified by the mean square displacement (MSD) are strongly influenced by the particle-surface interaction. By analyzing the fluctuations on time scales of several minutes the trap stiffness can be extracted. Combining the experimentally observed trap stiffness with the values predicted from quantitatively modeling the force landscape around the energy minimum of the trap, the magnetic moment of a single superparamagntic particle can be extracted with high precision.

MA 17.11 Tue 9:30 Poster B1

Magnetic characterization of iron oxide superparamagnetic nanoparticles on surfaces — •Stanislav Emelianov, Maryam Youhannayee, and Mathias Getzlaff — Institute für angewandte physik, Heinrich-Heine-universität Düsseldorf

Nowadays Magneto-optic effects are widely used in magnetic research. Magnetic characteristics of thin films and nanoparticles properties are of big interest for scientists due to its wide application in different field such as medicine. In our experiment we investigate the properties of iron oxide superparamagnetic nanoparticles on surface applying SQUID and also the methodology and the setup of the transverse magneto-optic Kerr effect (TMOKE) which is based on the analysis of p-polarized laser beam intensity after interaction with magnetic samples. In our experiment superparamagnetic nanoparticles are prepared by wet chemical synthesis. It is a coprecipitation of Ferric Chloride and Ferrous Sulphate with Ammonium hydroxide. The obtained parameters are illustrated by means of hysteresis loops which indicate the relevant magnetic characteristics.

MA 17.12 Tue 9:30 Poster B1

Combined Optical and Magnetical Trapping of Magnetic Microbeads — •Florian Ostermaier[1], Benjamin Riedmüller[1], Tobias Neckernuss[2], Othmar Marti[2], and Ulrich Herr[1] — [1]Institut für Mikro- und Nanomaterialien, Universität Ulm, Ulm, Deutschland — [2]Institut für Experimentelle Physik, Universität Ulm, Ulm, Deutschland

Optical tweezers have been established as a powerful tool for manipulation of particles in the range from nanometers to micrometers with sub-nanometer accuracy. On the other hand, magnetic nanoparticles are widely used for bonding and detecting biological analytes in Lab-on-Chip systems. Magnetic nanoparticles can be effectively manipulated by magnetic field gradients. In previous works, we have developed a novel method for stable positioning of superparamagnetic nanoparticles on the micro-scale using a combination of the field gradient produced by tapered conductor lines and a superimposed homogeneous magnetic field. However, the accuracy of detection in the original setup is limited by the resolution of the optical microscope. The combination of both methods opens up new perspectives for applications of nanoparticles in absorbing media. We present first experimental results obtained by integrating a magnetic micro-trap into an optical tweezer setup. It is demonstrated that under suitable conditions stable positioning of commercially available microbeads (Dynabeads MyOne Streptavidin T1, diameter 1 μm) in the optical tweezer can be achieved.

MA 17.13 Tue 9:30 Poster B1

Transport of superparamagnetic particles on magnetically structured exchange bias layer systems in microfluidic devices

with transversal flow — •Meike Reginka, Dennis Holzinger, Iris Koch, and Arno Ehresmann — Department of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel

Designing an analysis platform for microfluidic devices based on the directed transport of particles requires an estimate of the particle's behaviour in the presence of transversal liquid flow. The controllable movement of superparamagnetic particle rows above magnetically stripe-patterned exchange bias (EB) layer systems can be used to efficiently transport analyte molecules attached to the particle in a microfluidic structure.[1] The head-to-head and tail-to-tail orientation of the magnetization in adjacent stripe domains vertical to the long stripe axis is introduced to the EB sample by ion bombardment induced magnetic patterning (IBMP). Particle velocities perpendicular to the direction of their simultaneous transport caused by transversal fluid flows of defined rates have been experimentally determined. It has been shown that their velocities along the flow direction are 2 to 3 magnitudes smaller than the mean fluid velocity since the particles are transported close to the sample surface. The trajectory of a particle remains almost unaffected and allows for the purification of biomolecules in microfluidic devices with transversal flow components.

[1] D. Holzinger, I. Koch, S. Burgard, and A. Ehresmann, ACS Nano 9, 7323 (2015)

MA 17.14 Tue 9:30 Poster B1

Micro Hall-Magnetometry: Studying magnetic nanostructures using First Order Reversal Curves (FORC) — •Merlin Pohlit, Paul Eibisch, Fabrizio Porrati, Antonia Morherr, Michael Huth, and Jens Müller — Institute of Physics, Goethe-University, Frankfurt a. M., Germany

Micro Hall-Magnetometry is a sensitive technique that allows to study the local magnetic induction of macroscopic samples as well as to perform high-resolution measurements of individual or small arrays of magnetic micro- and nanoparticles. For the latter experiments, six adjacent Hall-crosses that are tailored by electron beam lithography to fit to the samples' dimensions provide continuous access to the magnetization via the stray field emanating from the particles during magnetization reversal. While particular techniques for studying magnetic interaction effects within macroscopic samples like First Order Reversal Curves (FORC) or Henkel plots are well-established, the same methods are only scarcely applied in the research field of interacting nanomagnets. Here, we first demonstrate a proof-of-concept experiment by studying a floppy disk sample, thereby reproducing literature results, and comparing FORC diagrams obtained by using a micron-sized Hall-sensor and data collected by a commercial vibrating sample magnetometer. Subsequently, FORC data are obtained for a single Cobalt nanomagnet and will be presented alongside FORC measurements of dipolar-coupled arrays of Co nanoislands, i.e. the building blocks of artificial square spin ice[1,2]. [1]Pohlit et al., J. Appl. Phys. 117, 17C746 (2015) [2]Pohlit et al., JMMM, 10.1016/j.jmmm.2015.08.072 (2015)

MA 17.15 Tue 9:30 Poster B1

Control of the Magnetic Structure of [Co/Pd] and TbFe Thin Films by Direct Laser Interference Patterning — •Philipp Graus[1], Martin Stärk[1], Frank Schlickeiser[1], Dennis Nissen[2], Birgitt Hebler[2], Elke Scheer[1], Paul Leiderer[1], Manfred Albrecht[2], Mikhail Fonin[1], and Johannes Boneberg[1] — [1]Universität Konstanz — [2]Universität Augsburg

Pulsed two beam direct laser interference patterning (DLIP) is used to generate two dimensional temperature patterns on a magnetic sample. In contrast to other methods like electron beam lithography, DLIP offers the possibility to pattern large areas on a timescale of a few nanoseconds in a one-step process. Usually DLIP is used to pattern surfaces, but here we focus on local periodic heating on the nanoscale. We investigate the effect of heat on thin magnetic Co/Pd multilayer systems and TbFe alloys which offer a strong perpendicular anisotropy. We compare results from experiments from 55 μm interference period down to 500 nm period. For both types of materials three different magnetic regions arise. These regions can be assigned to defined temperatures. In the case of Co/Pd the temperature gives rise to a intermixing process of the former separated multilayer system. For TbFe a phase transition from amorphous to polycrystalline takes place. These findings have been confirmed by numeric simulations using the Landau-Lifshitz-Bloch (LLB) formalism.

MA 17.16 Tue 9:30 Poster B1

Spin wave eigenmodes in transversely magnetized thin film ferromagnetic wires — •Sven Stienen[1], Jürgen Lindner[1], Zheng Duan[2], Ilya Krivorotov[2], Nathalie Reckers[3], and Rodrigo Arias[4] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Institue of Ion Beam Physics and Material Research, 01328 Dresden, Germany — [2]Department of Physics and Astronomy, University of California, Irvine 92697, USA — [3]Experimentalphysik - AG Farle, Fakultät für Physik and Center for Nanointegration, Universität Duisburg-Essen, 47048 Duisburg, Germany — [4]Departamento de Fisica, FCFM, Universidad de Chile, Santiago, Chile

Research in the field of spin transport received increasing attention within the last couple of years, due to the possibility to transmit information without current losses. To utilize spin transport in a defined way, it is necessary to create spin channels to guide spin currents. In this context we present a study of spatially confined spin wave eigenmodes in transversely magnetized thin permalloy wires with three different widths. The focus is put on the strongly localized edge modes, which are investigated by means of broadband ferromagnetic measurements that are compared to an analytic model and micromagnetic simulations. Our data shows that the measured results of the edge mode cannot be explained by just taken into account intrinsic dipolar pinning. Only by inducing an extrinsic edge pinning in the permalloy wires, we are able to give a quantitative description of the eigenfrequency and spatial profile as function of the wire width.

MA 17.17 Tue 9:30 Poster B1

Field working window of magnetic domain wall sensors — •Benjamin Borie[1,2], Johannes Paul[1], Mathias Kläui[2], and Hubert Grimm[1] — [1]Sensitec GmbH, 55131 Mainz, Germany — [2]Institut für Physik, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany

The potential of timeless data storage with very low power provides a certain advantage to magnetic domain wall based sensors [1] as technological solutions. Still the industry remain unable to offer reliable devices [2]. The stochasticity of the domain wall behaviour concerning its pinning and depinning events as well as the complexity of the manufacturing constitute the major issues for the technology to reach the market. Sensors probe a certain field window of work. The failure events such as an unwanted nucleation and a pinning of a domain wall have to be outside this window. The study reports the influence of roughness, crystallisation, shape and material stacks on the magnetic operating window of a free layer of a multi-turn sensor driven by rotating external field. The roughness and the crystallite sizes are likely to create a potential landscape that increase the pinning and reduces the nucleation field. NiFe, CoFe and CoFeB free layers can be fabricated and investigated using transport measurements such as the GMR effect currently used by the sensor and MOKE microscopy measurements to ascertain an understanding of the physics involved. [1] M. Diegel et. al., IEEE Trans. Magn. 45, 3792 (2009) [2] A. Bisig et al., Nat. Commun. 4, 2328 (2013).

MA 17.18 Tue 9:30 Poster B1

Minimization of redepositions during ion beam etching by using a dual angle etching technique — •Michael Schneider[1], Martin Kewenig[1], Tobias Fischer[1], Bert Lägel[2], Thomas Löber[2], and Burkard Hillebrands[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Nano Structuring Center, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Germany

The occurence of redeposition effects in the ion beam etching process is usually minimized by optimizing the etching angle. However, there are still non-negligible redepositions, such as the formation of raised edges on microstructures. We observed raised edges with heights of up to several tens of nanometers, which is even larger than the thickness of the structures.

Etching in two steps by different angles can provide a further reduction of these effects. We have fabricated waveguides of the ferromagnetic materials $Ni_{81}Fe_{19}$ and $Co_{40}Fe_{40}B_{20}$ by using a dual angle etching technique. As a result, we achieved a significant reduction of the raised edges on microstructures, which has been examined by Atomic Force Microscopy and Scattered Electron Microscopy measurements.

These findings pave the way for future applications in magnon spintronics, since the surface quality of magnetic waveguides has a noticeable influence on the propagation properties of spin waves in such microstructures.

MA 17.19 Tue 9:30 Poster B1

Magnetic interactions within Fe-Pt nanoparticles — •Svitlana Ponomarova[1], Valentyn Tatarenko[1], Oleksandr Ponomarov[2], Valerii Odnosum[1], and Yurii Koval[1] — [1]G.V. Kuyrdyumov Institute for Metal Physics, Kyiv 03680, Ukraine — [2]IntroPro LLC, Kyiv 02140, Ukraine

As well known, magnetic and other material properties are very sensitive to the size of their particles, to their organization when they are non-isolated, and to the chemical content and spatial order. The binary Fe-Pt alloys exhibit high magnetic anisotropy in their ordered L10 phase with high coercivity, good mechanical properties and excellent chemical stability. In present work, calculation of parameters of exchange interactions within the magnetic Fe-Pt nanoparticles for the platinum content range of L10-(super)structure existence (35-55 at.% Pt) have been estimated. The Heisenberg model for the system of randomly located spins, concerning 'slowly'-relaxing arrangement of their atomic carriers in a lattice was updated for binary solid solutions, which consist of two magnetic components (Fe and Pt). Strict dependence between the Curie temperature and the nanoparticles' size was taken into consideration in frame of the finite-size-scaling theory. Available experimental and theoretical values of magnetic moments showed that the most appropriate set of spin numbers is sFe=3/2 and sPt=1/2. Decreasing of magnitudes of exchange interaction parameters was obtained with rising of nanoparticles size. Temperature dependences of spontaneous magnetizations for Fe and Pt subsystems of nanoparticles with different sizes at fixed equiatomic composition are obtained.

MA 17.20 Tue 9:30 Poster B1

Tuning the magnetic behavior of regular arrays of magnetic nanoparticles by their shape — •Alexander Fabian[1], Matthias T. Elm[1], Dieter Ehlers[2], Hans-Albrecht Krug von Nidda[2], and Peter J. Klar[1] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Gießen, Heinrich-Buff-Ring 16, 35392 Gießen — [2]Institut für Physik, UniversitätAugsburg, Universitätsstraße 1, 86159 Augsburg, Germany

Magnetite nanoparticles are a promising material for application in spintronic devices since magnetite possesses a very high spin polarization and a high Curie temperature. Reducing the size of the bulk material to the nanoscale may alter the magnetic properties e.g. nanoparticles will become superparamagnetic. Here, we present the characterization of the magnetic properties of regular arrays of magnetic nanoparticles with diameters of about 20 nm by FMR and SQUID measurements. Using a bottom-up process magnetic nanoparticles are arranged in regular arrays. Small openings with high lateral aspect ratios are defined in PMMA by e-beam lithography. Then the nanoparticles are self-assembled in the openings using the meniscus force deposition method. Angle dependent FMR measurements are performed. The resonance field shows a 180°-symmetry in both in-plane and out-of-plane configuration, which can be attributed to the elongated shape of the nanoparticle arrangements. SQUID measurements confirm a superparamagnetic behavior of the particles, but also exhibit differences in the magnetization in comparison to the typical superparamagnetic FC and ZFC curves of a circular thin film of nanoparticles.

