MA 40: Poster II: Bio- and Molecular Magnetism (1-9); Magnetic Coupling Phenomena/Exchange Bias (10-15); Magnetic Particlicles and Clusters (16-29); Micro and Nanostructured Magnetic Materials (30-51); Multiferroics (52-64); Spin Injection in Heterostructures (65-67); Spin-Dyn./Spin-Torque (68-93); Spindependent Transport (94-108)

Time: Friday 11:00–14:00 Location: P1A

MA 40.1 Fri 11:00 P1A

Functionalized multiwalled carbon nanotubes as container for Mn2+-based Molecular Magnets — •Janet Leschner, Christine Taeschner, Manfred Ritschel, Gesine Kreuzer, Mohammed Yehia, Jorge Borrero, Anupama Parameswaran, Rüdiger Klingeler, Vladislav Kataev, Albrecht Leonhardt, and Bernd Buechner — Leibnitz Institute for Solid State and Material Research, IFW Dresden, 01069 Dresden

We present the hydrothermal synthesis of Mn2+-based molecular magnets, their detailed magnetic and structural characterisation and utility as potential packing material for carbon nanotubes (CNTs). The latter is realised by utilizing open ended diamagnetic CNT carriers which exhibit no residual catalyst particles. The magnetic properties of CNT-molecular magnet-complexes are discussed with respect to the pure material, e.g. manganese-di-mandelate, based on our magnetic susceptibility and ESR (Electron-Spin-Resonance) studies.

MA 40.2 Fri 11:00 P1A

Magnetic properties of novel binuclear metal-organic complexes — •A. Parameswaran[1], Y. Krupskaya[1], R. Klingeler[1], V. Kataev[1], I. Bezkishko[2], V. Miluykov[2], O. Kataeva[2], O. Sinyashin[2], and B. Büchner[1] — [1]IFW Dresden, D-01171 Dresden, Germany — [2]Arbuzov Institute for Organic and Physical Chemistry, RAS, Kazan, Russia

We present static magnetization and ESR data on novel binuclear complexes containing two transition metal ions TM = Mn or Ni connected by two 1,2-diphosphocyclopentadienide bridges for different ligands L = CO, MeCN and PPh3. In the case of TM = Mn, the effective moment p_{eff} is in average close to that of the Mn(II) in the low spin state. However, we find a systematic substantial increase of p_{eff} by passing from L = CO ($p_{\mathrm{eff}} = 1.55\mu_{\mathrm{B}}$) via L = MeCN ($2.2\mu_{\mathrm{B}}$) to L = PPh3 ($p_{\mathrm{eff}} = 2.67\,\mu_{\mathrm{B}}$). The antiferromagnetic (AFM) Curie-Weiss temperatures amount to 1 K, 17 K and 18 K for these ligands, respectively. A systematic change of ESR spectra confirms these observations and reveals an appreciable anisotropy of the Mn - Mn AFM exchange due to the spin-orbit coupling effects. We conclude that by changing the ligand from a strong π-acceptor type (CO) to a weak one (PPh3) one can tune the electron density at the TM ion thereby affecting its local moment, the strength and the anisotropy of the intramolecurar magnetic exchange. Similarly strong effects are also visible in the Ni analogs. Surprisingly, however, for Ni complexes the magnetic interaction changes to ferromagnetic and is larger in magnitude compared to the Mn counterpart.

MA 40.3 Fri 11:00 P1A

Mixed-valent maganese high-spin complexes studied by X-ray spectroscopy methods — •Miriam Baensch[1], Manuel Prinz[1], Christian Taubitz[1], Karsten Kuepper[2], Andreas Scheurer[3], Stefan Sperner[3], Rolf W. Saalfrank[3], Andrei Postnikov[4], and Manfred Neumann[1] — [1]University of Osnabrück, Fachbereich Physik, D-49069 Osnabrück — [2]University of Ulm, Institut für Festkörperphysik, D-89069 Ulm — [3]Universität Erlangen Nürnberg, Department Chemie und Pharmazie, D-91058 Erlangen — [4]Paul Verlaine University, Institute de Physique Electronique et Chimie, 1 Bd Arago, F-57078 Metz, France

The investigations of transition metal containing polynuclear complexes are of current interest due to their relevance to various research areas like bioinorganic chemistry, molecular magnetism and catalysis. There are several manganese containing complexes comprising mixed-valent Mn ions, e.g. $Mn_{12}^{III/IV}$-acetate, the wheel-shaped $Mn_{12}^{II/III}$ and $Mn_{7}^{II/III}$ molecules. For the investigation of the electronic and magnetic structure of those mixed-valent high-spin complexes, it is important to have reference spectra of homonuclear manganese clusters with different Mn valencies. We present our X-ray spectroscopic and theoretical investigations of homo- and mixed-valent molecules, including X-ray photoelectron spectroscopy (XPS) and X-ray absorption spectroscopy (XAS), density functional theory and charge transfer multiplet model (CTM) calculations. We discuss the wheel-shaped, mixed-valent Mn_{12} and Mn_7 complexes using our pure Mn^{II} and Mn^{III} reference spectra of the Mn^{II}Star, and Mn_6^{III}Salox compounds.

MA 40.4 Fri 11:00 P1A

DFT studies of magnetic molecules — •Stefan Leiding and Juergen Schnack — Universität Bielefeld, Fakultät für Physik, Postfach 100131, D-33501 Bielefeld

The ability to tune the couplings between the spins of individual transition metal atoms by controlled attachment of molecular ligands is investigated with spin-dependent density functional theory. We use the SIESTA program to study the magnetic properties of molecules with single ion anisotropy. Vibrational spectra are evaluated as well.

MA 40.5 Fri 11:00 P1A

DMRG studies of magnetic molecules — •Joerg Ummethum and Juergen Schnack — Universität Bielefeld, Fakultät für Physik, Postfach 100131, D-33501 Bielefeld

The DMRG technique provides a powerful tool for the investigation of ground state and dynamical properties of low-dimensional strongly correlated quantum systems [1]. The results are most accurate for one-dimensional systems with nearest neighbour interactions but an application to rather complex magnetic molecules described by the Heisenberg model is also possible [2].

We present new results of our DMRG studies of the antiferromagnetic Heisenberg icosidodecahedron for different spin quantum numbers. Special emphasis is laid on the lowest energy levels in the subspaces of total magnetic quantum number which possess a so-called rotational band structure for many systems [3].

[1] S. R. White, Phys. Rev. B **48**, 10345 (1993); U. Schollwöck, Rev. Mod. Phys. **77**, 259 (2005);
[2] M. Exler and J. Schnack, Phys. Rev. B **67**, 094440 (2003);
[3] J. Schnack and M. Luban, Phys. Rev. B **63**, 014418 (2000).

MA 40.6 Fri 11:00 P1A

X-ray absorption spectroscopy of molecular magnets — •Zoe Kugler[1], Patryk Krzysteczko[1], Carl-Georg Freiherr von Richthofen[1], Elke Arenholz[2], Andy Thomas[1], Thorsten Glaser[1], and Günter Reiss[1] — [1]Bielefeld University, Bielefeld, Germany — [2]Advanced Light Source, Lawrence Berkeley National Laboratory, Berkeley, USA

We investigated the Mn_6Cr single-molecule magnet (SMM) using x-ray absorption spectroscopy (XAS). The C_3-symmetric Mn_6Cr complex is based on three molecular building blocks and has a total spin ground state of $S_t = 21/2$. Any application for this molecuar magnets, such as molecular spintronic devices, require a fundamental understanding of the SMM's behavior on surfaces.

We investigated Mn_6Cr molecules on different surfaces by using x-ray absorption spectroscopy. To investigate the SMMs structural behavior with respect to the conductivity of the surface we have adsorbed the molecules on top of 'half' magnetic tunnel junctions (MTJ), where the top layer is the insulating barrier of a conventional MTJ. By varying the thickness of the barrier we could influence the conductivity of the top layer and therefore the interaction of the SMM with the surface. We will present the temperature dependent XA spectra from 3K up to 300K.

MA 40.7 Fri 11:00 P1A

Inelastic electron tunneling spectroscopy on single molecule magnets in MgO based magnetic tunnel junctions — •Jana Münchenberger, Zoe Kugler, Andy Thomas, and Günter Reiss — Bielefeld University, Universitätsstraße 25, D-33615 Bielefeld

We investigated single molecule magnets (SMMs) on MgO based magnetic tunnel junctions (MTJs). The junctions are prepared by dc- and rf-magnetron sputtering in a vacuum system with a base pressure of 10^{-7}mbar. The MTJs with MgO barrier are doped with SMMs to investigate their vibrational modes on the barrier's surface by IET-

Spectroscopy.

