MA 19: POSTER Ia

Time: Tuesday 9:30–13:00 Location: Poster A

MA 19.1 Tue 9:30 Poster A

Tracking Temperature Dependent Relaxation Times of Individual Protein Molecules using NV-Magnetometry — •Lukas Schlipf[1], Eike Schäfer-Nolte[1], Thomas White[1], Markus Ternes[1], Amit Finkler[2], Friedemann Reinhard[2], Jörg Wrachtrup[1,2], and Klaus Kern[1,3] — [1]Max-Planck Institute for Solid State Research, 70569 Stuttgart, Germany — [2]3rd Institute of Physics and Research Center SCoPE, University Stuttgart, 70569 Stuttgart, Germany — [3]Institut de Physique de la Matière Condensée, Ecole Polytechnique Fédérale de 8 Lausanne (EPFL), CH-1015 Lausanne, Switzerland

The nitrogen-vacancy (NV) center in diamond is a true single-spin magnetometer, whose spin-state can be initialized and read-out optically enabling sensing of even single-electron spins in various systems, including molecules. We demonstrate the tracking of the spin dynamics of ensemble and individual magnetic ferritin proteins using this magnetic sensor in an ultra high vacuum environment and a temperature from 4 K to 300 K [1]. We employ different detection protocols to probe the influence of the ferritin nanomagnets on the longitudinal and transverse relaxation times of the NV center. The temperature dependence of the observed spectral features can be well understood by the thermally induced magnetization reversals of the ferritin [2]. Using an integrated scanning probe we can also increase the spatial resolution of our measurements with the goal of reaching single-molecule sensitivity. [1] E. Schäfer-Nolte et al., Rev. Sci. Instr. 85, 013701 (2014) [2] E. Schäfer-Nolte et al., Phys. Rev. Lett. 113, 217204 (2014).

MA 19.2 Tue 9:30 Poster A

Thermodynamics of the frustrated J_1-J_2 Heisenberg ferromagnet on a BCC lattice with arbitrary spin — •Patrick Müller[1], Johannes Richter[1], Andreas Hauser[1], and Dieter Ihle[2] — [1]Institut für Theoretische Physik, Otto-von-Guericke-Universität Magdeburg, D-39016 Magdeburg, Germany — [2]Institut für Theoretische Physik, Universität Leipzig, D-04109 Leipzig, Germany

The so-called J_1-J_2 models with competing nearest-neighbor (J_1) and next-nearest-neighbor (J_2) couplings are canonical models to study frustration effects in magnetic systems. Such models have been widely studied in low dimensions, see, e.g. [1]. In the present study we investigate the influence of frustration on the thermodynamic properties of the J_1-J_2 spin-S ferromagnet ($J_1 = -1,\ J_2 > 0$) on the BCC lattice. We use a second order Green's function (GF) approach to calculate the spin-wave spectrum, the Curie temperature T_C, the magnetization, the specific heat, the susceptibility and the magnetic correlation length. We complement our GF results with data from a high-temperature expansion [2]. Both methods are used to determine T_C as a function of the frustration parameter J_2 and the spin quantum number S and derive empirical formulas for $T_C(J_2, S)$. We find that T_C vanishes at a critical value J_2^c that is very close to the classical transition point $J_2^{c,clas} = \frac{2}{3}$. [1] M. Härtel, J. Richter, D. Ihle, and S.-L. Drechsler, Phys. Rev. B 81, 174421 (2010); M. Härtel, J. Richter, O. Götze, D. Ihle and S.-L. Drechsler, Phys. Rev. B 87, 054412 (2013). [2] A. Lohmann, H.-J. Schmidt and J. Richter, Phys. Rev. B 89, 014415 (2014).

MA 19.3 Tue 9:30 Poster A

Magnetic properties of the covalent chain antiferromagnets $RbFeSe_2$ and $TlFeX_2$ (X=S, Se) — •Zakir Seidov[1,2], Vladimir Tsurkan[2,3], Hans-Albrecht Krug von Nidda[2], Axel Günther[2], Irina Filipova[3], and Alois Loidl[2] — [1]Institute of Physics, Azerbaijan National Academy of Sciences, H.Cavid ave.131, AZ-1143 Baku, Azerebaijan — [2]EP V, Center for Electronic Correlations and Magnetism, University of Augsburg, D-86159 Augsburg, Germany — [3]Institute of Applied Physics, Academy of Sciences of Moldova, MD-202208 Chisinau, Moldova

Single crystals of the ternary iron chalcogenides $RbFeSe_2$, $TlFeS_2$, and $TlFeSe_2$ (with linear chains consisting of FeX_4 tetrahedra, X=S, Se) have been investigated by means of magnetic susceptibility, magnetization, specific heat and ESR measurements. All three compounds exhibit three-dimensional collinear antiferromagnetic order with strongly reduced moments below T_N=248K, 196K, and 290K, respectively. The magnetic moments are oriented perpendicular to the chain direction. The specific heat measurements of $TlFeX_2$ (X=S, Se) do not show any anomaly at T_N[1], while there is a λ anomaly in $RbFeSe_2$. However, the calculated entropy value for $RbFeSe_2$ is much smaller than expected for a low-spin $S = 1/2$ Fe^{3+} spin system. The linear increase of the paramagnetic susceptibility and ESR intensity of $RbFeSe_2$ and $TlFeX_2$ (X=S, Se) strongly suggests a one-dimensional metallic character.

[1] M.Aldzhanov et al., phys. stat. sol. (b) 159, 1990, K107.

MA 19.4 Tue 9:30 Poster A

Polaron dynamics and evolution of polaronic microstructure in manganites — •Sangeeta Rajpurohit[1] and Peter Blöchl[1,2] — [1]Institute of Theoretical Physics, Clausthal Institute of Technology — [2]Institute of Material Physics, University of Göttingen

Mixed-valence manganites exhibit interesting transport properties because of their complex interplay between charge, orbital, lattice and spin degrees of freedom. Strong electron-phonon coupling due to Jahn-Teller distortion localizes the electrons in the e_g states as polarons. These polarons dictate the charge transport, structural and magnetic ordering properties of manganites. We investigate the dynamics on long length and time scales with Car-Parinello molecular dynamics for a model Hamiltonian. The model Hamiltonian takes into account the electrons in the e_g orbitals of Mn, the classical spin of the t_{2g} electrons on Mn and the cooperative Jahn-Teller distortions of the oxygen octahedra. The electrons are treated as two-component spinors, allowing for non-collinear spin arrangements. So far, we explored the complex phase diagram of one-dimensional model manganites as function of the model parameters. These studies provide guidance for the study of the dynamics and the microstructure evolution of realistic two and three dimensional manganates. The parameters used in the model will be extracted from Density Functional Theory using hybrid functionals.
The work has been supported by the DFG through SFB 1073 B03.

MA 19.5 Tue 9:30 Poster A

Coupled spin-charge order in frustrated itinerant triangular magnets — •Sahinur Reja[1], Rajyavardhan Ray[2], Jeroen van den Brink[1], and Sanjeev Kumar[2] — [1]IFW Dresden, Dresden, Germany — [2]IISER Mohali, India

We uncover four new spin-charge ordered ground states in the strong coupling limit of the Kondo lattice model on triangular geometry. Two of the states at one-third electronic filling ($n = 1/3$) consist of decorated ferromagnetic chains coupled antiferromagnetically with the neighboring chains. The third magnetic ground state is noncollinear, consisting of antiferromagnetic chains separated by a pair of canted ferromagnetic chains. An even more unusual magnetic ground state is discovered at $n = 2/3$. The state is coplanar, similar to the 120° Yafet-Kittel phase. However, unlike the 120° state, it consists of three types of spin triangles repeating over the lattice. These magnetic orders are stabilized by opening a gap in the electronic spectrum: a "band effect". In addition to the peculiar spin textures, all these phases support modulations in the electronic charge density. In particular the charge disproportionation at $n = 2/3$ is large with an ordering pattern resembling the observed charge ordering in various triangular lattice systems, such as, 2H-$AgNiO_2$, 3R-$AgNiO_2$ and Na_xCoO_2.

MA 19.6 Tue 9:30 Poster A

Critical behavior at the order-disorder transition in multiferroic $DyMnO_3$ — •Markus Schiebl, Alexey Shuvaev, Anna Pimenov, Graeme Eoin Johnstone, Uladzislau Dziom, and Andrei Pimenov — Institute for Solid State Physics, Vienna University of Technology, 1040 Vienna Austria

We present the results of detailed dielectric investigations of the relaxation dynamics in $DyMnO_3$ multiferroic manganite. In addition to known domain wall relaxation a second strong mode is observed at low frequencies. We provide an experimental evidence that the new relaxation mode is coupled to the chirality switching of the spin cycloid. We demonstrate that the relaxation dynamics in $DyMnO_3$ is typical for an order-disorder phase transition. Therefore, $DyMnO_3$ follows an order-disorder transition scenario implicating that a short range cycloidal order of Mn-spins exists above T_C. The results suggest that the paramagnetic sinusoidal phase should be explained as a dynamic equilib-

rium between the clockwise and counterclockwise cycloidal magnetic orders. The short range order in the paraelectric phase is transformed to a long range cycloid at the ferroelectric transition temperature.

MA 19.7 Tue 9:30 Poster A

Magneto-optical study of the insulating helimagnet Cu_2OSeO_3 — Rolf B. Versteeg[1], •Simon Schäfer[1], Aisha Aqeel[2], Graeme R. Blake[2], Thomas T.M. Palstra[2], and Paul H.M. van Loosdrecht[1] — [1]II. Physikalisches Institut, Universität zu Köln, 50937 Cologne, Germany — [2]Zernike Institute for Advanced Materials, University of Groningen, Groningen, The Netherlands

The Mott insulator Cu_2OSeO_3 has recently gained considerable scientific interest owing to the presence of a Skyrmion lattice phase. We report our findings of a comprehensive study of the magneto-optical properties of bulk Cu_2OSeO_3. The different optical transitions observed in the light polarization rotation spectra allow us to map out the magnetic phase diagram of Cu_2OSeO_3.

MA 19.8 Tue 9:30 Poster A

Electronic structure of $Pr_xCa_{1-x}MnO_3$ using local hybrid DFT calculation — •Mohsen Sotoudeh[1] and Peter Blöchl[1,2] — [1]Institute of Theoritical Physics, Clausthal University of Technology, Leibnizstr. 10, D-38678 Clausthal-Zellerfeld, Germany — [2]Institute of Materials Physics, University of Göttingen, Friedrich-Hund-Platz 1, 37085 Göttingen, Germany

The manganite group of perovskites exhibits a complex phase diagram due to the competition of charge, orbital,spin and structural degrees of freedom. Of particular interest is the metal-insulator transition responsible for the collossal magneto-resistance effect. We performed first-principles calculations of $Pr_xCa_{1-x}MnO_3$ for $0 \leq x \leq 1$ with local hybrid density-functional calculations. The atomic structure for $x = 0, \frac{1}{2}, 1$ has been compared with experimental data. The comparison of the calculated spectra with x-ray photoelectron spectroscopy (XPS), electron energy loss near edge structure (ELNES) provides a choice for the mixing factor of the hybrid functionals. We studied the ferromagnetic (B-type) and selected antiferromagnetic (A-, C-, and G-type) arrangements for $x = 0, \frac{1}{4}, \frac{1}{2}, \frac{3}{4}, 1$ to explore the competition between the various ordering phenomena. We will furthermore discuss effects of magnetic ordering on the electronic structure related to excitation and transport.The work has been supported by the DFG through SFB 1073 C03.

