MA 16: Poster I

Topological Insulators, Multiferroics, Spin Structures and Magnetic Phase Transitions, Spin Excitations and Spin Torque, Magnetic Nanoparticles and Clusters,Magnetic Materials (Heusler, Semiconductors, Half-Metals, Oxides, Shape Memory), Magnetic Imaging and Scattering Methods,Bio- and Molecular Magnetism

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

MA 16.1 Tue 10:30 Poster D

Following Photo-Induced Strains in Multiferroic $BiFeO_3$ Using Ultrafast X-Ray Diffraction — •Daniel Schick[1], Marc Herzog[1], Haidan Wen[2], Peter Gaal[3], and Matias Bargheer[1] — [1]Institut für Physik & Astronomie, Universität Potsdam, Karl-Liebknecht-Str. 24-25, 14476 Potsdam, Germany — [2]X-ray Science Division, Argonne National Laboratory, Argonne, Illinois 60439, USA — [3]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Wilhelm-Conrad-Röntgen Campus, BESSY II, Albert-Einstein-Str. 15, 12489 Berlin, Germany

$BiFeO_3$ had a deep impact in the field of multiferroics, since it is magnetic and ferroelectric at room temperature, opening a wide field of applications, e.g. for spintronics and memory devices which can be addressed magnetically and electrically. Furthermore, it is highly desirable to photo-control the polarization and magnetization in $BiFeO_3$ directly by ultrafast optical excitation. Here we use femtosecond laser pulses with a photon-energy of 3.1eV ($\lambda = 400$nm) to excite a 40nm $BiFeO_3$ thin film above its band gap of 2.8eV. Ultrafast X-Ray Diffraction (UXRD) at a laser-driven Plasma X-Ray Source (PXS) is applied to follow the subsequent lattice dynamics on a sub-picosecond timescale. We observe a fast evolution of the photo-induced strains in the excited $BiFeO_3$ within 10ps. We compare these UXRD results with broadband all-optical experiments to get a deeper understanding of the origin of these strains in $BiFeO_3$ induced by the interband excitation.

MA 16.2 Tue 10:30 Poster D

Magnetic and dielectric properties of doped magnetite - multiferroicity? — •Eugen Ruff[1], Florian Schrettle[1], Stephan Krohns[1], Peter Lunkenheimer[1], Victor A.M. Brabers[2], and Alois Loidl[1] — [1]Experimental Physics V, University of Augsburg, 86135 Augsburg, Germany — [2]Department of Physics, Eindhoven University of Technology, 5600 MB Eindhoven, Netherlands

We investigate pure and Al-doped magnetite (single-crystals) using magnetometry, specific heat measurements, and broadband dielectric spectroscopy to analyze the magnetic properties at the Verwey transition and to check for its ferroelectric properties. At low magnetic fields the magnetic moment of magnetite shows an interesting anomaly at the Verwey transition. One can speculate, that this is due to magnetic softening, which is verified by magnetization measurements around the Verwey temperature. For an Al-content $x < 0.3$ ($Fe_{3-x}Al_xO_4$) the anomaly shifts to lower temperatures with increasing x and for $x \geq 0.03$ it is suppressed. The results of dielectric spectroscopy and specific heat measurements confirm this behavior. At low temperatures, the dielectric properties of the low doped samples are consistent with relaxor ferroelectricity as evidenced by Schrettle et al. [PRB 83, 195109 (2011)] for the undoped material. We found the detected relaxorlike peak to be strongly influenced by doping. The analysis of the temperature dependent relaxation time reveals a freezing of polar dynamics, which becomes faster with higher doping level.

MA 16.3 Tue 10:30 Poster D

magnetic and topological properties of edge states in the multi-band superconductor Sr_2RuO_4 — •Yoshiki Imai[1], Katsunori Wakabayashi[2], and Manfred Sigrist[3] — [1]Department of Physics, Saitama University, Japan — [2]WPI-MANA, NIMS, Japan — [3]Theoretical Physics, ETH-Zurich, Switzerland

Motivated by spin-triplet superconductor Sr_2RuO_4, the magnetic and topological properties of the edge states are investigated by means of the ribbon-shaped model with three Fermi surfaces as electronlike, holelike and two-dimensional ones, which correspond to the α-β bands and γ band of Sr_2RuO_4 in the two-dimensional bulk system. While there exists a full quasiparticle excitation gap, the gapless edge states appear in the ribbon system, in which these edge states are topologically protected and produce the spin and charge currents. While spin current results from the spin-orbit interaction, the charge current appears even without the external magnetic field and originates from the time-reversal symmetry breaking in chiral p-wave superconducting condensate. The effect of the repulsive interaction gives rise to the spin-polarization near the edges due to the Stoner mechanism. The magnetization from the currents couples correlation-induced magnetism through the spin-orbit interaction, so that the orientation of both magnetization is uniquely determined. The net spontaneous magnetic field from the edge current is strongly reduced due to the compensation of magnetic fields induced by correlation effect. This obtained result may explain the negative result from the experimental searches for chiral edge currents.

MA 16.4 Tue 10:30 Poster D

***Ab initio* description of topological insulators** — •Christian Franz, Michael Czerner, and Christian Heiliger — I. Physikalisches Institut, Justus Liebig University, Giessen, Germany

In this contribution we investigate 3D topological insulators (TI) using ab initio methods. These materials are insulating as bulk material but have a conducting surface state bridging the band gap, which is protected by time reversal symmetry. Prominent examples of 3D-TIs are BiSb alloys and Bi_2Se_3. In addition to being protected against (non-magnetic) impurities and other perturbations, the spin of these surface states is locked to their momentum. Therefore, backscattering is suppressed for this states, creating a two dimensional electron gas with high mobility. This inspired many proposed application.

We analyze the band structure of TIs. Since the spin-orbit interaction which creates a band inversion is crucial in TIs we will use a fully relativistic description. This is compared to a result without spin-orbit interaction to identify the band inversion. The appearance of the surface state is demonstrated using half-infinite boundary conditions. Alloys are described using the coherent potential approximation. This is the first step towards an *ab initio* description of transport in TIs.

MA 16.5 Tue 10:30 Poster D

A scanning tunneling spectroscopy investigation of the Bi_2Te_3 surface — •Thomas Bathon, Paolo Sessi, Lydia El-Kareh, and Matthias Bode — Physikalisches Institut, Experimentelle Physik II, Universität Würzburg,

We present a combined scanning tunneling microscopy (STM) and spectroscopy (STS) characterization of the structural and electronic properties of the topological insulator Bi_2Te_3. By interpreting the bias-dependent topographical evolution of defects we can show that they make samples n-doped. With the help of Fourier-transformed dI/dU maps we study scattering processes around defects and reveal that backscattering is forbidden for topological surface states. Based on bias-dependent measurements we determine the energy dispersion relation, the position of the Dirac point, and the carrier velocity. We also show that, by moving away from the Dirac point, the linear dispersion relation—which is typical for massless Dirac fermions—does not hold anymore. Instead, strong warping effects can be detected.

MA 16.6 Tue 10:30 Poster D

Influence of substrate imposed strain on epitaxially grown $BiFeO_3$ thin films investigated by Raman spectroscopy — •Andreas Talkenberger[1], Cameliu Himcinschi[1], Florian Johann[2], Ionela Vrejoiu[2], and Jens Kortus[1] — [1]TU Freiberg, Inst. of Theor. Physics, Leipziger Str. 23, D-09596 Freiberg — [2]Max Planck Inst. of Microstr. Physics, Weinberg 2, D-06120 Halle

$BiFeO_3$ (BFO) is an interesting candidate for multiferroic applications. Therefore a deep understanding of the material properties and the fabrication of high quality epitaxial thin films is necessary. In this work we investigated epitaxially grown BFO thin films fabricated by pulsed laser deposition on $SmScO_3$ (110), $GdScO_3$ (110) and $DyScO_3$ (110) substrates by means of Raman spectroscopy. The BFO films on $DyScO_3$ were synthesized with 71° and 109° stripe domain patterns[1,2]. The Raman spectra were recorded using the 532 nm emission line of a frequency doubled Nd:YAG laser as well as the

442 nm emission line of a He-Cd laser. The wave number shift of the phonon modes at 171 and 220 cm^{-1} correlates to the epitaxial strains in the BFO films grown on the different substrates. Further, we found an anomalous behaviour of the phonon mode at 140 cm^{-1}. While the modes at 171 and 220 cm^{-1} are redshifted with increasing tensile strain, the mode at 140 cm^{-1} is blueshifted. A similar anomalous effect was observed previously in $BiCrO_3$ films for the phonon mode at 180 cm^{-1}. This work is supported by the German Research Foundation DFG HI 1534/1-1 and SFB762. [1] F.Johann, Phys. Rev. B 84, 094105 (2011), [2] F.Johann, Phys. Status Solidi B 249, 2278 (2012)

MA 16.7 Tue 10:30 Poster D

Localized magnetoelectric effect in $BaTiO_3$/Hexaferrite composite ceramics — •Harsh Trivedi[1], Vladimir Shvartsman[1], Doru Lupascu[1], Rob Pullar[2], and Andrei Kholkin[2] — [1]Institute für Materialwissenschaft, Universität Duisburg-Essen, Essen Germany — [2]CICECO, University of Aveiro, Aveiro, Portugal

Due to its novel technological implications, the magnetoelectric(ME) effect has led to a bright prospectus for materials that show a direct or indirect coupling between the magnetic and electric order parameters. Owing to scarcity of intrinsic multiferroics, the strain mediated composite systems are a promising approach towards realizing an increased magnetoelectric coupling in bulk materials. The present state of the art in these materials demand concerted efforts toward a better understanding of microscopic mechanisms in the coupling phenomena. Since bulk ME measurements suffer inherent drawbacks concerned with electrical poling, in this work we have studied localized ME effect using scanning probe microscopy(SPM) techniques like Magnetic Force Microscopy(MFM) and Piezoresponse Force Microscopy(PFM) of bulk ME composite ceramics with a homogeneous distribution of piezoelectric($BaTiO_3$) and ferrite($BaFe_{12}O_{19}$/$SrFe_{12}O_{19}$) phases. MFM shows a clear restructuring of juxtaposed magnetic domains indicating motion of the domain walls under the effect of applied electric field. Also we observed the effect of magnetic field on the localized hysteresis behavior of constituent $BaTiO_3$ phase. The observed ME coupling is attributed to strain induced changes taking place

MA 16.8 Tue 10:30 Poster D

Electrically induced magnetic transition at the LSMO/BTO interface — •Markus Schmitz[1], Alexander Weber[1], Daniel Schumacher[2], Paul Zakalek[1], and Thomas Brückel[1] — [1]Jülich Centre for Neutron Science JCNS und Peter Grünberg Institut PGI, Forschungszentrum Jülich GmbH, Germany — [2]Deutsches Elektronen Synchrotron DESY, Hamburg, Germany

The magnetoelectric coupling is one of the most fascinating and active research areas today. The control of the magnetism due to an applied electric field may lead to new device concepts. First principles calculations of $La_{(1-x)}Sr_xMnO_3$/$BaTiO_3$(001) interfaces show magnetic reconstructions due to the change of the polarization of BTO by applying an external electric field [1]. The different electron densities influence the equilibrium between super- and double-exchange favoring a ferromagnetic or an antiferromagnetic order at the interface for the two different orientations of the polarization. Here we report on LSMO/BTO, grown with an Oxide Molecular Beam Epitaxy system. The epitaxial layer-by-layer growth was confirmed by in-situ RHEED analysis and the crystalloine quality of the surface was investigated by LEED and Atomic Force Microscopy. The structural characterization was carried out by X-ray reflectometry and X-ray diffraction. The macroscopic magnetic properties were determined by MOKE and SQUID magnetometry.

[1] Burton, J. D. and Tsymbal, E. Y. (2009) Prediction of electrically induced magnetic re- construction at the manganite/ferroelectric interface. Phys. Rev. B , 80, 174406.

MA 16.9 Tue 10:30 Poster D

Mechanisms of Multiferroicity of $GdMnO_3$ explored by Resonant Soft X-Ray Scattering in High Magnetic Fields — •Enrico Schierle[1], Victor Soltwisch[1], Christoph Trabant[1,2], Alex Frano[1,3], Sven Landsgesell[1], Fabiano Yokaichiya[1,4], Detlef Schmitz[1], Andrej Maljuk[1,5], Christian Schüssler-Langeheine[1], Ralf Feyerherm[1], Dimitri Argyriou[1,6], and Eugen Weschke[1] — [1]Helmholtz-Zentrum Berlin, Germany — [2]Universität zu Köln, Germany — [3]MPI-FKF Stuttgart, Germany — [4]Laboratrio Nacional de Luz Sincrotron, Campinas-SP, Brasil — [5]IFW, Dresden, Germany — [6]ESS, Lund, Sweden

Several orthorhombic $REMnO_3$ oxides show strongly coupled ferroelectric (FE) and magnetic order, with FE polarization induced by Mn-spin cycloids[1,2]. There is now growing evidence for a decisive role of ordering of the RE-4f moments as well[3-5]. $GdMnO_3$ seems to be the prime candidate for multiferroicity connected with magnetic RE order[4]. We employed Resonant Soft X-Ray Scattering to explore the magnetic Gd-4f and Mn-3d spin order and its coupling to ferroelectricity. While the prominent features can be already observed in the Zero-field FE phase, detailed knowledge could be derived by studying the magnetic field stabilized FE phase using the High-Field-Diffractometer operated at the UE46-PGM-1 beam line at BESSY II. [1] Kimura et al., Nature 426, 55-58 (2003) [2] Kenzelmann et al., PRL 95, 087206 (2005) [3] Schierle et al., PRL 105, 167207 (2010) [4] Feyerherm et al., Journal of Physics: Conference Series 200, 012032 (2010) [5] Walker et al., Science 333, 1273 (2011)

MA 16.10 Tue 10:30 Poster D

Nonlinear optical probing in (Ba,Sr)TiO_3/$La_{0.7}Sr_{0.3}MnO_3$ multilayers — •Johannes Aprojanz[1,2], Arseni Buryakov[2], Elena Mishina[2], Markus Michelmann[1], and Vasily Moshnyaga[1] — [1]I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen — [2]Moscow State Institute of Radioengineering, Electronics and Automation, Prosp. Vernadskogo 78, 119454 Moscow, Russia

Ferroelectric oxides stand out due to their excellent nonlinear optical properties and strong electro-optic effect, which offer promising applications as electro-optical modulators. Second harmonic generation (SHG) as a nonlinear optical probe is a powerful tool for studying ferroelectric switching, since it gives direct insight into the domain state in the material. In this work, we report on SHG measurements on $Ba_xSr_{1-x}TiO_3$/$La_{0.7}Sr_{0.3}MnO_3$ (BSTO/LSMO), $x = 0.15-0.5$, multilayers grown on $SrTiO_3$ substrates by means of metalorganic aerosol deposition (MAD). The voltage characteristics of SHG-signal prove ferroelectric hysteretic behavior at room temperature with switching fields in the range of 100 kV/cm. A detailed study of ferroelectric properties will be given as a function of magnetic field, $B = 0-1$ T. This work was supported by IFOX of the European Community's 7th Framework Programme.