We tested the MTJs with regard to the influence of several preparation parameters such as annealing temperature, solvent and solvent concentration on the barrier and the TMR ratio. We succeeded to produce MgO based MTJs doped with SMMs with a TMR ratio of about 34% at room temperature and 52% at 13 K (annealed at 170^0C).

The vibrational modes are obtained by IETS-measurements at low temperature. The results are compared with IR-spectra of the molecules. First measurements showed a good agreement between the IET-spectra and the IR-spectra of the molecules.

MA 40.8 Fri 11:00 P1A

Investigation of Electronic Spin Dynamics in the Giant Keplerat Molecule $Fe_{30}Mo_{72}$ by ^{57}Fe Moessbauer Spectroscopy and Magnetisation Measurements — •Til Dellmann[1,2], F. Jochen Litterst[1], H.-Henning Klauss[2], Jürgen Schnack[3], Bernd Büchner[4], Anupama Parameswaran[4], Rüdiger Klingeler[4], and Achim Müller[5] — [1]IPKM TU Braunschweig — [2]IFP TU Dresden — [3]Fakultät für Physik, Uni Bielefeld — [4]IFW Dresden — [5]Anorganische Chemie I, Uni Bielefeld

In the frustrated polyoxomolybdate nanomolecule $Fe_{30}Mo_{72}$, 30 Fe(III) ions (S=5/2) are located on the vertices of an icosidodecahedron coupled via nearest neighbor antiferromagnetic interactions J_0. However, recent ac suszeptibility measurements by Schröder et al. [1] show that the interactions are non-isotropic and can be described by a random distribution around J_0.

We performed ^{57}Fe Moessbauer spectroscopy on this system down to 2 K. Dynamic magnetic hyperfine spectra with magnetically inequivalent sites appear below 6 K. We conclude slow paramagnetic relaxation in agreement with dc magnetisation measurements. Furthermore, the magnetic field dependence at low temperatures (T=50mK) has been studied by ac susceptibility measurements. No magnetsation steps could be observed as predicted by the quantum rotational band model [2]. The implications of our results on this low temperature quantum model are being discussed on the poster.

[1] C. Schröder et al., Phys.Rev.B 77 (2008), 224409

[2] J. Schnack et al., Europhys. Lett., 56 (6), pp. 863-869 (2001)

MA 40.9 Fri 11:00 P1A

Spin states of a novel Ni(II) trimer complex — •Y. Krupskaya[1], A. Parameswaran[1], A. Alfonsov[1], R. Klingeler[1], V. Kataev[1], B. Büchner[1], M. Gressenbuch[2], and B. Kersting[2] — [1]IFW Dresden, D-01171 Dresden — [2]Institute of Inorganic Chemistry, University of Leipzig, D-04103 Leipzig

We have investigated magnetic properties of a novel macrocyclic chelate trinuclear Ni(II)-Complex $[Ni_3(L)(OAc)_2]$ with $[O_3N_2\mathbf{Ni}(\mu\text{-}S)\mathbf{Ni}(N_2O_2)(\mu\text{-}S)\mathbf{Ni}N_2O_3]$ as the core by measurements of the static magnetization M and high-frequency ν tunable electron spin resonance (HF-ESR). Both temperature T and magnetic field B dependences of M reveal an appreciable antiferromagnetic coupling between three Ni(II) ($3d^8$, $S_{\mathrm{Ni}} = 1$) ions in the complex which is maintained by μ-sulphur bridges. The data on the saturation magnetization at $T = 2\,\mathrm{K}$ give evidence that the ground state of the molecule can be characterized by a total spin $S_0^{\mathrm{tot}} = 1$. A strong nonlinear development of the inverse magnetic susceptibility $\chi(T)^{-1} = [M(T)/B]^{-1}$ in the range $T = 2 - 100\,\mathrm{K}$ measured at $B = 1$ and $5\,\mathrm{T}$ indicates a thermal activation of high energy spin multiplets $S_1^{\mathrm{tot}} = 2$ and $S_2^{\mathrm{tot}} = 3$. In this T-regime HF-ESR measured at $\nu = 92 - 350\,\mathrm{GHz}$ and B up to $15\,\mathrm{T}$ reveals multiple excitations associated with the intramultiplet spin-flip transitions. The ν-dependence of the resonance field of the ESR modes yields a magnetic anisotropy gap of the order of $50\,\mathrm{GHz}$ ($\sim 2.4\,\mathrm{K}$) and a g-factor of ~ 2.2. We propose a scheme of the energy spectrum of the spin states and discuss the relationship between magnetic interactions and the topology and chemical bonding in this spin trimer complex.

MA 40.10 Fri 11:00 P1A

Tuning the static and dynamic magnetization properties of exchange bias modulated thin films — •Christine Hamann[1], Jeffrey McCord[1], Jürgen Fassbender[2], Roland Mattheis[3], Rainer Kaltofen[1], Rudolf Schäfer[1], and Ludwig Schultz[1] — [1]IFW Dresden — [2]Forschungszentrum Dresden-Rossendorf — [3]IPHT Jena

Aiming for new magnetic properties, the lateral combination of different magnetic properties into hybrid magnetic thin film structures are of increasing interest. We investigated exchange bias patterned thin NiFe/IrMn films to correlate the static and dynamic magnetization processes of the artificial hybrid material to the intrinsic material properties. Arrays of stripes with modulated exchange bias, i.e. exchange bias strength and direction, and a periodicity of a few micrometers were created. Inductive magnetometry revealed a distinct influence of geometry and orientation on the magnetization loop yielding either single-step shifted hysteresis loops or two-step loops with exchange spring effect. By means of high resolution Kerr microscopy, this could be attributed to either coherently or separately reversed stripe magnetization. As for the dynamics, the films exhibited either multiple resonance frequencies (as superposition of the input properties) or a single hybrid resonance frequency. The acquired frequencies at zero bias field as well as according damping parameters could be varied by a factor of about two. The different phenomena are discussed in terms of direct exchange coupling via the extended NiFe film as well as quasi-magnetostatic interactions at the stripe interfaces.

MA 40.11 Fri 11:00 P1A

Modification of the magnetostatic coupling in NiFe/Au/Co/Au multilayers by He-ion bombardment through a nanosphere mask — •Oliver Buhl[1], Dieter Engel[1], Tanja Weis[1], Arno Ehresmann[1], W. Glapka[2], Piotr Kuswik[2], Maciej Urbaniak[2], M. Blaszczyk[2], Bogdan Szymanski[2], Feliks Stobiecki[2], Iosif Sveklo[3], Andrzej Maziewski[3], and K. Joszwiak[4] — [1]Department of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, 34132 Kassel, Germany — [2]Institute of Physics, Polish Academy of Sciences, Poznań, Poland — [3]Faculty of Physics, University of Białystok, Poland — [4]Poznań University of Technology, Institute of Materials Science, Poznań, Poland

He-ion bombardment through a nanosphere mask enables locally a defined modification of the magnetostatic coupling between the NiFe and the Co layers. A single layer of polystyrene nanospheres arranged in a regular hexagonal lattice on top of the layer system can be used as a lithography mask in combination with keV-He-ion bombardment, resulting in local anisotropy reductions around the spheres. This could be visualized by a regular artificially created domain structure with hexagonal symmetry, observed when a perpendicular-to-plane magnetic field of a certain value has been applied [1]. First results of VSM and MFM measurements will be presented.

[1] W. Glapka, P. Kuświk, I. Sveklo, M. Urbaniak, K. Jóźwiak, T. Weis, D. Engel, A. Ehresmann, M. Błaszczyk, B. Szymański, A. Maziewski, F. Stobiecki, Acta. Phys. Pol., (2008) at press

MA 40.12 Fri 11:00 P1A

Controlled positioning of nanobeads by strayfields of artificial topographically flat magnetic patterns generated by keV-He-ion bombardment — •Daniel Lengemann, Alla Albrecht, Jannick Langfahl-Klabes, Tanja Weis, Dieter Engel, and Arno Ehresmann — Department of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel

Ion bombardment induced lateral magnetic patterning (IBMP) has been used to generate different magnetic patterns (artificial domains) in an IrMn/NiFe bilayer system without changes in the surface topography. This technique enables to create areas with effective antiparallel magnetizations in adjacent patterns stable in remanence. In the resulting stray fields (essentially emitted by the artificial domain walls) it is possible to position nanobeads along these walls. The dependence of this positioning on the domain wall width, domain wall type and size of the nanobeads will be discussed and first results will be presented.