MA 19.9 Tue 9:30 Poster A

Optimierung von Spindynamik-Simulationen grosser Strukturen mittels räumlicher Dekomposition unter Verwendung der Message Passing Interface (MPI) Bibliothek — •Simon Bekemeier, Thomas Hilbig und Christian Schröder — Bielefelder Institut für Angewandte Materialforschung (BIfAM), Computational Materials Science and Engineering (CMSE), Fachhochschule Bielefeld, Wilhelm-Bertelsmann-Str. 10, 33602 Bielefeld

Atomistische Spindynamik-Simulationen grosser Strukturen, wie z.B. Nanopartikel oder Multi-Schichtsysteme, benötigen enorme Ressourcen, sowohl hinsichtlich der Rechenzeit als auch bzgl. des Speicherbedarfs. Um Simulationen dieser Art bewältigen zu können, müssen die zugrunde liegenden Algorithmen derart angepasst werden, dass die vorhandenen, aber verteilten, Ressourcen von Hochleistungsrechen-Clustern effizient genutzt werden können. In diesem Beitrag wird ein Dekompositionsalgorithmus vorgestellt, der die verschiedenen die Effizienz der Parallelisierung beeinflussenden Faktoren berücksichtigt. Auf Basis dieses Algorithmus wurden Untersuchungen zur Optimierungen der Verteilung der Rechenlast und der Daten sowie der notwendigen Kommunikation durchgeführt, deren Ergebnisse vorgestellt und diskutiert werden.

MA 19.10 Tue 9:30 Poster A

Magnetization reversal process modeling in systems with different anisotropies — •Andrea Ehrmann[1] and Tomasz Blachowicz[2] — [1]Niederrhein University of Applied Sciences, Faculty of Textile and Clothing Technology, Germany — [2]Silesian University of Technology, Institute of Physics, Poland

Examinations of magnetic systems by use of a single macro-spin can support understanding magnetization reversal processes in principal. Such a macro-spin calculation based on constant energy minimization during the reversal process from positive to negative saturation and vice versa has been implemented in PTC(c) Mathcad. It describes the coherent rotation of a single magnetic moment using the total energy density, consisting of different magnetic anisotropies as well as the external magnetic field. In this way, hysteresis loops of longitudinal and transverse magnetization components can be calculated. Besides coercive fields and shapes of the magnetization loops, the calculation can also be used to detect angular orientations of the sample relative to the external magnetic field for which the transverse signals vanish.

The calculated loops differ slightly from experimental results concerning shape and position, which can be attributed to the simplicity of the model neglecting the coupling between the single magnetic moments and the resulting fanning, as evident from more realistic Monte Carlo simulations. However, the simple macro-spin model can reproduce qualitatively all important features of the magnetization reversal in many thin-film and nano-structured samples [1].

[1] A. Ehrmann and T. Blachowicz, AIP Advances 4, 087115 (2014)

MA 19.11 Tue 9:30 Poster A

Investigating the magneto-dynamics of magnetic nanoparticle ensembles by hybrid molecular and spin dynamics simulations — •Lisa Teich and Christian Schröder — Bielefeld Institute for Applied Materials Research, University of Applied Sciences Bielefeld, Wilhelm-Bertelsmann-Str. 10, 33602 Bielefeld, Germany

Ensembles of magnetic nanoparticles immersed in conductive gel matrices show promising features for the development of novel magnetoresistive sensor devices [1]. In order to simulate the structuring process of such systems one has to consider the magnetic and mechanical degrees of freedom simultaneously. Here, we present a new approach that couples molecular dynamics simulations based on HOOMD-blue [2] and classical spin dynamics simulations based on Monte Carlo and stochastic spin dynamics methods [3]. Using this approach we have investigated the magneto-dynamics of various Cobalt nanoparticle ensembles and will discuss the results.

[1] J. Meyer, T. Rempel, M. Schäfers, F. Wittbracht, C. Müller, A. V. Patel, A. Hütten, *Smart Mater. Struct.* **22**, 025032 (2013)

[2] J. A. Anderson, C. D. Lorenz, and A. Travesset, *J. Comp. Phys.* 227 (10): 5342-5359 (2008)

[3] L. Engelhardt, C. Schröder, in *Molecular Cluster Magnets*, Ed. R. E. P. Winpenny, World Scientific Publishers, Singapore (2011)

MA 19.12 Tue 9:30 Poster A

Simulation of skyrmionic bubbles in thin layers — •Kai Litzius[1,2], Benjamin Krüger[1], and Mathias Kläui[1,2] — [1]Johannes Gutenberg-Universität Mainz, Institut für Physik, Staudingerweg 7 55128 Mainz, Germany — [2]Graduate School Materials Science, Staudinger Weg 9, 55128 Mainz, Germany

Magnetic bubbles are circular regions of out-of-plane magnetization that is orientated in the opposite direction compared to the surrounding parts of the film [1]. As skyrmionic states, they show a special topology and are thus energetically protected from being deformed into a ferromagnetic uniform state. This ensures a high stability of a bubble and makes them promising candidates for spintronic devices [2].

Here, the static and dynamic properties of magnetic bubbles in thin layers with out-of-plane easy axis are investigated by micromagnetic simulations including the Dzyaloshinskii-Moriya interaction (DMI). We can show that a bubble can indeed be stabilized for a certain parameter range. The obtained states are highly dependent of the choosen saturation magnetization (Ms) and DMI resulting in significant differences in appearance and shape of topology. From our results, we can identify, which materials are ideally suited to stabilize skyrmion states.

[1] P. Milde et al., Science. 2013; 340(6136): 1076-1080.

[2] F. Büttner et al., Nature Physics (in press 2014)

MA 19.13 Tue 9:30 Poster A

Observation of Binary Vortex Core States in Magnetic Mutlilayers — •Sebastian Wintz[1,2], Mi-Young Im[2], Anja Banholzer[2], Tobias Schneider[2], Markus Weigand[3], Jörg Raabe[4], Roland Mattheis[5], Peter Fischer[2], Artur Erbe[1], and Jürgen Fassbender[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Lawrence Berkeley National Laboratory, Berkeley, USA — [3]Max-Planck-Institut für Intelligente Systeme, Stuttgart, Germany — [4]Paul Scherrer Institut, Villigen, Switzerland — [5]Leibniz Institut für Photonische Technologien, Jena, Germany

Topological spin textures such as skyrmions or vortices are attracting significant attention because of their fundamentally interesting magnetostatic and dynamic properties. In particular, magnetic vortices have been studied intensively during the past decade. Such a spin

vortex consists of a planar, flux-closing magnetization curl that tilts out of the plane in the central core. Although being relatively small, the core is of crucial importance for the overall vortex structure. For a stacked trilayer geometry, two basic vortex core configurations can be expected, namely parallel (PL) and antiparallel (AP) cores. In the present contribution, we address the direct observation of both PL and AP core configurations in trilayer vortex pairs. Transmission x-ray microscopy is used to directly image the congruent cores in a Co(48)/Ru(0.8)/Ni81Fe19(43) (nm) trilayer stack. Moreover, switching between both configurations in the same vortex pair was achieved by applying high frequency in-plane magnetic fields.

MA 19.14 Tue 9:30 Poster A

Thermodynamics and magnetism at the first-order magnetostructural transition in Mn_3GaC powder and single crystal samples — •Franziska Scheibel[1], Tino Gottschall[2], Mahdiyeh Ghorbani Zavareh[3], Moritz Riebisch[1], Öznur Çakir[4], Michael Farle[1], and Mehmet Acet[1] — [1]Faculty of Physics and CENIDE Universität Duisburg-Essen, Duisburg, Germany — [2]Material Science Technische Universität Darmstadt, Darmstadt, Germany — [3]High Magnetic Field Laboratory HZDR, Dresden-Rossendorf, Germany — [4]Physics Department Yildiz Technical University, Istanbul, Turkey

For magnetic refrigeration materials with a large adiabatic temperature-changes ΔT and large entropy changes ΔS are required. Such large changes are possible at first-order magnetostructural transitions (FOMST). At a FOMST, the thermal hysteresis limits the reversibility of ΔT. Therefore, materials with narrow thermal hysteresis play a major role in applications. Mn_3GaC powder shows a FOMST from a ferromagnetic (FM) to an antiferromagnetic (AF) phase at 155 K with ΔS=15 $Jkg^{-1}K^{-1}$ and ΔT=4.8 K in 2 T field. Direct ΔT measurements show a high degree of reversibility at the transition. ΔT measurements for magnetic field rates of $1.1{\cdot}10^{-2}$ Ts^{-1}, 0.7 Ts^{-1} and $7.8{\cdot}10^{2}$ Ts^{-1} were done to understand the time-dependent properties of the transition process and the effect of hysteresis. The magnetocrystalline anisotropy energy for this material was determined from ferromagnetic resonance measurements on a Mn_3GaC single crystal around the FOMST.

Work supported by the Deutsche Forschungsgemeinschaft (SPP 1599).

MA 19.15 Tue 9:30 Poster A

Functional Approach to Electrodynamics of Media — •Ronald Starke[1] and Giulio Schober[2] — [1]Institut f. Theo. Physik, Bergakademie Freiberg — [2]Institut f. Theo. Physik, Uni Heidelberg

We put forward a new approach to electrodynamics of materials allowing us to derive universal (material-independent) relations between electromagnetic response functions such as the dielectric tensor, the magnetic susceptibility and the microscopic conductivity tensor. Our formulae include all effects of inhomogeneity, anisotropy, magnetoelectric coupling and relativistic retardation. Moreover, we relate the 36 component functions of the constitutive tensor used in the context of bi-anisotropic media to only 9 causal response functions which specify the current response to an external vector potential.

MA 19.16 Tue 9:30 Poster A

Quantum information processing based on multiferroic helical spin chain — •maryam azimi[1], levan chotorlishvili[1], sunil kumar mishra[2], sebastian greshner[3], teimuraz vekua[3], wolfgang hübner[4], and jamal berakdar[1] — [1]Institute of Physics, Martin-Luther University, 06120 Halle, Germany — [2]Department of Physics, Indian Institute of Technology, Banaras Hindu University, Varanasi 221005, India — [3]Institute of Theoretical Physics, Leibniz University, 30167 Hannover, Germany — [4]Department of Physics and Research Center OPTIMAS, University of Kaiserslautern, PO Box 3049, D-67653 Kaiserslautern, Germany

We show that quantum information features and quantum phases are extremely sensitive to an external electric field applied to one dimensional frustrated spin 1/2 chains[1]. The electric field leads to the formation of chiral spin structure and simultaneously generates entanglement characterized by many spin correlation[2]. We also use this system as a working substance for a quantum Otto heat engine[3,4]and detect a direct connection between the chirality, the entanglement and the efficiency of the engine. Also a relation between the threshold temperature of pair entanglement with the spin chirality and the minimum of the fidelities related to the electric and the magnetic field is obtained. By increasing the electric field the efficiency of the quantum Otto cycle reaches a saturation status. [1] M. Menzel et al., Phys. Rev. Lett. 108, 197204 (2012). [2] M. Azimi et al., Phys. Rev. B 89, 024424 (2014). [3] H. T. Quan et al., Phys. Rev.E. 76, 031105 (2007). [4] M. Azimi et al., New Journal of Physics 16, 063018 (2014).

MA 19.17 Tue 9:30 Poster A

Synthesis, structure, and magnetic properties of dilithium orthosilicates Li_2MSiO_4 (M = Fe, Mn, Ni, Co) — •Kiryl Batvinyeu[1], Christoph Neef[1], Hans-Peter Meyer[2], and Rüdiger Klingeler[1] — [1]Kirchhoff Institute for Physics, University of Heidelberg, Heidelberg, Germany — [2]Institute of Earth Sciences, University of Heidelberg, Heidelberg, Germany

We report on the synthesis and characterization of dilithium orthosilicates Li_2MSiO_4 with M = Fe, Mn, Ni, and Co. We have obtained various polymorphs such as beta(II) ($Pmn21$), gamma(s) ($P12_1/n1$) of Li_2FeSiO_4 and gamma(II) ($Pmnb$), gamma(0) ($P12_1/n1$) of Li_2MnSiO_4 by means of solid state reactions. In all polymorphs, the transition metal ions are coordinated tetrahedrally. Our magnetic studies enable to construct the magnetic phase diagrams which are characterized by long range magnetic ordering of the respective transition metal moments in the high-spin state. The magnetic phase diagrams are discussed against the background of the actual structures, lattice parameters, and possible exchange paths.