MA 16.11 Tue 10:30 Poster D

Anisotropy study of the magnetoelectric properties of $LiFeSi_2O_6$ — •Matthias Ackermann[1], Petra Becker[1], Ladislav Bohatý[1], and Thomas Lorenz[2] — [1]Institut für Kristallographie, Universität zu Köln — [2]II. Physikalisches Institut, Universität zu Köln

$LiFeSi_2O_6$ belongs to the class of pyroxenes with the general formula AMT_2O_6 (A=mono- or divalent metal, M=di- or trivalent metal, T=tetra- or trivalent metal). The members of this class are well known for their multiferroic/linear magnetoelectric properties. [1] The structure of $LiFeSi_2O_6$ consists of one-dimensional zig-zag chains of edge-sharing [FeO_6] octahedra running along the crystallographic c-axis. Within the (110) and ($\bar{1}$10) planes these chains are connected by chains of [SiO_4] tetrahedra. At 230 K the compound undergoes a structural phase transition with a change in space group symmetry from $C2/c$ to $P2_1/c$. [3] Below the magnetic ordering temperature $T_C \sim 18$ K $LiFeSi_2O_6$ belongs to the magnetic space group $P2_1/c'$ [2] and shows the linear magnetoelectric effect. In this contribution we present a detailed investigation of the linear magnetoelectric properties and their anisotropy of this compound.

This work was supported by the DFG through SFB 608.

[1] S. Jodlauk et al. J. Phys.: Condens. Matter **19**, 432201 (2007)
[2] G. J. Redhammer et al. Phys Chem Min. **28**, 337 (2001)
[3] M. Behruzi et al. Acta Crystallogr. A **40** (Suppl.), C-247 (1984)

MA 16.12 Tue 10:30 Poster D

Coupling effects at the interface of nanostructured $BiFeO_3$/$La_{0.7}Sr_{0.3}MnO_3$ und epitaxial strain — •Christian Mix[1,2], Simone Finizio[1,2], Robert Reeve[1], Pascal Krauscheid[1], Frank Demuth[1], Christian Engel[1], Mathias Kläui[1], and Gerhard Jakob[1] — [1]Institute of Physics, Universität Mainz — [2]Graduate school of excellence MAINZ, Mainz

$BiFeO_3$ (BFO) is one of the few room temperature multiferroics, possessing antiferromagnetic and ferroelectric order [1, 2]. Imaging the domain structure with respect to the interface of artificial multiferroics is of increasing interest to understand the nature of magnetoelectric and exchange coupling at the interface [3].

Here, we report on heteroepitaxial growth of $BiFeO_3$ thin films under different levels of epitaxial strain and buffered by LSMO of varying thickness. Piezo force microscopy (PFM) and reciprocal space maps are utilized to investigate the influence of epitaxial strain on crystal

structure and ferroelectric domain structure. In addition, scanning electron microscopy with spin polarization analysis (SEMPA) and x-ray magnetic circular and linear diachroism (XMCD, XMLD) photo emission microscopy (PEEM) are used to investigate the ferromagnetic and antiferromagnetic domain structure in BFO/LSMO bilayer structures. Financial support by Stiftung Innovation für Rheinland-Pfalz (Project 961-386261/944) is gratefully acknowledged.

[1] N. Spaldin, M. Fiebig, Science 15, Vol. 309, no. 5733, (2005) [2] R.J. Zeches et al., Science 326, 977, (2009) [3] Q. He et al., Nature Com. 2, 225, (2010)

MA 16.13 Tue 10:30 Poster D

Understanding the phase sequence of Fe-Pd alloys from first principles — •Markus Ernst Gruner[1], Sandra Kauffmann-Weiss[2], Sven Hamann[3], Peter Entel[1], Sebastian Fähler[2], and Alfred Ludwig[3] — [1]Faculty of Physics and CeNIDE, University of Duisburg-Essen, 47048 Duisburg — [2]IFW Dresden, P.O. Box 270116, 01171 Dresden — [3]Institute of Materials, Ruhr-Universität Bochum, 44801 Bochum

Just as the prototypical Ni-Mn-Ga Heusler system also the disordered face centered $Fe_{70}Pd_{30}$ alloy shows large magnetic field induced strains in a slightly tetragonal fct martensite. Recent experiments achieved epitaxial growth of $Fe_{70}Pd_{30}$ thin films with $c/a = 1.09$, thus extending the classical Bain path beyond the fcc end [PRL 107, 206105 (2011)]. The combination of XRD spectroscopy and DFT modelling reveals that this process is related to an alternative relaxation mechanism, which leads to a nanotwinned pattern constructed from fct building blocks. The extremely low formation energy of the fct twins results in a finely twinned superstructure in the simulation cell along [110], which corresponds to the experimentally observed soft transversal acoustic phonon in this direction. This is also a central feature of the Ni-Mn-Ga magnetic shape-memory Heusler compound and allows us to interpret the fct phase analogously as a metastable adaptive martensite, where the increasing twin defect energy at larger distortions prevents the relaxation to the bcc ground state. The close interrelation between electronic and structural properties can be exploited to tailor the phase sequence in magnetic shape-memory ternary alloys.

MA 16.14 Tue 10:30 Poster D

High-field magnetization and magnetoelasticity of single crystalline $HoFe_5Al_7$ — •S. Yasin[1], A.V. Andreev[2], D. Gorbunov[2], Y. Skourski[1], S. Zherlitsyn[1], and J. Wosnitza[1] — [1]Dresden High Magnetic Field Laboratory, Helmholtz-Zentrum Dresden-Rossendorf, 01314 Dresden, Germany — [2]Institute of Physics ASCR, Na Slovance 2, 18221 Prague 8, The Czech Republic

Magnetization and ultrasound measurements have been performed in pulsed magnetic fields up to 60 T on a ferrimagnetic $HoFe_5Al_7$ single crystal (Curie temperature T_C = 213 K, compensation point T_{comp} = 65 K) with tetragonal crystal structure of $ThMn_{12}$ type. The compound poses an "easy-plane" magnetic anisotropy with the easy magnetization direction along the [110] axis and spontaneous magnetic moment $M_s = 2\ \mu_B$/f.u. at $T = 2$ K. For the magnetic field applied along this direction two field-induced magnetic transitions of first-order are observed. The presence of both transitions is accompanied by sharp anomalies in the acoustic properties. The temperature dependences of the critical fields as well as the shape of the acoustic anomalies suggest a different nature of the above magnetic transitions. The magnetoelastic study has been supplemented with magnetization measurements under hydrostatic pressure. T_C decreases with a rate dT_C/dp = -10 K/GPa, whereas T_{comp} increases with dT_{comp}/dp = 3.5 K/GPa. We discuss our results in relation to the exchange interactions of the Ho-Fe sublatices. *Part of this work was supported by EuroMagNET under the EU contract No. 228043.

MA 16.15 Tue 10:30 Poster D

First-principles study of the magnetic phases of bcc and fcc Fe — •David Reith[1], Pedro Bedolla[2], Raimund Podloucky[1], Peter Mohn[2], Tobias C. Kerscher[3], Sascha B. Maisel[3], and Stefan Müller[3] — [1]Universität Wien — [2]TU Wien — [3]TU Hamburg-Harburg

The cluster expansion (CE) technique in combination with Monte-Carlo simulations [1] is applied for deriving temperature and magnetic field dependent stabilities of the magnetic phases of bcc and fcc Fe. The input structures as calculated by VASP [2,3] provide the total energies of the spin configurations as needed for the CE. In addition to the standard spin-polarized configurations utilized for fcc Fe, the magnetic structures for bcc Fe also includes non-collinear orientations in order to model spin fluctuations. The magnetic field for the MC simulation is implemented in terms of a chemical potential. (Supported by FWF.)

[1] D. Lerch et al., Modelling Simul. Mater. Sci. Eng. 17, 055003 (2009) [2] G. Kresse and J. Furthmüller, Phys. Rev. B 54, 11169 (1996). [3] G. Kresse and D. Joubert, Phys. Rev. B 59, 1758 (1999).

MA 16.16 Tue 10:30 Poster D

The Strong Disorder Renormalisation Group and Tensor Network Methods — •Andrew Goldsborough and Rudolf Römer — Department of Physics and Centre for Scientific Computing, The University of Warwick, Coventry, United Kingdom

We have developed a tensor network method of performing the numerical strong disorder renormalisation group (SDRG) approach [1] on the random 1D spin-1/2 Heisenberg model. We use matrix product operators (MPOs) as a means of describing the Hamiltonian. The coarse-graining is achieved by concentrating on the interaction with the largest energy gap and calculating the lowest eigenvectors of the two-site hamiltonian. This unitary operator can then be contracted with the two-site MPO to create a new one site MPO. The idea can be interpreted as a multi-level coarse-graining of the Hamiltonian or as a multi-level tensor network state with the form of a binary tree tensor network (TTN). This realisation enables us to use the methods of TTNs and MERAs (multi-scale entanglement renormalisation ansatz) to gain more control over the system. We will show first results and compare the performance all methods.

[1] T. Hikihara, A. Furusaki, and M. Sigrist, Phys. Rev. B 60,12116 (1999)

MA 16.17 Tue 10:30 Poster D

Magnetic Order and Magnon Dispersion Relation in Ultrathin Fe and FePd Alloy Films Grown on Pd(100) — •Huajun Qin, Tzu-Hung Chuang, Yu Zhang, Khalil Zakeri Lori, and Jürgen Kirschner — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany

Ultrathin Fe films with thicknesses of one and two atomic layers were grown on Pd(100) substrate at room temperature. Spin-polarized electron energy loss spectroscopy (SPEELS) has been utilized to measure the magnon dispersion relation. The results are compared to the ones of a chemically disordered FePd alloy film, with a thickness of two atomic layers, prepared by mild annealing of an Fe monolayer on Pd(100) surface at the temperature of 400 K [1]. All SPEELS measurements are performed at T=13 K. It is found that the magnon energies in the 2 ML FePd alloy film are considerably higher than the ones in the Fe monolayer, but are comparable to the ones in the 2 ML Fe film. This observation may be attributed to the enhanced Pd magnetic moment in the FePd alloy film and the role of interlayer exchange coupling. Our dynamic measurements predict that the alloy films shall have a higher Curie temperature than the Fe monolayer, in good agreement with our static measurements obtained by means of magneto-optical Kerr effect.

[1] H.L. Meyerheim, R. Popescu, and J. Kirschner, Phys. Rev. B **73**, 245432 (2006).

MA 16.18 Tue 10:30 Poster D

Depinning of magnetic domain walls using pure spin currents — •Nils Motzko[1], Björn Burkhardt[1], Piotr Laczkowski[2], Laurent Vila[2], and Mathias Kläui[1] — [1]Institut für Physik, Johannes Gutenberg Universität Mainz — [2]Laboratoire Nanostructure et Magnetisme, CEA/INAC, 38054, Grenoble, France

The controlled motion of magnetic domain walls (DWs) is a vital component of various spintronic devices and memory applications, however, conventional methods of DW manipulation via fields or charge currents suffer from limitations due to their scalability or due to Joule heating. An alternative approach is to employ pure spin currents, for example in non-local spin valve (NLSV) configurations. In our measurements the NLSV consists of two permalloy halfrings which are connected via a non-magnetic copper conduit, a geometry which permits the precise positioning of DWs. Here, we analyze the influence of a pulsed spin current on the depinning field of a DW and we observe pure spin current induced depinning without any external field at a charge current density of $0.5*10^{12}$ A/m^2 and a corresponding spin current density of $6.7*10^9$ A/m^2. The calculated efficiency ($1.1*10^{-12}$ T/(A/m^2)) is more than 100 times higher than for current induced DW motion (CIDM) (M. Laufenberg et. al., Phys. Rev. Lett. 97, 046602 (2006)). This is attributed to the fact that in our measurements the pure spin current acts as a torque completely perpendicularly to the

DW magnetization due to the NLSV design maximizing the acting torque.

MA 16.19 Tue 10:30 Poster D

Control of magnetization dynamics by pure spin currents — •Henning Ulrichs[1], Vladislav Demidov[1], Sergej Demokritov[1], and Sergei Urazhdin[2] — [1]University of Muenster, Corrensstrasse 2-4, 48149 Muenster, Germany — [2]Emory University, Atlanta, GA 30322, USA

Recent experiments have shown that pure spin currents can be used to realize efficient control of magnetization dynamics, opening new possibilities for implementation of high-frequency spintronic devices. Here, we review our experimental studies [1-4] on this subject using micro-focus Brillouin light scattering spectroscopy.

We demonstrate that pure spin currents can be utilized for wide-range control of the effective magnetic damping in micrometer-sized structures. In particular, we achieved a reduction of the damping coefficient significantly below values typical for the used magnetic material. This effect can be utilized for stimulation and electric control of nonlinear dynamic phenomena such as parametric spin-wave instability. In addition, we study the effect of pure spin currents on thermal magnetic fluctuations and show that they can be controllably enhanced or suppressed. Finally, we demonstrate excitation of coherent single-mode auto-oscillations in devices where the local injection of pure spin currents results in a complete compensation of damping.

1. Phys. Rev. Lett. 107, 107204 (2011)
2. Appl. Phys. Lett. 99, 172501 (2011)
3. Phys. Rev. B 86, 134420 (2012)
4. Nature Materials 11, 1028 (2012)

MA 16.20 Tue 10:30 Poster D

Spin-transfer torque in Fe/MgO/Fe-MTJs with perpendicular magnetic anisotropy — •Jia Zhang, Michael Crezner, and Christian Heiliger — I. Physikalisches Institut, Justus Liebig University, Giessen, Germany

Recently, it was shown that MgO based magnetic tunnel junctions (MTJs) with ultrathin CoFe magnetic electrodes can have perpendicular magnetic anisotropy (PMA) and a low current for current driven switching[1]. In this work, the perpendicular anisotropy and spin-transfer torque in Fe/MgO/Fe-MTJs with ultrathin magnetic Fe layers in the presence of spin-orbital coupling are investigated by full relativistic Korringa-Kohn-Rostoker (KKR) first-principles calculations[2]. First, the critical thickness of Fe with perpendicular anisotropy is determined by calculating the magnetic crystal anisotropy and the shape anisotropy. Second, the bias voltage and angular dependence of spin-transfer torques is calculated. It is found that spin-orbital coupling have three significant effects on the spin-transfer torque: (1) The PMA contributes a new out-plane pseudo-torque in addition to the interlayer exchange coupling torque. (2) The spin-orbital coupling greatly change the magnitude of the spin-transfer torque. (3) The tunneling anisotropy leads to a strong angular dependence of spin-transfer torque.