MA 40.13 Fri 11:00 P1A

Comparison of the behaviour of Magnetic Force Microscopy tips in measurements in external in-plane magnetic fields — •Christoph Schmidt[1], Tanja Weis[1], Dieter Engel[1], Arno Ehresmann[1], Volker Hoeink[2], Jan Schmalhorst[2], and Guenter Reiss[2] — [1]Department of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, 34132 Kassel, Germany — [2]University of Bielefeld, Department of Physics, Nano Device Group, P.O. Box 100131, 33501 Bielefeld, Germany

Magnetic Force Microscopy (MFM) measurements in external in-plane magnetic fields are influenced by the undesired effect of the field on the magnetic moment of the tip. A simple approach is to use the point dipole approximation and consider this effect as a tilt of the tip's magnetic dipole moment. By measuring a topographically flat calibration sample with an artificially created periodic magnetic pattern, stable in a certain external magnetic field range this tilt can be

determined [1]. The fabrication procedure of ion bombardment induced magnetic patterning (IBMP) for such calibration samples and results of the calibration of two different kinds of commercial MFM tips will be discussed.

MA 40.14 Fri 11:00 P1A

Study of interfacial spin glass layer in exchange coupled $Ni_{80}Fe_{20}/Ir_{19}Mn_{81}$ bilayers — •S. K. Mishra, F. Radu, H. A. Dürr, and W. Eberhardt — Albert-Einstein Str. 15, D-12489, Berlin, Germany

We report on an experimental study of the angular and antiferromagnet thickness dependence of exchange coupling in the $Ni_{80}Fe_{20}/Ir_{19}Mn_{81}$ polycrystalline bilayers. The longitudinal component of the magnetization yields a very rich phenomenology at critical thickness of antiferromagnet. The experimental study suggests a non monotonic behavior for both exchange bias and coercivity fields as the function of antiferromagnetic layer thickness. These results are discussed within the framework of the spin glass model of the exchange bias. Simulations of the magnetic hysteresis loops suggest a variation of the antiferromagnetic anisotropy and of the other interfacial exchange coupling parameters across the critical thickness of the antiferromagnet layer.

MA 40.15 Fri 11:00 P1A

Highly ordered spin-states in epitaxial $[Co/Cr/Fe/Cr(001)]_n$ spin-valve type superlattices — •Frank Brüssing[1], Boris Toperverg[1], Maximilian Wolff[1], Hartmut Zabel[1], and Katharina Theis-Bröhl[2] — [1]Department of Physics, Ruhr-University Bochum, 44780 Bochum, Germany — [2]University of Applied Sciences Bremerhaven, 27568 Bremerhaven, Germany

We have grown $[Co/Cr/Fe/Cr(001)]_n$ epitaxial superlattices on MgO (001) by molecular beam epitaxy with spin valve properties. We adjusted the film thickness of Fe and Co layers such that their magnetization magnitudes are roughly equal. For a proper spin-valve type behavior the Cr spacer thickness was chosen as to provide a week antiferromagnetic coupling in remanence. The quality of the layering and the epitaxial relationship were verified via x-ray methods. The layer resolved magnetization in the as-grown state and with an applied magnetic field was studied by olarized neutron reflectometry. Ferromagnetic and antiferromagnetic alignment between neighboring Co and Fe layers can be recognized via intensity variations of the superlattice Bragg peaks, which are different for odd and even orders. Interestingly, additional half-order peaks appear in the asgrown state indicating a new possibly spiral magnetic state. Applying a magnetic field removes this state irreversibly. We speculate that a combination of magnetic anisotropy and dipolar coupling during growth governs the spiral state. This project was supported by the DFG via SFB491.

MA 40.16 Fri 11:00 P1A

Superparamagnetic Switching of Two-dimensional Magnetic Islands Studied by Monte Carlo Simulation — •Thim Stapelfeldt, Elena Y. Vedmedenko, Stefan Krause, Gabriela Herzog, and Roland Wiesendanger — Institut für Angewandte Physik, Universität Hamburg, Jungiusstrasse 11, 20355 Hamburg

Small islands of magnetic material with strong uniaxial anisotropy can be used to store binary information. To maximize the bit density of storage devices consisting of magnetic islands, the size of these islands has to be shrunk as much as possible. A critical bit density is reached, when the islands become so small that they approach the superparamagnetic (SP) limit.

We present a theoretical investigation of the superparamagnetic behavior of two-dimensional Fe/W(110) islands by means of a Monte Carlo simulation based on a single flip Metropolis algorithm. In our simulations the SP region is defined by characteristic temperatures, that indicate the transitions between different magnetic states, i.e. from paramagnetic to SP and from SP to ferromagnetic state. We present the size dependence of the characteristic temperatures, the energy barriers ΔE and attempt frequencies ν_0. We compare the energy barriers with energy barriers derived via SP-STM measurements and give a suggestion of the dominating switching mechanism.

MA 40.17 Fri 11:00 P1A

Kondo effect in a magnetic trimer — •Philipp Knake and Alexander Chudnovskiy — 1. Institut für Theoretische Physik, Universität Hamburg

The system under consideration is a magnetic trimer on a metallic substrate. To describe it, we use an Anderson model in the low energy sector and in mean field theory. The spin degrees of freedom are taken into account by a fermionisation method first suggested by Popov and Fedotov. While for one single magnetic impurity the physics will be governed by the Kondo-effect, in the case of the magnetic trimer there additionally occur geometric effects (related to the RKKY effect). Instead of just one Kondo-temperature characterising the system of a single atom, there arise three characteristic temperatures in the latter case, the highest determining the physics. For some special geometries of the trimer, like the equilateral triangle and the linear chain, one can solve the mean field equations analytically in some limiting cases and thus achieve analytical expressions for the characteristic temperatures.

MA 40.18 Fri 11:00 P1A

Influence of magnetostatic interaction between nanoparticles on the magnetization behavior : Comparison between experiments and simulations — •Srinivasa Rao Saranu, Brook Esseye Anshebo, and Ulrich Herr — Institute of Micro and Nanomaterials,Ulm University,89081 Ulm,Germany

To achieve high density data storage in pattern recording media the particles must arrange as close as possible. Influence of area coverage of the particles on magnetization behavior was studied. Co and Ni nanoparticles were prepared using plasma gas condensation technique. Diameter and area coverage of the particles were measured using SEM. To study the effect of magnetostatic interaction on magnetization behavior, particles was deposited on Si substrate and in-situ covered with Cu film. The area coverage of the particles varied from 3% to 20%. Hysteresis curves for these samples were recorded with field applied in-plane and perpendicular to the substrate using vibrating sample magnetometry (VSM). Co particles with an average diameter of 30nm show ferromagnetic behavior at room temperature. When the coverage exceeds 5 %, the remanent magnetization along the in-plane direction was larger than that perpendicular to the sample, whereas the saturation field was smaller, which can be attributed to the magnetostatic interaction between the particles. In 40 nm Ni particles, similar behavior was observed but effect of magneto static interaction was smaller than for the Co particles. Influence of interactions on switching field distribution of the particles was studied. The results are compared with micromagnetic simulations of suitable model systems.

MA 40.19 Fri 11:00 P1A

The use of XMCD to determine the magnetic and structural composition of nanoparticles — •Daniela Nolle[1], Eberhard Goering[1], Liberato Manna[2], Albert Figuerola[2], Thomas Tietze[1], Sebastian Brück[1], and Gisela Schütz[1] — [1]Max Planck Institute for Metal Research, Heisenbergstr. 3, 70569 Stuttgart, Germany — [2]National Nanotechnology Laboratory of CNR-INFM, Unità di Ricerca IIT, Distretto Tecnologico ISUFI, via per Arnesano km. 5, I-73100 Lecce, Italy

We have investigated different FePt/FeOx nanoparticles using X-ray magnetic circular dichroism (XMCD). All investigated nanoparticles are produced in a "one-pot"-synthesis and consist of a FePt core (fcc structure) and a FeOx shell (inverse spinell structure) in different volume ratios.To determine the structural and magnetic composition of the nanoparticles we performed XMCD measurements both in the surface sensitive total electron yield mode (TEY) and the bulk-sensitive transmission mode. The measured spectra have been analysed in terms of a linear superposition of suitable reference data of metallic FePt, Magnetite (Fe3O4), and Maghemite (γ-Fe2O3). A comparison between TEY and transmission measurements for the 18 nm hybrid system shows, that the iron oxide shell is mainly magnetite like, while the surface has predominantly maghemite character.This method demonstrates the strength of simultaneously performed XMCD experiments utilizing different scanning depth measurement modes and provides a detailed structural and magnetic model for the investigated nanoparticles, which is consistent to corresponding SQUID measurements.