MA 19.18 Tue 9:30 Poster A

ESR studies of the $S = 1/2$ ladder compound $Cu(Qnx)Cl_2$ — •A. Ponomaryov[1], M. Ozerov[1], E. Čižmár[2], J. Wosnitza[1], K. Povarov[3], A. Zheludev[3], A. Zvyagin[4], and S. Zvyagin[1] — [1]High Magnetic Field Laboratory (HLD), Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [2]Institute of Physics, P.J. Šafárik University, Košice, Slovakia — [3]Neutron Scattering and Magnetism, Laboratory for Solid State Physics, ETH Zürich, Switzerland — [4]Institute for Low Temperature Physics and Engineering, Kharkov, Ukraine

By means of electron spin resonance we systematically studied $Cu(Qnx)Cl_2$ (Qnx - quinoxaline), a Heisenberg $S = 1/2$ spin-ladder compound with J_{leg} = 18.6 K and J_{rung}= 34.2 K. The linewidth, g-factor shift, and absorption intensity were investigated in the temperature range from 2 to 300 K. The low-temperature measurements revealed an ESR line splitting, which is a signature of a finite anisotropy. The observed results were analyzed using mean-field theory. The uniform Dzyaloshinskii-Moriya interaction was suggested to play a key role, strongly affecting the ESR properties of this compound at low temperature.

The work was partly supported by the DFG.

MA 19.19 Tue 9:30 Poster A

Effect of Microstructure on Spinodal Decomposition and Magnetic Properties of Melt-Spun Alnico — •Konrad Loewe[1], Michael Duerrschnabel[2], Rajasekhar Madugundo[3], George C. Hadjipanayis[3], and Oliver Gutfleisch[1,4] — [1]TU Darmstadt, Materialwissenschaft, Alarich-Weiß-Str. 16, 64287 Darmstadt, Germany — [2]TU Darmstadt, Angewandte Geowissenschaften, Schnittspahnstraße 9, 64287 Darmstadt , Germany — [3]Department of Physics and Astronomy, University of Delaware, Newark, DE, USA — [4]Fraunhofer ISC, IWKS Group Materials Recycling and Resource Strategy, Hanau, Germany

The aim of this work is to investigate the effect of very fine grain sizes on the spinodal decomposition in the Alnico system. Commercial Alnico 8 was melted and melt-spun with varying copper wheel speeds, which led to a grain size of around 2 micron. This value was further reduced to sub-micrometer size by a small addition of Boron (1at%). The spinodal decomposition was induced through a two-step annealing treatment under magnetic field in the range of 600-900°C. It was found that the nanometer-sized spinodal structures become bigger with increasing wheel speeds and smaller with the addition of Boron. Contrary to expectations, the coercivity of the sample containing Boron is slightly reduced compared to the one without it, which is attributed to the formation of unwanted secondary phases.

MA 19.20 Tue 9:30 Poster A

Correlation between the magnetic properties of a carboxylic acid and its coordination to a metal surface: An paramagnetic and ferromagnetic resonance (EPR/FMR) study — •S. Masur, T. Marzi, S. Liébana Viñas, R. Meckenstock, and M. Farle — Faculty of Physics, University of Duisburg-Essen, Germany

To get stable mono-disperse and artificially shaped magnetic nanopar-

ticles carboxylic acids are often used. While studying the static and dynamic magnetic properties of the single crystalline Fe_2O_3 nanoparticles by FMR the interface to the carboxyl group provides a paramagnetic center that can be influenced by the FMR signal. The same paramagnetic center is found at the interface of carboxylic acids and Ag nanoparticles. Therefore this type of paramagnetic active interfaces are perfect candidates for monitoring spin transport properties through those interfaces. Here we characterize the principal behavior of these EPR interfaces. Oleic acid gets chemisorbed as a carboxylate, leading to the formation of two covalent COO- bonds and a delocalized electron. Covering a substrate with a monolayer of this cubic Fe_2O_3 nanoparticles (all cubes have a (001) direction perpendicular to the substrate and are randomly oriented in plane) and performing an angle dependent EPR from in-plane to out-of-plane a fourfold anisotropy in the EPR-signal is observed, which is not visible for a pure in-plane EPR. This indicates that the hard direction of the g-tensor of the carboxyl Fe_2O_3 interface is correlated with the [111]-cube-direction. This Effect was further investigated on oxidized Iron-films layered with oleic acid.

MA 19.21 Tue 9:30 Poster A

Magnetism and defects in V-doped TiO2 — •Alevtina Smekhova[1,2], Roman Baulin[2], Oguz Yildirim[3], Maik Butterling[3], Steffen Cornelius[3], Andrei Novikov[2], Anna Semisalova[2], Andrei Orlov[4], Elena Ganshina[2], Nikolai Perov[2], Wolfgang Anwand[3], Andreas Wagner[3], Kay Potzger[3], and Alexander Granovsky[2] — [1]Universität of Duisburg-Essen und CENIDE, Duisburg, Germany — [2]Lomonosov Moscow State University, Moscow, Russia — [3]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Dresden, Germany — [4]Federal State Research and Design Institute of Rare Metal Industry, Moscow, Russia

The idea about defect-induced ferromagnetic long-range order at RT in some semiconducting materials is not new, but still needs to be further proved. In the case of TiO2 doped by 3d transition atoms the most interesting situation within this thought is with doping by Vanadium. Recently we found that in 1at% and 3at% V-doped TiO2 thin films prepared by magnetron sputtering the saturation magnetization correlates well with an amount of negatively charged defects estimated by Doppler-Broadening technique of Positron Annihilation Spectroscopy (PAS) and only slightly depends on the film conductivity. Meanwhile the MO spectroscopy showed a principal difference between these two doping levels and strong dependence on film resistivity. So, negatively charged defects and free carriers have to be taken into account separately from each other for the explanation of RT ferromagnetism in titanium dioxide films. Support by a German-Russian joint research group HRJRG-314 & RFBR 12-02-91321-SIGa is acknowledged.

MA 19.22 Tue 9:30 Poster A

Investigation and optimization of magnetic properties of micro-patterned Permalloy structures for giant magneto-impedance sensors — •Gregor Büttel, Haibin Gao, and Uwe Hartmann — Institute of Experimental Physics, Saarland University, P. O. Box 151150, D66041, Saarbrücken, Germany

Permalloy (Ni81Fe19) structures were fabricated by lithography and dc magnetron sputtering. Aspect ratio and sputtering parameters were varied and their influence on domain structures and hysteresis were studied by vibrating sample magnetometry and magneto-optical Kerr effect microscopy in an applied external field. We obtained a very high Kerr contrast for Permalloy by post-processing data algorithms and sputtered dielectric coating layer. Coercivity and anisotropy were optimized by control of sputter rate, biasing field and magnetic annealing to yield soft magnetic films with a thickness between 200 and 1000 nm with low anisotropy, perpendicular to the long axis of the rectangular structures and to the underlying waveguide. The often reported perpendicular anisotropy and stripe domains above a critical thickness of the elements were found in our samples as well. The critical thickness changes slightly depending on the possible waveguide substrate like Cu, Au and Al vs. SiO2. However, we could obtain films without stripe domains and a transcritical shape of the hysteresis curve above a thickness of 500 nm by adjusting the sputter rate accordingly. For films within the thickness regime of 200-500 nm we could diminish strongly the transcritical shape of the hysteresis curve by magnetic annealing, although stripe domains remain.

MA 19.23 Tue 9:30 Poster A

Microscopic investigation of laser-induced ferromagnetic domain formation in FeRh thin films and microstructures — •Ahmet Akin Ünal[1], Adem Parabas[2], Yuriy Aleksandrov[3], Hatice Doganay[4], Florian Kronast[1], and Fikret Yildiz[2] — [1]Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany — [2]Gebze Institute of Technology, Department of Physics, Kocaeli, Turkey — [3]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [4]Forschungszentrum Jülich, Peter Grünberg Institut (PGI-6), Jülich, Germany

The temperature dependent transition from the antiferromagnetic (AF) to the ferromagnetic (FM) order in FeRh takes place via nucleation and growth of microscopic magnetic domains. Since this transition can be induced by femtosecond laser pulses, FeRh has become a promising material for establishing ferromagnetism in ultrashort time scales. Although the system is extensively investigated, the dynamics of the FM domain formation and the subsequent disappearance in the AF matrix is still under strong debate. A better understanding of the AF-FM phase coexistence at the microscopic level and of the parameters influencing the FM domain evolution such as sample temperature and laser fluence is important for device applications. Here, we report our recent magnetic imaging experiments in FeRh thin films and microstructures using X-ray photoemission electron microscope.

MA 19.24 Tue 9:30 Poster A

Influence of domain wall substructures on the domain structures of Permalloy elements — •Sukhvinder Singh, Haibin Gao, and Uwe Hartmann — Institute of Experimental Physics, Saarland University, P O. Box 151150, D66041, Saarbrücken, Germany

Substructures (Bloch lines, cross-tie wall components, vortex-antivortex pairs) of domain walls significantly affect the magnetic properties of patterned materials [1, 2]. In this study we have investigated their influences on the magnetization configurations of microstructured thin films. The patterns were prepared in rectangular shapes of various aspect ratios by means of e-beam lithography. Thin films of Permalloy (Ni81Fe19) in the range of 20 nm to 150 nm thickness were prepared by DC sputtering. Substructures of domain walls were observed by magnetic force microscopy. The results were compared with micromagnetic simulations and the relative contributions of different magnetic energies were investigated. The magnetic energies of the Landau state, the diamond state and cross-tie configurations were calculated. The increase in the total energy and the stabilization of the magnetic flux more efficiently due to the nucleation of new vortex-antivortex pairs was observed. The existence of seven domain states and the change in their statistical distribution were explained in terms of structural variations in dependence of the applied field sweep rate.

[1] C. Y. Kuo et al. J. Magn. Magn. Mater. 310, e672 (2007) [2] C. Zinoni et al. Phys. Rev. Lett. 107, 207204 (2011)

MA 19.25 Tue 9:30 Poster A

The Coercivity Hc Change in Spinel Ferrite Compound Alloyed with Metals — •Ali Alidoust and Mahboubeh Houshiar — Shahid Beheshti University,Tehran,Iran

In this work, magnetic nanoparticles Co1-xNixFe2O4 with nickel concentration x=0.0, 0.5 and 1 has been prepared by coprecipitation method and their structural and magnetic properties were obtained by XRD, SEM and VSM techniques. XRD analysis shows cubic inverse spinel structures for all the nanoparticles, with space group Fd-3m without extra phases in nano dimensions. The average size of the crystals is estimated to be between 23-35 nm. This is in agreement with the SEM results. The lattice constant was seen to decrease with concentration. The analysis of VSM results with external magnetic field up to 15kOe shows that the cobalt ferrite nanoparticles are ferromagnetic with high Ms and Hc at room temperature. These values dencrease with increasing x. The S shape hysteresis loop for NiFe2O4 shows nickel ferrite nanoparticles have superparamagnetic properties. The reason for this behavior can be due to the substitution of Ni ions in Octahedral cubic spinel sites which can also explain their magnetic behaviours.

MA 19.26 Tue 9:30 Poster A

Exchange Bias Tubes for controlled fuel-free transport of superparamagnetic particles — •Timo Ueltzhöffer[1], Robert Streubel[2], Dennis Holzinger[1], Iris Koch[1], Denys Makarov[2], Oliver G. Schmidt[2], and Arno Ehresmann[1] — [1]Department of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel — [2]Leibniz Institute for Solid State and Materials Research Dresden, Helmholtzstraße 20, D-01069 Dresden

Magnetically stripe patterned exchange bias tubes were fabricated and studied in respect to their suitability for fuel-free transport of superparamagnetic particles. For that purpose a CoFe/IrMn Exchange Bias (EB) system was fabricated via sputter deposition on a strained Ti-layer. The EB layer system is magnetically patterned with 5 μm parallel stripe domains with their magnetizations oriented head-to-head / tail-to-tail and subsequently rolled up by removal of the underlying sacrificial layer [1]. The resulting tubular system is suitable for being used as a substrate for the directed near surface transport of superparamagnetic particles [2]. In this study we were able to show that the transport system could be rolled up successfully to tubular structures while the magnetic properties are preserved.