MA 17.21 Tue 9:30 Poster B1

Application of He-ion microscopy for advanced light-ion induced magnetic patterning of exchange bias layer systems — •Alexander Gaul[1], Nicolas Müglich[1], Daniel Emmrich[2], André Beyer[2], Johanna Hackl[3], Hatice Doganay[3], Slavo Nemsak[3], Armin Gölzhäuser[2], and Arno Ehresmann[1] — [1]Department of Physics & CINSaT, University of Kassel — [2]Physics of Supramolecular Systems and Surfaces, University of Bielefeld — [3]PGI-6, FZ-Jülich

Light-ion bombardment induced magnetic patterning (IBMP) of exchange bias (EB) bilayer systems by Helium ions through a shadow mask is a well-known technique to locally tailor the magnetic anisotropy on the micrometer length scale. Here we demonstrate the use of Helium ion microscopy (HIM) for the fabrication of artificial magnetic domains in EB systems without shadow masks. In this way, magnetic domain patterns with lateral dimensions on nano meter scales become feasible. Therefore, designed magnetic domain patterns were written by a He ion beam of 10 nm diameter into the continuous EB layer. The influence of size, anisotropy and shape on the formation of magnetic domains and domain walls within one sample has been analyzed by magnetic force microscopy (MFM) to detect the domain wall charge distribution, by x-ray magnetic circular dichroism photoemission electron microscopy (XMCD-PEEM) to get detailed information about the magnetization orientation within the domains, and domain walls and by Kerrmicroscopy to study the remagnetization behavior in different regions of the domains with spatial resolution.

MA 17.22 Tue 9:30 Poster B1

Tuning of aspect ratio and magnetic material parameters for pronounced flux closure in giant magnetoimpedance (GMI) sensors — •Gregor Büttel, Julian Joppich, and Uwe Hartmann — Institute of Experimental Physics, Saarland University, D66041, Saarbrücken, Germany

It is well known that sputter-deposited Permalloy (Py) shows a strong perpendicular anisotropy above a critical thickness destroying its soft magnetic properties needed for GMI-based magnetic field sensors. Therefore many groups use a multilayer system with a non-magnetic spacer to prevent the appearance of stripe domains and a wide hysteresis curve. We have studied the magnetic properties and microstructure of such micrometer-sized structures sputtered from targets of slightly different Ni:Fe ratio while analyzing target and sample composition by EDX. Different spacer materials are investigated for their influence on strong flux closure of the magnetic layers by MOKE microscopy and MFM. We find that the target ratio strongly determines the critical thickness and at a Ni:Fe ratio of around 79:21 a film can be deposited up to 1000 nm showing neither stripe domains nor columnar microstructure. This is interesting for GMI thin film sensors, as multilayer systems show a weaker flux closure and complicated domain structures compared to Py/spacer/Py layer systems in our micromagnetic simulations and measurements.

MA 17.23 Tue 9:30 Poster B1

Fabrication and lift-off of magnetic nanoparticles functionalized by exchange bias layer system via nanoimprint lithography — •Jendrik Gördes[1], Timo Ueltzhöffer[1], Sabrina Reuter[2], Uh-Myong Ha[2], Arno Ehresmann[1], and Hartmut Hillmer[2] — [1]Department of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel — [2]Institute of Nanostructure Technologies and Analytics (INA) and Department of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel

Polymer nanoparticles have been fabricated by substrate conformal imprint lithography (SCIL [1]). The particles were functionalized by covering them with an exchange bias layer system. The particles were geometrically characterized by scanning electron microscopy. Magnetically they were characterized by Kerr magnetometry. The functionalization by an exchange bias layer system introduces a defined magnetic anisotropy along a geometric axis of the brick-shaped particles. Agglomeration characteristics of these particles were investigated.
[1] V. R. Kolli, C. Woidt and H. Hillmer, Advanced Materials Research. Vol. 1119, pp. 179-183 (2015) Trans Tech Publications

MA 17.24 Tue 9:30 Poster B1

Evolution of magnetic domains in ion-induced single nanostructures — •Anna Semisalova[1], Sebastian Wintz[1,2], Gregor Hlawacek[1], Ciarán Fowley[1], Kay Potzger[1], Jürgen Lindner[1], Jürgen Fassbender[1,3], and Rantej Bali[1] — [1]HZDR, Institute of Ion Beam Physics and Materials Research, Dresden, Germany — [2]Paul Scherrer Institute, Villigen-PSI, Switzerland — [3]TU Dresden, Germany

Ion-induced chemical disordering of paramagnetic B2-$Fe_{60}Al_{40}$ causes an increase in the Fe-Fe nearest neighbours, leading to the formation of ferromagnetic (FM) A2-$Fe_{60}Al_{40}$ [1]. Here we present FM stripes and dots in B2-$Fe_{60}Al_{40}$ directly written with a highly-focused (2 nm) Ne^+ beam [2], and study the evolution of their magnetic domains with structure size. Domain imaging (using Scanning Transmission X-ray Microscopy and Magnetic Force Microscopy) shows the transition from irregular domains for the broadest stripes to well defined alternating domain structure for 500 nm wide stripes, and to a single domain state for widths below 100 nm. Similarly, dot structures exhibit a transition from a vortex to a single domain state. Our results show that thin-film $Fe_{60}Al_{40}$ is a model system for one-step patterning of well-defined FM nanostructures of desired geometries [2]. [1] Bali et al., Nano Lett. 14, 435 (2014) [2] Röder et al., Sci. Rep. 5, 16786 (2015)

MA 17.25 Tue 9:30 Poster B1

Spatially resolved ferromagnetic resonance (FMR) using X-rays and thermal excitation — •Taddäus Schaffers[1,2], Ralf

Meckenstock[2], Detlef Spoddig[2], Andreas Ney[1], Christian Schöppner[2], Hendrik Ohldag[3], Stefano Bonetti[4], and Michael Farle[2] — [1]Johannes Kepler University Linz, Austria — [2]University of Duisburg-Essen, Germany — [3]SSRL, SLAC National Accelerator Laboratory, Menlo Park, CA — [4]Stanford University, CA, USA

In order to study local magnetic properties of micro-sized samples with FMR it is necessary to use a different kind of modulation or detection than in the conventional FMR measurements. By detecting the FMR with a microresonator it is possible to detect down to 10^6 spins [1]. Using thermal modulation instead of magnetic field modulation a spatial resolution of 110 nm is achieved and local magnetic properties are measured [2]. We combine thermal excitation with microresonator detection which enables us to study the influence of inhomogeneous stray fields on the FMR position and linewidth of two perpendicular Co-microstripes and compare the results to the integral detection. An alternative way to measure spatially resolved FMR is to change the detection mechanism from measuring the reflectected microwave power to using X-rays. By doing this it is possible to measure with a spatial resolution down to 35 nm [3].

[1]Narkowicz,et.al.,J. Magn. Res. **175**(2005)275
[2]Meckenstock, Rev Sci Instrum. **79**(2008).041101
[3]Bonetti,Rev Sci Instrum. **86**(2015)093703

MA 17.26 Tue 9:30 Poster B1

Development and Commissioning of a Multi-Frequency FMR Setup — •Martin Buchner, Taddäus Schaffers, and Andreas Ney — Johannes Kepler Universität, Linz, Austria

Ferromagnetic resonance spectroscopy is used to measure dynamic magnetic properties. Furthermore, a precise determination of the g-factor by analyzing the FMR signals' frequency dependence is possible [1]. Ferromagnetic excitation is achieved by inducing a microwave in the sample system (in this case a permalloy film). For microwave coupling commonly cylindrical resonators are used. However, the frequency range achieved by those is limited. In this contribution we present a setup which replaces the resonator by a coaxial cable that is short-circuited at one end and therefore exhibits standing wave behavior. At this end the microwave is induced into the sample. Thus, with the method shown, measurements in a wider frequency range are possible. A further advantage is the accessibility of the sample which enables to measure other properties like electric and magneto resistance as well as the inverse spin Hall effect as a measure for spin pumping at the same time.

[1] F. M. Römer et al. Appl. Phys. Lett. **100**, 092402 (2012).

MA 17.27 Tue 9:30 Poster B1

First-principles study of magnetic perovskite interfaces — •Igor Maznichenko[1], Arthur Ernst[2], and Ingrid Mertig[1,2] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, D-06099 Halle, Germany — [2]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany

Materials with perovskite structure demonstrate a broad spectrum of physical properties. Colossal magnetoresistance, ferroelectricity, multiferroicity, superconductivity, charge ordering, metal-insulator transition, Jahn-Teller and other effects are observed in perovskites. These properties of the mentioned materials with the common formula ABO_3 are very sensitive to the type of the cations A and B. $La_{2/3}Sr_{1/3}MnO_3$ (LSMO) is a strongly correlated 3d transition metal oxide with a Curie temperature (T_C) above RT (370 K). For other La/Sr ratios different types of antiferromagnetism are observed. Another perovskite - ruthenate, $SrRuO_3$ (SRO) is a 4d ferromagnet with T_C = 160 K. Two component perovskite superlattices have two different terminations due to the asymmetry AO/BO_2. In particular in LSMO/SRO superlattices this can be treated as a function of the Sr amount at one of interfacial LSMO layer. Using a first-principles Green function method within density functional theory, we examinate magnetic coupling at different interfaces.

MA 17.28 Tue 9:30 Poster B1

Investigation of 3d-5d double perovskites as potential room temperature multiferroics — •Shivani Gour[1,2], Vikas Shabadi[1], Philipp Komissinskiy[1], Rajeev Gupta[2], and Lambert Alff[1] — [1]Institute of Materials Science, Technische Universität Darmstadt, Alarich-Weiss-Strasse 2, 64287 Darmstadt, Germany — [2]Materials Science Programme, Indian Institute of Technology Kanpur, India

In the search for multiferroic materials with ferromagnetic and ferroelectric order in a single phase, the $A_2BB'O_6$ double perovskites hold the potential for room-temperature functionality. The fabrication challenge with these multi-cation complex oxides lies in the precise control of oxidation states of the elements and achieving a high degree of B-site chemical order. Based on recent theoretical investigations to identify potential ferromagnetic insulators among 3d-5d double perovskites, the compound Bi_2MnReO_6 was predicted to have magnetic ordering temperatures well above 300 K. We report on the fabrication of epitaxial thin films of the analogous novel Mn-Re based compounds on single crystal $SrTiO_3$ (001) substrates, using pulsed laser deposition. Given the specific configuration of the outer electronic shells and the close to 150° Mn-O-Re bond angle, the magnetic moments on Mn and Re are expected to be coupled via superexchange in a ferrimagnetic state. Detailed structural investigations were performed by X-ray diffraction and the magnetic properties were studied by SQUID magnetometry.

MA 17.29 Tue 9:30 Poster B1

Investigation of the symmetry reduction of erythrosiderites by single crystal X-ray diffraction — •Tobias Fröhlich[1], Daniel Brüning[1], Ladislav Bohatý[2], Petra Becker[2], and Markus Braden[1] — [1]II. Physikalisches Institut, Universität zu Köln — [2]Institut für Kristallographie, Universität zu Köln

Erythrosiderites $A_2[FeX_5(H_2O)]$, where A stands for an alkali metal or ammonium ion and X for a halide ion, are antiferromagnets with Néel-temperatures ranging from 6 to 23 K [1]. This family of compounds allows to investigate the impact of structural parameters on the magnetoelectric properties by comparing their closely related structures as determined by single-crystal X-ray diffraction. The compound $(NH_4)_2[FeCl_5(H_2O)]$ was found to be multiferroic with strong magnetoelectric coupling [2]. The structures of $(NH_4)_2[FeCl_5(H_2O)]$ is investigated by single-crystal X-ray diffraction. The compound exhibits a phase transition to the multiferroic phase at $T_N \approx 7$ K. There exists a further structural transition at about 80 K. In the past, it was assumed that this transition is from space group $P\,{}^{2_1}_{n}\,{}^{2_1}_{m}\,{}^{2_1}_{a}$ to $P11\,{}^{2_1}_{a}$ [3]. However, recent macroscopic measurements indicate, that the structure becomes polar, with a polarization perpendicular to the c-axis. In this case, a symmetry reduction to P11a is predicted.

[1] J. Luzón et al., Physical Review B, **78**, 054414 (2008). [2] M. Ackermann, D. Brüning, T. Lorenz, P. Becker, L. Bohatý, New Journal of Physics **15**, 123001 (2013). [3] M. Ackermann, PhD-thesis (2014).

MA 17.30 Tue 9:30 Poster B1

Microscopic and spectroscopic investigation of self assembled Fe_4 single molecule magnets on surfaces — •Fabian Paschke[1], Philipp Erler[1], Peter Schmitt[2], Nicole Barth[1], Andreas Irmler[1], Thomas Huhn[2], Fabian Pauly[1], Luca Gragnaniello[1], and Mikhail Fonin[1] — [1]Fachbereich Physik, Universität Konstanz, 78457 Konstanz — [2]Fachbereich Chemie, Universität Konstanz, 78457 Konstanz

The investigation of single molecule magnets (SMMs) allows the observation of unique magnetic properties, such as pure molecular hysteresis and quantum tunneling of magnetization. The deposition of intact SMMs on suitable substrates as well as the investigation and control of their magnetic properties is a part of a promising route to molecular-based data storage or quantum computing applications.