[1] S. Ikeda et al. Nature Mater. 9, 721(2010).

[2] C. Heiliger et al., Phys. Rev. Lett. 100, 186805 (2008) ; J. Appl. Phys. 103, 07A709 (2008)

MA 16.21 Tue 10:30 Poster D

A theoretical analysis of the spin dynamics of magnetic adatoms traced by pump-probe scanning tunneling spectroscopy — •Michael Schüler, Yaroslav Pavlyukh, and Jamal Berakdar — Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, Heinrich-Damerow-Straße 4, 06120 Halle

The inelastic tunneling spectroscopy (IETS) provides a very suitable tool for the detailed analysis of the magnetic properties of adatoms and molecules. Furthermore, the inelastic scanning tunneling microscopy (STM) using a spin-polarized tip also allows for manipulating the spin configuration and for tracing the nanosecond spin dynamics of the magnetic adsorbates in a pump-probe manner. Based on a non-perbutative model, we theoretically investigate the excitation mechanism of the sample spin, its dependence on the anisotropic environmentand demonstrate how the relaxation dynamics can be monitored with the help of the tunnelling current. The predictions of a simple analytical model support our numerical findings and reveal the underlying physics. We also compare our results to recent experiments.

MA 16.22 Tue 10:30 Poster D

Current-induced spinwave doppler shift evidenced by time-resolved kerr microscopy — Jean-Yves Chauleau, Hans Bauer, •Helmut Koerner, Mirkow Ribow, Georg Woltersdorf, and Christian Back — Physics Departement, Universität Regensburg, universitätsstrasse 31, 93040 Regensburg, Germany

Action of spin-polarized electric currents on magnetic textures is now well established both from experimental and theoretical viewpoints. These effects are known as spin-transfer torques (STT). In the case of continuous magnetic distributions, current-induced domain wall (DW) dynamics is a recurrent system of investigation. However, DWs are fairly complicated magnetic structures whose dynamics is consequence of a subtle combination of damping, spin-drift velocity and non-adiabatic parameter. An alternative to domain walls dynamics has been reported by Vlaminck and Bailleul. The current-induced shift of spinwave resonances (spinwave Doppler shift) has been experimentally evidenced using an inductive approach.

In this study, we demonstrate the ability of time-resolved scanning Kerr microscopy (TRMOKE) to investigate the spin-transfer torque effects on propagating spin waves in Permalloy stripes. This approach allows not only the measurement of the full waves spectrum but also a direct imaging of the different modes present in the stripe. Wavevector, damping length and group velocity are directly measured experimentally. This is of utmost importance in order to accurately obtain the spin drift velocity, essential root of any evaluation and study of the non-adiabatic parameter.

MA 16.23 Tue 10:30 Poster D

All-electrical spin-wave spectroscopy on skyrmions in MnSi — •Ioannis Stasinopoulos[1], Thomas Schwarze[1], Andreas Bauer[2], Helmuth Berger[3], Johannes Waizner[4], Markus Garst[4], Christian Pfleiderer[2], Achim Rosch[4], and Dirk Grundler[1,5] — [1]Physik-Department E10, TU München, Garching, Germany — [2]Physik-Department, FG Magnetische Materialien, TU München, Garching, Germany — [3]EPFL, Institut de physique de la matiere complexe, Lausanne, Switzerland — [4]Institute for Theoretical Physics, Univ. Köln, Köln, Germany — [5]STI, EPFL, Lausanne, Switzerland

Skyrmions are topologically stable spin textures with the spins pointing in all directions wrapping up a sphere. The resulting core spins point in opposite direction compared to the outside ones. The recently discovered skyrmion phase (so-called A phase) is formed in a specific magnetic field-temperature (H-T) region of chiral helimagnets, such as MnSi, where skyrmions crystallize at about $T = 28\,\mathrm{K}$ and $\mu_0 H = 200\,\mathrm{mT}$ in a hexagonal lattice with a typical lattice constant of 18 nm. Our group uses an all-electrical microwave spectroscopy setup based on a vector analyzer and lithographically fabricated coplanar waveguides to excite and simultaneously probe the skyrmion states in MnSi. An out-of plane static magnetic field in combination with a He flow cryostat is used to define the skyrmion phase conditions. The observed resonances lie in the low GHz regime. Financial support by the DFG via TRR80 and NIM is acknowledged.

MA 16.24 Tue 10:30 Poster D

Magnetic and electric excitations of helices and Skyrmions in chiral magnets — •Johannes Waizner[1], Markus Garst[1], Achim Rosch[1], Ioannis Stasinopoulos[2], Thomas Schwarze[2], Andreas Bauer[3], Helmuth Berger[4], Christian Pfleiderer[3], and Dirk Grundler[2,5] — [1]Institute for Theoretical Physics, Univ. Köln, Köln, Germany — [2]Physik Department, E10, TU München, Garching, Germany — [3]Physik Department, FG Magnetische Materialien, TU München, Garching, Germany — [4]EPFL, Institut de physique de la matiere complexe, Lausanne, Swizerland — [5]STI, EPFL, Lausanne, Swizerland

An oscillating magnetic field induces precession in a ferromagnet resulting in a ferromagnetic resonance (FMR) that is described by the Kittel formula for a homogeneous magnetisation. We extend the theory of FMR to the case of chiral magnets, i.e., ferromagnets with a Dzyaloshinkii-Moriya interaction, taking into account the effect of demagnetisation fields. In the so-called conical phase, we find two magnetic modes whose weights depend on the polarisation of the driving magnetic field. In the Skyrmion lattice phase, several magnetic modes exist; we find that the mode with the largest weight has a smaller resonance frequency than the ones of the conical phase. As the Skyrmions carry polarisation in insulating chiral magnets, the modes can also be excited electrically. We compare our findings to recent experimental results.

MA 16.25 Tue 10:30 Poster D

Ac spin Hall effect in FMR spin pumping — •Dahai Wei,

Martin Obstbaum, Markus Härtinger, Georg Woltersdorf, and Christian Back — Institut für Experimentelle und Angewandte Physik, Universität Regensburg,Regensburg, Germany

The spin Hall effect (SHE), which converts charge current into or from a spin current, has been intensively studied in order to understand its basic mechanism. Furthermore, different materials are investigated in the search for larger spin Hall angles needed for more efficient spin-charge conversions on the basis of dc spin and charge currents. In addition to searching for materials with larger SH angles, ac spin currents, which can be two orders of magnitude larger than the dc ones in spin pumping, may be very promising [1].

We studied both the ac and the dc SHE of Pt/Py bilayers by the ferromagnetic resonance (FMR) based spin pumping technique. The spin currents pumped into the Pt layer have both dc, and a much larger ac component which has not been measured up to now. The ac voltages generated by the ac spin Hall effect was directly picked up at the same frequency of the spin pumping.

[1]Hujun Jiao & Gerrit E. W. Bauer, AC Voltage Generation by Spin Pumping and Inverse Spin Hall Effect. arXiv:1210.0724.

MA 16.26 Tue 10:30 Poster D

Current-induced domain wall motion at low current densities in La0.7Sr0.3MnO3 nanostructures imaged with high resolution x-ray magnetic microscopy — S. Finizio[1], M. Foerster[1], C. A. F. Vaz[1,2], F. Büttner[1,2,5], M. Mawass[1], •R. Lo Conte[1], T. Miyawaki[3], A. Bisig[2], L. Méchin[4], F. Nolting[6], and M. Kläui[1] — [1]JGU, Mainz, Germany — [2]SwissFEL, PSI, Villigen PSI, Switzerland — [3]University of Nagoya, Nagoya, Japan — [4]GREYC, UMR 6072, CNRS-ENSICAEN-UCBN, Caen Cedex, France — [5]TU Berlin, Berlin, Germany — [6]SLS, PSI, Villigen PSI, Switzerland

The effect of current pulses on the magnetization of nanometric La0.7Sr0.3MnO3 (LSMO)-half-rings has been investigated by high resolution x-ray magnetic microscopy. The potential high spin polarization and low room temperature saturation magnetization of LSMO make it a promising candidate for spin-torque-based technology applications. Here we investigate Current-Induced Domain Wall Motion (CIDWM) in LSMO nanostructures at low current densities (1-5x10 GA/m2). Their magnetic configuration was imaged by X-ray Magnetic Circular Dichroism - Photoemission Electron Microscopy (XMCD-PEEM). We observe mainly an initial single vortex wall and DW transformations, annihilation and nucleation after current injection due to the low Curie temperature (Tc ~ 340K) of our nanostructures. Low velocity (~0.5mm/s)DW displacements have been observed and interesting information on the energetics of the DW configurations has been obtained. While low current densities allow to move walls, the low Tc of LSMO limits the application for a CIDWM-based technology.

MA 16.27 Tue 10:30 Poster D

3D soft x-ray imaging of magnetite coated microballoons for theranostic applications — •Andreas Späth[1], Hanno Dietrich[1], Birgit Graf-Zeiler[1], Gaio Paradossi[2], and Rainer H. Fink[1] — [1]Friedrich-Alexander Universität Erlangen-Nürnberg, Physical Chemistry II and ICMM, Erlangen, Germany — [2]Università di Roma Tor Vergata, Dipartimento di Scienze e Tecnologie Chimiche, Rome, Italy

Poly(vinylalcohol) stabilized microballoons (diameter 4 - 10 microns) are promising hybrid systems for various applications in theranostics. Their surface can easily be functionalized chemically, and they can be filled with a large variety of therapeutic gases, thus providing very good contrast agents in ultrasound imaging. By embedding superparamagnetic iron oxide nanoparticles (SPIONs) into the polymer shell magnetic field guidance and even a magnetothermally triggered drug release from these micro containers is possible. This could be a highly valuable progress in selective destruction of tumor cells with highly active pharmazeuticals.

Within this contribution we will clarify the shell morphology and SPION distribution in various batches of magnetically functionalized PVA microballoons by transmission soft x-ray microspectroscopy (TXM) and TEM and extend these investigations to third dimension by reconstructions of TXM focal series and x-ray holography. X-ray magnetic dicroism (XMCD) and SQUID measurements were applied for a basic magnetic characterization of the particles.

MA 16.28 Tue 10:30 Poster D

Measurement of magnetic moment distribution of ferrofluids with single nanoparticle resolution using atomic force microscopy — •Stephan Block[1] and Christiane A. Helm[2] — [1]ZIK HIKE, Fleischmannstr. 42 - 44, D-17475 Greifswald, Germany — [2]Institut für Physik, Ernst-Moritz-Arndt Universität, Felix-Hausdorff-Str. 6, D-17487 Greifswald, Germany

An atomic force microscopy (AFM) method is presented, which allows the simultaneous measurement of magnetic and geometric properties of nm-sized objects (nanoparticles, e.g. colloids or clusters). An oscillating magnetic field is applied to the sample and the surface magnetization is probed using a magnetic AFM-tip. Spatial changes of the magnetic flux density affect the vibration amplitude of the tip and thus, (dynamic) magnetic properties of the surface can be determined with a lateral resolution of few nanometers. The principles of the experimental setup and the data analysis are outlined. It is shown that the resolution is sufficiently high to resolve magnetic moments of single superparamagnetic maghemite nanoparticles (diameter > 4 nm). The approach is applied to determine the distribution of magnetic moments in different ferrofluids on a single particle level.

MA 16.29 Tue 10:30 Poster D

Granular GMR effects in systems with organic matrix — •Judith Meyer, Markus Schäfers, Thomas Rempel, and Andreas Hütten — Bielefeld University, Universitätsstr.25, 33615 Bielefeld

The giant magnetoresistance effect (GMR effect) was found in magnetic multilayer systems [1,2] and was later also reported within granular systems by several research groups who had embedded magnetic particles in a metallic matrix [3,4]. In contrast to previous granular layered systems, we have incorporated Co nanoparticles in a conductive nonmagnetic biogel. Transport measurements carried out using a 4-point-probe measurement at room temperature revealed GMR effects of more than 60 percent. AC transport measurements were found to improve the long-term stability of the effect amplitude. Regarding future applications, the possibility of printing gel will allow for the development of granular gel-GMR sensors more rapid and less expensive in fabrication compared to conventional devices. The large effect amplitudes will ensure high sensor sensitivity and the mechanical flexibility of the matrix might additionally open up new fields of application.

MA 16.30 Tue 10:30 Poster D

Individual and collective ferromagnetic resonance of 43 nm Fe/Fe_xO_y core/shell-nanocubes — •Alexandra Terwey, Ralf Meckenstock, Detelf Spoddig, Christian Schöppner, Marina Spasova, and Michael Farle — AG Farle, Experimentalphysik, Universität Duisburg Essen, Germany

Here we determine the magnetization, anisotropy and linewidth of 43 nm Iron/Ironoxide core/shell nanocubes, from a statistical distribution in solution over small agglomerates to single particles on a substrate. The nanocubes, surrounded by an organic matrix of ligands were produced according to a modified recipe of Kim et al. [1]. For the ferromagnetic resonance (FMR) a new technique with a microcavity set up has been used. This technique allows to investigate different configurations of particle arrangements and thereby to study in detail the effects of dipolar coupling. The microcavity FMR has a resolution of 10^6 spins [2]. The number of particles was continuously reduced until only single particles remained in the microcavity. FMR at room temperature with a frequency of 9 GHz shows single particle resonance with linewidths of 6 mT. We determined a magnetocrystalline anisotropy $K_4 = (5 \pm 0,5) \cdot 10^3 \frac{J}{m^3}$ which is only 10% of the Fe bulk value. The behaviour of single particles in comparison to a statistical distribution will be discussed on the poster. Financial support by MERCUR (PR-2011-0007) is acknowledged.

[1] Kim et al., JACS, 129, 5812-5813 (2007)
[2] Banholzer et al., Nanotech. 22, 295713 (2011)

MA 16.31 Tue 10:30 Poster D

Experimental investigation and modeling of the spin structure in FePt@MnO heterodimer nanoparticles — •Xiao Sun[1], Alice Klapper[1], Oleg Petracic[1], Oskar Koehler[2], Heiko Bauer[2], Wolfgang Tremel[2], and Thomas Brueckel[1] — [1]Jülich Centre for Neutron Science JCNS-2 und Peter Grünberg Institut PGI-4, Forschungszentrum Jülich GmbH — [2]Institut für Anorganische und Analytische Chemie, Johannes Gutenberg-Universität Mainz

Magnetic nanoparticles (NPs) have attracted much interest for decades. We have focused on FePt@MnO heterodimer NPs consisting of a ferromagnetic FePt particle in contact to an antiferromagnetic MnO particle. Single FePt, single MnO and FePt@MnO dimer NPs with different sizes (5-20nm) have been studied using SQUID magne-

tometry employing zero field cooled (ZFC)/field cooled (FC) magnetization curves at various fields, hysteresis curves and thermoremanent (TRM)/ isothermoremanent (IRM) curves. An exchange bias effect in dimer particles has been observed by the shift of hysteresis loops at different temperatures suggesting a magnetic coupling between FePt and MnO. An exchange bias shift is not observed in single FePt or MnO NPs. Monte Carlo simulations of the spin structure in single MnO NPs and FePt@MnO dimer NPs are compared to the experimental findings. Neutron scattering experiments aiming to study the spin structure inside single MnO NPs and inside the MnO subunit of FePt@MnO heterodimers using polarized neutron diffraction are proposed.