[1] E. Bermúdez Urena, Y. Mei, E. Coric, D. Makarov, M. Albrecht and O. G. Schmidt, J. Phys. D: Appl. Phys. 42 (2009) 055001

[2] D. Holzinger, D. Lengemann, F. Göllner, D. Engel and A. Ehresmann, Appl. Phys. Lett. 100, (2012) 153504

MA 19.27 Tue 9:30 Poster A

Investigation of Magnetic Vortices in Cap Structures — •Dennis Nissen[1], Senoy Thomas[2], Sri Sai Phani Kanth[3], and Manfred Albrecht[1] — [1]Institute of Physics, University of Augsburg, 86159 Augsburg, Germany — [2]Materials Science and Technology Division, National Institute for Interdisciplinary Science and Technology, 695015 Thiruvananthapuram, India — [3]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany

Vortex states, characterized by the circularity of the in-plane magnetization and the out-of-plane component of the vortex core, are of great fundamental importance and relevant for application. One approach to realize such magnetic vortex states is to manufacture large arrays of spherical SiO_2-particle monolayers followed by film deposition of permalloy. In this way, it is possible to obtain magnetic cap structures on the particles forming vortex states[1].

We show the dependence of Py cap structures on the nucleation and annihilation field as function of the aspect ratio. Furthermore, we show how the magnetization reversal in exchange coupled IrMn/Fe caps with a diameter of 900 nm occurs. In this regard, the magnetic vortex at zero magnetic field vanishes as the temperature approaches the blocking temperature of IrMn accompanied by an increase in coercivity[2].

[1]R. Streubel et al., Phys. Rev. B 85, 174429 (2012).
[2] S. Thomas, D. Nissen, and M. Albrecht, Appl. Phys. Lett. 105, 022405 (2014).

MA 19.28 Tue 9:30 Poster A

Lifetime measurements for CoFeB/MgO/CoFeB tunneling junctions — •Andres Conca[1], Frederick Casper[2,3], Johannes Paul[4], Ronald Lehndorff[4], Mathias Kläui[3], Britta Leven[1], and Burkard Hillebrands[1] — [1]FB Physik und Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Institute of Inorganic and Analytical Chemistry, Johannes Gutenberg-Universitaet Mainz, 55099 Mainz, Germany — [3]Institute of Physics, Johannes Gutenberg-Universitaet Mainz, 55099 Mainz, Germany — [4]Sensitec GmbH, Hechtsheimer Str. 2, 55131 Mainz, Germany

An analysis of the lifetime of TMR elements using the Weibull statistical distribution is presented. The distribution is governed by two parameters, the characteristic lifetime η and the shape parameter β, which gives information about the presence of an *infant mortality* in the population. First of all, the suitability of the Weibull distribution for the description of breakdown processes in MgO-based tunneling junctions at different voltages is proven. Secondly, a study of the dependency of the characteristic lifetime extrapolated to the low voltage regime, and the parameter on the nominal barrier thickness, the RA product and the deposition power for the MgO barrier is shown. Finally, a discussion of the absolute overall values and the dependencies and the suitability of the elements for sensor production is given.

Support by the state of Rhineland-Palatinate (MBWWK and MWKEL) and by the ERDF programm in the frame of the Spintronic Technology Platform (STeP) is gratefully acknowledged.

MA 19.29 Tue 9:30 Poster A

Dynamics and thermodynamics of interacting magnetic dipoles — •Eva Hägele[1], Christian Schröder[1], Heinz-Jürgen Schmidt[2], and Marshall Luban[3] — [1]Bielefeld Institute for Applied Materials Research (BIfAM), Computational Materials Science & Engineering (CMSE), University of Applied Sciences Bielefeld, 33602 Bielefeld, Germany — [2]Department of Physics, University of Osnabrück, 49069 Osnabrück, Germany — [3]Department of Physics and Astronomy, Iowa State University, Ames, IA 50011, USA

We investigate the dynamical and thermodynamical properties of magnetic dipoles interacting solely via their magnetic fields. We find that in the case of two interacting magnetic dipoles all relevant thermodynamic and dynamic quantities such as specific heat, zero field susceptibility and the thermal expectation value of the autocorrelation function can be calculated analytically and numerically. We expand our investigations to complex systems such as rings of N dipoles. Further, we show that our numerical methods can be used to model and simulate nanomagnetic logic applications. With regard to this our investigations concentrate on modeling real experimental structures by means of point-dipoles. Based on these models we have performed finite temperature spin dynamics simulations. We compare our results to recent experimental findings.

MA 19.30 Tue 9:30 Poster A

Magnetic characterization of self-assembled arrays of magnetite nanoparticles — •Alexander Fabian[1], Matthias Thomas Elm[1], Hans-Albrecht Krug von Nidda[2], and Peter Jens Klar[1] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 16, D-35392 — [2]Institut für Physik, Universität Augsburg, Universitätsstraße 1, 86159 Augsburg, Germany

Magnetite (Fe_3O_4) is one of the oldest magnetic materials used by mankind. Its high spin polarization of nearly 100% at the Fermi-energy and its high Curie temperature of about 850 K makes it interesting for applications in miniaturized spintronic devices. Reducing the size of a bulk material to the nanoscale may strongly alter the magnetic properties. In order to build magnetic nanodevices using nanoparticles it is therefore not only necessary to arrange the nanoparticles in a controlled way, but also to investigate their magnetic properties as well as the interaction between them. Here we present a bottom up approach to arrange spherical shaped magnetite nanoparticles with a diameter of about 20 nm. For this purpose rectangular openings are written into PMMA resist by electron beam lithography. These openings are then filled during a horizontal dip coating process by using the meniscus force deposition method. Several arrangements with different aspect ratios are prepared. The arrangements were characterized by SQUID measurements showing a superparamagnetic behavior of the nanoparticles. Additionally nanoparticle thin films were investigated by ferromagnetic resonance measurements showing typical spectra of magnetite.

MA 19.31 Tue 9:30 Poster A

Theoretical investigation of the magnetic ground state in DUT-8(Ni) — •Kai Trepte and Gotthard Seifert — Technical University of Dresden, Institute for Theoretical Chemistry

Ab initio calculations using density functional theory (DFT) have been carried out to study the magnetic ground state (ferromagnetic (FM) or antiferromagnetic (AFM)) of the metal organic framework (MOF) DUT-8(Ni) [1]. This MOF is flexible, which means that it has an open and a close structure. For these structures the coupling constant J has been calculated in order to identify the energetically favoured magnetic ordering.

The ground state of the open as well as the close structure has been found to be AFM. These theoretical results are in agreement with recent experimental observations using EPR measurements.

[1] Klein, N. et.al., Physical Chemistry Chemical Physics, 12 (2010).

MA 19.32 Tue 9:30 Poster A

Magnetic domain wall sensing — •Benjamin Borie[1,2], Johannes Paul[2], Matthias Bürkle[2], Mathias Kläui[1], and Hubert Grimm[2] — [1]Institut für Physik, Johannes Gutenberg-Universität Mainz, 55099 Mainz, Germany — [2]Sensitec GmbH, 55131 Mainz, Germany.

An extensive effort is made by industry to introduce magnetic technologies using domain walls into sensors [1]. Domain wall quasiparticles are of interest for storing the state of a device and they can be operated at very low power. Magnetic domain walls are strongly influenced by the external and internal parameters of the material, the shape and the environment of the device. To reduce undesired effects such as non-reproducible operation, the device materials and geometries need to be engineered and high reproducibility can be achieved [2]. We study the influence of roughness, crystallisation, shape and material stacks on the magnetic operating field window of a free layer of a multi-turn

sensor driven by a rotating external field. The magnetic operating window is limited by the nucleation field and the propagation field. The roughness and crystallisation are likely to induce a potential landscape that can result in a decrease of the nucleation field and the stacks may induce an asymmetry in this value. A large number of samples can be rapidly fabricated and tested by Kerr microscopy technique and using the GMR effect to ascertain the necessary statistics.

[1] Marco Diegel, et. al., IEEE Transaction on magnetics, vol.45, No.10, October 2009 [2] A. Bisig et al., Nature Communications 4, 2328 (2013).

MA 19.33 Tue 9:30 Poster A

Study of Spin flop transition in Fe/Cr multilayer grown on nanorippled Si substrate — •Sarathlal Koyiloth Vayalil[1], Ajay Gupta[2], and Stephan V. Roth[1] — [1]Photon Science, Deutsches Elektronen-Synchrotron, Notkestrasse-85, 22607, Hamburg, Germany — [2]Amity Center for Spintronic Materials, Amity University, Sector 125, NOIDA, 201313, India

In this work, Fe/Cr giant magneto resistance multilayer prepared on nano-rippled Si (100) substrate has been studied. It has been demonstrated that, one can do a systematic study of spin flop transition in a polycrystalline films deposited on a nano-rippled substrate, by using the possibility of controlling the exchange field by varying the Cr spacer layer thickness and anisotropy field by varying the modulation depth of the ripples. The multilayer having a nominal structure [Fe (3.0 nm)/ Cr (1.0 nm)] x10 was deposited the nano-rippled Si substrate using electron beam evaporation. The multilayer exhibits a spin flop transition when magnetic field is applied in a direction along the easy axis. On the other hand when the field is applied normal to the easy axis, no spin flop transition is observed. This is in conformity with the theory of antiferromagnetic system. In our knowledge this is the first observation of spin flop transition in polycrystalline antiferromagnetically coupled multilayers.

MA 19.34 Tue 9:30 Poster A

Lorentz microscopy of laser-induced vortex formation in microstructures — •Tim Eggebrecht[1], Jan Gregor Gatzmann[2], Vladyslav Zbarsky[3], Sascha Schäfer[2], Claus Ropers[2], Markus Münzenberg[3], and Konrad Samwer[1] — [1]I. Physikalisches Institut, Universität Göttingen — [2]IV. Physikalisches Institut, Universität Göttingen — [3]Grenz- und Oberflächenphysik, Universität Greifswald

For many years magnetic microstructures have been used for storing data in the hard drive industry. Several new methods were developed in order to save bits faster and with higher density in space. We present one of these potential methods in this work.

To produce magnetic microstructures, we show the focused ion beam method on thin Si_3N_4 membranes. Magnetically soft CoFeB thin films are capable to achieve a predictable long-range magnetic order. Thereby, we are able to investigate single magnetic vortices caused by shape anisotropy in single elements. We used a modified transmission electron microscope (TEM) to introduce a laser beam, which can be positioned on the sample. The laser system facilitates single femtosecond pulses and the Lorentz imaging mode of the TEM provides a direct observation of change in magnetization. After excitation with a single pulse, we see a reversing in rotation of vortices to the opposite. Furthermore, we examine the dependence on shape and size of the microstructures of this process.

We acknowledge support by the DFG via SFB 1073.

MA 19.35 Tue 9:30 Poster A

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

Pulsed two-beam laser interference is used to generate two-dimensional temperature patterns on a magnetic sample. We show that the original domain structure of a Co/Pd multilayer thin film can be switched into a small grain size state upon exceeding the Curie temperature by thermal demagnetization. This finding is supported by numeric simulations using the Landau-Lifshitz-Bloch formalism. The small domains can be switched back into the original domain sizes by demagnetization. At even higher temperatures the multilayer system is irreversibly changed. In this area no out-of-plane magnetization can be found after a subsequent demagnetization. Thus, a two-dimensional temperature pattern can be transferred into a magnetic stripe pattern. In this way one can achieve magnetic nanowire arrays with lateral dimensions in the order of 100 nm. Typical patterned areas are in the range of several millimeters. Hence, the parallel Direct Laser Interference Patterning (DLIP) method of magnetic thin films is an attractive alternative to the conventional serial electron beam writing of magnetic nanostructures.