Here we show the controlled deposition of an Fe_4 SMM by means of electrospray ionization on two different substrates, namely h-BN/Rh(111) and graphene/Ir(111). The organic ligand shell of the complex is tailored by choosing the shortest tripodal ligand possible, resulting in a highly ordered self-assembly of flat lying molecules, whose anisotropy axis is oriented perpendicular to the sample surface. Submonolayers and well-ordered monolayers of Fe_4 molecules are investigated by scanning tunneling microscopy and spectroscopy. Typical dI/dV spectra obtained around the Fermi energy are symmetrical with steps at energies of around 5 meV. We attribute these features to spin-excitations of the molecules due to a spin-flip of the tunneling electron.

MA 17.31 Tue 9:30 Poster B1

Correlation of the orbital moment with the local structure of CoOEP — •Nico Rothenbach[1], Katharina Ollefs[1], Andrei Rogalev[2], Fabrice Wilhelm[2], Francois Guillou[2], and Heiko Wende[1] — [1]University of Duisburg-Essen, Faculty of Physics and CENIDE — [2]European Synchrotron Radiation Facility (ESRF), ID12

We correlate the orbital magnetic moment of Co-octaethylporphyrin (CoOEP) molecules with its local geometric structure. This is achieved by means of combined XMCD and EXAFS study at the Co K-edge in the hard X-ray regime at the ESRF. The understanding of the mag-

netic interactions within molecular hybrid systems is essential for possible future applications e.g. for molecular spintronics [1]. Recently investigations of CoOEP on graphene/Ni(111) have shown a magnetic coupling via graphene to the Ni substrate. Sum rule analysis of XMCD spectra taken at the Cobalt $L_{2,3}$-edge revealed a ratio of orbital to spin moment of $\sim 55\%$ [2,3]. To study the orbital moment of CoOEP we measured the Co K-edge XMCD which is only sensitive to the orbital moment due to the absence of the SOC in the initial 1s state. We carried out measurements on two different samples: On the one hand we pressed the molecules to a pellet and on the other hand, we droped an mixture of the molecules dissolved in ethanol on a Si-Substrate. To correlate these results for the magnetic properties to the local structure we performed EXAFS measurements at the Co K-edge.

[1] H. Wende, Nature Materials 8, 165 (2009)
[2] C. F. Hermanns et al., Adv. Mater. 25, 3473 (2013)
[3] D. Klar et al., Phys. Rev. B 89, 144411 (2014)

MA 17.32 Tue 9:30 Poster B1

Competing Spin-charge States in Electron-doped Triangular Molecular Magnets — •Rajyavardhan Ray[1,2] and Sanjeev Kumar[2] — [1]Institute for Theoretical Solid State Physics, IFW Dresden e.V. PO Box 270116, D-01171 Dresden, Germany — [2]Indian Institute of Science Education and Research (IISER) Mohali, Sector 81, SAS Nagar, Manauli PO 140306, India

We report a rich phase diagram of spin-charge coupled ground states for an electron coupled to the background of frustrated magnetic texture of a triangular molecular magnet (MM). These states arise out of interplay and competition between different energy scales of the problem. The ground state magnetic texture of the MM shows a reentrant behaviour with an exchange coupling dependent response for the electron.

MA 17.33 Tue 9:30 Poster B1

Visualisation of electric dipole matrix elements in Brillouin zone — •Ondřej Stejskal, Radek Ješko, Rudolf Sýkora, and Jaroslav Hamrle — IT4Innovations, VSB-Technical University of Ostrava, Czech Republic

Optic and magneto-optic properites of crystals are determined by the well-known Kubo formula [1] for direct inter-band transitions. It states that the absorption of a photon followed by the excitation of electron in solids is governed by electric dipole element $\langle i|p|f\rangle$, where $|i\rangle$, $|f\rangle$ are initial and final electron states and p is the momentum operator. In order to understand in detail the electric dipole elements, we visualise them in the reciprocal space on surfaces with constant energy difference between initial and final electron bands. It allows us to identify hot-spots contributing to the magneto-optic response. The dipole elements are calculated using Wien2k package [2] and visualised for nonmagnetic bcc W and ferromagnetic bcc Fe.

[1] C. Wang and J. Callaway, Phys. Rev. B 9, 4897 (1974)
[2] P. Blaha, K. Schwarz, G. Madsen, D. Kvasnicka and J. Luitz, WIEN2k, 2001

MA 17.34 Tue 9:30 Poster B1

Magnetic Imaging of Domain Wall Spin Structures in Fe Rings using SEMPA — Pascal Krautscheid[1,2], •Daniel Schönke[1], Maike Lauf[1], Benjamin Krüger[1], Robert M Reeve[1], and Mathias Kläui[1,2] — [1]Institut für Physik, Johannes Gutenberg-Universität, 55099 Mainz, Germany — [2]Graduate School of Excellence Materials Science in Mainz, 55128 Mainz, Germany

For spintronic devices, a control over spin structures and an ability to manipulate magnetization dynamics is required. Here the geometrical control of the domain wall (DW) configuration in nanoscale Fe rings was investigated using scanning electron microscopy with polarization analysis (SEMPA) and micromagnetic simulations. Previous measurements for Co and Py showed a transition from a transverse to a vortex DW on increasing the ring size [1]. The observed vortex wall configuration is accessible in a large range of ring sizes in Fe, with the experimental phase boundary found to be close to the one representing the global energy minimum. It is found that the transverse wall phase boundary is shifted to smaller dimensions for Fe than for Py. For state manipulation, spin accumulation (SA) generated by electrical currents has gained interest due to possibilities for switching the magnetization state of a device. With recent work showing that such SA can be detected via X-ray imaging [2], the future application of SEMPA to image such SA is a promising avenue with the surface sensitivity of the technique expected to be advantageous [3]. [1] M. Kläui, J. Phys.: Condens. Matter 20 (2008). [2] Kukreja et al., Phys. Rev. Lett. 115, 096601 (2015).* [3] Zhang et al., Sci. Rep. 4, 4844 (2014).

MA 17.35 Tue 9:30 Poster B1

Design of a X-ray zone plate microscope for magnetic domain imaging in the EUV range — •Andreas Schümmer[1], Markus Gilbert[1], Christine Jansing[1], Hans-Christoph Mertins[1], Roman Adam[2], Claus Schneider[2], Larissa Juschkin[3], and Ulf Berges[4] — [1]University of Applied Sciences,FH Münster, 48565 Steinfurt, Germany, — [2]Forschungszentrum Jülich, Peter Grünberg Institut (PGI-6), 52428 Jülich, Germany — [3]Rheinisch-Westfälische Technische Hochschule Aachen, 52062 Aachen, Germany — [4]TU Dortmund, Zentrum für Synchrotronstrahlung, 44227 Dortmund, Germany

We present a new design of a Scanning Reflection X-ray Microscope (SRXM) based on zone plate imaging in the extreme ultraviolet (EUV) spectral range at the DELTA beamline 12 optimized for the 3p absorption edges of 3d transition metals. The operation in reflection mode will allow magnetic domain imaging in buried layers exploiting magneto-optical reflection spectroscopy employing T-MOKE, L-MOKE, XMLD and XMCD [1] as magnetic contrast mechanisms. In contrast to transmission, the STXM geometry will allow the study of buried layers, layer systems and interfaces on surfaces even of thick samples. The advantage of the EUV spectral range over the soft X-ray range is the increased reflectance which is about two orders of magnitude larger than at the 2p edges. [1] M. Tesch, M. Gilbert, H - Ch. Mertins, D. Bürgler et al., Appl. Opt. 52, 4294 (2013)

MA 17.36 Tue 9:30 Poster B1

Anisotropic magneto-optical properties of ultrathin Fe/GaAs(001) layers — •Martin Buchner[1], Sebastian Putz[1], Stefan Günther[2], Matthias Kronseder[1], Dieter Schuh[1], Dominique Bougeard[1], Jaroslav Fabian[1], and Christian Back[1] — [1]Department of Physics, Regensburg University, 93053 Regensburg, Germany — [2]Department of Materials, ETH Zürich, 8093 Zürich, Switzerland

Spin-orbit coupling plays an important role in solids lacking space inversion symmetry. It has been shown that the resulting interfacial spin-orbit fields at the Fe/GaAs(001) interface lead to several anisotropic electronic properties like tunneling anisotropic magnetoresistance [1] as well as lateral anisotropic magnetotransport phenomena [2].

Recently, it has been proposed that the anisotropic interfacial spin-orbit fields also should affect the optical properties of the Fe/GaAs(001) heterostructure [3]. Here, we report the observation of anisotropic polar magneto-optical Kerr effect in epitaxial Fe/GaAs(001). We observe a clear twofold symmetry of the Kerr rotation angle depending on the orientation of the linear polarization of the probing laser beam with respect to the crystallographic directions of the sample.

[1] J. Moser et al., Phys. Rev. Lett. 99, 056601 (2007).
[2] T. Hupfauer et al., Nat. Commun. 6, 7374 (2015).
[3] S. Putz et al., Phys. Rev. B 90, 045315 (2014).

MA 17.37 Tue 9:30 Poster B1

Skyrmions and spin spirals in canted and in-plane magnetic fields investigated by STM — •Lorenz Schmidt, Pin-Jui Hsu, Andrè Kubetzka, Kirsten von Bergmann, and Roland Wiesendanger — Department of Physics, Universität Hamburg

Ultrathin magnetic films can exhibit topologically non-trivial spin textures as a result of competing magnetic interactions. Previous spin-polarized scanning tunneling microscopy experiments showed that an atomic bilayer of palladium and iron on Ir(111) shows spin spirals in zero field and the application of a perpendicular magnetic field leads to the formation of skyrmions [1,2].

Here we investigate the changes caused by in-plane magnetic fields in skyrmions and spin spirals with STM in a vectorial magnetic field by making use of non-collinear magnetoresistance contrast [3]. The canted magnetic field induces an asymmetry in the skyrmion, breaking its rotational symmetry. This allows to determine the cycloidal nature of the skyrmion and its sense of rotation.

[1] N. Romming *et al*, Science **341**, 636 (2013)
[2] N. Romming *et al*, Phys. Rev. Lett. **114**, 177203 (2015)
[3] C. Hanneken *et al*, 10.1038/NNANO.2015.218 (2015)

MA 17.38 Tue 9:30 Poster B1

Study of the magnetic properties of spin waves in thin Yttrium Iron Garnet films. — •Oleksandr Talalaevskyy[1], Martin Decker[1], Johannes Stigloher[1], Arpita Mitra[2], Christian Back[1], and Bryan Hickey[2] — [1]University of Regensburg, Regens-

burg, Germany — [2]University of Leeds,Leeds, UK

Yttrium Iron Garnet (Y3Fe5O12) is one of the most promising materials for studying high frequency magnetization dynamics. Due to its extremely low Gilbert damping parameter which can reach values of 1*10-5 for YIG spheres.Experiments with spin waves propagation are very important for understanding magnetization dynamics. In particular interest has recently increased since thin YIG films of reasonably high quality can nowadays be prepared by pulsed layer deposition or sputter deposition. Thin YIG can be used for effective excitation of the autooscillations by running a current through a Pt layers deposited on top of the film. We present an experimental study of the spin wave excitation and propagation in YIG stripes prepared by the magnetron sputtering. We report the time resolved magneto-optic Kerr effect measurements of spin waves(SW) parameters in thin YIG films. The mode structure of the spin waves is studied in dependence on the external magnetic film thickness and width of the stripe. We are able to detect a SW signal for distances up to 150 μm away from the CPW for narrow (2 μm) stripes.We calculate the spin wave attenuation length of the first mode for 50 nm and 40 nm thick samples. Furthermore we study the dependence of the maximal spin wave propagation length as function of the width of the stripe.

MA 17.39 Tue 9:30 Poster B1

Influence of oxygen content on magnetic properties in La1/2Sr1/2MnO3-δ thin films — Lei Cao[1], •Alexander Weber[2], Oleg Petracic[1], and Thomas Brückel[1,2] — [1]Jülich Centre for Neutron Science JCNS and Peter Grünberg Institut PGI, JARA-FIT, Forschungszentrum Jülich GmbH, Jülich — [2]Jülich Centre for Neutron Science JCNS at Heinz Maier-Leibnitz Zentrum MLZ, Forschungszentrum Jülich GmbH, Garching

Complex oxides have a variety of promising applications ranging from sensors and spintronic devices to multifunctional materials. Most relevant future materials for e.g. electronics and photovoltaics are based on oxides. However, the influence of the oxide content after sample preparation on the physical properties is mostly unknown. We report on the fabrication of La1/2Sr1/2MnO3-δ thin films on SrTiO3 substrates by sputter deposition. Using an in-situ x-ray diffraction setup we investigate the crystallographic properties while annealing the samples in varying oxygen atmospheres and at various temperatures. By employing SQUID magnetometry we then study the magnetic properties of the annealed systems. We thus relate the influence of oxygen absorption/desorption to the magnetic properties. Both Tc and the shape of the magnetic hysteresis turn out to depend on the oxygen stoichiometry.