MA 16.32 Tue 10:30 Poster D

Formation of ferrite nanoparticles monitored during the preparation process by Mössbauer spectroscopy — •Mathias Kraken[1], Nathalie Leise[1], Andre Borchers[1], Dirk Menzel[1], Jochen Litterst[1], Ingke-Christine Masthoff[2], Ilka-Marina Grabs[2], and Georg Garnweitner[2] — [1]Institut für Physik der kondensierten Materie, Technische Universität Braunschweig, 38106 Braunschweig, Germany — [2]Institut für Partikeltechnik, Technische Universität Braunschweig, Braunschweig, Germany

In the recent years, a broad variety of different preparation methods for magnetic nanoparticles has been established. In this context, the non-aqueous sol-gel method is a rather new process, based on the bottom-up approach, which produces spherical nanoparticles with a small size distribution [1].

Mixtures of $Fe(acac)_3$ with different solvents are placed in a reactor at temperatures above room temperature (typically 200°C). The physical properties of the formed particles depend on the time spent in the reactor.

We investigated solutions of $Fe(acac)_3$ with triethyleneglycol and benzyl alcohol for different reaction times in the reactor by dynamic light scattering, DC susceptibility and Mössbauer spectroscopy in order to gain more information about the process of the formation of the nanoparticles during the stay of the solution in the reactor.

[1] I.-M. Grabs et al., Cryst. Growth Des. 12, 1496 (2012).

MA 16.33 Tue 10:30 Poster D

Characterization of the elastic properties of hydrogels using nickel nanorods as probes — •Philipp Bender, Andreas Tschöpe, and Rainer Birringer — Universität des Saarlandes, Saarbrücken, Germany

With diameters below 42 nm, Ni nanorods are uniaxial ferromagnetic single-domain particles. The nanorods are synthesized by electrodeposition of nickel into porous alumina templates and after several preparation steps dispersed into gelatin gels matrices. Applying a homogeneous magnetic field during gelation results in magnetically textures ferrogels. When the gels are placed in a homogeneous magnetic field, the magnetic torque causes a rotation of the magnetic moments of the rods in field direction. The alignment can occur by a rotation out of the long rod axis working against shape anisotropy or by a rotation of the rods itself, which is restricted by the surrounding elastic network. In a static homogenous magnetic field the magnetic torque, the counteracting torque due to shape anisotropy and the mechanical torque, caused by the shear deformation of the surrounding gel matrix, are at equilibrium. This equilibrium condition was used to develop several methods to characterize the elastic properties of soft hydrogel matrices by magnetization measurements using nickel nanorods as probes. In the present study the initial susceptibilty of the magnetization curves is evaluated in order to determine the shear modulus.

MA 16.34 Tue 10:30 Poster D

Enhanced anisotropy of Ni nanoparticles embedded in IrMn matrices — •Balati Kuerbanjiang[1], Ulf Wiedwald[2], Felix Häring[2], Johannes Biskupek[3], Ute Kaiser[3], and Ulrich Herr[1] — [1]Inst. of Micro and Nanomaterials, Ulm University, 89081 Ulm — [2]Inst. of Solid State Physics, Ulm University, 89069 Ulm — [3]Electron Microscopy Group of Materials Science, Ulm University, 89081 Ulm

Magnetic nanoparticles have huge potential in future applications such as data storage, nanosensors and biomedicals. However, superparamagnetic effect puts a limit on the minimum size of the particles in terms of usage. One way to overcome this limit is attaining exchange anisotropy by coupling the ferromagnetic (FM) particles to an antiferromagnetic (AFM) media. Different from most of the literature works, we developed a sample preparation system where we can independently change the type of FM and AFM materials, allowing us to study the effect in a flexible way. In this work, we have produced Ni nanoparticles using plasma gas condensation technique and *in-situ* embedded them in an IrMn matrix. We show that the embedded Ni nanoparticles display enhanced coercivity H_c and exchange bias H_{ex}. Furthermore, we find that the effect is stronger in smaller particles, and the extracted exchange energy values are in the range of the values found in FM/IrMn bilayer systems. The particle size dependencies of H_c and H_{ex} have been measured in detail, and we propose a micromagnetic model to describe the observed trends. By conducting FC/ZFC measurements, we show a clear increase of blocking temperature for embedded particles compared to identical non-embedded particles.

MA 16.35 Tue 10:30 Poster D

Quadratic magnetooptical effects in two-dimensional permalloy particles investigated by scanning X-ray microscopy — •S.A. Nepijko[1], O.V. Pylypenko[2], L.V. Odnodvorets[2], E. Kisker[3], H.J. Elmers[1], and G. Schönhense[1] — [1]Institute of Physics, University of Mainz, Staudingerweg 7, 55128 Mainz, Germany — [2]Sumy State University, Rimsky-Korsakov str. 2, 40007 Sumy, Ukraine — [3]Institute of Applied Physics, University of Düsseldorf, Universitätsstrasse 1, 40225 Düsseldorf, Germany

We have investigated the magnetization structure and magnetization curves of individual rectangularity shaped permalloy particles using scanning X-ray microscopy in the ultrasoft X-ray regime. Magnetic contrast originates from M-edge X-ray magnetic circular dichroism and from the transverse magnetooptical Kerr effect [1, 2]. We studied magnetization curves in dependence on the field direction for particles of different shapes and sizes. Adjacent particles cause a significant dipole interaction. Asymmetric magnetization loops indicate the presence of non-linear magnetooptical effects. [1] M. Schroeder et al., Nucl. Instrum. Methods Phys. Res., Sect. A, 467-468 (2001) 1404; [2] S.A. Nepijko et al., APA, published online: 19 Sept. 2012

MA 16.36 Tue 10:30 Poster D

Towards EMCD measurements of non-crystalline materials — •Jan Rusz[1], Shunsuke Muto[2], Vancho Kocevski[1], and Kazuyoshi Tatsumi[2] — [1]Department of Physics and Astronomy, Uppsala University, Sweden — [2]Department of Materials, Physics and Energy Engineering, Nagoya University, Japan

Electron magnetic circular dichroism (EMCD) is a young experimental technique that brings a promise of measurement of atom-specific magnetic characteristics at sub-nanometer resolution - an information that is not accessible by any other experimental technique yet. We propose a method of circumventing one of its major present obstacles, namely, the high demands on the quality of measured samples. Until now, only single-crystal samples could be measured. Those had to be oriented in a specific geometry, in order to exploit symmetries of the measurement set up. In the newly proposed method, theoretically analysed in Muto, Tatsumi, Rusz, Ultramicroscopy (in press), the symmetry requirements and specific orientations are effectively removed. Moreover, the method unveiled an exciting possibility to measure polycrystals and possibly even amorphous magnets. The method is based on modern methods of statistical analysis of the multivariate datasets, namely the multivariate curve analysis method (Tauler, 1995). Based on theoretical simulations we explore the feasibility of EMCD experiments on polycrystals and amorphous materials.

MA 16.37 Tue 10:30 Poster D

Exchange Bias in all-Manganite $La_{0.7}Sr_{0.3}MnO_3/SrMnO_3/La_{0.7}Sr_{0.3}MnO$ Trilayers — •Markus Jungbauer, Sebastian Hühn, Markus Michelmann, Camillo Ballani, and Vasily Moshnyaga — I. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

A great interest to exchange bias phenomenon in artificially layered thin films is caused by fundamental importance of this well-known but still controversially explained effect as well as by its promising applicability in spintronics (TMR and multiferroics). We studied exchange bias for all-manganite $La_{0.7}Sr_{0.3}MnO_3/SrMnO_3/La_{0.7}Sr_{0.3}MnO_3$ trilayers with ferromagnetic $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) and G-type antiferromagnetic $SrMnO_3$ (SMO) layers, grown on (001) $SrTiO_3$ substrates by metalorganic aerosol deposition (MAD). The field shift of the magnetic hysteresis loop H_E and the coercitivity H_C decay exponentially with temperature, vanishing at $T = 100\,K$. H_E exhibits a global maximum as a function of the SMO interlayer thickness at $t_{SMO} \approx 4.5\,nm$. We argue that the EB behaviour can be explained by the interplay of a spinglass state at the interface and theoretically proposed mechanism based on the Dzyaloshinskii-Moriya interaction[1].

Financial support of EU via FP7 (IFOX) is acknowledged.

[1] S. Dong, et al., Phys. Rev. Lett. **103**, 127201 (2009)

MA 16.38 Tue 10:30 Poster D

Magneto-resistive characterization of hybrid magnetic films — •Kadir Sentosun[1], Julia Trützschler[1], Manuel Langer[2], Ingolf Mönch[3], Roland Mattheis[4], Thomas von Hofe[1], Jurgen Fassbender[2], and Jeffrey McCord[1] — [1]Institute for Material Science, University Kiel, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Germany — [3]Leibniz Institute for Solid State and Materials Research, Dresden, Germany — [4]Institute of Photonic Technology, Jena, Germany

Thin films with an initial unidirectional anisotropy are patterned by ion irradiation [1] into stripe-like two dimensional structures with alternating directions of exchange bias (EB). By this a structure with laterally varying perpendicular alignment of EB is obtained. The magnetization behaviour of the NiFe/IrMn thin films is investigated by complementary methods: Structures of different stripe width are analysed by inductive magnetometry, the change of anisotropic magneto-resistance (AMR) with varying field angles is investigated by a four probe contact measurement technique, and the magnetization reversal is studied by Kerr microscopy. Transversal magnetization components related to domain wall activity are derived from the AMR measurements. The characteristic AMR sensitivity is maximized when the measuring current direction is along the net magnetization, also oriented parallel to the applied magnetic field direction. Pure uniaxial magnetic field sensitivity is obtained through the perpendicularly aligned magnetization modulation. [1] J. Fassbender and J. McCord, J. Magn. Magn. Mater. 320, 579-596 (2008)

MA 16.39 Tue 10:30 Poster D

Preparation of epitaxial FeMn/Co-exchange-bias systems on MgO single crystals — •Mathias Schmidt, Patrick Audehm, Eberhard Goering, and Gisela Schütz — Max-Planck-Institut für Intelligente Systeme, Heisenbergstr. 3, 70569 Stuttgart

Exchange bias systems are very important for several applications in the area of magnetic storage media. Inside that class of materials, FeMn/Co-thin films are one of the most prominent examples. For research issues, they are usually produced on Cu single crystals fitting almost perfectly to the lattice constant of FeMn, leading to epitaxial growth. For receiving a deeper understanding of the exchange-bias, which is still under strong debate, we used different methods as SQUID, AFM and MOKE but also XAS, XMCD and XRMR (X-Ray Magnetic Reflectometry). Because of the weak deformation resistance of Cu substrates, especially the latter method is nearly impossible to access, which is in principle necessary to receive a detailed magnetic and physical depth profile of the sample. Molecular beam epitaxy was used to produce FeMn/Co-systems on (100) MgO substrates. With the help of different buffer layers, we could achieve epitaxial properties through all sample layers, creating well defined interfaces. We will present the preparation process and the results of multiple characterization methods revealing new insights into the physical and magnetic properties of these exchange-bias systems.

MA 16.40 Tue 10:30 Poster D

Ferromagnetic-antiferromagnetic transition in 1D Fe-based nanocontacts — •Ilia N. Sivkov[1], Dmitriy I. Bazhanov[2], and Valeriy S. Stepanyuk[1] — [1]Max Planck Institute of Microstructure Physics, Halle, Germany — [2]Physics Department, Moscow State University, Moscow, Russia

The recent progress in nanoelectronics and spintronics leads to an intensive experimental and theoretical study of spinpolarized electron transport in one-dimensional nanostructures - nanowires and nanocontacts. The spin-polarized electron transport through mixed magnetic nanostructures can increase significantly the data recording and transmission densities without increasing the size of nanostructures. In our recent study we have shown that it is possible to create the stable mixed Pd-Fe nanowires which exhibit a ferromagnetic-antiferromagnetic(FM-AFM) transition during stretching. We investigate this phenomena in finite atomic mixed chains suspended between Pt, Pd and Au leads using density functional theory. The spin-dependent transmission calculation was performed using non-equilibrium Green's function method and density functional theory. Effect of FM-AFM transition on conductance and magnetoresistance is discussed.

MA 16.41 Tue 10:30 Poster D

influence of top Ni layer on exchange bias and blocking temperature in Ni/NiMn/Ni trilayers — •yasser shokr[1], mustafa erkovan[1,2], Daniela schiestl[1], chii-bin wu[1], mohammed yaqoob khan[1], and wolfgang kuch[1] — [1]Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany. — [2]Gebze Institute of Technology, Dept. of Physics, 41400 Kocaeli, Turkey

The exchange bias (EB) field and the blocking temperature for exchange bias (Tb) in the system Y ML Ni/X ML Ni25Mn75/12 ML Ni on Cu3Au(001) were investigated by magneto-optical Kerr effect (MOKE). The study concentrates on the influence of the antiferromagnetic (AFM) layer thickness on the EB field and on Tb. For every AFM layer thickness X the top ferromagnetic (FM) layer thickness Y has been changed from 0ML and then 12 ML to 22 ML in steps of 5 ML. we show that the EB field is reduced after deposition of the top Ni layer. This is interpreted in term of pining of uncompensated moments in the volume of the AFM layer. In addition, magnetic interlayer coupling between the two Ni layers influence the EB field.

MA 16.42 Tue 10:30 Poster D

Magnetic excitations in half- and overdoped manganites — Holger Ulbrich[1], •Thomas Bardenheuer[1], Paul Steffens[2], Yvan Sidis[3], Daniel Lamago[3], and Markus Braden[1] — [1]II. Physikalisches Institut, Universität zu Köln, 50937 Köln — [2]Institut Laue Langevin, Grenoble — [3]Laboratoire Léon Briilouin, CE Saclay, Gif sur Yvette Cedex

Magnetic excitations were studied by inelastic neutron scattering on various manganites that exhibit charge, orbital and spin ordering. At half-doping the magnetic excitation spectra can be perfectly modelled by a simple Heisenberg model of magnetic interaction which perfectly agrees with the Goodenough scenario of charge and orbital ordering. There seems to be no qualitative difference in all the half-doped manganites studies so far irrespective of their layered or three-dimensional character. For higher doping we observe a stripe-like arrangement of the electronic and magnetic ordering. Furthermore the magnetic excitation spectra closely resemble the hour-glass like dispersion observed in many high-temperature superconducting cuprates. Besides a large ratio of intra- to inter-stripe magnetic inteaction parameters, a short range of the magnetic ordering perpendicular to the stripes can be identified as decisive parameter to induce a hour-glass dispersion in insulating stripe phases.