MA 19.36 Tue 9:30 Poster A

Detection of magneitc vortex core switching by MOKE Microscopy — •Georg Dieterle[1], Joachim Gräfe[1], Matthias Noske[1], Ajay Gangwar[1,2], Johannes Förster[1], Markus Weigand[1], Hermann Stoll[1], Georg Woltersdorf[3], Christian H. Back[2], and Gisela Schütz[1] — [1]Max Planck Institute for Intelligent Systems, Stuttgart, Germany — [2]Department of Physics, University of Regensburg, Regensburg, Germany — [3]Department of Physics, Martin Luther University Halle, Halle, Germany

Experimental detection of the switching of the magnetic vortex core, 10 - 20 nm in diameter, so far requires instrumentations like synchrotron based X-ray microscopes. Here we show how vortex core switching can be detected by a table top MOKE microscope in combination with a sophisticated lock-in technique. In that way vortex core reversal can be measured in about 2 minutes by switching the vortex core about 2000 times per second and averaging the Kerr Signal for vortex core up and vortex core down. In addition our technique enables the determination of switching probabilities during the measurement by performing a continuous calibration of the 100 % switching probabilities. For that purpose an excitation sequence is applied in which, in addition to the excitation to be investigated, excitations known for 100% vortex core reversal, are added. Experimental data will be demonstrated for vortex core reversal by excitation of the vortex core gyromode with in-plane rotating fields. The vortex core will be switched up and down using varying amplitudes and frequencies of the excitation field.

MA 19.37 Tue 9:30 Poster A

Exchange coupling between soft magnetic materials and hard magnetic Dysprosium layers — •Markus Ehlert, Thomas Hupfauer, Markus Schitko, and Dieter Weiss — Institute of Experimental and Applied Physics, University of Regensburg, Germany

The control of the magnetic properties of thin ferromagnetic films is crucial for the functionality of spintronic devices, e.g., for the detection of the spin Hall effect [1]. The goal of our work is to improve the magnetic stability of commonly used soft ferromagnets by making use of the exchange coupling between soft and hard magnetic materials. We report on measurements of the magnetic interplay between soft magnetic Fe or Co layers and hard magnetic Dysprosium (Dy) layers. Microstructured thin films of Fe, Co, Dy and multilayers of Fe/Dy and Co/Dy were prepared by electron-beam lithography and ultra-high vacuum sputtering. The magnetic properties of the materials were determined by means of the Anisotropic Magnetoresistance (AMR) effect. All measurements were carried out below the Curie temperature of Dy at 4.2 K in a high magnetic field cryostat with fields up to 10 T. By analyzing and comparing the corresponding AMR data we show that the presence of a Dy layer on top of a soft magnetic material significantly influences its magnetic properties. In our experiments we could enhance, e.g., the in-plane coercive field by one order of magnitude. We also investigate the dependence of this effect on the thickness of the soft magnetic material. All experimental results can consistently be explained with the model of the AMR effect.

[1] M. Ehlert *et al.*, Phys. Status Solidi B **251**, 1725-1735 (2014).

MA 19.38 Tue 9:30 Poster A

Huge exchange bias in polycrystalline MnN/CoFe bilayers at room temperature — •Mareike Dunz and Markus Meinert — Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany

In spintronics, the exchange bias effect is used to pin a ferromagnetic layer to an antiferromagnet, making its magnetization less sensitive to external magnetic fields.

We present a polycrystalline MnN/CoFe bilayer system that shows huge exchange bias of more than 1000 Oe at room temperature. The antiferromagnetic MnN was reactively sputtered on a buffer layer and found to crystallize in the tetragonal face centered θ-phase by x-ray diffraction. To activate exchange bias, the samples were annealed at various temperatures in a vacuum furnace and field cooled for 30 minutes. We discuss the temperature and film thickness dependence of the exchange bias in detail.

MA 19.39 Tue 9:30 Poster A

Electrical and magnetic properties of cuprate-manganate multilayers grown by metalorganic aerosol deposition — •Philipp Busse, Florian Fischgrabe, Sebastian Hühn, Markus Jungbauer, Markus Michelmann, and Vasily Moshnyaga — I. Physikalisches Institut, Universität Göttingen, Germany

Multilayers of superconducting cuprates and ferromagnetic manganates reveal interesting effects like spin injection, proximity effects, giant magnetoresistance and interlayer magnetic coupling [1], [2]. The growth of cuprate layers by metalorganic aerosol deposition (MAD) was studied for different deposition parameters (temperature, deposition rate and precursor molarity) and the used substrates (Al2O3, MgO and SrTiO3). Epitaxial growth of La2-xSrxCuO4 (LSCO) on SrTiO3 (100) substrates was evidenced by global (x-ray diffraction) and local (STM) structural characterization. A magnetic coupling between LCO and La0.7Sr0.3MnO3 (LSMO) was indicated by an increase of coercive field of ferromagnetic LSMO in the LSMO/LCO bilayer. Acknowledgment goes to the SFB 1073-B04 for support.

[1] J. F. Ding et al., Appl. Phys. Lett. 102, 032401 (2013) [2] A. M. Goldman et al., J. Magn. Magn. Mater. 200, 69 (1999)

MA 19.40 Tue 9:30 Poster A

Ramifications of the bombardment of exchange bias bilayers with low energy Helium ions — •Henning Huckfeldt and Arno Ehresmann — Institute of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, 34132 Kassel, Germany

The use of low energy Helium ions as flexible and feasible tool to modify the magnetic properties of exchange bias material systems in magnitude and/or coupling direction is known for more than a decade. While a number of models were proposed describing the link between structural effects evoked by ion bombardment and the change in magnetic properties experimental proof was hard to find. We present results of a novel experimental approach to investigate the effect using Helium ion bombardment of exchange bias layers in the absence of an external magnetic field to separate between the effects of local heating leading to a relaxation of the coupling direction and effects caused by structural defects due to collision cascades in the material.

MA 19.41 Tue 9:30 Poster A

Exchange bias in perpendicularly magnetized AFM/FM double layers — •Orestis Manos, Manuel Glas, Jan Schmalhorst, and Günter Reiss — Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany.

Recently, the combination of exchange bias (EB) systems and perpendicularly magnetized electrodes in magnetic tunnel junctions (pMTJs) has attracted considerable scientific interest. Exchange bias refers to the shift of the magnetic hysteresis loop away from zero field, due to the exchange interaction between a ferromagnet (FM) and an antiferromagnet (AFM) (e.g., FeMn) across their common interface, which is usually accompanied by an increase in coercivity. The EB in in-plane magnetized systems is based on the alignment of the crystal plane parallel to the sample surface. It is already realized that the crystallographic growth of the AFM material affects critically the existence of exchange bias. In principle, the first aim concerns the change of the growth direction of FeMn (111) perpendicular to the sample plane. Therefore, we have fabricated perpendicularly magnetized stacks consisting of A/Fe-Mn/Co-Fe-B/MgO with A = Pt, Ru, and Ta [1]. Afterwards, the samples were ex-situ post-annealed at several temperatures and their crystallographic properties were investigated by X-ray diffraction (XRD) spectroscopy. A [111] growth direction was obtained for all seed layer. Laue oscillations on the (111) FeMn reflex suggest a highly ordered thin film.The samples with Pt seed layer showed an exchange bias field of 50 Oe.

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

MA 19.42 Tue 9:30 Poster A

Investigation of 3d-5d double perovskites as potential room temperature multiferroics — •Ashish Kulkarni[1,2], Vikas Shabadi[1], Philipp Komissinskiy[1], Rajeev Gupta[2,3], and Lambert Alff[1] — [1]Institute of Materials Science, Technische Universität Darmstadt, Alarich-Weiss-Strasse 2, 64287 Darmstadt, Germany — [2]Materials Science Programme, Indian Institute of Technology Kanpur, 208016 Kanpur, India — [3]Department of Physics, Indian Institute of Technology Kanpur, 208016 Kanpur, India

In the search for multiferroic materials with ferromagnetic and ferroelectric order in a single phase, the $A_2BB'O_6$ double perovskites hold the potential for room-temperature functionality. The fabrication challenge with these multi-cation complex oxides lies in the precise control of oxidation states of the elements and achieving a high degree of B-site chemical order. Based on recent theoretical investigations to identify potential ferromagnetic insulators among 3d-5d double perovskites, the compound Bi_2MnReO_6 was predicted to have magnetic ordering temperatures well above 300 K. We report on the fabrication of epitaxial thin films of the analogous novel compound La_2MnReO_6 on single crystal $SrTiO_3$ (001) substrates, using pulsed laser deposition. Given the specific configuration of the outer electronic shells and the 150° Mn-O-Re bond angle, the magnetic moments on Mn and Re are expected to be coupled via superexchange in a ferrimagnetic state. Detailed structural investigations were performed by X-ray diffraction and the magnetic properties were studied by SQUID magnetometry.

MA 19.43 Tue 9:30 Poster A

Structural and magnetic properties of MnBi thin films grown by magnetron sputtering — •Sareh Sabet, Erwin Hildebrandt, and Lambert Alff — Institute of Materials Science, Technische Universität Darmstadt, Germany

The intermetallic compound MnBi is a promising rare-earth-free permanent magnet material. The low-temperature phase (LTP) of MnBi has attracted much attention due to its high intrinsic coercivity (H_{ci}) with a positive temperature coefficient and a high magnetocrystalline anisotropy (H_A). These properties make MnBi unique among all candidates for high-temperature applications. Thin films of LTP-MnBi were deposited onto silica glass substrates by alternating sputter deposition of Bi and Mn layers, as well as from an alloyed MnBi target with 55 at.% Mn content, followed by a subsequent annealing at different temperatures ranging from 400 to 600° C for 1 h. We present the structural and magnetic properties of the resulting thin films in correlation with fabrication parameters.

MA 19.44 Tue 9:30 Poster A

Magnetic charactarization of pure and doped epitaxial γ'-Fe_4N thin films — •Philipp Zilske and Markus Meinert — Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany

Because of their excellent magnetic properties, iron nitrides are potential materials for spintronic devices. For example, negative TMR of -75% was demonstrated in MTJs with one Fe_4N electrode [1].

To study the influence of doping, epitaxial γ'-Fe_4N films were grown on MgO (001) substrates by reactive magnetron sputtering. Diffraction measurements revealed that films with the correct stoichiometry can be grown at 450°C. The magnetic properties of the γ'-Fe_4N were studied by vectorial Kerr magnetometry. The hysteresis loops reveal a biaxial anisotropy due to the cubic perovskite structure and very sharp switching. Particularly the latter points to high crystal quality of the films. The loops characterize the crystalline [100] direction as the easy magnetization axis.

In addition, epitaxial Fe_3MnN, Fe_3NiN and Fe_3CoN films were prepared successfully and we discuss their magnetic properties.

[1] Y. Komasaki et al., *J. Appl. Phys.* **105**, 07C928 (2009)

MA 19.45 Tue 9:30 Poster A

Study of spontaneously induced chemical ordering in epitaxial thin films of the double perovskite La_2FeCrO_6 — •Supratik Dasgupta, Vikas Shabadi, Philipp Komissinskiy, and Lambert Alff — Institute of Materials Science, Technische Universität Darmstadt, Alarich-Weiss-Strasse 2, 64287 Darmstadt

In double perovskites ($A_2BB'O_6$), antisite disorder plays a crucial role for their functional properties. A large difference in ionic radii and the formal valence states of the two B-site cations is known to favour a chemically ordered state. In the case of the ferrimagnetic insulator La_2FeCrO_6, Fe and Cr have nearly the same ionic radii and the same valence state, making chemical order difficult to achieve. Recently, for La_2FeCrO_6 nearly 90% ordering was reported in epitaxial thin films grown by pulsed laser deposition (PLD) with a saturation magnetization of 2 μ_B/f.u. corresponding to a Fe-O-Cr superexchange interaction [1]. We have systematically studied the influence of various PLD parameters on the growth of epitaxial thin films of La_2FeCrO_6 along with an extensive structural, chemical and magnetic characterization. Laser fluence and substrate temperature have been found to be the most critical parameters that determine chemical order.