MA 17.40 Tue 9:30 Poster B1

High-T_C Interfacial Magnetism in $(LaMnO_3)_{2n}/(SrMnO_3)_n$ and $(La_2CoMnO_6)_{2n}/(SrMnO_3)_n$ Superlattices — •Marius Keunecke[1], Sven Esser[1], Danny Schwarzbach[1], Markus Jungbauer[1], Sebastian Hühn[1], Vasily Moshnyaga[1], Ricardo Egoavil[2], Gustaf Van Tendeloo[2], Nicolas Gauquelin[2], Johan Verbeeck[2], Kerry O'Shea[3], and Donald MacLaren[3] — [1]I. Physikalisches Institut Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]EMAT, University of Antwerp, Groenenborgerlaan 171, 2020 Antwerp, Belgium — [3]Scottish Universities Physics Alliance, School of Physics and Astronomy, University of Glasgow, Glasgow, Glasgow G12 8QQ, UK

Superlattices of $(LaMnO_3)_{2n}/(SrMnO_3)_n$ (LMO/SMO, n=6) and $(La_2CoMnO_6)_{2n}/(SrMnO_3)_n$ (LCMO/SMO, n=5) on $SrTiO_3$ (001) were prepared by a metalorganic aerosol deposition technique (MAD). A high structural quality of samples was evidenced by XRD, XRR and TEM. SQUID magnetization measurements for the LMO/SMO SLs clearly show two ferromagnetic (FM) phases with $T_{C1} \approx 230K$ and $T_{C2} = 358K$. The low-temperature phase is likely located in the LMO layers. The high-temperature FM phase might originate from the LMO/SMO interface due to the electron transfer across the interface. No high-T_C phase and no interfacial charge transfer was found in LCMO/SMO. By introducing a LMO buffer layer with sufficient thickness (6 ML) between both interfaces the high temperature interfacial FM phase can be restored. Financial support of the EU FP7 (Project *IFOX*) and SFB 1073 (TPB04) is acknowledged.

MA 17.41 Tue 9:30 Poster B1

Experimental Analysis of the Anomalous Hall Effect Arising from Noncollinear Antiferromagnetism in MnIr Thin Films — •Jan Krieft[1,2], Christian Sterwerf[1,2], Karsten Rott[1,2], Jan-Michael Schmalhorst[1,2], and Günter Reiss[1,2] — [1]Physics Department, Bielefeld University, 33615 Bielefeld, Germany — [2]Center for Spinelectronic Materials and Devices , Universitätsstrasse 25, 33615 Bielefeld, Germany

First-principles electronic structure calculations and symmetry arguments predict a large anomalous Hall conductivity in Mn3Ir due to a noncollinear antiferromagnetic structure. Based on field cooling in a high field cryostat, we verified the existence of a small scale anomalous Hall effect in a high-temperature antiferromagnet, which is therefore not proportional to the classical magnetization. In this work, we report on an anomalous Hall effect occurring, however it is smaller than theoretically predicted.

MA 17.42 Tue 9:30 Poster B1

Antiferromagnetic properties of Mn2Au thin films and exchange bias of Fe/Mn2Au heterostructures — •Alexey Sapozhnik[1,2], Simone Finizio[3], Radu Abrudan[4], Anton Devishvili[5], Mathias Kläui[1], Hans-Joachim Elmers[1], Hartmut Zabel[1], and Martin Jourdan[1] — [1]Institut für Physik, JG Universität, Mainz, Germany — [2]MAINZ Graduate School, Germany — [3]PSI, Switzerland — [4]HZB, Germany — [5]Uppsala University, Sweden

Large efforts are being made to implement spintronic devices based on antiferromagnets (AFM). Metallic AFMs such as Mn2Au are attractive because of their potential manipulation via currents. Here we report magnetic properties of Mn2Au and Fe/Mn2Au revealed by MOKE, resonant magnetic x-ray and polarized neutron techniques. X-PEEM on high-quality epitaxial Fe/Mn2Au (001) films exhibits ~1mkm size Fe domains imprinted by AFM domains in Mn2Au. Mn-L3 XMLD suggests that these domains are preferentially oriented along the in-plane [110] AFM easy axis. However, the very high Néel temperature prevents the domain distribution manipulation. To overcome these problems, Fe/Mn2Au films were deposited at lower substrate temperature, which effectively decreases the crystal grain size and lowers the Néel temperature. Upon field cooling a significant exchange bias effect is observed, in contrast to heterostructures grown at higher temperatures. Temperature dependent hysteresis loops exhibit asymmetric reversal behavior. Polarized neutron reflectivity confirms domain wall motion at negative coercivity, but partial rotation at positive coercivity.

MA 17.43 Tue 9:30 Poster B1

Growth of Pb on ultrathin Fe layers on Ir(111) — •Jonas Sassmannshausen, André Kubetzka, Niklas Romming, Kirsten von Bergmann, and Roland Wiesendanger — Department of Physics, University of Hamburg, 20355 Hamburg, Germany

Recently, it was found that a monolayer of iron (Fe) on an iridium substrate (Ir(111)) shows a square lattice of skyrmions, even in zero external magnetic field [1]. This skyrmion lattice can be converted into a spin spiral ground state by covering it with a layer of palladium (Pd) [2].

Here, instead of Pd we deposit an adlayer of lead (Pb), for which high spin-orbit coupling at the Fe-Pb interface can be expected. We investigate the growth of Pb on ultrathin Fe layers on Ir(111) by means of scanning tunneling microscopy. For a preparation well above room temperature we observe intermixing of Pb and Fe. We vary the film thickness as well as the substrate temperature to optimize the Pb film quality. Our results show that temperatures below 300 K reduce alloying and improve the formation of well defined Pb overlayers.

[1] S. Heinze *et al.*, Nature Phys. **7**, 713 (2011)
[2] N. Romming *et al.*, Science **341**, 6146 (2013)

MA 17.44 Tue 9:30 Poster B1

Stripe domain patterns in non-centrosymmetric ultrathin Fe/Ni-films on Cu(001) — •Thomas Meier, Matthias Kronseder, Michael Zimmermann, and Christian Back — Institut für experimentelle und angewandte Physik, Universität Regensburg, Deutschland

In ultrathin ferromagnetic films with perpendicular anisotropy a spin-reorientation transition from out-of-plane to in-plane orientation of the magnetization vector may occur. The competition of exchange and dipole interaction leads to the formation of stripe domain patterns in the vicinity of the spin reorientation transition. Here, we investigate fluctuations of domain patterns in ultrathin epitaxial Ni/Fe-bilayer- and trilayer-films grown on Cu(001) using the technique of threshold photoemission magnetic circular dichroism in combination with photoemission electron microscopy allowing real-time observation of the domain pattern and its dynamics. The breaking of the inversion sym-

metry by the interfaces leads to the emergence of the Dzyaloshinski-Moriya-interaction (DMI). Here we analyze the influence of the DMI on the domain pattern and develop an improved domain model including the DMI based on the theory of Kashuba et al. (Phys. Rev. B 48(14), 10335), which describes the evolution of the domain width depending on the perpendicular anisotropy. Furthermore we analyze the strength of fluctuations with respect to temperature and externally applied out-of-plane magnetic fields.

MA 17.45 Tue 9:30 Poster B1

Investigation on new TMR stacks for inverse magnetrostrictive sensors — •Niklas Dohmeier[1], Günter Reiss[1], Karsten Rott[1], Ali Tavassolizadeh[2], Dirk Meyners[2], Eckhard Quandt[2], and Hendrik Hölscher[3] — [1]Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany — [2]Institute for Materials Science, Christian-Albrechts-Universität zu Kiel — [3]Institute of Microstructure Technology, Karlsruhe Institute of Technology (KIT)

We show new TMR stacks for magnetostrictive sensors based on $CoFeB\,/\,MgO\,/\,CoFeB$ tunnel junctions.
With a free $CoFeB$ layer the direction of its magnetization is not well defined, as in the earlier stacks.
Therefore, in order to achieve the highest sensitivity, a bias field is required to set the magnetization of the free layer at the optimum direction.
$CoFeB$ layers. Below the barrier the exchange bias is induced via the antiferromagnet $MnIr$. The upper part is pinned with an artificial antiferromagnet consisting of $MnIr$ and $CoFe$ layers.
Via two consecutively field coolings with different temperatures and field orientations exchange bias in different directions was achieved.
These TMR stacks have been made by magnetron sputtering and investigated by magneto-optical Kerr effect (MOKE), TMR measurements and four point bending experiments.

MA 17.46 Tue 9:30 Poster B1

Voltage-Induced Magnetic Manipulation of a Microstructured Iron Gold Multilayer System — •Robert Sittig — Max Planck Institute for Intelligent Systems — Universität Stuttgart

This work was aimed at developing a microstructured system of ultra thin iron for voltage-induced magnetic manipulation.

For this purpose a layer sequence with capacitor geometry, based on a central MgO/Fe/Au-junction, is proposed. First, the quality of the materials, deposited on Si-substrate via sputter coating, is checked carefully with multiple characterization methods. Then a 5-step microstructuring pattern is designed for proper electronic connection. The corresponding lithographic processes are realized in a direct laser writer system and accordingly optimized. With the completed samples, the effect of static and pulsed electric fields on the magnetic film are studied in a MOKE microscope.

This work holds prospects for application in low-power spintronics and non-volatile data storage along with possible service as magnon source.

MA 17.47 Tue 9:30 Poster B1

Free-Standing Thin Films of Magnetic Intercalated Dichalcogenides studied by XMCD and ultrafast TEM — •Thomas Danz[1], Qi Liu[2], Ra'anan I. Tobey[2], Sascha Schäfer[1], and Claus Ropers[1] — [1]4th Physical Institute, University of Göttingen, Germany — [2]Zernike Institute for Advanced Materials, University of Groningen, The Netherlands

Transition metal dichalcogenides (TMDCs) represent a broad class of layered materials with a variety of intrinsic structural and electronic properties. These properties can be further diversified by intercalation of atoms and small molecules between the loosely bound layers. In particular, the intercalation of $3d$ transition metals results in an array of magnetic properties. Therefore, $3d$ intercalated TMDCs provide a platform to study magnetic, structural, and electronic dynamics with tunability by concentration, intercalated species, and host lattice [1]. Here, we present a sample preparation technique providing large area, free-standing films of $3d$ intercalated TMDCs down to a thickness of 30 nm. The properties of the initial bulk samples are largely retained, as evidenced by static TEM diffraction and XMCD measurements [2]. Furthermore, first results of optical pump/electron probe measurements on the ultrafast sample dynamics in the Göttingen Ultrafast Transmission Electron Microscope (UTEM) [3] will be presented.
[1] W. Y. Liang, in: Intercalation in Layered Materials, M. S. Dresselhaus (Ed.), Springer, pp. 31–73 (1986).
[2] Th. Danz *et al.*, in preparation.
[3] A. Feist *et al.*, Nature **521**, 200 (2015).

MA 17.48 Tue 9:30 Poster B1

Temperature and magnetic field dependent Raman spectroscopy on thin $(La_{0.65}Pr_{0.45})_{0.7}Ca_{0.3}MnO_3$ films — •Sebastian Merten[1], Oleg Shapoval[2], Bernd Damaschke[1], Konrad Samwer[1], and Vasily Moshnyaga[1] — [1]I. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, D-37077 Göttingen, Germany — [2]IIEN, Academy of Science of Republic Moldova, Academia 3/3, MD-2028 Chinisau, Republic of Moldova

Mixed-valence manganites are still in the focus of fundamental research due to their rich phase diagram and intriguing phenomena like the colossal magnetoresistance (CMR). Crucial for understanding the physics of the manganites is the strong electron-phonon coupling manifested as the Jahn-Teller (JT) effect. To study the strong coupling between electrons and phonons, we performed Raman spectroscopy on $(La_{0.65}Pr_{0.45})_{0.7}Ca_{0.3}MnO_3$ thin films ($\lambda = 532$ nm, $P = 2.9$ mW) as a function of temperature and applied magnetic field. We observed four pronounced modes at 235 cm^{-1}, 434 cm^{-1}, 485 cm^{-1} and 609 cm^{-1} where the last two arise from the JT effect. The temperature as well as magnetic field dependent Raman spectra show a disorder-order transition observable as an abrupt intensity decrease of the JT modes and a strong increase of the phonon mode at 434 cm^{-1}. This behaviour correlates well with the metal-insulator transition and the CMR effect thus demonstrating a strong change of the electron-phonon coupling at the phase transition and its importance for the CMR effect. Financial support from SFB 1073 (TP B04) is acknowledged.

MA 17.49 Tue 9:30 Poster B1

Nanostructuring on MnSi thin films — •David Schroeter[1], Nico Steinki[1], Patryk Krzysteczko[2], Alexander Fernández Scarioni[2], Peter Krebs[2], Hans Werner Schumacher[2], Stefan Süllow[1], and Dirk Menzel[1] — [1]Institut für Physik der Kondensierten Materie, TU Braunschweig, Germany — [2]Physikalisch-Technische Bundesanstalt, Braunschweig, Germany

The chiral magnet MnSi, which crystallizes in the cubic B20 structure, has evoked much interest due to the existence of skyrmions. Furthermore the material shows an extended magnetic phase diagram when introduced to a reduction of the dimensionality of the system. Therefore it is of great interest to analyze nano-sized MnSi in form of thin films and nano wires.
We have grown high quality thin films via molecular beam epitaxy and structured them using electron beam lithography. Hall bar structures with widths between 100 nm and 10 μm have been produced and characterized regarding their structural properties. First measurements of the electrical and magnetical characteristics have been started. The results will be presented and deviations from three and two dimensional material will be discussed.