[1] H. Ulbrich et al., Phys. Rev. Lett. **106**, 157201 (2011) [2] H. Ulbrich, Phys. Rev. B **84**, 094453 (2011) [2] H. Ulbrich, Phys. Rev. Lett. **108**, 247209 (2012)

MA 16.43 Tue 10:30 Poster D

Test of band structure calculations for Heusler compounds by spin-resolved photoemission spectroscopy — Michaela Kolbe[1], Stanislav Chadov[2], Elena Arbelo Jorge[1], Gerd Schönhense[1], Claudia Felser[2], Hans-Joachim Elmers[1], Mathias Kläui[1], and •Martin Jourdan[1] — [1]Institut für Physik, Johannes Gutenberg-Universität, Staudingerweg 7, 55128 Mainz — [2]Max-Planck-Institut für Chemische Physik fester Stoffe, Dresden

The electronic density of states of epitaxial thin films of the Heusler compound Co_2MnGa is probed in situ by spin-resolved ultraviolet photoemission spectroscopy. The experiments reveal several characteristic features in the intensity spectrum and a clear Fermi edge signature. A high spin polarization of 55% at the Fermi edge is followed by a sign change at the binding energy of 0.8 eV. Corresponding calculations of the band structure and the photoemission spectrum were performed employing a spin-polarized relativistic Korringa-Kohn-Rostoker code. Good agreement between the experimental data and calculations was obtained, including dynamical correlation effects [1].

[1] M. Kolbe et al., Phys. Rev. B, 86, 024422 (2012)

MA 16.44 Tue 10:30 Poster D

Carbon Nanotubes filled with Nanoparticles from the System Ni-Mn-Ga — •Marcel Haft, Silke Hampel, Markus Gellesch, Sabine Wurmehl, Lars Giebeler, Maria Dimitrakopolou, and Bernd Buechner — Leibniz-Institute for Solid State and Materials Research, IFW-Dresden, D-01171

Properties of nanoscale materials can completely change when scaling a bulk-material down to its smallest size. However, especially at nanoscale dimensions oxidation is a fundamental challenge in intermetallic materials, which has so far obstructed the investigation of attractive intermetallic materials at the nanoscale. In this work,

we propose a novel approach for the synthesis of intermetallic (magnetic) nanoparticles which is based on the encapsulation of materials inside carbon nanotubes. Hereby carbon nanotubes function as a template for the formation of nanoparticles and nanowires with well-defined sizes and provide protective carbon shells which hinder oxidation of the nanoparticles. We present several wet chemical filling methods, both from solution and from melt of metal nitrates and halides. The samples were well characterized by means of electron microscopy (SEM, TEM), x-ray probes and temperature dependent magnetometry. We observe, that the metallic nanoparticles inside carbon nanotubes exhibit enhanced magnetic performance (increased coercitivity) compared to bulk material. So far Nickel, Manganese and Gallium were filled separately into carbon nanotubes as model compounds. In future we will fill nanoparticles of the respective binary compounds and eventually also the ternary Heusler compound Ni2MnGa into carbon nanotubes.

MA 16.45 Tue 10:30 Poster D

Interface-controlled Magnetism and Transport of Ultrathin Manganite Films — •Sebastian Hühn[1], Markus Jungbauer[1], Markus Michelmann[1], Oleg Shapoval[2], Alexander Belenchuk[2], Jo Verbeeck[3], and Vasily Moshnyaga[1] — [1]I. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany, — [2]IIEN, Academy of Sciences of Moldova, Academiei str., 3/3, MD-2028, Chisinau, Moldova — [3]EMAT, University of Antwerp, Groenenborgerlaan 171, B-2020 Antwerp, Belgium

The recent great fundamental and technological interest for interfaces in thin films of correlated oxides (manganites, aluminates, titanites and cuprates) is caused by two main reasons: 1) to stabilize the bulk-like magnetism, metallicity and ferroelectricity in ultrathin films and 2) to create new interface-originated properties not akin to the bulk phases. We investigate thin ferromagnetic manganite films with various interface modifications grown by metalorganic aerosol deposition (MAD) technique on $SrTiO_3$ substrates with different orientations. Structure and morphology is studied by AFM/STM, XRD, XRR and HREM; transport and magnetization by PPMS and MPMS, respectively. We observe ferromagnetic metallic behavior of a three unit cell thick interface engineered lanthanum manganite film, modified by 2 u.c. of strontium manganite, grown on STO(100). Financial support from EU FP 7, IFOX (interfacing oxides) project is acknowledged.

MA 16.46 Tue 10:30 Poster D

Magnetic resonance study of Heusler compounds — •A. Alfonsov[1], S. Rodan[1], M. E. Belesi[1], V. Kataev[1], B. Peters[2], F. Yang[2], M. Emmel[3], G. Jakob[3], H.-J. Elmers[3], S. Wurmehl[1], and B. Büchner[1] — [1]IFW Dresden, D-01169 Dresden, Germany — [2]Department of Physics, Ohio State University,191 West Woodruff Avenue Columbus, Ohio 43210, USA — [3]Institut für Physik, Johannes Gutenberg-Universität Mainz, D-55099 Mainz, Germany

Heusler alloys have attracted a considerable attention in recent years since these compounds are predicted to be halfmetallic ferromagnets. High magnetic moments and high values of the Curie temperature give them a significant potential for spintronics applications. To control the macroscopic physical properties of these materials it is crucial to have a precise knowledge of the structural and magnetic ordering also on a local scale. For instance, the halfmetallicity in these materials strongly depends on the local atomic order. To obtain such knowledge one has to call for local probe techniques. In this work we present recent nuclear magnetic resonance and electron spin resonance study of various Co-, Mn- and Fe-based Heusler compounds where we address the local structural and magnetic properties.

MA 16.47 Tue 10:30 Poster D

The influence of p- and n-doping on the intrinsic properties of the Heusler compound Fe_2VAl — •Franziska Seifert[1,2], Christian G.F. Blum[1], Frank Steckel[1], Christian Hess[1], Bernd Büchner[1], Sabine Wurmehl[1], Stefan Martin[2], and David Rafaja[2] — [1]Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden — [2]TU Bergakademie Freiberg, Germany

The Heusler compound Fe_2VAl is considered as a non-magnetic thermoelectric material. In this work, we studied the intrinsic properties of the Heusler compound Fe_2VAl and the influence of p- and n-doping on the intrinsic materials properties of the corresponding Si and Ti doped compounds using single crystals. Electron back scattering diffraction reveals the presence of a V-rich secondary phase in particular in crystals with Si and in the parent compound. The depletion of V from the Fe_2VAl matrix apparently leads to localized Fe moments and to ferromagnetism in the corresponding samples. Interestingly, the sample with Ti and less V depletion shows a significant enhancement of the figure of merit compared to the other samples.

MA 16.48 Tue 10:30 Poster D

First-principles study of the structural stability of Mn_3Z (Z=Ga, Sn and Ge) Heusler compounds — •D. Zhang[1], B. Yan[1,2], S.-C. Wu[1], J. Kuebler[3], G. Kreiner[1], and C. Felser[1,2] — [1]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany — [2]Johannes Gutenberg-Universität Mainz, Staudingerweg 9, 55128 Mainz, Germany — [3]Institut für Festkörperphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany

We investigate the structural stability and magnetic properties of cubic, tetragonal and hexagonal phases of Mn_3Z (Z=Ga, Sn and Ge) Heusler compounds using the first-principles density-functional theory. We propose that the cubic phase plays an important role as an intermediate state in the phase transition from the hexagonal to the tetragonal phase. Consequently, Mn_3Ga and Mn_3Ge behave differently from Mn_3Sn, because the relative energies of the cubic and hexagonal phases are different. These results agree with experimental observations from these three compounds. The weak ferromagnetism of the hexagonal phase and the perpendicular magnetocrystalline anisotropy of the tetragonal phase obtained in our calculations are also consistent with experiment.

MA 16.49 Tue 10:30 Poster D

Autocorrelation measurement with femtosecond laser pulses of correlated polaron dynamics in manganites — •Manuel Mchalwat, Christin Kalkert, Camillo Ballani, Vasily Moshnyaga, Markus Münzenberg, and Konrad Samwer — 1. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

In manganites the spatial and time scales of correlations range from microns and seconds as for the electronic phase separation down to 1 . . . 2 nm and femtoseconds as for the Jahn-Teller polarons. Recently it was shown that the third harmonic voltage in electrical transport is proportional to the concentration of correlated polarons. To get access to the their ultrafast dynamics we performend an autocorrelation measurement of the third harmonic voltage with femtosecond laser pulses thus photo-inducing correlated polarons. Further we discuss our results with respect to thermal and non-thermal influences.

The work has been supported by the DFG through SFB 602 TP A2 and by Femtolasers.

MA 16.50 Tue 10:30 Poster D

Theoretical study of the mechanical stability and magnetic properties of Mn_2-based Heusler compounds with heavy transition metals — •L. Wollmann[1,2], G. H. Fecher[1], and C. Felser[1] — [1]Max Planck Institute for Chemical Physics of Solids, Nöthnitzer Straße 40, 01187 Dresden, Germany — [2]Johannes Gutenberg University, Staudingerweg 9, 55128 Mainz, Germany

We have investigated by ab-initio calculations the class of Mn_2YZ Heusler compounds (with Y = Rh, Ru and Z = Ga, In, Tl, Ge, Sn, Pb) in order to explore their potential for applications in the field of spintronics. The calculations have been performed using the FPLAPW+(lo)-method as implemented in Wien2k. By applying uniaxial strain in the linear region in three directions it was possible to evaluate the mechanical stability. Proving that they do not adapt the cubic Heusler structure by evaluating the elastic properties, we report to have found promising candidates for new Heusler phases (tetragonal or lower symmetry) formed by the mentioned compositions. The mechanical properties, as well as the electronic and magnetic structure of tetragonal and cubic compounds will be discussed.

MA 16.51 Tue 10:30 Poster D

Magnetic and transport properties of the Heusler system $Ni_{2-x}Mn_{1+x}Sn$. — •Tina Fichtner, Guido Kreiner, Gerhard H. Fecher, Walter Schnelle, and Clauida Felser — Max-Planck-Institut für Chemische Physik fester Stoffe, Dresden

In the present work we have investigated a new series of polycrystalline alloys of the general composition $Ni_{2-x}Mn_{1+x}Sn$ with x = 0, 0.2, 0.4, 0.5, 0.6, 0.8, 1. The alloys were obtained as single-phase materials by inductive melting of the elements and subsequent annealing at 700°C. $Ni_{2-x}Mn_{1+x}Sn$ crystallizes in the cubic Heusler structure, thus forming a solid solution series from Ni_2MnSn to Mn_2NiSn. The stochiomet-

ric Heusler compounds of this series show ferro- or ferrimagnetic order with T_c ranging from 346 to 550 K, respectively. The magnetic moment at 1.8 K decreases in the series from 4.1 μ_B to 2.3 μ_B. The cubic symmetry is stable from low to high temperature. Instead of building a non-cubic structure, a miscibility gap forms pointing out an entropic stabilization of the cubic phase. Here, we report on the magnetic and transport properties with respect to the chemical disorder.

MA 16.52 Tue 10:30 Poster D

Electronic, structural and magnetic properties of $NiFe_2O_4$ ultra thin films — •Michael Voigt[1], Christian Caspers[1], Bernardus Zijlstra[1], Sebastian Flade[1], Sven Döring[2], Mihaela Gorgoi[3], Claus M. Schneider[1], and Martina Müller[1] — [1]Peter-Grünberg-Institut (PGI-6), Forschungszentrum Jülich — [2]Experimentalphysik, Universität Duisburg-Essen — [3]BESSY II, Helmholtzzentrum Berlin für Materialien und Energie

The spinel $NiFe_2O_4$ (NFO) is an insulating oxide that is ferrimagnetic with a Curie-temperature way above room temperature. This rare combination of properties makes this material intriguing for integration into heterostructures for spintronics. The magnetic properties of ultra-thin ferrite films, however, strongly differ from the bulk, i.e. an enhanced magnetization is observed for $d_{NFO} \leq 10$ nm, though the reason for this is still unclear.
To gain insights into this phenomenon, we investigated ultra-thin NFO films (d = 2 - 20 nm) deposited on $SrTiO_3$ via pulsed laser deposition, and studied the structural, magnetic and electronic properties via SQUID, XRD, NEXAFS and HAXPES. The latter two methods allow us to probe the oxidation states and the atomic coordination element specifically for the Ni- and Fe-cations. The Ni- & Fe-2p/3p spectra show that the ultra-thin films grow with bulk-like electronic properties. From the spectral shape we conclude, that even for lowest film thickness no cation inversion takes place. Furthermore, we deduce a two-phase growth mode from XRD data, in which NFO grows highly strained for d $\leq$ 4 nm and starts to relax for larger thicknesses.

MA 16.53 Tue 10:30 Poster D

Structural and magnetic properties of Ni-Co-Mn-Sn thin films — •Ramudu Machavarapu, Christian Mix, and Gerhard Jakob — Institut für Physik, Johannes Gutenberg-Universität Mainz, 55128 Mainz

Ni-Co-Mn-Sn alloys have drawn interest recently due to their multifunctional properties like magnetic shape memory effect (MSME), magnetocaloric effect and direct conversion of heat to electricity. It is well recognized that the austenite of the Ni-(Co)-Mn-X (X = In, Sn, Sb) alloys has a ferromagnetic state below the Curie temperature (TC) and a paramagnetic state above TC. However, the low-temperature martensite exhibits different magnetic behavior such as ferromagnetic, paramagnetic, antiferromagnetic and spin glass, depending on exact composition. These alloys also have shown thermoelastic martensitic transformations at high temperatures. To gain a deep understanding of the functional properties of these alloys, it is very important to investigate their structural and magnetic properties in detail.

Thin films of Ni-Co-Mn-Sn have been prepared on single crystalline MgO (100) substrate using DC magnetron sputtering. The preparation parameters like sputtering power, substrate temperature and argon gas pressure were optimized. Crystal structure of thin films was studied using X-ray diffraction. Detailed structural transformations and magnetic properties were investigated using superconducting quantum interference device (SQUID) magnetometer.