[1] S. Chakraverty *et al.*, Phys. Rev. B **84**, 064436 (2011).

MA 19.46 Tue 9:30 Poster A

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

Mixed valence manganites are still in the focus of fundamental research due to their rich phase diagramm with different electronic and magnetic phases. Crucial for the understanding oft he physics of manganites ist he strong electron-phonon coupling due to the Jahn-Teller effect. Here we report on a detailed Raman study of $(La_{0.65}Pr_{0.45})_{0.7}Ca_{0.3}MnO_3$ thin films. To assign the observable Raman modes, we performed polarized Raman spectroscopy at room temperature (λ = 532 nm, P = 1.2 mW). We observed four pronounced modes at 235 cm^{-1}, 434 cm^{-1}, 485 cm^{-1} and 609 cm^{-1}. The 485 cm^{-1} and 609 cm^{-1} mode can be assigned to an anti-stretching and stretching mode, respectively, due to the Jahn-Teller effect in agreement with previous work [1]. Furthermore, the temperature as well as magnetic field dependent Raman spectra show a correlation with the metall-insulator transition and the collosal magnetoresistance. Financial support from DFG, SFB 1073 (TP B04) is acknowledged.*

[1] M. N. Iliev, M. V. Abrashev et al., Phys. Rev. B, Vol. 57 (p.2872), 1998;Phys. Rev. B, Vol. 73 (p.064302), 2006

MA 19.47 Tue 9:30 Poster A

Quadratic magnetooptic spectroscopy of bcc Fe and Co_2MnSi thin films — •Robin Silber[1,2], Gerhard Götz[2], Lukáš Beran[3], Daniel Král[3], Jaromír Pištora[1], Günter Reiss[2], Martin Veis[3], Timo Kuschel[2], and Jaroslav Hamrle[1] — [1]VSB - Technical University of Ostrava, Czech Republic — [2]CSMD, Physics Department, Bielefeld University, Germany — [3]Charles University in Prague, Czech Republic

The magnetooptic Kerr effect (MOKE) is a well known physical phenomena that enables detailed characterization of magnetic material properties. However, quadratic MOKE (QMOKE) is not well understood yet. Hence, QMOKE anisotropy measurements [1] or QMOKE spectroscopy are methods convenient for investigations of the magnetooptic effect quadratic in magnetization. Within the materials having a cubic crystal symmetry, any dependence of the permittivity elements on the direction of the magnetizaton (within the second order in magnetization) can be expressed by two, generally complex parameters G_{11}-G_{12} and $2G_{44}$ [2]. We present here QMOKE spectra of those parameters for the bcc Fe and the Co_2MnSi Heusler alloy thin films as a novel spectroscopic approach revealing detailed magnetooptic information within the second order effects in magnetization. Both materials exhibit change of the QMOKE spectra with change of the crystallographic structure, which is achieved by post annealing at different temperatures.

[1] K. Postava et al., J. Appl. Phys. 91, 7293 (2002)
[2] J. Hamrle et al., J. Phys. D: Appl. Phys. 40, 1563 (2007)

MA 19.48 Tue 9:30 Poster A

Structural and magnetic properties of Fe/Pt epitaxial bilayers — •Sascha Keller[1], Andres Conca[1], Thomas Brächer[1], Jochen Greser[1], Laura Mihalceanu[1], Jörg Lösch[2], Burkard Hillebrands[1], and Evangelos Th. Papaioannou[1] — [1]Fachbereich Physik, Technische Universität Kaiserslautern, Erwin-Schrödinger-Str. 56, 67663 Kaiserslautern, Germany — [2]Institut für Oberflächen- und Schichtanalytik (IFOS) and Forschungszentrum OPTIMAS, Trippstadter Str. 120, 67663 Kaiserslautern, Germany

The FePt system in the form of multilayers and alloys has attracted large attention from the magnetic research community especially for technological applications in storage media. However many questions are still open concerning the correlation between magnetic properties and structure of Fe and Pt layers. Here, we address this topic with the fabrication of high quality epitaxial thin Fe/Pt bilayer structures on MgO (001) substrates by using different growth temperatures. Both, Fe and Pt surfaces are analysed by *in situ* ultra high vacuum scanning tunnelling microscopy and structural parameters are derived using height-height-correlation, as well as grain size analysis. X-Ray diffraction pole figures shows the 45° in plane epitaxial relation between the Fe layer and the MgO substrate for all growth temperatures while the Pt layer exhibits different characteristics with different growth temperatures. Longitudinal magneto-optical Kerr effect measurements show the co-existence of two kinds of anisotropies: that of a cubic term plus a uniaxial anisotropy term. The strength of each term can be manipulated according to the structural properties of the films.

MA 19.49 Tue 9:30 Poster A

Skyrmions close to room-temperature – epitaxy and magnetism of FeGe thin films — •David Schroeter, Josefin Engelke, and Dirk Menzel — Institut für Physik der Kondensierten Materie, Technische Universität Braunschweig, Mendelssohnstr. 3, 38106 Braunschweig, Germany

Non-centrosymmetric chiral magnets in the cubic B20 structure with broken space-inversion symmetry show intriguing properties involving the existence of skyrmions. An application of skyrmions in spintronic devices requires materials with magnetic ordering close to room temperature. Among the chiral B20 magnets, FeGe has the highest ordering temperature (278 K). However, since the synthesis of single crystals is difficult, only very small-sized species of single-crystalline FeGe exist. We have grown FeGe as a thin film on Si(111) substrates using molecular beam epitaxy. The films have been structually characterized by RHEED and AFM. A detailed magnetic characterization has been obtained by SQUID magnetometry. We have investigated the complex magnetic phase diagram in comparison to that of bulk FeGe and explored the modification of the skyrmionic phase under the influence of the reduced dimensionality and the strain in the thin films.

MA 19.50 Tue 9:30 Poster A

Suppression of magnetic order in epitaxial $Mn_{1-x}Fe_xSi$ thin films — •Patricia Herbst, Josefin Engelke, David Schroeter, and Dirk Menzel — Institut für Physik der Kondensierten Materie, Technische Universität Braunschweig, Mendelssohnstr. 3, 38106 Braunschweig, Germany

The chiral magnet MnSi, which crystallizes in the cubic B20 structure and has evoked much interest due to the existence of skyrmions, orders magnetically below T = 29.5 K. The magnetic order can be suppressed by iron doping and vanishes completely for a Fe substitution of 15% in bulk material. Thin films of the B20 magnets, however, are known to show different magnetic properties, which are modified due to strain and film anisotropy. Therefore, we have investigated epitaxial $Mn_{1-x}Fe_xSi$ grown on Si(111) substrate by molecular beam epitaxy. A first series of samples was prepared by codeposition and a second series was codeposited and additionally annealed afterwards. The properties of these two different types of films are compared and discussed. For all films with Fe doping a decreased ordering temperature is observed and the complete suppression of magnetic order is investigated. At low temperature a Kondo minimum masks the possibly occurring deviation from the T^2-law, which is known from bulk material and which corresponds to non-Fermi liquid behavior.

MA 19.51 Tue 9:30 Poster A

Low-field AMR in planar Hall effect structured manganites — •Eduard Unger[1], Camillo Ballani[1], Alexander Belenchuk[2], Sabastian Hühn[1], Markus Jungbauer[1], Markus Michelmann[1], and Vasile Moshnyaga[1] — [1]I. Physikalisches Institut, Universität Göttingen — [2]IIEN, Academy of Sciences of Moldova, 3/3 Academiei street, MD-2628 Chisinan, Republic of Moldova

The anisotropic magnetoresistance (AMR) is widely used for sensing of both direction and absolute value of magnetic fields. Besides conventionally used ferromagnetic metallic materials, like permalloy ($Ni_{80}Fe_{20}$), thin epitaxial manganite films, e.g. $La_{0.7}(Sr_{1-y}Ca_y)_{0.3}MnO_3$, show large AMR ratios at temperatures slightly below T_C, which can be tuned close to room temperature by changing the Sr/Ca ratio. For a special AMR geometry, called "planar Hall effect", the transverse voltage is a measure for the samples magnetization, M, thus allowing one to achieve very high field sensitivity by applying a small bias magnetic field close to coercive field H_C, where the largest effect dM/dH is expected. With the goal to achieve low H_C and high AMR ratios, we have grown thin manganite films on $SrTiO_3$ substrates with different orientations by metalorganic aerosol deposition (MAD) technique and studied the dependence of planar Hall effect on the temperature, applied magnetic field, film thickness and form anisotropy by combining electrical measurement with a MOKE setup in order to link magnetic and electrical properties. Financial support from EU FP 7 Project IFOX (interfacing oxides) is acknowledged.

MA 19.52 Tue 9:30 Poster A

Out-of-plane and in-plane vector MOKE investigations of CoFeTb thin films — •Timo Oberbiermann, Gerhard Götz,

Christoph Klewe, Günter Reiss, and Timo Kuschel — CSMD, Physics Department, Bielefeld University, Germany

Ferromagnetic thin films with an out-of-plane (oop) magnetic easy axis are of great interest, due to their potential for realizing next-generation spintronic devices like magnetic tunnel junctions which are capable of current-induced magnetization switching.

We used vectorial magnetometry based on the magnetooptic Kerr effect to investigate the magnetic properties of $(CoFe)_{1-x}Tb_x$ thin films which exhibit a partial oop-directed magnetization.

An established method uses the change in polarization for reflected s- and p-polarized light as well as different orientations of the sample and the external field directions in order to determine all three components of the magnetization vector [1]. Therefore, this technique needs several changes in the setup. However, another recently reported method [2] allows to obtain the in-plane components without setup changes by measuring the changes in polarization and reflectivity at the same time.

As a combination we now observe the changes in polarization and reflectivity simultaneously, both for s- and p-polarized light. This allows a quantitative determination of all three magnetization components during the reversal process of the magnetization in $(CoFe)_{1-x}Tb_x$ thin films without altering the experimental setup.

[1] T. Kuschel et al., J. Phys. D: Appl. Phys. 44, 265003 (2011)
[2] E. Jiménez et al., Rev. Sci. Instrum. 85, 053904 (2014)

MA 19.53 Tue 9:30 Poster A

Temperature and bias-voltage dependence of atomic-layer-deposited HfO_2-based magnetic tunnel junctions — •Savio Fabretti[1], Robert Zierold[2], Kornelius Nielsch[2], Carmen Voigt[3], Carsten Ronning[3], Patrick Peretzki[3], Michael Seibt[4], and Andy Thomas[1,5] — [1]Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany — [2]Institute of Nanostructure and Solid State Physics, Universität Hamburg, 20355 Hamburg, Germany — [3]Institute for Solid State Physics, Friedrich-Schiller-University Jena, 07743 Jena, Germany — [4]4. Physikalisches Institut, Georg-August University Göttingen, 37077 Göttingen — [5]Institut für Physik, Johannes Gutenberg Universität Mainz, 55128 Mainz, Germany

Magnetic tunnel junctions with HfO_2 tunnel barriers were prepared through a combination of magnetron sputtering and atomic layer deposition. The atomic layer deposition leading to a polycrystalline electrode-barrier system revealed by high-resolution transmission electron microscopy. We investigated the tunnel magnetoresistance ratio and the current-voltage characteristics between room temperature and 2 K. Here, we achieved a tunneling magneto resistance ratio of 10.3% at room temperature and 19.3% at 2 K. Furthermore, we studied the bias-voltage and temperature dependencies and compared the results with those of commonly used alumina- and magnesia-based magnetic tunnel junctions. We observed a polycrystalline/amourphous electrode-barrier system via high-resolution transmission electron microscopy [1].