MA 17.50 Tue 9:30 Poster B1

Improvement of the epitaxial growth of MnSi thin films — •Patricia Herbst[1], David Schroeter[1], Peter Krebs[2], Dirk Thorsten Dziomba[2], Stefan Süllow[1], and Dirk Menzel[1] — [1]Institut für Physik der Kondensierten Materie, Technische Universität Braunschweig, Braunschweig, Germany — [2]Physikalisch Technische Bundesanstalt, Braunschweig, Germany

The challenge to increase the data storage density in information technology combined with an improvement of data processing requires new concepts of spin-electronic devices. One possible route is the creation of functionalites which utilize magnetic skyrmions. Nano-sized B20 MnSi in form of thin films and quantum wires offers a high potential to promote such future technology, not least as the magnetic phase diagram shows an enlarged skyrmionic phase compared to bulk. The structural and morphological quality of the required films is of great importance. Therefore, it is mandatory to establish growth techniques which provide for reliable and reproducible outcome of high grade. In this work MnSi thin films have been grown via molecular beam epitaxy and characterized using AFM and SQUID measurements. Films with 30 nm thickness show a RMS surface roughness of 3 nm compared to prior results with considerably poor surface morphology. The enhanced film quality makes it now possible to observe and identify clearly the magnetic phase transitions from simple magnetization measurements.

MA 17.51 Tue 9:30 Poster B1

Observation of an optically induced magnetic vortex glass in an iron thin film — •Tim Eggebrecht[1], Marcel Möller[2], Jan

Gregor Gatzmann[2], Nara Rubiano da Silva[2], Armin Feist[2], Ulrike Martens[3], Konrad Samwer[1], Markus Münzenberg[3], Claus Ropers[2], and Sascha Schäfer[2] — [1]I. Physikalisches Institut, Universität Göttingen — [2]IV. Physikalisches Institut, Universität Göttingen — [3]Grenz- und Oberflächenphysik, Universität Greifswald

In this work, we show the generation of magnetic defect states in an ultrathin iron/silicon-nitride bilayer after optical excitation with ultrashort laser pulses. Above a well-defined threshold in laser intensity, the initial magnetic ripple structure transforms on micrometer scales into a dense interwoven network of localized vortices and antivortices with glass-like properties.

Magnetic structures are mapped by transmission electron microscopy (TEM) with Lorentz contrast, where out-of-focus imaging conditions give access to the transverse sample magnetization. The electron microscope is modified to allow for in-situ femtosecond laser excitation.

We analyze the vortex-antivortex network structure, its charateristic length scales and discuss the appearance of topologically protected defects in a rapid heating and quenching model. In particular, possible contributions from the Kibble-Zurek mechanism and subsequent vortex-antivortex annihilation pathways are considered.

We acknowledge support by the DFG via SFB 1073/projects A05 and B01.

MA 17.52 Tue 9:30 Poster B1

Magnetic and magnetoelastic properties of NiCoMnAl-shape memory Heusler alloys — •Andreas Becker and Andreas Hütten — Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany

Magnetic shape memory alloys offer a large variety of functionality. Magnetic Materials, which undergo a first order phase transformation, are especially needed in magnetocaloric cooling, because they exhibit a large temperature and entropy change upon magnetic loading. Such materials often consist of rare materials and are therefore not suitable for commercial applications.

Measurements reveal, that NiCoMnAl-Heusler-alloys thin films, grown on an MgO-Substrate or a Vanadium buffer layer by sputtering deposition, achieve a large magnetocaloric effect, while consisting of common elements. The aim of our research is to investigate the magnetic and magnetoelastic properties of austenite films. To measure the induced strain, caused by the martensitic phase transition and the spinpolarization, TMR-junctions are grown and fabricated by e-beam lithography on top of the Heusler alloy films. Additionally, temperature dependent XRD-measurements of different compositions will be presented.

MA 17.53 Tue 9:30 Poster B1

Magnetic Properties of Layered Chromium Trihalides — •Nils Richter[1,2], Franziska Racky[1], Daniel Weber[3], Clemens Wuth[4], Bettina V. Lotsch[3], and Mathias Kläui[1,2] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz — [2]Graduate School of Excellence Materials Science in Mainz (MAINZ) — [3]Max-Planck Institut für Festkörperforschung Nanochemistry Stuttgart — [4]Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg

There is an ever-growing interest in two-dimensional materials to facilitate further size-reduction and enhanced efficiency in microelectronics [1]. Especially magnetic properties of such materials are important for spintronic and magnetoelectronic applications [2]. The class of chromium trihalides, CrX_3 (X = Cl, Br, I), are van der Waals bonded, layered semiconductors and show (anti-)ferromagnetism [3]. We examine the magnetic properties of large crystallites of these compounds using a superconducting quantum interference device (SQUID). Furthermore we are able to exfoliate all of them with thicknesses down to a few layers. We test these ultra-thin systems of just a few layers, whether their magnetism persists on this scale by probing their magnetic stray field with ballistic Hall-sensors made of high-mobility GaAs/AlGaAs 2DEGs[4].

[1] Lemme, M. C. et al., F. MRS Bull. 39 (2014). [2] Felser, C. et al., Angew. Chem., Int. Ed. 46 (2007). [3] Wang, H. et al., J. Phys. Condens. Matter 23 (2011). [4] A. K. Geim et al., Appl. Phys. Lett. 71 (1997).

MA 17.54 Tue 9:30 Poster B1

Effect of microstructure on the magnetic properties of transition metal implanted TiO2 films — •Oguz Yildirim[1], Steffen Cornelius[1,2], Maik Butterling[1], Wolfgang Anwand[1], Andreas Wagner[1], Alevtina Smekhova[3,4], René Hübner[1], Roman Böttger[1], Jan Fiedler[1], Carsten Bähtz[5], and Kay Potzger[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstr. 400, 01328 Dresden, Germany — [2]Delft University of Technology, Department of Chemical Engineering, Materials for Energy Conversion and Storage, Delft, The Netherlands — [3]Lomonosov Moscow State University (MSU) Moscow, Russia — [4]University of Duisburg-Essen, Faculty of Physics and CENIDE Duisburg,Germany — [5]Rossendorf Beamline, European Synchrotron Radiation Facility Grenoble, France

The origin of the ferromagnetic order in TM:TiO2 (TM: transition metal) systems is studied by investigating the interplay between structural order, defects and incorporation of implanted TM ions within the host lattice. The defect properties of the host TiO2 films are altered by preparing different microstructures of TiO2 (e.g. amorphous, polycrystalline anatase and epitaxial anatase). The difference in microstructure is also found to influence the incorporation of the implanted ions into the host lattice. The crystallographic incorporation of the implanted TM atom is found only in crystalline films. Moreover, it is observed that the suppression of the dopant related secondary phases can also be achieved by changing the microstructure. Based on this discussion we propose an ideal microstructural candidate for a dilute magnetic oxide material based on our results.

MA 17.55 Tue 9:30 Poster B1

Electronic-transport characterization of (Ga,Mn)As thin films — •Jan Teschabai-Oglu[1], Martin Lonsky[1], Klaus Pierz[2], Hans Werner Schumacher[2], and Jens Müller[1] — [1]Physikalisches Institut, Goethe-Universität, Frankfurt (M), Germany — [2]Physikalisch-Technische Bundesantalt, Braunschweig, Germany

A semiconductor, which is also a ferromagnet, may be used in spintronic applications, where logic and memory operations could in principle be integrated on a single device. Subject of our research is the semiconductor (Ga,Mn)As, where ferromagnetism is induced by a high concentration of magnetic elements (Mn) in the host GaAs matrix. Inspired by recent results of a diverging $1/f$-noise level in the ferromagnetic semimetal and colossal magnetoresistance material EuB6 [1], where the existence of percolating nanoscale magnetic clusters is established, we perform systematic studies of fluctuation (noise) spectroscopy on epitaxial thin films of (Ga,Mn)As [2] with different growth parameters. We present results of the (magneto-)resistivity and both ordinary and anomalous Hall effect to characterize the electronic (magneto-)transport properties. These studies are complemented by measurements of the resistance and Hall resistance noise yielding intrinsic $1/f$-type or Lorentzian power spectral densities. We discuss the temperature and magnetic field dependences of the noise in terms of carrier number and/or mobility fluctuations.

[1] P. Das et al., Phys. Rev. B 86, 184425 (2012)
[2] A. B. Hamida et al., Phys. Stat. Solidi B 251, 1652 (2014)

MA 17.56 Tue 9:30 Poster B1

Superexchange Interactions in Double Perovskite Osmates — •Ryan Morrow[1,2], Rohan Mishra[1], Oscar D. Restrepo[1], Molly R. Ball[1], Wolfgang Windl[1], Jennifer R. Soliz[1], Adam J. Hauser[1], James C. Gallagher[1], Michael A. Susner[1,4], Michael D. Sumption[1], Fengyuan Yang[1], Sabine Wurmehl[2,3], Ulrike Stockert[2,3], Bernd Büchner[2,3], Adam A. Aczel[4], Jiaqiang Yan[4], Michael A. McGuire[4], John W. Freeland[5], Daniel Haskel[5], and Patrick M. Woodward[1] — [1]OSU, Columbus, OH, United States — [2]IFW, Dresden, Germany — [3]TUD, Dresden, Germany — [4]ORNL, Oak Ridge, TN, United States — [5]ANL, Argonne, IL, United States

Double perovskites containing rock salt ordered 3d and 4d/5d cations have been intensely studied for their wide range of technologically relevant properties. Design of functional materials in the insulating state, where magnetic properties are dictated by superexchange interactions, remains challenging however due to the poorly understood competition between numerous potential exchange pathways. In this work, a number of insulating double perovskite osmates, A2BOsO6 (A=Sr,Ca,La; B=Cr,Fe,Co,Ni) have been chosen and studied using magnetometry, specific heat, XMCD, and neutron powder diffraction techniques in order to systematically probe the effects of electronic configuration and bonding geometry on the magnetic ground state. It is concluded that the magnetic ground state is controlled by a tunable competition between short range and long range superexchange interactions which are sensitive to electronic configuration and bonding geometry.

MA 17.57 Tue 9:30 Poster B1

Charge-spin-lattice correlations in the half-metallic CMR material $HgCr_2Se_4$ — •S. Hartmann[1], E. Gati[1], C. Lin[2], Y. Shi[2], Y. Li[2], J. Müller[1], and M. Lang[1] — [1]Physikalisches Institut, Goethe Universität, SFB/TR49, 60438 Frankfurt, Germany — [2]Institute of Physics, Chinese Academy of Sciences, Beijing, China

Understanding the origin of large or colossal magnetoresistance (CMR) effects, observed in a wide range of materials, including hexaborides, remains a challenging field of research in magnetism. The universal occurrence of electronic and magnetic phase separation in these materials has led researchers to suggest the intriguingly simple model of percolating magnetic polarons as a possible mechanism to explain the CMR. In a recent study on the ferromagnetic semimetal EuB_6, where the existence of percolating nano-scale magnetic clusters is established, we found a very large lattice response at the ferromagnetic transition, a significant part of which originates in the magnetically-driven delocalization of charge carriers [1]. Inspired by these results we performed high-resolution thermal expansion and magnetostriction measurements on the half-metallic CMR material $HgCr_2Se_4$ [2], where the paramagnetic to ferromagnetic transition at 105K drives an insulator-to-metal transition with an 8-orders-of-magnitude decrease of the longitudinal resistivity (MR effect: $7 \cdot 10^4$ at 8T and 110K!). We will discuss the phenomenology of the coupling of charge and magnetic degrees of freedom to the lattice distortion and compare our results to other CMR materials. [1] Manna et al., PRL 113, 067202 (2014); [2] Guan et al., PRL 115, 087002 (2015)

MA 17.58 Tue 9:30 Poster B1

Synthesis and Characterization of intermetallic $Fe_xMn_{3-x}Si$ (x = 0-2) — •Sebastian Selter[1], Ahmad Omar[1], Christian G. F. Blum[1], Bernd Büchner[1,2], and Sabine Wurmehl[1,2] — [1]Leibniz Institute for Solid State and Materials Research IFW, D-01171 Dresden, Germany — [2]Institut für Festkörperphysik, Technische Universität Dresden, D-01062 Dresden, Germany

The class of Heusler compounds exhibits a plethora of remarkable properties. Recently, special interest arised in magnetocaloric properties found in selected Heusler compounds. The magnetocaloric effect may be related to a metamagnetic transition which is understood to evolve as a result of the interplay between co-existing ferromagnetic and antiferromagnetic interactions. The Fe-Mn-Si system is promising to observe this effect, due to the magnetism of the parent compounds, which exhibit both ferromagnetism (Fe_2MnSi) and antiferromagnetism (Mn_3Si).

A substitution series between the two materials was prepared by arc-melting stoichiometric amounts of the respective elements. Samples were characterized as-cast as well as after an additional annealing step at 900 °C for 3 days followed by quenching in water.

Consequently, the effect of substitution on the magnetic behavior in this system is discussed and set in context to the microstructure and phase evolution of the series.

MA 17.59 Tue 9:30 Poster B1

Magnetocrystalline anisotropy in nearly-compensated Mn2RuxGa — •Ciaran Fowley[1], Karsten Rode[2], Davide Betto[2], YongChang Lau[2], Naganivetha Thiyagarajah[2], Gwenael Atcheson[2], Jürgen Lindner[1], Jürgen Fassbender[1,3], Alina Deac[1], and Mike Coey[2] — [1]Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf — [2]Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN), Trinity College Dublin, Dublin 2, Ireland — [3]Institute for Physics of Solids, TU Dresden, Dresden, Germany

Mn2RuxGa (MRG) has recently been shown to be a zero-moment ferrimagnetic half-metal, when x ~ 0.5 [1]. When grown on a TiN buffer, directly on a (001)-SrTiO3 substrate, the magnetic easy-axis is perpendicular to the film plane. The moments of the two Mn sub-lattices 4a and 4c, will only be precisely compensated at a fixed temperature because the temperature dependence of the 4c sublattice is much greater than that of the 4a sublattice [2]. For the present sample Tcomp = 350 K, giving a small net magnetization of 50 kA/m at room temperature. We have measured the transverse Hall resistance (Rxy) on samples patterned into Hall bars as a function of external field applied at an angle, θ, to the film normal. We fit the data obtained to a generalised Sucksmith-Thompson (GST) model [3], in order to extract values of the magnetic anisotropy constants K1 and K2. References: [1] Kurt H, et al., PRL 114, 027201 (2014), [2] Betto D et al., PRB 91, 094410 (2015), [3] Sucksmith W and Thompson JE, Proc. R. Soc. London, Ser. A 225, 362 (1954).