We acknowledge financial support by the DFG within priority program SPP 1239 (Ja821/3-3).

MA 16.54 Tue 10:30 Poster D

Zero Field ^{55}Mn NMR study of Ni-Mn-Ga shape memory alloys — •Maria Eleni Belesi, Christian G. F. Blum, Bernd Büchner, and Sabine Wurmehl — Leibniz Institute for Solid State and Materials Research, Dresden, Helmholtzstrasse 20, 01069 Dresden, Germany

Ferromagnetic shape memory alloys exhibit a structural transition from the high temperature austenitic phase to the low temperature martensitic phase. The structural transition can be driven either by temperature or by a magnetic field. Nuclear Magnetic resonance (NMR) is a powerful local technique which is well known to provide information on the static and dynamic phenomena accompanying structural phase transitions. We have performed ^{55}Mn NMR experiments at zero magnetic field on as-cast and annealed Ni-Mn-Ga samples prepared by arc melting. The evolution of the local structure from the high temperature austenitic phase to the low temperature martensitic phase is probed ^{55}Mn NMR lineshape measurements.

MA 16.55 Tue 10:30 Poster D

Martensitic Transition in Ni-Mn-Ga/Ni-Mn-Sn Multilayer Thin Films — •Niclas Teichert[1], Anna Möhn[2,3], Anja Waske[3], Biswanath Dutta[4], Tilmann Hickel[4], and Andreas Hütten[1] — [1]Department of Physics, Thin Films and Physics of Nanostructures, Bielefeld University, 33615 Bielefeld, Germany — [2]IFW Dresden, Institute for Complex Materials, 01069 Dresden, Germany — [3]TU Dresden, Institut für Festkörperphysik, 01062 Dresden, Germany — [4]Max-Planck-Institut für Eisenforschung GmbH, 40237, Düsseldorf, Germany

Both Ni-Mn-Sn and Ni-Mn-Ga are ferromagnetic shape-memory Heusler alloys and show a martensitic transition accompanied by a magnetocaloric effect (MCE) in a certain composition range. The MCE is inverse in Ni-Mn-Sn and conventional in Ni-Mn-Ga. We want to achieve a coupling of both effects in multilayer thin films in order to enhance the MCE. This approach gives rise to additional interface entropy, magnetic interaction across the interfaces and lateral strain due to the lattice mismatch.

We prepared different epitaxial Ni-Mn-Ga/Ni-Mn-Sn multilayer thin films on heated MgO(001) substrates by magnetron sputtering. The number of layers as well as the layer thickness is varied to study the effects of interfaces, strain and interdiffusion between the layers on the martensitic transition. This is done by temperature dependent resistivity and magnetoresistance measurements, magnetic measurments, X-Ray diffraction and Auger electron spectroscopy.

MA 16.56 Tue 10:30 Poster D

Tunnel magneto-Seebeck effect in tunnel junctions with perpendicular magnetic anisotropy — •Tim Eggebrecht[1], Marvin Walter[1], Vladyslav Zbarsky[1], Markus Münzenberg[1], Volker Drewello[2], Karsten Rott[2], Günter Reiss[2], Andy Thomas[2], Patrick Peretzki[3], Michael Seibt[3], Michael Czerner[4], Michael Bachmann[4], and Christian Heiliger[4] — [1]I. Physikalisches Institut, Universität Göttingen — [2]Department of Physics, Bielefeld University — [3]IV. Physikalisches Institut, Universität Göttingen — [4]I. Physikalisches Institut, Universität Giessen

In CoFeB/MgO/CoFeB tunnel junctions (MTJs) with in-plane magnetic anisotropy the tunnel magneto-Seebeck effect (TMS) has already been observed. Recently, MTJs with perpendicular magnetic anisotropy (PMA) were fabricated by reducing the thickness of the two CoFeB layers. The thickness has to be lower than 1.3 nm, as observed by other groups. These MTJs with 4 monolayers MgO barrier show a TMR of more than 40 % and a very low switching current density of $2 \cdot 10^5$ A/cm^2.

In this work, the tunnel magneto-Seebeck effect is studied in junctions with in-plane and perpendicular magnetic anisotropy. The heating is achieved with a diode laser which delivers powers of up to 150 mW. The influence of the thin CoFeB layers and the MgO barrier on the TMS is studied.

MA 16.57 Tue 10:30 Poster D

HF-ESR studies of the compounds $\{[Cu(bpy)_3][Cu_2(C_2O_4)_3]\cdot H_2O\}_n$ and $\{[Cu(bpy)_3][Mn_2(C_2O_4)_3]\cdot H_2O\}_n$ — •Dijana Žilić[1,2], Boris Rakvin[2], Marijana Jurić[2], Pavica Planinić[2], Damir Pajić[3], Krešo Zadro[3], Yulia Krupskaya[1], Vladislav Kataev[1], and Bernd Büchner[1] — [1]Leibniz Institute for Solid State and Materials Research IFW Dresden, Dresden, Germany — [2]Rudjer Bošković Institute, Zagreb, Croatia — [3]Faculty of Science, University of Zagreb, Zagreb, Croatia

The homometallic $\{[Cu(bpy)_3][Cu_2(C_2O_4)_3]\cdot H_2O\}_n$ (**1**) and the heterometallic $\{[Cu(bpy)_3][Mn_2(C_2O_4)_3]\cdot H_2O\}_n$ (**2**) compounds, where bpy = 2,2'-bipyridine, consist of a three-dimensional (3D), polimeric anionic network $[M_2(C_2O_4)_3]_n{}^{2n-}$ (where M = Cu^{2+} or Mn^{2+}) with cations $[Cu(bpy)_3]^{2+}$ occupying the vacancies of the network.

Frequency- and temperature-dependent high field electron spin resonance (HF-ESR) measurements on a polycrystalline sample of **1** and **2** are presented. Supported by X-band ESR on the polycrystalline of **1** and on the single crystal of **2**, as well as, SQUID magnetization measurements, the magnetic properties of the compounds **1** and **2** are discussed.

MA 16.58 Tue 10:30 Poster D

Domain-structure-induced giant magneto-impedance — •Matthäus Langosch, Thomas Karwoth, Haibin Gao, and Uwe

Hartmann — Institute of Experimental Physics, Saarland University, P. O. Box 151150, D-66041, Saarbruecken, Germany

Recent magneto-impedance studies in the low frequency range up to 100 kHz confirm the GMI effect on <100> iron single crystals (iron whiskers) [1]. In this range, contributions of magnetic domain structures and domain wall dynamics have to be taken into account. Compared to optimized GMI samples like amorphous Co-based microwires, iron whiskers have cubic magneto crystalline anisotropy and the GMI effect shows a strong current dependence. The dependence is related to the Oersted-field-induced domain structure when the current is in the order of tens of mA. The magnitude and the phase of the effective circumferential permeability, obtained through calculations based on the standard skin effect formalism and the experimental data, show various magnetic field and current frequency regimes. Further experimental investigations including magneto-optical Kerr effect microscopy and pickup-coil measurements give a deeper insight in these GMI regimes.

[1] M. Langosch, H. Gao and U. Hartmann J. Phys. D: Appl. Phys. 45, 085001 (2012)

MA 16.59 Tue 10:30 Poster D

Giant magnetoimpedance of composite wires with an insulation layer — Ralf Betzholz[1], •Haibin Gao[1], Zhenjie Zhao[2], and Uwe Hartmann[1] — [1]Institute of Experimental Physics, Saarland University, P.O. Box 151150, D-66041 Saarbruecken, Germany — [2]Department of Physics, East China Normal University, 3663 Zhongshan North Road, 200062 Shanghai, P.R. China

Composite wires with a three-layered structure were investigated with regard to the origin of the giant magnetoimpedance (GMI) effect. The samples consisting of a copper core, a silicon dioxide layer and an outer Permalloy shell were prepared by RF magnetron sputtering. The GMI ratio was measured at various driving current frequencies and with different insulating layer thicknesses. A theoretical model based on coupling the Maxwell equations to the Landau-Lifschitz-Gilbert equation was developed to investigate the composite wire impedance and its dependence on external magnetic field, current frequency and insulating layer thickness. Reasons for discrepancies between the theory and experimental findings were discussed.

MA 16.60 Tue 10:30 Poster D

First-principles study of inorganic-organic hybrids: $(NH_4)_2CuCl_4$, $(CH_3NH_3)_2CuCl_4$ and $(C_2H_5NH_3)_2CuCl_4$ — •Pegah Zolfaghari[1], Gilles A de Wijs[1], and Robert A de Groot[1,2] — [1]Radboud university Nijmegen, Electronic Structure of Materials,Institute for Molecules and Materials, Netherlands — [2]Rijksuniversiteit Groningen, Solid State Materials for Electronics,Zernike Institute for Advanced Materials, Netherlands

Hybrid inorganic-organic compounds with the general formula $(C_nH_{2n+1}NH_3)_2CuCl_4$ are an interesting class of new materials in condensed matter physics. These materials provide a considerable opportunity for scientific studies. The ferromagnetic intra-layer interactions in Cu^{2+} organic-inorganic hybrids enable magnetic applications in electronic devices. The organic blocks are essential for the synthesis by the self-assembly. We report electronic structure calculations based on first principles methods as well as the LDA+U method. A linear relation between the intra-layer interaction and tilting of the $[CuCl_6]^{4-}$ octahedra is observed. The magnetic coupling between the octahedra shows a weak quasi 2-D nearest neighbor character. This results in relatively low Curie temperatures.

MA 16.61 Tue 10:30 Poster D

Origin of the Giant Magnetocaloric effect — •Prasenjit Roy[1], Gilles A de Wijs[1], and Robert A de Groot[1,2] — [1]Electronic Structure of Materials, Radboud University Nijmegen, Institute for Molecules and Materials, Heyendaalseweg 135, 6525 AJ Nijmegen, The Netherlands — [2]Laboratory of Chemical Physics, Zernike Institute of Advanced Materials, Nijenborgh 4, NL-9747 AG Groningen, The Netherlands

Adiabatic demagnetization as tool for refrigeration at room temperature has been studied extensively over the past decade. Recently the origin of the colossal magneto-caloric effect has been discovered by electronic structure calculations: the coexistence of weak and strong magnetism in one compound: mixed magnetism. Current research focuses on the study of the relation between structure, chemical composition and details of the mixed magnetism in the MnFePSi systems, with emphasis on the behavior of the weakly magnetic part of the compounds.

MA 16.62 Tue 10:30 Poster D

Investigation of the magnetocaloric effect in La(Fe,Si,Co)13 compound in pulsed magnetic fields — •Mahdiyeh Ghorbani Zavareh[1,2], Iurii Scurschii[1], Konstantin Skokov[3], Oliver Gutfleisch[3], and Joachim Wosnitza[1] — [1]HZDR Institute of Ion-Beam Physics and Materials Research P.O. Box 510119, 01314 Dresden, Germany — [2]TU Dresden Helmholtzstr. 10, 01069 Dresden, Germany — [3]Materials Science, Technical University Darmstadt, Petersenstr. 23, 64287 Darmstadt, Germany

We report on direct measurements of the magnetocaloric effect (MCE) of La(Fe,Si,Co)13 compound, which belongs to a family of materials prospective for magnetic refrigeration applications. Measurements in quasi-static magnetic fields up to 2 Tesla have shown the change of temperature up to 6 K. A new technique of measuring the MCE directly in pulsed magnetic field has been developed. This allows to investigate MCE in magnetic fields up to 70 Tesla. The set-up has been tested by measuring MCE of polycrystalline gadolinium. We have measured MCE of La(Fe,Si,Co)13 compound in the fields up to 10 Tesla. The data obtained are in a good agreement with the quasi-static data.

MA 16.63 Tue 10:30 Poster D

Investigation of the magnetocaloric effect in La(Fe,Si,Co)13 compound in pulsed magnetic fields — •Mahdiyeh Ghorbani Zavareh[1,2], Iurii Scurschii[1], Konstantin Skokov[3], Oliver Gutfleisch[3], and Joachim Wosnitza[1] — [1]Dresden High Magnetic Field Laboratory, Helmholtz-Zentrum Dresden Rossendorf, D-01314 Dresden, — [2]TU Dresden Helmholtzstr. 10, 01069 Dresden, Germany — [3]Materials Science, Technical University Darmstadt, Petersenstr. 23, 64287 Darmstadt, Germany

We report on direct measurements of the magnetocaloric effect (MCE) of La(Fe,Si,Co)13 compound, which belongs to a family of materials prospective for magnetic refrigeration applications. Measurements in quasi-static magnetic fields up to 2 Tesla have shown the change of temperature up to 6 K[1]. A new technique of measuring the MCE directly in pulsed magnetic field has been developed. This allows to investigate MCE in magnetic fields up to 70 Tesla. The set-up has been tested by measuring MCE of polycrystalline gadolinium. We have measured MCE of La(Fe,Si,Co)13 compound in the fields up to 10 Tesla. The data obtained are in a good agreement with the quasi-static data.[1]J. Lyubina, O. Gutfleisch, M. D. Kuz'min, and M. Richter, J. Magn. Magn. Mater. 321, 3571 (2009).

MA 16.64 Tue 10:30 Poster D

Magnetic and Structural investigation of high performance Rare earth permanent magnets — •Sapana Tripathi, Eberhard Goering, Gisela Schütz, and Dagmar Goll — Max Planck Institut für Intelligente Systeme, Heisenbergstr. 3 ,70569 Stuttgart

The study of rare earth permanent magnets has a great importance from the viewpoints of both academic research and large variety of applications in modern technologies. The most powerful permanent magnetic material at present which derive their exceptional magnetic characteristic from the favorable combination of rare earth metal is Neodymium-Iron-Boron (Nd,Dy)2Fe14B magnets. In order to clarify the contribution of rare earth elements in magnetism, the magnetic characteristics have been determined quantitatively from X-ray magnetic circular dichroism (XMCD) , element specific hysteresis loops and magnetic moments using our new 7 Tesla magnet XMCD system, which is able to saturate the (Nd,Dy)2Fe14B magnets. Further investigations related to the micro structure are presented as energy dispersive X-ray analysis, high-resolution transmission electron microscopy and SQUID measurements. The results prove an unexpected very weak ferromagnetism rare earth side.