MA 40.20 Fri 11:00 P1A

Magnetic field effect on the assembly of FePt and CuAu nanoparticles from the gas phase on amorphous carbon — •Ute Queitsch, Inge Lindemann, Darius Pohl, Bernd Rellinghaus, and Ludwig Schultz — IFW Dresden, P.O. Box 270116 D-01171, Germany

The key to successful applications of nanoparticles is their organization at the nanoscale, i.e. the creation of defined and regular nanostructures of particles with controlled morphology in highly ordered arrays. Gas phase preparation has proven to allow for the preparation of nanopar-

ticles of various materials with narrow size distribution. A regular arrangement of the particles was accomplished by self organization on bacterial S layer templates [1]. One problem inherent to this approach is the agglomeration of the nanoparticles due to the statistical arrival at the substrate. The deposition of gas phase prepared FePt nanoparticles with 5 nm in size in the presence of a magnetic field of 1 T onto carbon-coated TEM grids leads to the formation of hexagonal-like particles patterns with interparticle distances of 7nm and thereby to a significant decrease of agglomeration [2]. Interestingly, comparable results are found for CuAu nanoparticles. The magnetic properties of the CuAu nanoparticles and the physical origin for the observed self-organization are discussed.

[1] U.Queitsch et al., Appl. Phys. Lett. 90, 113114 (2007)
[2] U.Queitsch et al., J. Phys. D: Appl. Phys., 41 (2008)

MA 40.21 Fri 11:00 P1A

Synthesis and magnetic characterisation of MnAs nanoparticles on GaAs surfaces — •Michael Wolff[1], Maria Messing[2], Knut Deppert[2], and Kornelius Nielsch[1] — [1]Univ Hamburg, Inst Appl Phys, D-20355 Hamburg, Germany — [2]Lund Univ, S-22100 Lund, Sweden

In order to explore the possibility to generate ferromagnetic nanoparticles via annealing of monodisperse aerosol particles, Mn particles are generated in a spark discharge and then, after being sintered and size-selected in an aerosol setup, deposited on (111)B-GaAs substrates. The Mn particles transform into MnAs particles by annealing them under an Arsine background pressure. The reaction takes place in a MOVPE chamber under hydrogen atmosphere. The particle diameter can be controlled and is varied between 15 and 40 nm. While the crystallographic orientation of the Mn particles before annealing is randomly distributed, the crystal structure of the MnAs particles after annealing seems to be determined by the GaAs surface. The magnetic properties are studied using a SQUID magnetometer. The coercive field is expected to depend on the particle diameter and the orientation of the applied field. The substrate's influence on the magnetic properties is investigated by comparing particles on different GaAs surfaces.

MA 40.22 Fri 11:00 P1A

Tuning the Dimensionality and Magnetic Properties of Mixed Valence Mn(II)/Mn(III) Coordination Polymers — Sudarshana Mukherjee[1], Yanhua Lan[1], •George Kostakis[2], Redolphe Clérac[3], Christopher Anson[1], and Annie Powell[1,2] — [1]Institut für Anorganische Chemie der Universität Karlsruhe, Engesserstr. 15, D-76131 Karlsruhe, Germany — [2]Institut für Nanotechnologie, Forschungszentrum Karlsruhe, Postfach 3640, D-76021 Karlsruhe, Germany — [3]Université de Bordeaux, UPR 8641, Pessac, F-33600, France

Four 3D metal organic frameworks and the 1D coordination polymer have been synthesized. The 3D frameworks of compounds can be described as diamondoid networks. Magnetic studies show that weak MnII-MnIII antiferromagnetic interactions (in the range of -0.55 - 0.22 K) mediated by syn-anti carboxylate bridges are present in all compounds. While the 1D coordiantion polymer remains paramagnetic down to 1.8 K, the 3D networks exhibit long-range ferrimagnetic ordering below 7.4 K (1), 4.6 K (2), 3.0 K (3) and 7.7 K for 4. The decrease of the critical temperature reflects the increase of the coordination sphere number around the Mn(II) site from four in 1, five in 2 and six in 3 that lower the bond strength and also the magnetic interactions. This result also reinforces the hypothesis that the structures of 1 and 4 are similar as also suggested by the X-ray analysis.

MA 40.23 Fri 11:00 P1A

Magnetoelastic effects of magnetic nanoparticles in a copolymer matrix — •W. Schirmacher[1], A. Omran[2], L. Schulz[3], S. Vallopilly[4], P. Böni[2], W. Petry[2], and P. Müller-Buschbaum[2] — [1]Institut für Physik, Universität Mainz — [2]Physik-Department E13, TU München — [3]Universite de Fribourg, Switzerland — [4]LENS Indiana Synchrotron Facility, Bloomington IN, USA

Magnetic properties of thin composite films, consisting of polystyrene-coated γ-Fe_2O_3 (maghemite) nanoparticles embedded into polystyrene-block-polyisoprene (PS-b-I) matrices, have been investigated. The magnetization measured as a function of external field and temperature show typical features of "super-paramagnets", including a hysteresis at low temperatures and dispersive blocking, as expected for polydispersive samples. However, the differential magnetic susceptibility depends only weakly on temperature between roomtemperature and 2K. This strongly contradicts the superparamagnetic model, for which a Curie law is expected. We are able to explain our findings if we assume a mechanical twist of the particle due to the applied field. This coupling mechanism yields a temperature-independent susceptibility which is inversely proportional to the shear modulus of the copolymer matrix. We are able to successfully fit the hysteresis curves of our samples with this model.

MA 40.24 Fri 11:00 P1A

Templated self-assembly of Fe_3O_4 nanoparticles in lithographically nanopatterned lines — •Maria Jose Benitez[1,2], Oleg Petracic[1], Mathias Feyen[2], Anhui Lu[2], and Hartmut Zabel[1] — [1]Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, D-44780 Bochum — [2]Max-Planck Institut für Kohlenforschung, D-45470 Mülheim an der Ruhr

We report on self-assembled Fe_3O_4 nanoparticle films on silicon substrates. Furthermore, using electron beam lithography we fabricate patterned trenches of 100-1000nm width for the assisted self-assembly of magnetite nanoparticles. The nanoparticles with a diameter of 20 nm were synthesized by thermal decomposition of iron oleate complex in trioctylamine and oleic acid. Individual nanoparticle behavior is governed by superparamagnetism. Above the blocking temperature, the self-assembled films and the templated nanoparticles show collective behavior due to dipolar coupling as evidenced from magnetometry measurements.

MA 40.25 Fri 11:00 P1A

The effect of the sputtering gas (Ar, Xe) on FePt clusters formation, structural and magnetic properties — •valentina cantelli, jörg grenzer, johannes von borany, and jürgen fassbender — Institute of Ion Beam Physics and Materials Research, Forschungszentrum Dresden-Rossendorf, Dresden, Germany

$L1_0$ FePt phase is widely studied for magnetic recording media because of an excellent magnetocrystalline anisotropy ($K_U \sim 5\text{-}8 \times 10^{-7}$ erg/cm^3) and large magnetic moments. [1] We will report about the effect of the sputtering gases, Ar and Xe, on FePt clusters formation using magnetron sputtering deposition at high working pressures. Sequential monolayers or co-deposition have been investigated comparatively. 5 or 3 nm thick layers were deposited at RT onto SiO_2/Si substrates, subsequently annealed at 550°C in order to induce the A1-$L1_0$ ordering transformation. The highest $L1_0$ fraction was found using Xe as sputtering gas. Xe ions impact enhances layers coarsening in as-deposited films: 2 nm crystallites agglomerate in clusters having a lateral size of about 50 nm; and decreases the transformation activation energy reducing the critical thickness for the ordering transition. Layers deposited with Ar as sputter gas show an almost close morphology. Strong ferromagnetic behavior has been obtained only in the case of a sequential monolayers deposition, underlining the importance to reduce the diffusion path to an atomistic scale. [2]

[1] H. Kanazawa, G. Lanhoff, T. Suzuki, J. Appl. Phys. 87 (2000) 6143; [2] M. L. Yan, N. Powers, D. J. Sellmyer, J. Appl. Phys. 93 (2003) 8292

MA 40.26 Fri 11:00 P1A

Influence of ligands on magnetic properties of chemically synthesized FePt-nanocrystallites — •Thomas Trausnig[1], Stephan Landgraf[2], Klemens Rumpf[3], Petra Granitzer[3], Ilse Letofsky-Papst[4], Karin Wewerka[4], Gerald Kothleitner[4], Heinz Krenn[3], and Roland Würschum[1] — [1]Institut für Materialphysik, Technische Universität Graz, Petersgasse 16, A-8010 Graz, Austria — [2]Inst. f. Physikalische & Theoret. Chemie, TU Graz — [3]Inst. f. Physik, Karl-Franzens-Universität Graz — [4]Inst. f. Elektronenmikroskopie & Feinstrukturforschung, TU Graz

FePt-nanoparticles have attracted considerable interest recently with respect to possible application potentials for future storage media. FePt-particles were synthesized chemically by thermal decomposition of iron pentacarbonyl and reduction of platinum acetylacetonate. The spherical particles with a small diameter of 3.4 nm and a narrow size distribution are coated by oleic acid and oleylamine. Variation of the particle distance can be obtained by a ligand exchange process, substituting the oleic acid/oleylamine ligand shell by an octanoic acid/octylamine or an hexanoic acid/hexylamine ligand shell. The influence of the different ligand shells as well as of subsequent thermal annealing on the superpara- and ferromagnetic behaviour is studied by SQUID magnetometry.