[1] Fabretti et al., APL 105, 132405 (2014) doi: 10.1063/1.4896994

MA 19.54 Tue 9:30 Poster A

Spin pumping in epitaxially grown Fe/Pt systems with an MgO interlayer — •Laura Mihalceanu, Sascha Keller, Viktor Lauer, Jochen Greser, Andrés Conca, Burkard Hillebrands, and Evangelos Th. Papaioannou — Fachbereich Physik and Landesforschungszentrum OPTIMAS, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Germany

Understanding interface effects on spin pumping is a very exciting challenge in the field of spin currents excitation via magnetization dynamics. Here, we address the influence of the interface quality on spin pumping by using epitaxially grown samples. We use the Fe/Pt system as a model system to investigate the interface. For this purpose we study the interlayer effects by varying material composition, layer thickness and deposition temperature [1]. We focus on the impact of layer thickness of Pt on the spin-pumping efficiency. This efficiency can be obtained by measuring the current of the inverse spin Hall effect. Furthermore, we choose the Pt thickness which presents the highest spin-pumping efficiency and modify the interface by using an insulating layer of MgO. We show the dependence of spin pumping on the thickness of MgO and on the structural quality of the grown samples.

[1] E. Th. Papaioannou, P. Fuhrmann, M. B. Jungfleisch, T. Brächer, P. Pirro, V. Lauer, J. Lösch, and B. Hillebrands, Applied Physics Lettres 103, 162401 (2013).

MA 19.55 Tue 9:30 Poster A

Sputtered and annealed polycrystalline La0.67Sr0.33MnO3 and PbZr0.2Ti0.8O3 layers on Silicon (111) — •Oana T. Ciubotariu[1,2], Manuel Monecke[2], Patrick Thoma[2], Roxana Dudric[1], Romulus Tetean[1], Dietrich R. T. Zahn[2], and Georgeta Salvan[2] — [1]Faculty of Physics, Babeş-Bolyai University, RO-400084 Cluj-Napoca, Romania — [2]Semiconductor Physics, Technische Universität Chemnitz, D-09107 Chemnitz, Germany

In a new approach to fabricate organic spintronic devices, heterostructures of La0.67Sr0.33MnO3 (LSMO) and PbZr0.2Ti0.8O3 (PZT) thin films were proposed. By sandwiching ferroelectric layers between the ferromagnetic electrode and the organic semiconductor, the resistance of such devices can be controlled by applying electric and magnetic fields [1]. In this work we studied: LSMO, PZT, and PZT/LSMO layers on Si(111) substrates. The LSMO and PZT layers were deposited in a high vacuum chamber by pulsed radio frequency magnetron sputtering at room temperature. After the deposition, the LSMO layers were annealed in ambient atmosphere at 775 °C. Their crystallinity was confirmed via X-ray diffraction. The PZT films were annealed in ambient atmosphere at temperatures in the range 500-700 °C for one hour. For the LSMO films the annealing time was observed to influence the magnetic properties which were investigated using a SQUID magnetometer. The Curie temperature, the remanence, and the coercitive field increase with annealing time while the saturated magnetic moment reaches a constant value for annealing times larger than three hours.

[1] Sun, D. et al. Nat. Commun. 5:4396 doi: 10.1038/ncomms5396 (2014)

MA 19.56 Tue 9:30 Poster A

Local probe of disorder-induced magnetism in Fe60Al40 thin films by Mössbauer and X-ray spectroscopy — •Alevtina Smekhova[1,3], Dirk Walecki[1], Rantej Bali[2], Kay Potzger[2], Steffen Cornelius[2], Oscar Liedke[2], Jürgen Lindner[2], and Heiko Wende[1] — [1]Universität of Duisburg-Essen, Fakultät für Physik und CENIDE, Experimentalphysik, 47048 Duisburg, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Institut für Ionenstrahlphysik and Materialforschung, DE - 01314 Dresden, Germany — [3]Lomonosov Moscow State University, Faculty of Physics, 119991 Moscow, Russia

It is known for decades that $Fe_{60}Al_{40}$ system is paramagnetic at RT in the chemically ordered simple cubic B2 (CsCl) phase but exhibits ferromagnetism being chemically disordered in the A2 one [1]. This phenomenon is appealing for different applications where the delicate control of magnetic properties is needed. In $Fe_{60}Al_{40}$ thin films of different thicknesses chemical disorder can be induced by ion beam irradiation technique with ions possessing sufficient energy to disarray Fe and Al atoms; and nowadays it is successfully used in combination with lithography for magnetic pattern creation with a sub-50nm resolution [2]. We report on recent results of Mössbauer and element-specific X-ray spectroscopy studies of $Fe_{60}Al_{40}$ thin films which reveal that local environment and/or related magnetic properties strongly depend on the degree of disorder, annealing temperature and film thickness (40nm or 250nm). [1] G. Huffman et al., J.Appl. Phys. **38** (1967) 735 [2] R. Bali et al, Nano Lett. **14** (2014) 435

MA 19.57 Tue 9:30 Poster A

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

We show new approaches for magnetostrictive sensors based on tunneling magnetroresistive (TMR) elements. The key materials in these stacks are $CoFeB$ and MgO which are standard materials for TMR stacks.

Since the inverse magnetostriction in this material leads only to increasing or decreasing (depending on the inital magnetization) of the resistance, the measurement of the bending through this effect is limited. That is why new TMR stacks were developed in which the magnetizations of the two ferromagnetic layers are not parallel or antiparallel. This leads to new opportunities for the application of magnetrostrictive sensors, e.g., in AFM.

We will discuss different approaches such as double-exchange biasing, shaping or the combination of in-plane and out-of-plane anistropy.

These TMR stacks have been made by magnetron sputtering and investigated by magneto-optical Kerr effect (MOKE), alternating-gradient magnetometry (AGM) and TMR measurements.

MA 19.58 Tue 9:30 Poster A

Tayloring granular FePt films for electrolytic gating — Karin Leistner, Kenny Duschek, Ludwig Schultz, Ludwig Reichel, Sebastian Fähler, and •Christian Kozalla — Leibniz Institute for Solid State and Materials Research, Dresden, Germany

Reversible changes of magnetism in metals are of key interest in today's research. Electric control of magnetization and anisotropy has already been achieved by electrolytic charging of continuous FePt films [1]. Here we aim for charging granular FePt films in order to study electric field effects at the superparamagnetic limit [2]. To allow for charging a granular film, a conduction path must be realized in a first step. In comparison to the well established FePt/MgO architecture we study the growth of granular L10 ordered FePt films on a Nb-doped SrTiO3 substrate. L10 ordering in this case is achieved at lower substrate temperatures. However, the conduction volume of the substrate turns out to be too large for reasonable anomalous Hall-Effect (AHE) measurement, needed for in situ magnetic characterization during charging. The AHE measurement is successful when an additional Fe layer is sputtered on granular L10 FePt. In these Fe/FePt bilayers a sufficient conduction path and at the same time single phase hard magnetic behavior can be realized. These exchange coupled films are promising candidates for future electrolytic gating experiments.

[1] K. Leistner et al. Physical Rev. B 87, 224411, (2013); doi: 10.1103/PhysRevB.87.224411

[2] F. Kurth et al. Physical Rev. B 82, 184404, (2010); doi:10.1103/PhysRevB.82.184404

MA 19.59 Tue 9:30 Poster A

Laser-induced changes of electronic transport properties in manganites — •Manuel Mchalwat[1], Henning Ulrichs[1], Bernd Damaschke[1], Vasily Moshnyaga[1], Markus Münzenberg[2], and Konrad Samwer[1] — [1]1. Physikalisches Institut, Georg-August-Universität, Göttingen — [2]Institut für Physik, Ernst-Moritz-Arndt Universität, Greifswald

Manganites show structural phenomena at a variety of spatial and time scales ranging from nanometers and picoseconds for single polarons up to microns and seconds for the electronic phase separation. Many of these influence physical properties, e. g. the metal-insulator transition, which is accompanied by a change of the crystal structure and believed to be driven by the formation of correlated polarons near the transition temperature.

By exciting the sample near the transition by short laser pulses we change the electronic tranport properties by influencing the electronic correlations. These changes show up in a change in the third harmonic voltage.

The work has been supported by the DFG through SFB 1073 TP B01 and by Femtolasers.

MA 19.60 Tue 9:30 Poster A

Control of stoichiometry in $LaMnO_3/La_2MnO_4$ thin films grown by pulsed laser deposition — •Arun Singh Chouhan[1,2], Supratik Dasgupta[1], Vikas Shabadi[1], Aldin Radetinac[1], Philipp Komissinskiy[1], Ajay D Thakur[2], and Lambert Alff[1] — [1]Institute of Materials Science, Technische Universität Darmstadt, Alarich-Weiss-Strasse 2, 64287 Darmstadt — [2]Department of Physics, Indian Institute of Technology Patna, India

Growth of perovskites (ABO_3) by pulsed laser deposition (PLD) requires a simultaneous precise control of multiple process parameters. In particular, the interplay between laser fluence, growth atmosphere, and pressure affects the stoichiometry and, thereby, also the physical properties of compounds such as $LaMnO_3$ where the B-site cation is known to have multiple stable oxidation states. Although stoichiometric bulk $LaMnO_3$ is an A-type antiferromagnetic insulator, several independent studies have reported a ferromagnetic order in thin films, attributed to an off-stoichiometry driven double exchange interaction between the mixed Mn^{3+} and Mn^{4+} oxidative states. In spite of repeated efforts, as grown thin films with magnetic saturation below $\sim 0.4\,\mu_B$/f.u. have so far not been reported. Here, we present a systematic growth study with a fine control of cation stoichiometry and oxidation state, allowing to stabilize $LaMnO_3$ (with Mn^{3+}) and La_2MnO_4 (with Mn^{2+}) from the same target by choosing the appropriate deposition conditions.

MA 19.61 Tue 9:30 Poster A

Structural and magnetic characterization of $\alpha'-Fe_8N_x$ thin films — •Tim Helbig, Imants Dirba, Oliver Gutfleisch, and Lambert Alff — Material Science, TU Darmstadt, Alarich-Weiss-Str. 16, 64287 Darmstadt, Germany

Buffer-free and epitaxial $\alpha-$Fe and $\alpha'-Fe_8N_x$ thin films have been grown by RF magnetron sputtering onto MgO (100) substrates. With increasing nitrogen content in the plasma during deposition, an expansion of the $\alpha-$Fe unit cell along the c−axis was observed resulting in a tetragonal distortion of approximately 10% (c = 3.15 Å) which corresponds to the value for $\alpha'-Fe_8N$ (002). Fe bcc lattice expansion led to an increase in magnetic moment up to $2.61 \pm 0.06\ \mu_B$ per Fe atom and an increased anisotropy of around 6000 Oe compared to that of pure Fe film (at 10 K temperature). Magnetic Force Microscopy (MFM) measurements have been performed indicating a transition from in plane magnetization due to shape anisotropy, to out of plane magnetization caused by the strain-induced magnetocrystalline anisotropy along the c−axis.

MA 19.62 Tue 9:30 Poster A

New magnetic phase in $LaMnO_3/SrMnO_3$ superlattices on $SrTiO_3$ (001) substrate — •Danny Schwarzbach, Markus Jungbauer, Sebastian Hühn, Markus Michelmann, and Vasily Moshnyaga — I. Physikalisches Institut, Georg-August-Universität Göttingen

Interface effects in perovskite oxide heterostructures have proven to result in interesting novel magnetic phenomena. We studied $(LaMnO_3)_{2ML\cdot n}/(SrMnO_3)_{1ML\cdot n}$ superlattices of $n \approx 3$ grown on $SrTiO_3$ substrates with (001) orientation by Metalorganic Aerosol Depistion (MAD) technique. These samples exhibit two ferromagnetic phases: the low T_C phase with $T_C \approx 270$ K is likely originated from LMO and has already been observed by other groups. We also detected high temperature FM phase with $T_C \approx 355$ K. The high T_C phase reveals a strong uniaxial in plane anisotropy, with easy axis aligned parallel to the monoatomic crystal steps of the substrate. The low temperature saturation magnetization of this phase corresponds to a fully saturated Mn monolayer, indicating a two-dimensional nature of high-T_C ferromagnetic phase.