1. D. Goll H. Kronmüller High-performance permanent Magnets Naturwissenschaften (2000) 87:423*438 2. Karl J. Strnat Modern Permanent Magnets for Applications in Electro-Technology University of Dayton, Ohio Proceedings of the IEEE, Volume 78, Number 6, June 1990

MA 16.65 Tue 10:30 Poster D

Electronic and magnetic properties of Ti_4O_7 and Ti_5O_9 Magnéli phases — Ivetta V. Slipukhina, •Konstantin Z. Rushchanskii, Stefan Blügel, and Marjana Ležaić — Peter Grünberg Institut, Forschungszentrum Jülich and JARA, 52425 Jülich, Germany

For several decades binary transition-metal oxides have attracted increasing attention as resistively switching materials. Resistive switching in many of these oxides is claimed to be based on the formation and disruption of highly-conductive filaments, through which the current flow is realized. However, still very little is known about the composition, structure and dimensions of these filaments. Recent low-temperature conductivity and *in situ* current-voltage measurements confirmed that the conducting filaments in $Pt/TiO_2/Pt$ [1], as well as Fe-doped $SrTiO_3$ [2] are composed of Magnéli phases Ti_nO_{2n-1} (mostly n=4 or 5), which are mixed-valence compounds with two Ti^{3+} ($3d^1$ electronic configuration) and $(n-2)$ Ti^{4+} ($3d^0$ configuration) ions.

In this work we aimed to develop a fundamental understanding of the mechanisms that underlie the phase transitions in Magnéli phases like Ti_5O_9 and Ti_4O_7. With this aim we performed DFT calculations in order to illuminate the changes in their electronic structure on a microscopic level and establish relations between the structural, electronic and magnetic properties and their role in phase transitions.

We acknowledge the support by SFB917-Nanoswitches and the Helmholtz Young Investigators Group Programme VH-NG-409.

[1] D.-H. Kwon *et al.*, Nature Nanotech. **5**, 148 (2010).
[2] R. Münstermann *et al.*, Advanced Materials **22**, 4819 (2010).

MA 16.66 Tue 10:30 Poster D

Site occupancy analysis of cobalt in a M-type ferrite hard magnetic material — •Shunsuke Muto, Kazuyoshi Tatsumi, and Kazuma Hattori — Graduate School of Engineering, Nagoya University, Nagoya 464-8603, Japan

High angular resolution electron channeling X-ray spectroscopy (HARECXS), as a useful extension of atom location by channeling enhanced microanalysis (ALCHEMI), has been applied to local structure analysis in crystals with the development of digitally-controlled TEM. In this method, intensities of characteristic X-ray are measured by digitally and continuously changing the incident beam direction. The obtained dataset contains information on e.g. impurity sites and their occupancies in the crystalline material of interest. In this study we applied the method to Sr-M type ferrite (SrFe12O19) having large uniaxial anisotropy (a=0.588 nm, c=2.302 nm), and examined the effect of higher order Laue zones (HOLZ) on the quantitative analysis.

The site occupancy analysis of a magnetic impurity, cobalt in the M-type ferrite, substituting for the five kinds of the Fe sites. HARECXS analyses around two independent zone axes could be very effective to precisely determine the site occupancy of the trace element. We discuss the correlation between the impurity occupation sites and magnetic properties.

MA 16.67 Tue 10:30 Poster D

Magnetic and structural properties of $LiMn_{1-x}Ni_xPO_4$ — •Thomas Kolb[1], Alexander Ottmann[1], Carsten Jähne[1], Hans-Peter Meyer[2] und Rüdiger Klingeler[1] — [1]Kirchhoff Institute for Physics, University of Heidelberg, D-69120 Heidelberg, Germany — [2]Institut für Geowissenschaften, University of Heidelberg, D-69120 Heidelberg, Germany

We present structural and magnetic properties of $LiMn_{1-x}Ni_xPO_4$ with $0 \leq x \leq 0.5$ synthesized by solid state reaction as well as by microwave-assisted hydrothermal synthesis. For both doping series, chemical analysis, i.e. Mn:Ni:P, performed by means of energy-dispersive X-ray analysis confirms that the actual Ni content agrees well to the nominal composition. Powder x-ray diffraction implies single-phase materials with orthorhombic olivine structure ($Pnma$). The evolution of lattice parameters obeys Vegard's law and agrees to the fact that replacing Mn^{2+} by smaller Ni^{2+} corresponds to negative chemical pressure $\Delta V/V \approx -8 \cdot 10^{-4}/\%\text{Ni}$. While the onset of long-range antiferromagnetic order at $T_N = 32\,\text{K}$ does not depend on the Ni-content, there are changes in the magnetic anisotropy.

MA 16.68 Tue 10:30 Poster D

Thermal Expansion and Grüneisen scaling in single-crystalline $LiMn_{1-x}Ni_xPO_4$ — Christopher Dietl[1], •Lars Wallbaum[1], Kunpeng Wang[1], Carsten Jähne[1], Herbert Müller[3], Hans-Peter Meyer[2], and Rüdiger Klingeler[1] — [1]Kirchhoff Institute for Physics, University of Heidelberg, D-69120 Heidelberg, Germany — [2]Institut für Geowissenschaften, University of Heidelberg, D-69120 Heidelberg, Germany — [3]Institut für Festkörperphysik, Technische Universität Wien, A-1040 Wien, Austria

Li-based olivine phosphates LiMPO4 (M = Mn, Fe, Co, Ni) exhibit an enormous potential for applications. One the one hand, their electrochemical cyclability and high-temperature stability renders them next-generation cathode materials for Li-ion batteries. In addition, they exhibit complex ordering phenomena, large magnetoelectric effects and unusual ferrotoroidic domains which are supposed to be relevant for data storage applications. In order to study the fundamental properties we have grown $LiMn_{1-x}Ni_xPO_4$ single crystals by the travelling-solvent floating-zone method. Thermal expansion studies along the crystallographic axes by means of capacitive dilatometry imply strong magnetic-elastic coupling. The onset of long-range magnetic order is associated with pronounced lambda-like anomalies in the a- and c-axis thermal expansion and the magnetic specific heat. The data show a strong positive hydrostatic pressure dependence of T_N and a large fluctuation regime. The effect of Ni-doping on the magnetic anisotropy as probed by the spin-flop field is discussed.

MA 16.69 Tue 10:30 Poster D

Magnetic and defect-properties of Co implanted TiO_2 — •Oguz Yildirim[1,4], Steffen Cornelius[1,4], Mykola Vinnichenko[1], Maik Buterling[2], Andreas Wagner[2], Alevtina Smekhova[3], and Kay Potzger[1] — [1]Institute of Ion Beam Physics and Materials Research, HZDR, POB 510119, 01314, Dresden, Germany — [2]Institute for Radiation Physics, HZDR, POB510119, 01328, Dresden, Germany — [3]MSU, Faculty of Physics, Solid State Physics and Magnetism Departments,Moscow, Russia — [4]TU Dresden, Helmholtzstr. 10, 01069, Dresden, Germany

The magnetic and structrual properties of the potential diluted magnetic oxide (DMO), i.e. Co implanted TiO_2 thin films have been investigated. These films have been grown by magnetron sputtering on $SrTiO_3$ single crystals. Avoidence of possible magnetic contamination has been verified by magnetometry measurements after substrate preparation and deposition. For magnetic doping, implantations of Co^+ ions have been performed at atomic concentrations of 0.5%, 2.5% and 3% respectively. The dependencies between the fluence implanted, defect creation and ferromagnetic properties have been investigated using magnetometry, positron annihilation spectroscopy and structural characterisation.

This work is supported by the Initiative and Networking Fund of the German Helmholtz Association, Helmholtz-Russia Joint Research Group HRJRG−314, and the Russian Foundation for Basic Research, RFBR $\#12-02-91321-SIG-a$.

MA 16.70 Tue 10:30 Poster D

Coordination-driven magnetic-to-nonmagnetic transition in manganese doped silicon clusters — •Linn Leppert[1], Vicente Zamudio-Bayer[2,3], Konstantin Hirsch[2,3], Andreas Langenberg[2,3], Jochen Rittmann[2,3], Martin Kossick[2,3], Robert Richter[3], Akira Terasaki[4], Thomas Möller[3], Stephan Kümmel[1], Bernd von Issendorff[5], and J. Tobias Lau[2] — [1]Theoretische Physik IV, Universität Bayreuth, 95440 Bayreuth, GER — [2]Institut für Methoden und Instrumentierung der Synchrotronstrahlung, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, 12489 Berlin, GER — [3]Institut für Optik und Atomare Physik, Technische Universität Berlin, 10623 Berlin, GER — [4]Cluster Research Laboratory, Toyota Technological Institute, 717-86 Futamata, Ichikawa, Chiba 272-0001, JP — [5]Fakultät für Physik, Universität Freiburg, 79104 Freiburg, GER

X-ray Magnetic Circular Dichroism (XMCD) spectroscopy allows to obtain fundamental insight into magnetic properties of free, size-selected clusters. We demonstrate using a combination of XMCD and non-empirical density functional theory that the magnetic moment of small Si clusters doped with a single Mn impurity is completely quenched as soon as a cluster size of 10 Si atoms is exceeded. This is a result of an abrupt increase of the impurity coordination from 10 to 11 Si atoms. Since the impurity coordination in small exohedrally doped Si clusters is close to that observed in bulk Si, smaller clusters are, contrary to intuition, far better suited for prediciting the magnetic properties of the bulk system than larger endohedrally doped clusters.

MA 16.71 Tue 10:30 Poster D

Pressure induced Ferromagnetism in undoped ZnO pellets — •Chen Yu-Chun[1], Eberhard Goering[1], Zumin Wang[1], Lars Jeurgens[2], Thomas Tietze[1], and Gisela Schütz[1] — [1]Max Planck Institute for Intelligent System, Stuttgart, Germany — [2]Empa, Swiss Federal Laboratories for Materials Science and Technology, Dübendorf, Switzerland

Room-temperature ferromagnetism (RTFM) has been found in undoped ZnO thin film1-2 and nanostructures3-4 even though bulk sam-

ples exhibit no ferromagnetic ordering. This unexpected phenomenon is still controversial; however, numerous reports have reconfirmed the presence of RTFM in ZnO and excluded unintended contribution from impurities. The origin of RTFM in d0 oxides is not yet fully understood. It is assumed that this amazing property could be ascribed to surface oxygen vacancies2,4. In our study we present that RTFM can be induced in bulk ZnO by pressing pure non-ferromagnetic ZnO nanoparticles into pellets. The possible mechanism behind this finding is short-range interaction between isolated spin moments is achieved after mechanical compression. The RTFM behavior can be further enhanced in post-annealed pellets. XPS analysis suggests that more oxygen-related vacancies created after thermal treatment play a crucial rule in this ferromagnetic behavior. It is also found that a carbon-free surface can facilitate the interaction between isolated spin moments. References 1. N. H. Hong, et al., J. Phys: Condens. Matter. 19, 036219 , 2007 2. P. Zhan, et al., J. Appl. Phys. 111, 033501, 2012 3. S. Banerjee, et al., 182501, 2007 4. J. I. Hong, et al., Nano Lett. 12, 576, 2012

MA 16.72 Tue 10:30 Poster D

Magnetic phases and anisotropy in ion irradiated SiC — •Yutian Wang[1], Lin Li[1], Slawomir Prucnal[1], Zhaorong Yang[2], Kay Potzger[1], and Shengqiang Zhou[1] — [1]Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, P.O. Box 510119, 01314 Dresden, Germany — [2]Key Laboratory of Materials Physics Institute of Solid State Physics, Chinese Academy of Sciences, Hefei 230031, People's Republic of China

SiC, as an important electronic and optoelectronic material, has been found to be ferromagnetic after ion or neutron bombardment. So far the original ferromagnetism is still unknown; however the fact that the intrinsic or artificial defects are closely related to the ferromagnetism is a consensus. We prepare ferromagnetic SiC by Ne ions irradiation. Our results show that the saturation magnetization has increased initially by increasing the irradiation fluence, then dropped to almost zero since a large irradiation fluence induced too much disorder[1]. We observe two coexisting magnetic phases. One is superparamagnetic with a blocking temperature around 50 K, while another one has a Curie temperature well above room temperature. The sample also exhibits magnetic anisotropy with the in-plane as the easy axis. Chemical or physical etchings were preformed to correlate the magnetization to the implantation depth. At last, the FDMNES fitting results of carbon K-edge of SiC XAS (X-ray absorption spectroscopy) also present in this contribution.

Refence: 1.Li, L., et al., Appl. Phys. Lett., 98, 222508 (2011).

MA 16.73 Tue 10:30 Poster D

Kerr- and Faraday microscope for space- and time-resolved studies — •Oliver Schmitt, Daniel Steil, Sabine Alebrand, Mirko Cinchetti, and Martin Aeschlimann — Department of Physics and Research Center OPTIMAS, TU Kaiserslautern, Germany

Characterization of the magnetic properties of thin films is extremely important both for fundamental studies as well as for technical applications. We present a multi-purpose magneto-optical microscope[1] for the investigation of structured magnetic thin films. The setup can be used for both static and dynamic (pump-probe) measurements. It is moreover compatible with samples with arbitrary magnetic anisotropy, as it allows Kerr measurements in polar and longitudinal geometry as well as in transmission (Faraday geometry). We demonstrate that the microscope can be used in the following modi: (i) static imaging mode (in polar Kerr and Faraday geometry) with a spatial resolution of 1 micron. (ii) time-resolved mode (polar Kerr geometry) with a temporal resolution of four hundred femtoseconds.

MA 16.74 Tue 10:30 Poster D

Scanning magnetoresistance microscopy as a multifunctional tool — •Dmitriy Mitin[1], Michael Grobis[2], and Manfred Albrecht[1] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]San Jose Research Center, HGST, 3403 Yerba Buena Rd., San Jose, California 95135, USA

Scanning magnetoresistance microscopy (SMRM) is a powerful imaging technique, that uses conventional hard disk drive recording heads as a sensor for raster scanning in physical contact with a magnetic film sample. The modern vintages of MR heads are capable of reaching the resolution down to 15 nm in down-track direction, what is comparable with magnetic force microscopy. The unique ability to apply a localized field up to 1 T to the sample makes this tool attractive for recording experiments on continuous films as well as on nanostructures. Thanks to the high bandwidth of the embedded inductive coil system, ultra short magnetic field pulses in the sub-ns range can be applied. This fact allows using this setup as a research instrument for studying dynamic magnetization reversal processes on the nanoscale.

MA 16.75 Tue 10:30 Poster D

Temperature Dependent High Resolution Imaging of the Domain Structure of LSMO Thin Films via SEMPA — Robert M. Reeve, •Pascal Krautscheid, Markus König, Christian Mix, Michael Foerster, Gerhard Jakob, and Mathias Kläui — Institut für Physik, Johannes Gutenberg-Universität Mainz, 55699 Mainz, Germany

The domain configuration of 50 nm thick $La_{0.7}Sr_{0.3}MnO_3$ films has been directly investigated using scanning electron microscopy with polarization analysis (SEMPA). The films are grown using pulsed laser deposition and then rapidly transferred ex-situ in a protective environment to the analysis chamber to maintain the cleanliness of the surface. Magnetic imaging is subsequently carried out at variable temperatures in our ultra-high vacuum SEMPA chamber, without the requirement for prior treatment of the surface. We are able to demonstrate a spatial resolution of 20 nm for the magnetic images. The large scale domain structure reflects a primarily uniaxial anisotropy in the films, consistent with previous work [APL 99, 062508 (2011)] and ex-situ measurements using the magneto-optic Kerr effect. The temperature dependence of the image contrast is investigated between 30 K and ambient conditions and compared to the behavior of the magnetization curves obtained from superconducting-quantum interference device (SQUID) magnetometry on the same samples. The SEMPA contrast is observed to decrease faster than the magnetization, which can be explained by the mechanism of the generation of spin polarization (double exchange) in this material.