Acknowledgement: Financial support by FWF - Austrian Science Fund (project S10405-N16) is appreciated.

MA 40.27 Fri 11:00 P1A

Magnetische Nanopartikel als Ultraschall- / Viskositätssensoren. — •Christian Höhl, Nouri Elmiladi und Karl Maier — Helmholtz-Institut für Strahlen- und Kernphysik, Rheinische Friedrichs-Wilhelm Universität, Bonn, Germany

Magnetische Nanopartikel (MNP) bestehen aus magnetischen Kernen die in nichtmagnetische Hüllen von einigen 10 nm eingelassen werden. Die Hülle kann weiter chemisch funktionalisiert werden und dazu dienen, die MNP kolloidal in Lösung zu bringen.

Durch eine asymmetrische Beschichtung der Hülle, z.B. mit organischen Molekülen, kann das MNP durch Ultraschall (US) in Kippschwingungen versetzt werden. Das aufgrund der magnetischen Anisotropie an das Partikel gebundene magnetische Moment sendet dann Radiosignale mit US Frequenz. Das so erzeugte lokale Wechselfeld kann über Kernspinresonz am Lösungsmittel ortsaufgelöst nachgewiesen werden. Die Amplitude des Wechselfeldes hängt über die Schwingungsamplitude der MNP von der Viskosität des Lösungsmittels und der Ultraschallamplitude ab.

Die Methode eignet sich auch, um chemische Reaktionen an den präparierten MNP's messtechnisch zu verfolgen. Umsetzung und Anwendung in medizinischer Diagnostik werden präsentiert.

MA 40.28 Fri 11:00 P1A

Carbon coated Fe, Co and Ni Nanoparticles produced by High Pressure CVD and their potential for Medical Applications — •A. A. El-Gendy, E. M. M. Ibrahim, V. Khavrus, Y. Krupskaya, A. Leonhardt, R. Klingeler, and B. Büchner — Leibniz Institute for Solid State and Materials Research (IFW) Dresden, Germany

Fe@C, Co@C and Ni@C nanocapsules have been produced by high pressure chemical vapour deposition (HPCVD). Scanning electron microscopy images prove that most of the particles are coated with carbon. High resolution transmission electron microscopy imaging confirms that these particles have a broad size distribution and a core/shell structure. In addition, individual nanoparticles are found inside a carbon capsule as well as several particles together in one shell. X-ray diffraction confirms the phases and allows calculating the average particle size from the width of the peaks. Our magnetisation studies confirm that the coated particles are ferromagnetic up to 400 K. AC magnetic heating studies have been performed which imply the potential of carbon coated nanomagnets for applications in hyperthermia therapies.

MA 40.29 Fri 11:00 P1A

Magnetically filled Carbon Nanotubes for Hyperthermia — •Yulia Krupskaya[1], Christopher Mahn[1], Anupama Parameswaran[1], Arthur Taylor[2], Kai Krämer[2], Anja Wolter[1], Silke Hampel[1], Rüdiger Klingeler[1], and Bernd Büchner[1] — [1]Leibniz Institute for Solid State and Materials Research (IFW) Dresden, Germany — [2]Department of Urology, Medical Faculty, Dresden University of Technology, Germany

We present a detailed magnetic study of filled Carbon Nanotubes (CNT), which highlights their potential for contactless magnetic heating in hyperthermia cancer treatment. We have performed magnetic field and frequency dependent AC magnetic heating experiments on Fe- and Co-filled CNT dispersions. We observe a substantial temperature increase of CNT dispersions under applied AC magnetic fields in different media. DC and AC magnetization studies were done in order to elucidate the heating mechanism. We observe a different magnetic response of CNT powders compared to CNT dispersed in aqueous solution, e.g., ferromagnetic Fe-CNT in powder do not show any hysteresis when being dispersed in liquid. Differences in the AC susceptibility confirm this observation. Our data indicate the motion of Fe-CNT in liquid under applied magnetic fields.

MA 40.30 Fri 11:00 P1A

Magnetotransport studies of the anisotropic and domain wall magnetoresistance in Co nanowires — •Francis Bern, Jose Barzola-Quiquia, and Pablo Esquinazi — Division of Superconductivity and Magnetism, University of Leipzig, D-04103 Leipzig

Cobalt wires of width x thickness $\sim 300 \ldots 600$ nm $\times$ 35 nm and cross sectional area − length ratios between 1.3 and 4 nm were prepared by electron lithography. The magnetoresistance as a function of field, angle between field and current, and between 4 K and 250 K was measured. The observed domain wall magnetoresistance of -0.65% and an anisotropic magnetoresistance effect of 1.6% at 4 K are higher than in similar works reported in the literature. The measured angle and temperature dependences of the coercive field agree with theoretical expectations. The achieved resolution in the magnetotransport measurements allows us to study the influence of notches and constrictions on the behavior of the magnetoresistance of the nanowires.

MA 40.31 Fri 11:00 P1A

Correlation of magnetic properties of electrodeposited Fe nanowires with deposition conditions and morphology — Veronika Hähnel[1,2], •Heike Schlörb[1], Sebastian Fähler[1], and Ludwig Schultz[1,2] — [1]IFW Dresden, P.O. Box 270116, 01171 Dresden, Germany — [2]TU Dresden, Faculty of Mechanical Engineering, Institute of Material Science, 01062 Dresden, Germany

Periodic arrays of magnetic nanowires deposited in self-organised nanoporous templates have recently attracted much attention in fundamental and applied research. Scientific interest focuses on these low dimensional nanostructures, as significant changes in terms of chemical and physical properties compared to bulk material are expected.
In this study Fe nanowires were deposited using DC voltage into a nanoporous aluminum oxide membrane with a pore diameter of 70 nm and an interpore distance of 110 nm. By adjusting the deposition time the wire length was varied up to 10 μm. With increasing length we observe that the axis perpendicular to the wire axis becomes the magnetically hard axis due to shape anisotropy. In addition, two different slopes are observed in magnetisation curves measured along the wire axis for long wires. Since this behaviour is not expected for isolated wires, it is discussed with respect to magnetostatic interactions favouring an antiferromagnetic alignment of neighbouring wires. As these features are only observed for wires having a smooth morphology, the influence of varied deposition conditions like potential, Fe^{2+} concentration and the electrolyte composition (e.g. adding H_3BO_3) on morphology and magnetic properties is analysed in detail.

MA 40.32 Fri 11:00 P1A

Weak electron localization and enhanced electron electron interaction in epitaxial Fe wires on GaAs(110) — •Christoph Hassel, Florian M. Römer, Günter Dumpich, and Jürgen Lindner — Fachbereich Physik, AG Farle, CeNIDE, Universität Duisburg-Essen, 47048 Duisburg, Germany

Epitaxial Fe films are prepared on GaAs(110) substrates. Structural investigations of these films are carried out using LEED and IV-LEED. After capping the Fe-films with Ag and Pt to prevent an oxidation, we determined the anisotropy constants of the Fe films using ferromagnetic resonance (FMR) and SQUID. The films are subsequently structured into wires using electron-beam lithography and Ar-ion beam etching. Fe wires in the range of 100 to 3000 nm are studied. Due to the interplay of uniaxial and fourfold anisotropy of Fe/GaAs(110), it is possible to structure the wires, so that the effective easy axis of magnetization is transversal to the long wire axis [1]. This is proven by magnetic force microscopy, magnetoresistance and by micromagnetic simulations using the OOMMF code. By varying the widths of the wires and thus the shape anisotropy, one can change this effective easy axis of magnetization. We measured the low temperature magnetoresistance behaviour of these wires in order to find contributions of the weak electron localization. However, our results can be quantitatively explained in the framework of enhanced electron-electron interaction and no effect of weak electron localization was found.