MA 17.60 Tue 9:30 Poster B1

High-throughput screening for antiferromagnetic Heusler compounds using density functional theory — •Jan Balluff, Markus Meinert, and Günter Reiss — Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany

Due to the exchange bias effect antiferromagnetic compounds are of particular interest for the field of spintronics. Since Heusler alloys are a very versatile family of compounds, searching for new, promising antiferromagnetic materials within this family is reasonable. Here, we report on a high-throughput screening among the Heusler compounds for systems with an antiferromagnetic ground state. Starting from a detailed evaluation of raw magnetic data for Heusler compounds extracted from the AFLOWLib, which contains data for more than 300,000 Heusler compounds, we determine possible candidates by means of formation energy and convex hull calculations. Further examination is done by explicit comparision of ferromagnetic / antiferromagnetic ground state calculations.

MA 17.61 Tue 9:30 Poster B1

Preparation and characterization of TiN buffered Co_2FeAl thin films — •Jana Ludwig, Alessia Niesen, Jan Schmalhorst, and Günter Reiss — Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany

TiN buffered Co_2FeAl thin films were prepared via DC magnetron sputtering. The TiN seed-layers (30 nm thickness) were deposited on MgO (001) and $SrTiO_3$ (001) substrates at a deposition temperature of 405°C in a mixture of Ar and N_2 atmosphere and a pressure of $p = 1.6 \cdot 10^{-3}$ mbar. A composit target was used to deposit the Co_2FeAl layers. The Ar-pressure was set to $p = 2.3 \cdot 10^{-3}$ mbar and the deposition of Co_2FeAl was carried out at room temperature. 2 nm thin MgO layers were deposited on top to prevent the samples from degradation. The crystallographic properties of Co_2FeAl and TiN were determined via x-ray diffraction and x-ray reflection measurements. $B2$ crystalline ordering was confirmed even for the as deposited state. The film thicknesses were varied between 10 nm and 0.8 nm in order to obtain and investigate in- and out-of-plane magnetized Co_2FeAl layers. Post annealing processes with temperatures up to 500°C were carried out in order to investigate the influence on the magnetic and structural properties. The magnetic properties of TiN buffered Co_2FeAl were investigated via MOKE measurements and revealed high perpendicular magnetic anisotropy for the 0.9 nm thin layers. The coercive fields increased with increasing post annealing temperature to 350 Oe and squareness ratios of 1 for temperatures above 300°C. The thermal stability was confirmed for temperatures up to 500°C.

MA 17.62 Tue 9:30 Poster B1

Structural, Optic and Magneto-Optic Properties of $NdFeO_3$ and $PrMn_{1-x}Fe_xO_3$ — •Radek Ješko[1], Ondřej Stejskal[1], Robin Silber[1,2], Matúš Mihálik[3], and Jaroslav Hamrle[1] — [1]IT4Innovations and Nanotechnology Centre, VSB-Technical University of Ostrava, Czech Republic — [2]Faculty of Physics, Bielefeld University, Germany — [3]Institute of Experimental Physics, Slovak Academy of Science, Košice, Slovak Republic

Orthorhombic perovskites are nowadays broadly studied materials due to their tuneable magnetic and electric properties. Here we study $NdFeO_3$ and $PrMn_{1-x}Fe_xO_3$ bulk poly and monocrystals. They were prepared by floating zone technique from sintered powder oxides precursors in adequate stoichiometric amounts and their structure was determined by x-ray diffraction. Their optic and magneto-optic properties were obtained by spectroscopic ellipsometry and magneto-optic spectroscopy, providing full spectral permittivity tensor in extended visible range of energies.

MA 17.63 Tue 9:30 Poster B1

High frequency ferromagnetic resonance study of Heusler compounds using a micro-cantilever — •Alexey Alfonsov[1,2], Eiji Ohmichi[3], Sabine Wurmehl[1,4], Bernd Büchner[1,4], Brian Peters[5], Fengyuan Yang[5], and Hitoshi Ohta[2,3] — [1]Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden, IFW Dresden, D-01171 Dresden, Germany — [2]Molecular Photoscience Research Center, Kobe University, Kobe 657-8501, Japan — [3]Graduate School of Science, Kobe University, 1-1 Rokkodai-cho, Nada, Kobe 657-8501, Japan — [4]Institut fur Festkörperphysik, Technische Universität Dresden, D-01062 Dresden, Germany — [5]Department of Physics, The Ohio State University, Columbus, Ohio 43210, USA

Heusler alloys have attracted a considerable attention in recent years since they are predicted to be halfmetallic ferromagnets. Possible 100% spin polarization of their conduction electrons together with high magnetic moments and high values of the Curie temperature give them a significant potential for spintronics applications. In order to create a fast switching and thermally stable spintronic device one should be able to control a magneto-crystalline anisotropy and a Gilbert damping of the used material. One of the most informative experimental methods to study magneto-crystalline anisotropy and Gilbert damping is frequency tunable ferromagnetic resonance (FMR). In this work we present a first study of magneto-crystalline anisotropy and Gilbert damping using a unique high frequency FMR technique where the response is detected by the micro-cantilever.

MA 17.64 Tue 9:30 Poster B1

Understanding the ordering phenomena in $Co_2FeAl_{0.5}Si_{0.5}$ through *in situ* neutron diffraction — •Ahmad Omar[1], Matthias Frontzek[2], Alexey Alfonsov[1], Bernd Büchner[1,3], and Sabine Wurmehl[1,3] — [1]IFW Dresden, 01069, Germany — [2]Paul Scherrer Institute, 5232 Villigen, Switzerland — [3]Institut für Festkörperphysik, TU Dresden, 01062, Germany

The $Co_2FeAl_{0.5}Si_{0.5}$ Heusler compound is predicted to be a halfmetallic ferromagnet in the ordered $L2_1$ structure but it is difficult to obtain a pure $L2_1$ order due to anti-site disorder. Hence, 100% spin polarization has not been observed in general. Therefore, it is important to understand the ordering phenomena with temperature in the material so as to optimize the ordering post-synthesis. We present *in situ* neutron diffraction measurements performed during high temperature annealing of powder samples along with powder neutron diffraction at room temperature on pre-annealed polycrystalline samples in order to compare the effect of various annealing procedures. We show that the annealing procedures commonly followed in literature do not offer significantly large improvement in the $L2_1$ order. A sharp $L2_1$-B2 ordering transition is not observed, in contrast to what is commonly understood. We also discuss the ordering phenomena in the light of existence and evolution of antiphase domains and domain boundaries though detailed line profile analysis of the neutron diffraction data. Based on our understanding, we have been able to optimize the annealing procedure. A higher $L2_1$ ordering, as compared to conventional annealing, has been obtained which was confirmed using zero-field NMR measurements.

MA 17.65 Tue 9:30 Poster B1

$Mn_{3+x}Ge$ Heusler compound with perpendicular magnetic anisotropy — •Hendrik Dohmeier, Alessia Niesen, Jan Schmalhorst, and Günter Reiss — Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany

New magnetic materials have to be prepared and characterized in order to build future spintronic devices like the spin-transfer-torque-(STT)-MRAM. Materials with a large perpendicular magnetic anisotropy are good candidates for this kind of devices. Mn_3Ge is a promising material due to the tetragonally distorted $D0_{22}$ crystal structure. An intrinsic characteristic of this tetragonal Heusler alloy is the uniaxial magnetic anisotropy with an out-of-plane oriented magnetic easy axis.[1] For this reason $Mn_{3+x}Ge$ thin films were prepared by dc magnetron co-sputtering on MgO (001) and $SrTiO_3$ (001) substrates to promote (001)-oriented films. Since crystalline quality and surface roughness dependend on the deposition temperature and stoichiometric composition, different parameters were tested to reduce roughness and suppress the creation of secondary crystal phases. Crystallographic and magnetic properties were investigated via x-ray diffraction (XRD), anomalous Hall effect (AHE) and magneto-optic Kerr effect (MOKE). The surface roughness was verified via x-ray reflection (XRR). XRD measurements verified the $D0_{22}$ crystal structure with an out-of-plane lattice constant of $c = 7.21$ Å, while MOKE and AHE measurements confirmed a magnetic out-of-plane anisotropy.

[1] H. Kurt et al., Appl. Phys. Lett. 101 (2012) 132410

MA 17.66 Tue 9:30 Poster B1

Search for magnetocaloric materials in the Co-Mn-Si system — •Franziska Seifert, Christian G.F. Blum, Bruno Weise, Anja Waske, Martin Knupfer, Bernd Büchner, and Sabine Wurmehl — Leibniz Institute for Solid State and Materials Research

Materials, which show a large magnetocaloric effect are interesting for modern cooling systems. One way to obtain a particularly large effect is by means of a magnetic phase transition. Some materials show a meta-magnetic transition (e.g. antiferromagnetic to ferromagnetic) with related large entropy changes. In this study we were able to find such a meta-magnetic transition in the Co-Mn-Si system. For this aim we prepared a sample series $Co_{2-x}Mn_{1+x}Si$ between the ferromagnetic Co_2MnSi and the antiferromagnetic Mn_3Si parent compound by changing the Co-Mn ratio. In some samples the MnCoSi phase is present, which might play an important role for structural and magnetic properties in that series.

MA 17.67 Tue 9:30 Poster B1

Growth & structural characterization of magnetically coupled trilayer systems Fe/x/Gd (x=Mn,Sc) — •Samira Webers[1], P. Anil Kumar[1], Dirk Walecki[1], Biplab Sanyal[2], Carmine Autieri[2], Mark Gubbins[3], and Heiko Wende[1] — [1]Faculty of Physics and Center of Nanointegration Duisburg-Essen (CENIDE), University of Duisburg-Essen, Germany — [2]Department of Physics and Astronomy, Uppsala University, Sweden — [3]Seagate, Northern Ireland

As predicted by theory, we show that it is possible to produce ferromagnetically coupled layers of Fe and Gd via an antiferromagnetic or non-magnetic intermediate layer like Sc or Mn. These studies build on our earlier investigation of the Fe/Cr/Gd system [1]. We are able to grow these trilayer systems by molecular beam epitaxy on GaAs(100) substrates. It has been found that by modification of the spacer layer thickness, we obtain a larger net magnetic moment for this system. As determined by magnetometry measurements, it is necessary to grow flat and well defined monolayers. For this reason, the growth characterization is crucial. We use *in situ* Reflection High Energy Electron Diffraction to investigate the layer growth and to crosscheck the thickness calibration.

[1] F. Stromberg et al., *Textured growth of the high moment material Gd(0001)/ Cr(001)/ Fe(001)*, J. Phys D: Appl. Phys. 44, 265004 (2011)

MA 17.68 Tue 9:30 Poster B1

Perpendicular CoFeB-based magnetic tunnel junctions with exchange bias — •Orestis Manos, Jan Schmalhorst, and Günter Reiss — Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany

This study investigates CoFeB-based magnetic tunnel junctions with perpendicular magnitized electrodes (pMTJs) combing exchange bias (EB). The magnetically soft electode is on top of the sample, consting of SiO_2/Mo(5)/MgO(1.8)/Co-Fe-B(1)/Mo(5) in (nm). The pinned bottom electrode is formed as SiO_2/Ta(10)/Ru(30)/Ta(5)/A(20)/X(10)/Co-Fe-B(1.2)/MgO(1.8) in (nm) where A=Pt, Ru and X=FeMn, IrMn [1]. In the aforementioned samples, the EB effect is observed as a shift of the magnetic hysteresis loop away from zero field, accompanied by an increase in coercivity. The phenomenon is related to the exchange interface interactions between the ferromagnet (FM) and the antiferromagnet (AFM). The crystallographic growth of the AFM affects critically the strength of the EB. The first aim is to change the growth direction of the FeMn/IrMn (111) from in-plane to perpendicular to the sample plane. The EB films were ex-situ post-annealed at several temperatures and their crystallograpic properties were investigated by X-ray diffraction (XRD). A [111] growth direction obtained for all seed layers. The samples with FeMn and IrMn combining Pt as a seed layer showed a perpendicular exchange bias field of 100 and 250 Oe, respectively.

[1] F. Garcia et al., J. Appl. Phys. 91, 6905 (2002)

MA 17.69 Tue 9:30 Poster B1

Quantitative analysis of the influence of keV Helium ion bombardment on the angular dependence of exchange bias — •Nicolas David Müglich[1], Markus Meyl[1], Alexander Gaul[1], Gerhard Götz[2], Günter Reiss[2], Timo Kuschel[2], and Arno Ehresmann[1] — [1]Institute of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, Kassel D-34132, Germany — [2]Physics Department, Center for Spinelectronic Materials and Devices, Bielefeld University, Universitätsstraße 25, 33501 Bielefeld, Germany

Ion bombardment induced magnetic patterning (IBMP)[1] is a powerful tool for designing artificial magnetic field landscapes. During this process a number of material properties are modified due to the energy transferred by the ions into the magnetic layer system. Although IBMP is an established method; a quantitative description of these modifications is still missing.

In the present study, angular resolved hysteresis measurements in de-

pendence of the Helium ion dose using vectorial Kerr magnetometry were performed. By comparing these results with calculations based on a Stoner-Wohlfarth-like model, a quantitative analysis of the modifications of the magnetic properties is given. Additionally the influence of magnetic patterning on the angular resolved dependence of the exchange bias is shown.