Support by the Seventh Framework Programme of the EU is acknowledged.

MA 19.63 Tue 9:30 Poster A

Interplay of magnetization, heat and charge currents in FeCo thin films in the presence of magnetic field — •Sasmita Srichandan, Matthias Kronseder, Christian Back, Josef Zweck, and Christoph Strunk — Institute of Experimental and Applied Physics, University of Regensburg, 93040 Regensburg, Germany

We present the magneto thermoelectric response to currents in 20 nm thick Fe_xCo_{1-x} films with compositions x= 0.3, 0.5, 0.6, 0.7, 0.8 deposited on 100 nm thick SiN_x membranes. The anisotropic magnetoresistance (AMR) has contributions from both coherent rotation of magnetization and domain switching. The angular dependence of the switching field H_{sw} at room temperature has a minimum at 20°. The shift of this minimum to 20° from 45° as predicted by the Stoner-Wohlfarth model owes to the aspect ratio of our FM strip, which causes inhomogeneous demagnetization fields at the ends of the strip. On the same films, features of H_{sw} in magneto thermopower (MTEP) measured in temperature gradients $\vec{\nabla}T$ of up to 250 K/mm are similar to those in the AMR. Additionally the membranes allow measurement of all 4 transport coefficients on the same film.

20 nm Fe_xCo_{1-x} films were also deposited on very thin 30 nm SiN_x membranes to study the effects of charge current and $\vec{\nabla}T$ on domain walls in TEM. The Lorentz microscopy images show two domain walls nucleated at both ends of the FM strip and via the microscopy we demonstrate the response to applied field and temperature gradient.

MA 19.64 Tue 9:30 Poster A

In-situ Polarised Neutron Reflectometry during Thin Film Growth by DC Magnetron Sputtering — Sina Mayr[1], Wolfgang Kreuzpaintner[1], Birgit Wiedemann[1], •Jingfan Ye[1], Andreas Schmehl[2], Thomas Mairoser[2], Alexander Herrnberger[2], Jean-Francois Moulin[3], Jochen Stahn[4], Panagiotis Korelis[4], Martin Haese-Seiller[3], Matthias Pomm[3], Amitesh Paul[1], Peter Böni[1], and Jochen Mannhart[5] — [1]Technische Universität München, Garching — [2]Zentrum für elek-

tronische Korrelation und Magnetismus, Universität Augsburg — [3]Helmholtz Zentrum Geesthacht, Instrument REFSANS, Garching — [4]Paul Scherrer Institut, Villigen PSI, Schweiz — [5]Max Planck Institut für Festkörperforschung, Stuttgart

Since thin magnetic layers are used in many magneto-electronic devices the understanding of their texture and the coupling between them is essential to improve functionality. As these parameters are likely to change during the deposition process, in-situ polarised neutron reflectometry (PNR) is used to monitor the development of the structural and magnetic thin film properties during growth. We carry out in-situ PNR measurements using a specially designed sputtering chamber as sample environment combined with modern neutron optical elements at AMOR at PSI. In this contribution, the epitaxial growth of Fe and Cr on a Cu(100)/Si(100) substrate and the evolution of the magnetic properties, particularly the exchange coupling effects in a Fe/Cr heterostructure as a function of film thickness will be presented.

MA 19.65 Tue 9:30 Poster A

Structural and magnetic properties of epitaxially grown Fe/Cu multilayers — •Amir Syed Mohd[1], Sabine Pütter[1], Stefan Mattauch[1], Alexandros Koutsioubas[1], Stephan Geprägs[2], and Thomas Brückel[1,3] — [1]Jülich Centre for Neutron Science JCNS, Forschungszentrum Jülich GmbH, Outstation at MLZ, 85747 Garching, Germany — [2]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany — [3]Jülich Centre for Neutron Science JCNS and Peter Grünberg Institute, JCNS-2, PGI-4: Scattering Methods, Forschungszentrum Jülich GmbH, 52428 Jülich, Germany

Alternate magnetic layers separated by non-magnetic layers are known for exhibiting interlayer coupling and its applications in memory devices. Fe/Cu multilayers are interesting to study because the lattice spacing and the crystal structure of Fe layer vary with thickness which may lead to change in magnetic ordering.

In this work we have deposited [Fe(x)/Cu(y)]x10 multilayers with Fe layer thickness of x (~1.5, 2.0 and 2.5 nm) and corresponding Cu layer thickness of y (~2.5, 2.0 and 1.5 nm), on Cu (100) buffer layer epitaxially grown on Si (100) substrate at ~280 K using MBE. In-situ RHEED measurements were performed to monitor the epitaxial growth during deposition. SQUID measurements suggest that the interlayer coupling is increasing with decreasing Fe layer thickness. Further, in order to determine depth dependent magnetization profile, polarized neutron reflectivity measurements are underway. The obtained results will be discussed in this presentation.

MA 19.66 Tue 9:30 Poster A

Ferromagnetism of nonstoichiometric manganese monosilicides at room temperature — •Anna S. Semisalova[1,2], Konstantin Yu. Chernoglazov[3], Nikolai S. Perov[1], Elena A. Gan'shina[1], Alexander B. Granovsky[1], Andrey V. Zenkevich[4], Shengqiang Zhou[2], and Vladimir V. Rylkov[3] — [1]Lomonosov MSU, Moscow, Russia — [2]HZDR, Dresden, Germany — [3]NRC Kurchatov Institute, Moscow, Russia — [4]MIPT, Dolgoprudny, Russia

Ferromagnetic Si-Mn alloys attract increasing interest due to their interesting properties - recently it was found that these alloys prepared by PLD method exhibit unusual magnetic characteristics which cannot be adequately interpreted within the framework of available theoretical models. Curie temperature TC in nonstoichiometric Si1-xMnx alloys slightly enriched in Mn (x ~ 0.52-0.55) was shown to be on order of magnitude higher (TC ~ 300 K) in comparison to the stoichiometric MnSi (TC ~ 30 K). The mechanism of high-temperature ferromagnetism is still not clear. The ferromagnetic exchange is associated with the formation of defects with localized magnetic moments coupled via spin fluctuations of itinerant electrons in the host. Also we suppose that structural defects have a strong influence on the formation of metastable phases with enhanced ferromagnetic response. In this contribution the recent experimental results on ferromagnetosm of PLD deposited SiMn alloys are summarized. Supported by RFBR (15-57-78022). 1. Rylkov et al. EPL 103, 57014 (2013) 2. Rylkov et al. JMMM, doi:10.1016/j.jmmm.2014.09.028

MA 19.67 Tue 9:30 Poster A

Investigation of the chiral spin structure of the double layer Fe on Ir(111) using SP-STM in a 3D vector magnetic field system — •Aurore Finco, Pin-Jui Hsu, Lorenz Schmidt, Andre Kubetzka, Kirsten von Bergmann, and Roland Wiesendanger — Department of Physics, University of Hamburg, Jungiusstr. 11, 20355 Hamburg, Germany

The detailed magnetic structure of the second atomic layer Fe on Ir(111) has been investigated with spin-polarized scanning tunneling microscopy (SP-STM). The second layer Fe exhibits reconstruction lines along which cycloidal spin spirals are guided. The low temperature measurements in a 3D-vector magnetic field system on the three rotational domains have revealed that these spirals have a unique rotational sense. In addition, no magnetic phase transition occurred when an out-of-plane magnetic field was applied up to 9T. The chirality of this complex spin structure indicates that the Dzyaloshinskii-Moriya interaction plays a crucial role in its formation.

MA 19.68 Tue 9:30 Poster A

Magnetic linear dichroism in angular resolved photoemission of the valence band of 3d metal thin films on W(110) — •Tobias Löffler[1], Torsten Veltum[1], Mathias Gehlmann[2], Sven Döring[2], Lukasz Plucinski[2], and Mathias Getzlaff[1] — [1]Institut für Angewandte Physik, Heinrich-Heine-Universität Düsseldorf, 40225 Düsseldorf — [2]Peter Grünberg Institut PGI-6, Forschungszentrum Jülich, 52428 Jülich

The technique of magnetic linear dichroism in the angular distribution (MLDAD) of photoelectrons allows the study of the electronic band structure as well as the study of magnetic properties of metallic thin films and single crystals. We are interested in a deeper understanding of the magnetic linear dichroism of ferromagnetic 3d metals. Special attention is turned to the question, which parts of the band structure are responsible for this phenomenon. In this study, linearly polarized synchrotron radiation in the VUV regime is used. The investigated system consists of epitaxially grown 3d metal thin films on a W(110) single crystal.

The exciting photon energy is varied to investigate the electronic structure of the valence band. At lower energies, existing dichroism measurements of Co(0001) on W(110) are confirmed [1] and extended to off-normal geometry. To investigate similarities, angle-resolved spectra of Co(0001) and Fe(110) on W(110) are compared.

[1] J. Bansmann et al., Surf. Sci. 454-456 (2000), 686-691

MA 19.69 Tue 9:30 Poster A

Stability of Single Skyrmionic Bits — •Julian Hagemeister, Niklas Romming, Kirsten von Bergmann, Elena Y. Vedmedenko, and Roland Wiesendanger — Institute of Applied Physics and Interdisciplinary Nanoscience Center Hamburg, University of Hamburg, Jungiusstrasse 11, 20355 Hamburg, Germany

The switching between topologically distinct skyrmionic and ferromagnetic states has been proposed as a bit-operation for information storage. Generally, long lifetimes of the bits in combination with short switching times are required for data storage devices. To study the feasibility of realizing these preconditions for skyrmionic bits, we have investigated their energy landscape in a broad range of magnetic fields and temperatures theoretically by means of classical Monte-Carlo (MC) simulations. A critical field B_c at which the mean lifetimes of the skyrmionic (Sk) and ferromagnetic (FM) states are identical has been identified. Notably, the field dependent mean lifetimes of the two states show a high asymmetry with respect to B_c in contrast to conventional uniaxial magnetic bits. The main reason for the asymmetry has been found to be a different field dependence of the skyrmionic and ferromagnetic activation energies. We were also able to correlate the stability of skyrmions in systems on discrete lattices with their attempt frequency rather than with their activation energy. We use this knowledge to propose a procedure permitting the determination of effective material parameters and the quantification of the MC time scale from the comparison of theoretical and experimental data.

MA 19.70 Tue 9:30 Poster A

Surface-Orientation-Dependent Spin Quenching of Adsorbed Co Porphyrin Molecules — •Lucas M. Arruda[1], Matthias Bernien[1], Fabian Nickel[1], Lalminthang Kipgen[1], Christian F. Hermanns[1], Jorge Miguel[1], Alex Krüger[1], Dennis Krüger[1], Nino Hatter[1], Jens Kopprasch[1], Qingyu Xu[1,2], and Wolfgang Kuch[1] — [1]Institut für Experimentalphysik, Freie Universität Berlin, 14195 Berlin — [2]Department of Physics, Southeast University, 211189 Nanjing

Metalloporphyrin molecules on surfaces have been attracting the attention of the scientific community since their metal ion is fourfold coordinated within the molecular plane and displays two empty coordination sites that can be occupied by additional ligands or a surface. We have investigated submonolayers of Co octaethyl porphyrin molecules on Cu(001) and Cu(111) as well as on Au(001) and Au(111)

surfaces by means of x-ray absorption spectroscopy and x-ray magnetic circular dichroism in an external magnetic field of 6 T at a temperature of 5 K. We find the Co magnetic moment quenched when the molecule is adsorbed on Cu(111), Au(001), and Au(111). On Cu(001), on the contrary, the Co ions display a significant magnetic moment. We attribute this modification of the molecular magnetic properties to the formation of a hybrid electronic state at the metal-organic interface. — Financial support by project VEKMAG (BMBF 05K13KEA) is gratefully acknowleged.