[1] C. Hassel, F. M. Römer, R. Meckenstock, G. Dumpich, and J. Lindner, Phys. Rev. B 77, 224439 (2008)

MA 40.33 Fri 11:00 P1A

Competition of Shape and Magnetocrystalline Anisotropies in Electrodeposited Co Nanowires — Ajeet K. Srivastav[1,2], •Heike Schlörb[1], Sebastian Fähler[1], and Ludwig Schultz[1] — [1]IFW Dresden, Germany — [2]IIT Kanpur, India

Ordered arrays of magnetic nanowires are of high interest for both fundamental understanding of magnetism in low dimensions as well as many applications ranging from biological, chemical to information storage systems. They allow studying unexpected effects of different magnetic anisotropies and magnetostatic interactions. Cobalt nanowires are expected to show a complex behaviour due to its hexagonal structure and the resulting high magnetocrystalline anisotropy. Cobalt nanowires were electrodeposited into AAO templates using a single sulphate electrolyte partly buffered by boric acid. The influence of different pH values on structure and temperature dependent magnetic properties was investigated. At high pH and room temperature the easy axis is aligned parallel to the wire axis as expected for

high aspect ratio nanowires due to shape anisotropy. Competing effects of shape and magnetocrystalline anisotropies result in a nearly isotropic behaviour at low pH values, when the hexagonal c-axis is oriented perpendicular to the wire axis. Due to the strong temperature dependency of the magnetocrystalline anisotropy the easy magnetization direction in Co nanowires changes from parallel to perpendicular to the wire axis when decreasing temperature. The crossover temperature strongly depends on electrolyte pH indicating changes in both fraction and orientation of the hexagonal phase when pH is increased.

MA 40.34 Fri 11:00 P1A

Magnetoresistance Measurements of Magnetic Nanowires Lithographically Contacted by an Optical Microscope — •Tim Böhnert, Judith Moser, Kristina Pitzschel, Shadyar Farhangfar, Robert Zierold, Lars Bocklage, Ulrich Merkt, Guido Meier, and Kornelius Nielsch — Institut für Angewandte Physik, Universität Hamburg

We fabricate μm-sized structures using projection photolithography with a modified optical microscope. This setup provides a fast and simple way to four-point measurements on individual nanowires. A 2 x 2 cm^2 rotatable printed foil mask can be projected on an area down to 300 x 300 μm^2 allowing us to create μm-sized features. The technique grants complete visual control over the mask alignment, which is a huge advantage compared to conventional lithography techniques for contacting prepatterned structures. We define four probe low-ohmic contacts to electrochemically synthesized Ni nanowires of different diameters. The switching behavior of the wires is studied by anisotropic magnetoresistance measurements. We will present details of the sample processing and first magnetoresistance measurements. The goal of the project is investigating the field- and current-induced magnetization reversal in straight wires, in bent wires, and in wires with tailored pinning sites.

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MA 40.35 Fri 11:00 P1A

Preparation of Ni nanowires on Si gratings and their properties — •Wolfgang Kreuzpaintner[1], Dieter Lott[1], Michael Störmer[1], Volker Neu[2], Cristina Bran[2], and Andreas Schreyer[1] — [1]GKSS Forschungszentrum GmbH, Max-Planck-Str. 1, 21502 Geesthacht — [2]IFW Dresden, Institute for Metallic Materials, Dpt. Magnetic Microstructures, Helmholtzstr. 20, 01069 Dresden

Ni was e-beam evaporated under a shallow angle of incidence onto a lithographically structured Si substrate with submicrometer grating. By pure geometrical shading effects, 10nm wide Ni nanowires were deposited spaced at 750nm. In order to prevent the Ni from oxidization a 10nm thick Al capping layer was additionally sputter deposited.

The structural properties of the such prepared Ni nanowires were studied using x-ray scattering and atomic force microscopy techniques. Results on the magnetic behaviour were obtained by neutron scattering and magnetic force microscopy.

MA 40.36 Fri 11:00 P1A

Magnetic nanowires and tubes with modulated diameter from a porous alumina template — •Kristina Pitzschel[1], Josep M. Montero Moreno[1,2], Ole Albrecht[1], Julien Bachmann[1], and Kornelius Nielsch[1] — [1]Institute of Applied Physics and Microstructure Research Center Hamburg, University of Hamburg — [2]Electrodep, Dept. Physical Chemistry, Universitat de Barcelona

We utilize porous alumina membranes as templates in which mild and hard anodizations are combined to yield modulations in the pore diameter [1]. Filling the pores with Ni by electrodeposition delivers wires replicating the changes in diameter. Alternatively, atomic layer deposition allows for the preparation of Fe_3O_4 tubes with the same silhouettes [2]. Both types of structures are ferromagnetic. Ensemble magnetic measurements evidence a strong correlation between geometric parameters and magnetic properties. [1] W. Lee *et al.*, Nature Nanotech. **3**, 234 - 239 (2008). [2] J. Bachmann *et al.*, J. Am. Chem. Soc. **129**, 9554-9555 (2007). This research was financially supported by the SFB668.

MA 40.37 Fri 11:00 P1A

Synthesis of hard magnetically terminated carbon nanotube systems — •Franziska Schäffel, Christine Täschner, Mark H. Rümmeli, Christoph Schünemann, Albrecht Leonhardt, Bernd Rellinghaus, Bernd Büchner, and Ludwig Schultz — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

We report on the synthesis of hard-magnetically terminated carbon nanotubes (CNT) from multilayer Fe-Pt thin film catalysts via plasma enhanced chemical vapour deposition (PECVD). Although FePt is rarely used as a catalyst for CNT synthesis it is of great interest due its special hard magnetic properties when in the chemically ordered $L1_0$ phase. The combination of such highly anisotropic nanomagnets with CNT opens up exciting possibilities to create novel CNT functionalities. The tailored growth of CNT with a hard magnetic particle at their tip is very promising for the realization of nanodevices, for example tips for magnetic force microscopy or magnetically actuated nanoelectronic systems.

MA 40.38 Fri 11:00 P1A

Preparation and characterization of Ni_2MnIn Heusler electrodes for spin valves — •Hauke Lehmann, Jan M. Scholtyssek, Jeannette Wulfhorst, Ulrich Merkt, and Guido Meier — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg

We grow Ni_2MnIn films by thermal coevaporation of Ni and the alloy MnIn. The films are deposited on Si_3N_4 membranes for transmission-electron microscopy (TEM) as well as on Si, SiO_2, and Si_3N_4 for investigations of the electronic structure. We determine the transport spin polarization by point-contact Andreev reflection spectroscopy (PCAR) [1]. The resistivity of the films is measured using a four-terminal van der Pauw setup. Nanopatterned Ni_2MnIn Heusler electrodes for spin-valve structures are prepared by electron-beam lithography. As a first test, the anisotropic magnetoresistance (AMR) of each individual electrode is measured. In a further step we want to investigate the spin-valve effect of the whole structure. In view of the temperature-sensitivity of the electron-beam resist, the electrodes are grown at low temperature and annealed afterwards. The post-growth annealing process is investigated in situ in the TEM using transmission-electron diffraction on films grown on Si_3N_4 membranes [2]. The change of the resistivity during the annealing process is analyzed.

[1] L. Bocklage, J. M. Scholtyssek, U. Merkt, and G. Meier, J. Appl. Phys. **101**, 09J512 (2007)
[2] J. M. Scholtyssek, G. Meier, and U. Merkt, J. Crystal Growth accepted (2008)

MA 40.39 Fri 11:00 P1A

Tunable magnetic and magnetotransport properties of $Zn_xFe_{3-x}O_4$ epitaxial films — •Michael Wagner, Deepak Venkateshvaran, Matthias Althammer, Andrea Nielsen, Sebastian Goennenwein, Matthias Opel, and Rudolf Gross — Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany

The structural, magnetic and transport properties of $Zn_xFe_{3-x}O_4$ are investigated in this work. Non-magnetic Zn^{2+}, when substituted for Fe^{3+} in Fe_3O_4 allows one to tune the magnetic and electronic properties without losing mobility of the carriers [1]. We have grown coherently strained, epitaxial thin films of $Zn_xFe_{3-x}O_4$ on MgO (001) substrates using pulsed laser deposition. Two sets of $Zn_xFe_{3-x}O_4$ films were deposited, one with x = 0, 0.1, 0.5 and 0.9 grown in pure argon, and a second with x = 0, 0.1, 0.33 and 0.9 grown in an Ar/O_2 (99:1) mixture. X-ray diffractometry measurements indicate high crystallinity with an FWHM of 0.04° in the rocking curves for the $Zn_xFe_{3-x}O_4$ (004) reflection. Magnetization measurements were performed using a SQUID magnetometer and magnetotransport properties were studied using micro-patterned Hall bars in magnetic fields up to 14 T. Our results are discussed within the framework of Zn substitution on the tetrahedral sites of Fe_3O_4, Fe vacancies, oxygen stoichiometry, and the exchange mechanisms responsible for ferrimagnetism [2]. This work was funded by the DFG within SPP 1285 and the DAAD.