[1] A. Ehresmann, I. Krug, A. Kronenberger, A. Ehlers and D. Engel: Journal of Magnetism and Magnetic Materials 280 (2004) 369-376

MA 17.70 Tue 9:30 Poster B1

Optimal doping of antiferromagnetic MnN for improved exchange bias — •Mareike Dunz, Björn Büker, and Markus Meinert — Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany

In many spinelectronic devices, an exchange bias system is used to pin a ferromagnetic reference layer by coupling it to an antiferromagnetic film. We report on a new polycrystalline exchange bias system consisting of MnN/CoFe bilayers that shows high exchange bias of up to 1800 Oe at room temperature. However, it has a broad blocking temperature distribution with its median around 160 °C and requires larger film thicknesses of the antiferromagnetic MnN compared to other exchange bias systems [1].

To optimize the system, doping of the MnN layer was investigated. Defect energies of elements throughout the periodic table substituting Mn were calculated by density functional theory to find optimal dopants. Exchange bias stacks with doping concentrations of a few percent were prepared by reactive co-sputtering and their magnetic properties were analyzed. Effects of the defect energy, large atomic number, or large atomic radii are discussed.

[1] M. Meinert, B. Büker, D. Graulich, and M. Dunz. Large exchange bias in polycrystalline MnN/CoFe bilayers at room temperature. Phys. Rev. B. 92(14), 144408 (2015).

MA 17.71 Tue 9:30 Poster B1

Non-collinear magnet U2Pd2In in applied magnetic field — •Leonid Sandratskii — Max Planck Institute of Microstructure Physics, Halle

The Uranium ternary compound U2Pd2In possesses an unusual ground-state magnetic structure with magnetic moments of the U atoms strictly orthogonal to each other. We report the analysis of the magnetic interactions in the U2Pd2In combining the first-principles calculations for non-collinear relativistic systems with symmetry analysis. Also, the self-consistent calculations are performed for U2Pd2In in an applied magnetic field of different strength. The theoretical results are compared with the results of recent experiments in strong magnetic fields.

MA 17.72 Tue 9:30 Poster B1

Cantilever Magnetometry on MnSi — •Matthias Dodenhöft[1], Schorsch Michael Sauther[1], Stephan Gerhard Albert[1], Felix Rucker[2], Andreas Bauer[2], Marc Andreas Wilde[1], Christian Pfleiderer[1,2], and Dirk Grundler[1,3] — [1]Phys.-Dep. E10, TU München — [2]Phys.-Dep. E51, TU München — [3]LMGN, IMX, STI, EPF Lausanne

Since the discovery of the Skyrmion lattice phase in 2009, the B20 compound MnSi has attracted much attention. However, a detailed experimental investigation of the Fermi Surface (FS) of bulk MnSi is still missing in literature. Existing density functional theory (DFT) band structure calculations are restricted by the strong electronic correlations present in MnSi. Therefore, a verification of the predicted FS by experiments is essential. Following a short report by Taillefer et al. (1986), we present de Haas-van Alphen (dHvA) measurements using cantilever magnetometry with a capacitive read-out. The Dingle temperatures extracted from experiment confirm an excellent sample quality enabling a detailed determination of the FS via the dHvA effect. Extracted frequency components of the dHvA signal are tracked for different field orientations in the (100), (110) and (211) plane and their evolution is compared with DFT results. Measurements for a fixed field orientation at different temperatures enable the determination of the effective mass of the orbits corresponding to each frequency component. We find effective masses that are strongly enhanced if compared to the bare band masses. We attribute this to electronic correlations not considered by DFT.

MA 17.73 Tue 9:30 Poster B1

Magnetic anisotropy and reduced neodymium magnetic moments in $Nd_3Ru_4Al_{12}$ — •D. Gorbunov[1], M. Henriques[2], A.V. Andreev[2], V. Eigner[2], A. Gukasov[3], X. Fabrèges[3], Y. Skourski[1], V. Petříček[2], and J. Wosnitza[1] — [1]Dresden High Magnetic Field Laboratory (HLD-EMFL), Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Institute of Physics, Czech Academy of Sciences, Prague, Czech Republic — [3]Laboratoire Léon Brillouin, CE de Saclay, Gif-sur-Yvette, France

The present study addresses the magnetic properties of $Nd_3Ru_4Al_{12}$ (hexagonal crystal structure) with focus on its magnetic anisotropy that allows a comparison between single-ion and two-ion mechanisms when comparing to $U_3Ru_4Al_{12}$. $Nd_3Ru_4Al_{12}$ is a strongly anisotropic uniaxial ferromagnet with a Curie temperature of 39 K. The magnetic moments are aligned collinearly along the [001] axis. The magnetic structure has orthorhombic symmetry for which the crystallographic Nd site is split into two magnetically inequivalent positions, Nd1 and Nd2. The Nd1 and Nd2 atoms exhibit reduced magnetic moments, 0.95 and 2.66 μ_B, as compared to the free Nd^{3+}-ion value (3.28 μ_B). We argue this being due to crystal-field effects and competing exchange and anisotropy interactions. Since the single-ion mechanism in $Nd_3Ru_4Al_{12}$ leads to uniaxial anisotropy and the two-ion mechanism of the actinide analog, $U_3Ru_4Al_{12}$, is known to lead to planar anisotropy, our study demonstrates the decisive influence of these different mechanisms on the magnetic anisotropy.

MA 17.74 Tue 9:30 Poster B1

Magnetic properties of the chain antiferromagnets $RbFeSe_2$, $TlFeX_2$ (X=S,Se), and $Tl_3Fe_2S_4$ — •Zakir Seidov[1,2], Vladimir Tsurkan[1,3], Hans-Albrecht Krug von Nidda[1], Irina Filipov[3], Axel Günther[1], Arzu Najafov[2], Rushana Eremina[4], Tatyana Gavrilova[4], Airat Kiiamov[5], Farit Vagizov[5], Lenar Tagirov[5], and Alois Loidl[1] — [1]EP V, Center for Electronic Correlations and Magnetism, University of Augsburg, 86135 Augsburg, Germany — [2]Institute of Physics, Azerbaijan Academy of Sciences, AZ- 1143 Baku, Azerbaijan — [3]Institute of Applied Physics, Academy of Sciences of Moldova, MD-20208 Chisinau, Moldova — [4]E.K.Zavoisky Physical Technical Institute, Russian Academy of Sciences, 420029 Kazan — [5]Institute of Physics, Kazan Federal University, Kazan 420008, Russia

The ternary iron chalcogenides, monoclinic $TlFeS_2$, $TlFeSe_2$, $RbFeSe_2$ consisting of linear chains of tetrahedra, and orthorhombic $Tl_3Fe_2S_4$ with zigzag chains of tetrahedra have been investigated by means of magnetic susceptibility, specific heat, Mössbauer, and ESR measurements. Single crystals of $TlFeS_2$, $TlFeSe_2$, $RbFeSe_2$, and $Tl_3Fe_2S_4$ exhibit three-dimensional collinear antiferromagnetic order with strongly reduced moments below 196K, 290K, 248K, and 90K, respectively. The magnetic moments are oriented perpendicular to the chain direction. $Tl_3Fe_2S_4$ reveals a susceptibility maximum at T_{max} = 435K, which is typical for one-dimensional antiferromagnetic spin chains, whereas $RbFeSe_2$ and $TlFeX_2$ (X = S, Se) exhibit a continuous linear increase of the susceptibility up to the highest measurement temperature (600K) suggesting 1D metallic character.

MA 17.75 Tue 9:30 Poster B1

Excitonic condensation in d^6 perovskites — •Juan Fernández Afonso[1] and Jan Kuneš[2] — [1]Institute of Physics of the Czech Academy of Sciences — [2]Institute of Physics of the Czech Academy of Sciences

We study the possibility of excitonic condensation in transition metal perovskites with d^6 configuration. Hartree-Fock-like LDA+U calculations have been performed for artificial cubic perovskite structure mimicking $LaCoO_3$. We find self-consistent solutions that correspond to several distinct ordered states. These arise from condensation of atomic size $e_g - t_{2g}$ excitons and lead to periodic arrangement of magnetic multipoles. The symmetry properties and stability of the different solutions are analyzed.

MA 17.76 Tue 9:30 Poster B1

ESR studies of the $S = 1/2$ Heisenberg chain compound $Cu(py)_2Cl_2$ — •A.N. Ponomaryov[1], J. Wosnitza[1], K.Yu. Povarov[2], M. Thede[2], A. Zheludev[2], E. Ressouche[3], and S.A. Zvyagin[1] — [1]High Magnetic Field Laboratory (HLD), Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Neutron Scattering and Magnetism, Laboratory for Solid State Physics, ETH Zürich, Switzerland — [3]INAC SPSMS, CEA and Université Joseph Fourier, F-38000 Grenoble, France

$Cu(NC_2H_5)_2Cl_2$, a $S = 1/2$ Heisenberg chain compound with exchange interaction J = 13.4 K, was studied by means of electron para-

magnetic resonance spectroscopy. A single resonance line was observed in the temperature range from 2 to 300 K. The angular dependence of the resonance absorption indicates the presence of two magnetic centers, which is in agreement with the crystallographic structure. The temperature dependence of the resonance linewidth line was analyzed by use of the Oshikawa and Affleck theory (Phys. Rev. B, 65, 134410). The corresponding spin-Hamiltonian parameters were extracted and analyzed.

This work was partly supported by the DFG.

MA 17.77 Tue 9:30 Poster B1

Study of candidate compounds for magnetocaloric materials in the system Mn2-xMxSb (M=Fe, Co) — •Mamuka Chikovani, Karen Friese, Paul Hering, Jörg Voigt, Jörg Persson, and Thomas Brückel — JCNS-2/PGI 4, Forschungszentrum Jülich GmbH, Germany

Magnetocaloric refrigeration is an emerging technology in today*s cooling devices and it has a potential to save about 20-30 % of energy compared to conventional vapor compression technology. Nowadays, the most important issue is to find cheap and abundant materials exhibiting a sizable magnetocaloric effect. We report on preparation and characterization of compounds of general composition * Mn2-xMxSb system with M = (Fe, Co). The substitution on the Mn site has an effect on magnetic properties and magnetic transitions. We synthesized samples of different stoichiometry by inductive melting of the elements in a cold crucible and performed studies using x-ray powder diffraction method and macroscopic magnetization measurements. Based on these data we could then calculate the entropy change. In the Fe-containing samples, in particular in Mn1.8Fe0.2Sb, we observe a small MCE associated to a paramagentic-ferrimagnetic phase transition. The Co-doped samples reveal a sizeable MCE accompanying a ferri-to-antiferromagnetic phase transition. Currently we study the response of the lattice parameter to the magnetic transitions with low temperature powder diffraction (300-15 K).

MA 17.78 Tue 9:30 Poster B1

Magneto-optical effects in $L_{10} - Mn_xGa$ films with giant perpendicular anisotropy — •Liane Brandt[1], Lijun Zhu[1], Jianhua Zhao[2], and Georg Woltersdorf[1] — [1]Institute of Physics, Martin-Luther-University Halle-Wittenberg, von-Danckelmann-Platz 3, 06120 Halle, Germany — [2]State Key Laboratory of Superlattices and Microstructures, Institute of Semiconductors, Chinese Academy of Sciences, P. O. Box 912, Beijing 100083, China

We report very large polar magneto-optical effects in metallic $L_{10} - Mn_xGa$ ($0.76 \leq x \leq 1.5$) epitaxial films with giant perpendicular magnetic anisotropy ($K_u \sim 1\ MJ/m^3$). Both the Kerr rotation and ellipticity show a strong dependence on the sample composition most likely caused by a variation of spin-orbit coupling strength and strain. A Kerr rotation of up to 0.1 degrees is observed for a 40 nm thick film for a wavelength of 650 nm at room temperature. The large polar Kerr effect, the high reflectivity, and the giant magnetic anisotropy make $L_{10} - Mn_xGa$ a promising material for high frequency spintronic and magneto-optic applications.

MA 17.79 Tue 9:30 Poster B1

Single crystal growth and magnetic anisotropy of transition metal substituted Li_3N — •Manuel Fix[1], Stephan Jantz[2], and Anton Jesche[1] — [1]EP 6, Electronic Correlations and Magnetism, University of Augsburg, Germany — [2]Solid State Chemistry, Insitute of Physics, University of Augsburg, Germany

The compounds $Li_2(Li_{1-x}T_x)N$ where $T = \{$Mn, Fe, Co and Ni$\}$ show a highly anisotropic behaviour of their magnetic properties resulting from large orbital contributions to the magnetic moment of the transition metals [1]. Moreover, dilute Fe-substitution in Li_3N leads to a quantum tunnelling of the magnetization similar to single-molecule magnets [2].

Here we show the growth of single crystals of Fe- and Ni-substituted Li_3N via a flux method. Single crystals of several millimetres along a side could be obtained. The samples were characterized structurally by powder X-Ray diffraction and Laue back-reflection and chemical analysis was performed via ICP-OES. To prevent degradation of the extremely air-sensitive samples, the growth as well as the characterization were performed under inert atmosphere. We present the magnetic properties obtained by measurements of isothermal and temperature-dependent AC and DC magnetization. Furthermore, the influence of a static external magnetic field on the quantum tunnelling of the magnetization and on thermally activated relaxation processes in $Li_2(Li_{1-x}Fe_x)N$ is discussed.