MA 16.76 Tue 10:30 Poster D

Quantitative MFM on a $BaFe_2(As_{0.24}P_{0.76})_2$ single crystal — •Fabian Rhein[1], Silvia Vock[1], Henry Stopfel[1], Ulrike Wolff[1], Volker Neu[1], Dmytro S. Inosov[2], Yong Liu[2], Chengtian Lin[2], Hans J. Hug[3], Niraj Joshi[3], Sevil Özer[3] und Ludwig Schultz[1] — [1]IFW Dresden, Institute for Metallic Materials, P.O. BOX 270116, 01171 Dresden, Germany — [2]Max Planck Institute for Solid State Research,Heisenbergstraße 1, 70569 Stuttgart, Germany — [3]Institute of Physics, University Basel, Klingelbergstrasse 82, CH-4056 Basel, Switzerland

The discovery of iron based superconductors (SC) in 2008, motivated the intensive investigation of characteristic properties of differently doped single crystals. In particular, the analysis of the temperature dependent magnetic penetration depth λ(T) and the properties of the vortex arrangement are important parameters to characterize a SC.
Quantitative magnetic force microscopy (MFM) enables the determination of these quantities. The measured MFM signal is a convolution between the stray field of a magnetic flux line and the magnetization of the tip. To be able to extract λ(T) from the measured data different methods exists. We show, that the commonly used monopole-monopole model[1,2] can be replaced by a more convenient tip calibration procedure[3] and a more realistic description of the magnetic flux line's stray field.
Furthermore we extracted the vortex arrangement by statistical evaluation methods.

MA 16.77 Tue 10:30 Poster D

A next-generation room-temperature AFM setup with optical access for magnetic imaging using a single spin sensor — •Thomas Häberle, Dominik Schmid-Lorch, Friedemann Reinhard, and Jörg Wrachtrup — 3. Physikalisches Institut und Forschungszentrum SCoPE, Universität Stuttgart, Germany

We work on a novel magnetic field sensor that is based on the nitrogen-vacancy (NV)-color center in diamond. The electron spin structure of the NV-center allows us to perform optically detected electron spin resonance (ESR) measurements, which can be made sensitive to the ambient magnetic field. Combined with an AFM, these atomic-sized color centers promise an even higher spatial resolution than the MFM [1] while reducing back-action on the sample to a minimum.

I present first results as well as the methods and instrumental setup used to conduct these measurements. The core component of the setup is a next-generation commercial AFM, featuring additional optical access. This allows readout of the spin state via confocal microscopy with simultaneous imaging and manipulation of the sample on a sub-nanometer scale with the AFM.

Applications of this technique are detection and imaging of single electron spins [2] and small nuclear spin ensembles.

[1]G. Balasubramanian et al., Nature Vol 455, 648-651 (2008)

[2]M.S. Grinolds et al., arXiv:1209.0203v1 [cond-mat.mes-hall] (2012)

MA 16.78 Tue 10:30 Poster D

Laterally resolved thermal imaging using magneto-optical indicator films — •Mikhail Kustov[1], Natalya Mamkina[2], Rostislav Grechishkin[2], and Jeffrey McCord[1] — [1]Nanoscale Magnetic Materials, Magnetic Domains, Institute for Materials Science, University of Kiel, 24143 Kiel, Germany — [2]Laboratory of Magnetoelectronics, Tver State University, 170000 Tver, Russia

A novel approach for imaging of lateral temperature distributions is demonstrated. The method involves an optical polarization microscope and a magneto-optical indicator film (MOIF), which is placed in contact with the investigated sample in the same way as for the imaging of magnetic stray fields [1]. Since the Faraday rotation is a function of the local saturation magnetization of the MOIF sensing layer and the saturation magnetization is a function of temperature, the MOIF can be exploited as a transducer of a local variation of temperature into a variation of magneto-optical contrast. In order to obtain maximum sensitivity the Curie temperature of the sensing layer is chosen to be close, but still above the temperature range of investigation. MOIFs with both planar and uniaxial magnetic anisotropy can be used.

Relying on optics, the imaging scheme has the potential to work up to high temporal resolution, only depending on thermal conductions. Temperature changes occurring within a few microseconds can be measured with lateral resolution. Temperature resolution of the order of 0.01K (for integral measurements) is demonstrated.

[1] R. Grechishkin et al., in: B. Azzerboni et al. (eds.), Magnetic Nanostructures in Modern Technology, pp.195-224.

MA 16.79 Tue 10:30 Poster D

Study of magnetocaloric properties of Gd_4Mn_8 molecules using the finite-temperature Lanczos method — •Christian Heesing and Jürgen Schnack — Universität Bielefeld, Universitätsstr. 25, D-33615 Bielefeld

The magnetocaloric effect can be used to cool or heat a system by varying the external magnetic field. To optimize this effect one needs magnetic molecules with big entropy changes when sweeping the field isothermally. Those big entropy changes can be found in molecules with a high density of low-lying high spin multiplets. In this contribution we discuss molecules of the Gd_4Mn_8 class [1] that have been studied by the finite-temperature Lanczos method [2] in the Heisenberg-model. This method generates very accurate approximations of thermal observables for Hilbert space dimensions of up to 10^{10}.

[1] T. N. Hooper *et al.*, Angew. Chem. Int. Ed. **51**, 4633 (2012)
[2] J. Schnack, O. Wendland, Eur. Phys. J. B **78** (2010) 535-541

MA 16.80 Tue 10:30 Poster D

The lanthaball molecules $\{Pr_{13}\}$, $\{Nd_{13}\}$, and $\{Ce_{13}\}$ - a family of classical Heisenberg systems? — Christian Schröder[1], •Jan Balluff[2], Anthony Chesman[3], Steven Yenias[4], and Marshall Luban[4] — [1]Dept. of Engineering Sciences and Mathematics, Univ. of Applied Sciences Bielefeld, Bielefeld, Germany — [2]Faculty of Physics, Univ. of Bielefeld, Bielefeld, Germany — [3]CSIRO Materials Science and Engineering, Clayton, Victoria, Australia — [4]Ames Laboratory & Dept. of Physics and Astronomy, Iowa State University, USA

The lanthaball molecules $\{Pr_{13}\}$, $\{Nd_{13}\}$, and $\{Ce_{13}\}$ are recently synthesized spherical polycarbonatolanthanoid clusters that show interesting magnetic properties. Within each molecule 12 rare-earth ions are located on the vertices of a slightly distorted icosahedron and one spin is placed in the center of the icosahedron. Recent measurements are indicative of intra-molecular antiferromagnetic coupling. However, because of the unquenched orbital momenta of the rare-earth ions one has to take into account spin-orbit-coupling effects which make an exact quantum mechanical treatment of such systems very difficult or even impossible. Here, we report on a classical approach based on a Heisenberg model where the total angular momenta of the rare-earth ions interact via a multiple exchange interaction scenario. We show that our calculations are in good agreement with our experimental data for all three molecules. Furthermore, we discuss extensions of our approach to include spin-orbit-coupling effects.

MA 16.81 Tue 10:30 Poster D

Electronic structure and magnetic properties of a macrocyclic dinickel complex — •Kai Trepte, Claudia Loose, and Jens Kortus — Institut für theoretische Physik

We present first-principle density functional theory (DFT) calculations on an triply bridged dinickel complex[1] including a hexaazadithiophenolate ligand. All DFT calculations are done using the all-electron NRLMOL program package. We focus on the electronic structure close to the Fermi level and calculate the magnetic exchange coupling J using the Heisenberg hamiltonian $H=-2J\vec{S_1}\vec{S_2}$ ($\vec{S_1}=\vec{S_2}=1$). We compare our results with known trends within this class of molecules[2].

[1] Inorg. Chim. Acta 362 (2009) 793-798
[2] Coord. Chem. Rev. 253 (2009) 2244 - 2260

MA 16.82 Tue 10:30 Poster D

Finite-temperature Lanczos investigations of anisotropic magnetic ring molecules — •Oliver Wendland and Jürgen Schnack — Bielefeld University, P.O. box 100131, D-33501 Bielefeld

We investigate magnetic properties of even-membered rings built of vanadium(III) with spin $s = 1$. Vanadium(III) ions are known to possess large anisotropies [1]. Thermodynamical observables are obtained by the finite-temperature Lanczos-method (FTLM), which has proven to be rather accurate [2].

[1] I. S. Tidmarsh, L. J. Batchelor, E. Scales, R. H. Laye, L. Sorace, A. Caneschi, J. Schnack and E. J. L. McInnes, Dalton Trans. (2009) 9402-9409

[2] J. Schnack, O. Wendland, Eur. Phys. J. B 78 (2010) 535-541

MA 16.83 Tue 10:30 Poster D

Influence of the gold atom on the magnetic properties of the Ni(II) dinuclear complex — •Jaena Park[1,2], Y. Krupskaya[1], V. Kataev[1], G. Steinfeld[3], N. Beyer[3], J. Lach[3], M. Golecki[3], U. Lehmann[3], M. Gressenbuch[3], B. Kersting[3], B. Büchner[1], and R. Klingeler[2] — [1]IFW Dresden, Germany — [2]University of Heidelberg, Germany — [3]University of Leipzig, Germany

Attaching a magnetic molecular complex to a surface, in particular to a metal surface, is important for molecular spintronics applications. In the present work we study the possibility of attaching a Ni-based dimer complex to a gold surface. We have investigated the influence of an attached gold atom on the magnetic properties of the Ni_2-complex. Here we report two Ni_2-complexes $[Ni_2L(dpbba)]ClO_4(2ClO_4)$ **(1)** and $[Ni_2L(dpbba)Au\,Ph]BPh_4(4BPh_4)$ **(2)** where a gold atom is attached to the phosphorus atom of the head part of **(2)**. Magnetization vs. field $M(H)$ at $T = 1.8\,\mathrm{K}$ and vs. temperature $M(T)$ at $\mu_0 H = 1\,\mathrm{T}$ were measured using a SQUID magnetometer. The analysis of the data using a Heisenberg spin Hamiltonian ($\mathcal{H} = 2JS_1S_2$) reveals that the intramolecular exchange interaction between two core Ni ions is ferromagnetic with $J = -23\,\mathrm{K}$ and $-26\,\mathrm{K}$ for **(1)** and **(2)**, respectively. Our high-field and high-frequency ESR measurements yield a g-factor of 2.17 for both complexes and a negative axial magnetic anisotropy $D = -0.063\,\mathrm{K}$ and $-0.056\,\mathrm{K}$ for **(1)** and **(2)**, respectively, which implies a bistable magnetic ground state in both cases. In conclusion, we observe that the magnetic properties of the Ni_2-complex are not significantly changed by the attachment of the gold atom.

MA 16.84 Tue 10:30 Poster D

Probing the local magnetic properties of $[\mathbf{Mn_6^{III}Cr^{III}}]^{3+}$ deposited on surfaces by SPES and XMCD — •Andreas Helmstedt[1], Aaron Gryzia[1], Niklas Dohmeier[1], Norbert Müller[1], Armin Brechling[1], Ulrich Heinzmann[1], Veronika Hoeke[2], Erich Krickemeyer[2], Thorsten Glaser[2], Mikhail Fonin[3], Samuel Bouvron[3], Philipp Leicht[3], Thomas Tietze[4], Eberhard Goering[4], and Karsten Kuepper[5] — [1]Faculty of Physics, Bielefeld University — [2]Faculty of Chemistry, Bielefeld University — [3]Department of Physics, University of Konstanz — [4]Max-Planck-Institut für Intelligente Systeme, Stuttgart — [5]Department of Physics, University of Osnabrueck

Comprehensive studies of the $[\mathbf{Mn_6^{III}Cr^{III}}]^{3+}$ single-molecule magnet deposited on Au and Si substrates by Spin-Resolved Electron Spectroscopy (SPES) and X-ray Magnetic Circular Dichroism (XMCD) are presented. $[\mathbf{Mn_6^{III}Cr^{III}}]^{3+}$ consists of two bowl-shaped Mn_3-triplesalen units linked by a hexacyanochromate. It exhibits a spin ground state of S_T=21/2. For excitation energies covering the Mn-$L_{2,3}$ region, the spin polarization of Auger electrons originating from the Mn^{III} ions in $[\mathbf{Mn_6^{III}Cr^{III}}]^{3+}$ has been measured at room temperature and without applying external magnetic fields. Radiation damage was monitored by XAS at the Mn-L_3 edge. Corresponding

XMCD data have been obtained at 2K and 7T. The local magnetic properties of the Mn constituents in $[\mathbf{Mn_6^{III}Cr^{III}}]^{3+}$ SMM derived from spin polarization data in the paramagnetic phase are compared to results obtained by XMCD. Differences between both methods are discussed.

MA 16.85 Tue 10:30 Poster D

Investigation of $[\mathbf{Fe_6^{III}Cr^{III}}]^{3+}$ Molecules Deposited on Surfaces by XAS, SPES and XMCD — •Niklas Dohmeier[1], Andreas Helmstedt[1], Aaron Gryzia[1], Norbert Müller[1], Armin Brechling[1], Ulrich Heinzmann[1], Veronika Hoeke[2], Erich Krickemeyer[2], Thorsten Glaser[2], and Karsten Küpper[3] — [1]Faculty of Physics, Bielefeld University — [2]Faculty of Chemistry, Bielefeld University — [3]Department of Physics, University of Osnabrueck

$[\mathbf{Fe_6^{III}Cr^{III}}]^{3+}$ is a heptanuclear metal-organic coordination compound containing six Fe^{III} ions and one Cr^{III} embedded in an organic environment. An airbrush-based preparation method leads to large homogeneous samples. X-ray absorption spectroscopy (XAS) was used to monitor the sample oxidation state and its reduction during the performed spin-resolved photoemission measurements (SPES). The spin polarization of the Auger electrons following the excitation with circularly polarized synchrotron light in the region of the Fe-$L_{2,3}$ absorption edge is measured to reveal information about the magnetic properties of $[\mathbf{Fe_6^{III}Cr^{III}}]^{3+}$. The results were compared to corresponding X-ray magnetic circular dichroism (XMCD) measurements performed at 4 K and 6.9 T. Sum rules are applied to both data sets. SPES and XMCD data for the reference material Fe_2O_3 are presented as well.