[1] J. Takaobushi et al., Appl. Phys. Lett. 89, 242507 (2006)
[2] D. Venkateshvaran et al., arXiv:0808.3642 (2008)

MA 40.40 Fri 11:00 P1A

The effect of oxygen nonstoichiometry on (Sr/La)2FeMoO6-d double perovskite — •Mikalai Kalanda[1], Anis Saad[2], Sergey Demyanov[1], and Alexander Petrov[1] — [1]Scientific-Practical Materials Research Centre NAS of Belarus, Minsk, Belarus — [2]Al-Balqua Applied University, Salt, Jordan

Layered magnetic semiconductors Sr2FeMoO6-d could be considered among the most prospective materials for spintronics. In this work we investigate synthesis of (Sr/La)2FeMoO6-d using semi-reduced precur-

sors SrFeO3-x, SrMoO4-x as initial reagents. It is established that the temperature dependence of magnetization is determinedby the oxygen index and external magnetic field values. in dependence on oxygen index and external magnetic field. For the (Sr/La)2FeMoO6.00 compound during cooling from 300 K down to 170 K magnetization goes up and then decreases and magnetization at 77 K almost reaches the values of magnetization at 300 K. At the increase of the measured magnetic field up to 1 T magnetization of (Sr/La)2FeMoO6.00 constantly grows at 300 - 77 K. It is supposed that the presence of point defect influence the exchange interactions mechanism, changing ferromagnetic interaction in the Fe3+ - O - Mo5 chains to (Sr/La)2FeMoO5.87 to the ferromagnetic one for (Sr/La)2FeMoO6.00 at 300 - 170 K between iron cations with a subsequent appearance of ferromagnetic exchange interaction lower than 170 K.

MA 40.41 Fri 11:00 P1A

Soft x-ray holography of FIB nanostructured Co/Pt multilayers — •Daniel Stickler[1], Robert Frömter[1], Christian Menk[1], Holger Stillrich[1], Carsten Tieg[2], Simone Streit-Nierobisch[3], Christian Gutt[3], Lorentz-M. Stadler[3], Olaf Leupold[3], Gerhard Grübel[3], and Hans Peter Oepen[1] — [1]Institut für Angewandte Physik, Universität Hamburg, Jungiusstr. 11 A, 20355 Hamburg, Germany — [2]European Synchrotron Radiation Facility (ESRF), 38043 Grenoble, France — [3]Deutsches Elektronen-Synchrotron (DESY), Notkestr. 85, 22607 Hamburg, Germany

Focused Ion Beam (FIB) milling is a powerful tool to produce ordered magnetic nanostructures. However, it is impossible to produce out-of-plane magnetized nanoscale structures from multilayer films by direct FIB writing. Co/Pt multilayers exhibit an out-of-plane easy axis due to strong perpendicular interface anisotropy. The interface contribution is known to be very sensitive to high energy ion irradiation. In case of 30 keV Ga ions it needs less than one ion per 100 surface atoms to destroy the perpendicular interface anisotropy. We demonstrate how this problem can be overcome by milling a Co/Pt multilayer, which has been deposited on a SiN membrane, from the rear side, through the SiN. The effect of the ions is determined as a function of applied dose utilizing the domain structure imaged by soft x-ray holography. When the magnetic material is removed we find only a very narrow range of destruction around the holes in contrast to the observations when milling from the Co/Pt side. This behaviour can be explained by the shielding of the halo of the ion beam by the SiN membrane.

MA 40.42 Fri 11:00 P1A

Magnetic viscosity in Co/Pt multilayers on nanospheres — •Cristina Bran[1], Volker Neu[1], Ulrike Wolff[1], Till Ulbrich[2], Manfred Albrecht[3], and Ludwig Schultz[1] — [1]IFW Dresden, Institute for Metallic Materials, P.O. Box 270116, D-01171 Dresden, Germany — [2]University of Konstanz, Department of Physics, D-78457 Konstanz, Germany — [3]Institute of Physics, Chemnitz University of Technology, D-09107 Chemnitz, Germany

Magnetic nanoparticles have attracted considerable interest in recent years due to the possible applications in high density data storage technology. Requirements are a well defined and localized magnetic switching behavior and a large thermal stability in zero fields. The thermal stability of $(Co/Pt)_N$ multilayers with different numbers of repeats (N), deposited on nanospheres [1] is studied by magnetic viscosity measurements. For this, the time dependent magnetization decay is recorded at different reversal fields. The linear evolution of magnetization with ln(t) is interpreted as a relatively large energy barrier distribution. By measuring recoil loops we determine the irreversible susceptibility, which, together with viscosity data, allows to calculate the activation volume and to correlate these results to the magnetic particle volume. The results show that the activation volume is much smaller than the particle's physical volume which indicates a non-uniform magnetic reversal within individual nanospheres. This finding is also a possible prerequisite for an individual particle switching expected from bit patterned media. [1] M. Albrecht et al, Nature Materials 4, 203 (2005).

MA 40.43 Fri 11:00 P1A

Combining glancing angle deposition and atomic layer deposition towards complex magnetic nanostructures — •Ole Albrecht[1], Robert Zierold[1], Christian Patzig[2], Detlef Görlitz[1], Bernd Rauschenbach[2], and Kornelius Nielsch[1] — [1]Institut für Angewandte Physik, Universität Hamburg, Jungiusstrasse 11, 20355 Hamburg — [2]Leibniz-Institut für Oberflächenmodifikationen e.V. (IOM), Permoserstrasse 5, 04318 Leipzig

We present a new method for the fabrication of periodically ordered magnetic nanostructures by a combination of two established deposition techniques, namely Glancing Angle (GLAD) and Atomic Layer Deposition (ALD). Tilted Si columns with different tilt angles and zigzag structures were produced on Si surfaces by GLAD technique [1]. ALD, as a self-limiting deposition, has the ability to cover the Si structures conformally and without shadowing effects [2]. By subsequent reduction, a magnetic layer (Fe_3O_4) was obtained on the structures. The magnetic properties were investigated using a superconducting quantum interference device (SQUID) magnetometer at room temperature. The magnetic parameters remanence and coercivity are strongly affected by the orientation of the sample with respect to the applied field. Additionally, the three rotation axes are distinct, namely the curves $H(\theta, \phi, \psi)$ and $M_{rem}(\theta, \phi, \psi)$ reflect the geometry of each sample.

[1] M. Hawkeye *et. al.*, J. Vac. Sci. Technol. A, **129**, 9554 (2007) [2] J. Bachmann *et. al.*, J. Am. Chem. Soc., **129**, 9554 (2007)

MA 40.44 Fri 11:00 P1A

Fabrication and magnetic properties of CFO films and arrays — •Sven Schnittger[1], Christian Jooss[1], and Sibylle Sievers[2] — [1]Institut für Materialphysik, Universität Göttingen — [2]Physikalisch-Technische Bundesanstalt, Braunschweig

Patterned arrays of magnetic dots are interesting model systems for the study of new types of magnetic ordering due to the competition of intra-dot and inter-dot interactions. Whereas various studies have been performed at arrays of soft magnetic materials with in-plane easy magnetization axis, arrays of materials with perpendicular easy axis and moderate magnetocrystalline anisotropy energy are not well studied. We choose ferrimagnetic cobalt ferrite (CoFe2O4) squares, which have moderate magnetocrystalline anisotropy. Thin film samples were prepared by ion sputtering and patterning was performed by electron beam lithography processes which were adapted to the patterning of highly insulating materials. The structural and magnetic properties of the samples were characterized by scanning electron microscopy, magneto-optical and SQUID measurements, atomic force and magnetic force microscopy. The magnetization distribution of the arrays is analyzed as a function of element shape and distance.