[1] A. Jesche *et al.*, Phys. Rev. B **91**, 180403(R) (2015)
[2] A. Jesche *et al.*, Nature Comm. **5**:3333 (2014)

MA 17.80 Tue 9:30 Poster B1

Structural and magnetic properties of Fe-Ce-W (12:1 and 29:3) intermetallic compounds — •Roman Karimi, Dagmar Goll, Ralf Loeffler, Roland Stein, and Gerhard Schneider — Materials Research Institute (IMFAA), Aalen University, Germany

For low-cost permanent magnet applications Ce-based hard magnetic intermetallic compounds are currently in the focus of research due to the better abundance of Ce in the earth crust compared to Nd or Dy. By bulk high-throughput experimentation based on heterogeneous non-equilibrium states the two hard magnetic compounds $Fe_{11}WCe$ (12:1 phase stronger magnetic) and $Fe_{29-x}W_xCe_3$ (29:3 phase, weaker magnetic) have been discovered in the ternary system Fe-Ce-W. As $Fe_{11}WCe$ looks very promising for novel permanent magnets single-phase material has been fabricated by arc-melting. The samples have been analyzed concerning their crystallographic structure and intrinsic magnetic properties using x-ray diffraction, domain pattern analysis and magnetometry. The lattice structure has been identified as $ThMn_{12}$ structure. For the intrinsic properties saturation polarization J_s, anisotropy constant K_1 and Curie temperature T_C values of J_s(RT) $\sim$ 1.1 T, K_1(RT) $\sim$ 2 MJ/m^3 and $T_C \sim$ 450 K were found for the 12:1 compound. Values of J_s(RT) $\sim$ 0.5 T and K_1(RT) $\sim$ 0.5 MJ/m^3 have been estimated for the 29:3 compound. Mechanical alloying is applied to realize nanocrystalline $Fe_{11}WCe$ magnets. Project supported by BMBF (project REleaMag) and Carl-Zeiss-Stiftung.

MA 17.81 Tue 9:30 Poster B1

Growth and characterization of β-Mn-type $Co_8Zn_8Mn_{4-x}Fe_x$ polycrystals — •Kai Dietze, Justus Christinck, Nico Steinki, Stefan Süllow, and Dirk Menzel — Institut für Physik der Kondensierten Materie, Technische Universität Braunschweig, Mendelssohnstr. 3, 38106 Braunschweig, Germany

In the ongoing research in spintronics, materials hosting magnetic skyrmions are getting more and more interesting due to the possible use of data storage and processing abilities. Generally, skyrmions are present in the magnetically ordered phase close to the ordering temperature far beneath 300 K. On the basis of their lacking inversion symmetry, some substitutes of β-Mn-type $Co_{10}Zn_{10}$ show promising characteristics for skyrmions above room-temperature. Lorentz transmission electron microscopy has indicated the presence of skyrmions in $Co_8Zn_8Mn_4$ around 345 K [1]. In our studies we focus on the crystal growth of $Co_8Zn_8Mn_{4-x}Fe_x$ samples and have performed a basic characterization. X-ray powder diffraction in combination with Rietveld-analysis confirms the β-Mn structure. SQUID magnetization and elevated-temperature resistivity measurements were performed in order to obtain information about the electronic and magnetic structure and specify the degree of purity.

[1] Y. Tokunaga et al., Nat. Commun. **6**, 7638 (2015).

MA 17.82 Tue 9:30 Poster B1

Coercivity Enhancement of Nd-Fe-B Permanent Magnets by Grain Boundary Diffusion — •Konrad Loewe, Tim Lienig, Dimitri Benke, and Oliver Gutfleisch — TU Darmstadt, FB Materials Science, 64287 Darmstadt

A way to enhance the relatively poor temperature stability of coercivity of modern Nd-Fe-B-based sintered magnets is the substitution of Heavy Rare Earth (HRE) for Nd in the so-called '2-14-1'-structure of the magnetic main phase. This way the anisotropy field Ha increases, albeit at the expense of the saturation magnetization Ms and therefore the maximum storable energy. A possibility to overcome this drawback is to concentrate the HRE only at the features of the microstructure where demagnetization is starting (so-called 'weak links'), i.e. the grain boundaries. In technical practice, the HRE are deposited on the surface of the finished magnets and diffuse into the volume during a heat treatment.

In the present work, it is shown that the diffusion of HRE mainly occurs over the grain boundaries leading to a distinct two phase microstructure consisting of HRE-lean grain cores surrounded by HRE-rich grain boundary areas. On the macroscopic scale the so obtained coercivity enhancement is decreasing with diffusion distance, leading to magnets with gradient properties over the range of several mm. The geometry dependent optimum distribution of coercivity is predicted with FEM simulations and correlated with experimental data.

MA 17.83 Tue 9:30 Poster B1

Magnetic properties of off-stoichiometric Mn-Bi single- and poly-crystals — •Semih Ener[1], Yu-Chun Chen[2], Konstantin P. Skokov[1], Helmut Kronmüller[2], Eberhard Goering[2], and Oliver Gutfleisch[1] — [1]Materials Science, Technische Universität Darmstadt, 64287 Darmstadt, Germany — [2]Max-Planck-Institut für Intelligente Systeme, 70569 Stuttgart, Germany

Current permanent magnet market is dominated by the high-performance Nd-Fe-B and low-cost hard-ferrite magnets. The rare-earth crisis in 2011 led researchers to focus on two main research topics: i) optimized usage of the rare-earths and ii) developing new hard magnetic materials. The low-temperature-phase (LTP-) MnBi is a promising candidate as a hard magnetic material due to its high theoretical magneto-crystalline anisotropy and positive β coefficient. In this study the single- and poly-crystals of off-stoichiometric Mn-Bi samples are presented. The optimum secondary phase (pure-Bi) concentration in the bulk samples is discussed for achieving reasonable coercivity and remanence values for the final product. The room temperature x-ray diffraction patterns show the LTP-MnBi phase as a main phase and secondary phase of pure-Bi for almost all investigated samples. Magnetic measurements show the possibility to tune the magnetic properties in a wide variety of coercive field and remanence values up to 1.75 T and 0.7 T, respectively. The authors gratefully acknowledge the support of the Deutsche Forschungsgemeinschaft for the project HPPMSNG.

MA 17.84 Tue 9:30 Poster B1

Room temperature ferromagnetism in graphite oxide nanoplatelets induced by Na-islands defects — •Katherine Gross[1], Jhon J. Prias[2,3], Hernando Ariza[2], and Pedro Prieto[1] — [1]CENM, Universidad del Valle, Colombia — [2]IIS, Universidad del Quindío, Colombia — [3]EITP, Universidad del Quindío, Colombia

We have studied the magnetic response of pyrolytic graphite oxide nanoplatelets (GONP) extracted from bamboo pyroligneous acid (BPA) by systematically varying the crystal structure and topological defects. The crystal structure of the samples as well as the surface topography is modified by increasing the carbonization temperature in a range from 473K to 973K. At 973K a higher ordered crystalline graphite structure is obtained. M vs. H measurements of GONP-BPA samples show ferromagnetic (FM) order at room temperature. Magnetic force microscopy gives direct evidence for local FM order at the topological defects. Magnetic properties are correlated with the presence of topological defects caused by a natural formation of Na-islands during the carbonization process, which modify considerably the topography of the nanoplatelets. Our overall results discard any correlation of the FM order with the presence of magnetic impurities.

MA 17.85 Tue 9:30 Poster B1

Electrochemical Properties and Valence Tuning of Li-Metal-Nitrides — •Elisa Thauer[1], Michael Richter[1], Alexander Ottmann[1], Christoph Neef[1], Manuel Fix[2], Anton Jesche[2], and Rüdiger Klingeler[1] — [1]Kirchhoff Institute for Physics, Heidelberg University, D-69120 Heidelberg, Germany. — [2]Experimentalphysik VI, Institut für Physik, Universität Augsburg, D-86135 Augsburg, Germany.

Lithium nitrides $Li_2(Li_{1-x}M_x)N$ with M = Fe or Ni are studied regarding their potential as anode materials in lithium-ion batteries by means of cyclic voltammetry and galvanostatic cycling. In addition, based on these results, the lithium content and thus the valence of the metal ions is altered electrochemically and the effect on the magnetic properties is studied by means of SQUID magnetometry.

MA 17.86 Tue 9:30 Poster B1

Magnetic moments and damping parameters of $4d$ and $5d$ transition metal doped FeCo alloys — •Rudra Banerjee, Carmine Autieri, and Biplab Sanyal — Uppsala University

FeCo alloys are very important for their high saturation magnetization and high Curie temperature, especially $Fe_{0.65}Co_{0.35}$ alloy that sits on the top of Slater-Pauling curve. However, there is a perpetual interest to achieve higher saturation moment. Also, for magnetic recording industry, materials with low damping parameters are sought for. Here we have done a systematic *first principles* study of FeCo alloys doped with $4d$ and $5d$ elements to study the magnetic behaviour of the systems. All the calculations have been done using density functional based Korringa-Kohn-Rostoker method with the configuration averaging described by coherent potential approximation. We report the saturation moments and Gilbert damping parameters for $Fe_{0.65}Co_{0.35-y}X_y$ and $Fe_{0.65}Co_{0.35-y-z}X_yX'_z$ system where X and X′ are $4d$ and $5d$ elements. We have found that 4d and 5d co-doped FeCo alloys posses magnetization and damping parameters suitable for applications.

MA 17.87 Tue 9:30 Poster B1

Synthesis and magnetic properties of $SrAl_2Fe_{10}O_{19}/\alpha''$-$Fe_{16}N_2$ nanocomposites — •Imants Dirba[1], Fabian Rhein[1,2], and Oliver Gutfleisch[1] — [1]Materials Science, Technische Universität Darmstadt, 64287 Darmstadt, Germany — [2]Siemens AG, Corporate Technology, 80200 Muenchen, Germany

Despite the superior magnetic properties of Nd-Fe-B, hard ferrites still dominate global permanent magnet market (in terms of tonnage) due to their low price combined with moderate magnetic performance. In this context, even a slight improvement in magnetic properties without significantly added cost would be of great importance. Here we report an attempt to increase the maximum energy product $(BH)_{max}$ of $SrAl_2Fe_{10}O_{19}$ hexaferrite by exchange-coupling on nanoscale with a phase with higher polarisation. Nanocomposites from $SrAl_2Fe_{10}O_{19}$ as a hard and α''-$Fe_{16}N_2$ as a soft (semihard) phase have been synthesized. Morphology, structural and magnetic properties have been investigated in order to optimize synthesis conditions and achieve exchange-coupling between both phases.

MA 17.88 Tue 9:30 Poster B1

Optical and magneto-optical spectroscopy of $Co_2FeGa_{0.5}Ge_{0.5}$ thin films — •Daniel Kral[1], Radek Jesko[2], Lukas Beran[1], Roman Antos[1], Martin Veis[1], Dominik Legut[2], Enrique Vilanova[3], Gerhard Jakob[3], and Jaroslav Hamrle[2] — [1]Institute of Physics, Charles University in Prague, Prague, Czech Republic — [2]Nanotechnology Centre, VSB-Technical University of Ostrava, Ostrava, Czech Republic — [3]Institute of Physics, University of Mainz, Mainz, Germany

Heusler compounds are well known as exceptionally tunable materials. They have received considerable attention due to their high Curie temperature and high spin polarization [1], which makes them good candidates for applications in novel spintronic devices.

In this work, we present a systematic study of optical and magneto-optical (MO) properties of $Co_2FeGa_{0.5}Ge_{0.5}$ Heusler compounds by means of spectroscopic ellipsometry and Kerr MO spectroscopy. The samples were grown by DC sputtering onto MgO/Al_2O_3 substrates under various conditions. MO Kerr spectroscopy was carried out in polar and longitudinal configurations in the photon energy range from 1.2 to 5 eV. The information about the spectral dependence of complete permittivity tensor of all samples was deduced form ellipsometric and MO measurements. Finally, all experimental data were confronted with ab-initio calculations.

This work was supported by Grant Agency of Czech Republic (grant no. 13-30397S).

[1] S. Wurmehl, et al., Appl. Phys. Lett. 88, 032503 (2006).

MA 17.89 Tue 9:30 Poster B1

Analysing the electronic behavior of $HoMn_2O_5$ with spectroscopic Ellipsometry — Paul J. Graham[1], •Bastian Besner[2], Gerd Neuber[2], Shirly J. Espinoza-Herrera[3], Michael A. Rübhausen[2], and Clemens Ulrich[1] — [1]School of Physics and School of Materials Science and Engineering, The University of New South Wales, Sydney, New South Wales 2052, Australia — [2]Institut für Nanostruktur- und Festkörperforschung, Center for Free-Electron Laser Science, Advanced Study Group APOG, University of Hamburg, Luruper Chaussee 149, 22761 D Hamburg, Germany — [3]ELI Beamlines Project, Institute of Physics of the ASCR, Na Slovance 2, 18221 Prague, Czech Republic

Spectroscopic ellipsometry is a reliable and accurate tool to measure the optical properties of various types of samples. To get a better scientific knowledge of the spin structure and magnetic frustration in multiferroics, it is necessary to measure the optical parameters of the samples at different temperatures. In this work, we present the optical properties of $HoMn_2O_5$ as a function of temperature measured with spectroscopic ellipsometry. To understand the incommensurate antiferromagnetic ordering below 40K, we measured at various temperatures ranging between 45K and 14K and sweeping the energy from 0.5 eV to 5 eV. The different behavior of the dielectric function in the different magnetic phases will be discussed. Furthermore we analyzed the anisotropic behavior of $HoMn_2O_5$ at room temperature and identified a 2-fold symmetry behavior of the pseudodielectric function.