MA 40.45 Fri 11:00 P1A

Hard magnetic films on nanoparticle templates: An approach towards patterned and percolated media — •Christoph Brombacher[1], Christian Schubert[1], Andreas Teichgräber[1], Steffen Schulze[1], Michael Hietschold[1], Sara Romer-Urban[2], Denys Makarov[3], Marc Saitner[4], Christian Pfahler[4], Alfred Plettl[4], Paul Ziemann[4], and Manfred Albrecht[1] — [1]Institute of Physics, TU Chemnitz — [2]Nanoscale Materials Science, Empa — [3]Department of Physics, University of Konstanz — [4]Institute of Solid State Physics, University of Ulm

The superparamagnetic limit is one of the main aspects which leads to novel concepts to increase the storage density in magnetic data storage devices. Patterned media, a concept in which a magnetic bit is represented by one specific nanostructure within a perfectly ordered array can be achieved by depositing magnetic materials onto spherical particle arrays. Co/Pt multilayers on nanoparticles, as well post-annealed FePt nanoparticle caps in their $L1_0$ phase, serve as examples for the creation of single-domain magnetic cap structures and the prospects for application in patterned media will be explored. A percolated medium, where domain-walls are effectively pinned by defect sites can be either created by the deposition of CoPt alloys onto close-packed, or by the deposition of Co/Pt multilayers onto none-close-packed particle arrays. These film systems have been characterized both structurally by XRD and TEM and magnetically by SQUID magnetometry and MFM. The effective pinning of domain-walls was further investigated by in-field MFM.

MA 40.46 Fri 11:00 P1A

Magnetic correlations in laterally patterned layered magnetic structures — •Elisabeth Josten[1], Ulrich Rücker[1], Sandra Gilles[2], Artur Glavic[1], and Thomas Brückel[1] — [1]IFF-Streumethoden, Forschungszentrum Jülich, 52425 Jülich — [2]IBN-Bioelektronik, Forschungszentrum Jülich, 52425 Jülich

Laterally patterned magnetic structures are the basic elements of spintronic devices. With ongoing miniaturization the influence of neighboring cells becomes more and more important. We study the influence

of the period of laterally striped magnetic multilayers on the magnetic properties and the magnetic domain formation.

Fe/Cr/Fe have been grown epitaxially on GaAs (100) single crystals by Molecular Beam Epitaxy (MBE). Cr interlayers that induce antiferromagnetic coupling between adjacent Fe layers were chosen to reduce the magnetic dipole moment and to induce a magnetic superstructure easily observable in polarized neutron reflectometry. The lateral structuring is performed by laser interference lithography or UV-nanoimprint lithography and Reactive Ion Etching. Structural characterization is carried out by Scanning Microscopy and X-Ray scattering under grazing incidence. The magnetic order and domain formation as a function of the applied magnetic field are determined by MOKE and polarized neutron reflectometry and off-specular scattering.

MA 40.47 Fri 11:00 P1A

Tailoring particle arrays by reactive ion etching: A novel method to realize percolated media — •Daniel Assmann[1], Christoph Brombacher[2], Marc Saitner[3], Christian Pfahler[3], Alfred Plettl[3], Paul Ziemann[3], Denys Makarov[1], Martin Siekman[4], Leon Abelmann[4], Hartmut Rohrmann[5], and Manfred Albrecht[2] — [1]Universitaet Konstanz — [2]Technische Universitaet Chemnitz — [3]Universitaet Ulm — [4]University of Twente, Enschede, The Netherlands — [5]OC Oerlikon, Balzers, Liechtenstein

Percolated perpendicular media (PPM) is a possible way to increase the storage density in magnetic hard discs by pushing the limit of superparamagnetism, so that the 1Tbit/in2-regime can be reached.

We present an approach to the realization of a PPM by generating arrays of sparsely distributed polystyrene (PS) nanospheres with adjustable diameters and periodicity as a template for the deposition of Co/Pt multilayers with perpendicular magnetic anisotropy.

The generation of the particle arrays is done by self assembled monolayers of particles which are isotropically plasma etched to reduce the size of the particles. After depostion of Co/Pt multilayers onto these patterns they form an exchange decoupled, single-domain magnetic nanostructure array surrounded by a continuous film.

The magnetic reversal characteristic of the film-particle system is dominated by domain nucleation and domain wall pinning at the particle locations creating a percolated perpendicular media system, which we illustrated by MFM imaging and MOKE hysteresis loops.

MA 40.48 Fri 11:00 P1A

Template-based electrodeposition of magnetic nanostructures — Iwona Dobosz[1,2], •Jakub Koza[1], Kristina Tschulik[1], Margitta Uhlemann[1], Annett Gebert[1], and Ludwig Schultz[1] — [1]Leibniz Institute for Solid State and Materials Research Dresden, PO Box 270116, 01171 Dresden, Germany — [2]AGH University of Science and Technology, Al. Mickiewicza 30, 30-059 Krakow, Poland

In the past years a demand for new types of materials with different structures and specific physical properties for miniaturized devices, like MEMS and micro-electronics, is increasing. The nanowire arrays seem to have a large potential for a variety of applications. The nanowire of Co, Fe and FeCo alloy were prepared by the electrodeposition process into the alumina oxide membrane (AAO). AAO's were prepared by the two step anodizing process in oxalic acid solution. The influence of the electrolyte composition, electrodeposition parameters and superimposition of the external magnetic field during the deposition was studied. The effect of above parameters on the nanowire properties were determined by means of XRD, TEM, SEM, VSM and SQUID techniques. It was found that the properties of the deposited wires could be tuned by the preparation parameters. Especially the magnetic properties were affected, which are known to be very sensitive on the preparation conditions.

MA 40.49 Fri 11:00 P1A

Characterization of nanostructured PdFe-alloy dots — •Alexandra Schumann, Melanie Ewerlin, Frank Brüssing, and Hartmut Zabel — Ruhr-Universität Bochum, Experimentalphysik 4

We have investigated the magnetic properties of PdFe alloy films and nanostructured PdFe-alloy dots. The dots were prepared by means of e-beam lithography and have diameters in the range of 200nm to 800nm and are placed on a grid with rectangular symmetry. Our aim is to investigate magnetic phase transitions in laterally structured dot arrays. As the critical temperature T_c increases with increasing Fe-concentration of the alloy, we can tune T_c of the individual dot as well as of the array. It is possible to "reset" the magnetic state of the film and/or the patterns by warming up the sample to the paramagnetic state. After cooling, the sample reaches a "virgin" demagnetized ferromagnetic state. To achieve a stable single domain state in each dot, it is necessary to develop a phase diagram, which shows the dependence of the single domain state on the film thickness and the dot diameter. This phase diagram will be shown here.

This work was supported by the SFB 491.

MA 40.50 Fri 11:00 P1A

Vortex stabilization in magnetic trilayer dots — •Philipp Szary, Oleg Petracic, and Hartmut Zabel — Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, D-44780 Bochum

We have investigated the spin structure in $Co/Al_2O_3/Py$ ($Py=Ni_{80}Fe_{20}$) trilayer nanodots both via micromagnetic simulation and experimentally by MOKE, SQUID and MFM measurements. Depending on the dot size isolated Py layers would show either a vortex or single domain state during magnetization reversal. However, the Co layer stays always in the single domain state. After combining both dots in a stack separated by an insulating layer, we observe three scenarios of reversal processes in the soft ferromagnetic Py layer due to dipolar coupling to the hard ferromagnetic Co layer, i.e. (1) stabilization, (2) triggering of the vortex state and (3) occurrence of a 360° domain wall. We have constructed a phase diagram, where regions of vortex stabilization, triggering and occurrence of a 360° domain wall are marked. We also have studied the case of a polycrystalline Co layer. Here the phase diagram is more complex with additional regions, i.e. a vortex in the Co layer, a vortex in both Co and Py layer or a destabilization of the vortex due to dipolar coupling.

MA 40.51 Fri 11:00 P1A

Synthesis of novel tubular shaped nanoparticles for application as a ferrofluid — •Robert Zierold[1], Julien Bachmann[1], Zhenyu Wu[2], Carl Krill[2], and Kornelius Nielsch[1] — [1]Institute of Applied Physics and Microstructure Research Center Hamburg, University of Hamburg — [2]Institute of Micro- and Nanomaterials, University of Ulm

A novel, fully tunable preparation of short (aspect ratio <10) ferromagnetic nanotubes is presented. Combining porous alumina as a template with Atomic Layer Deposition (ALD) offers the possibility of producing magnetic nanotubes [1]. By reducing the anodization time of aluminum and implementing multilayer ALD of silica and iron oxide, it is possible to control all system parameters (e.g. length, wall thickness, magnetic moment) of the tubular nanoparticles. By releasing the embedded tubes a ferrofluid-like suspension is formed. A novel synthesis strategy has been implemented for recycling the supporting aluminum substrate. The fluid viscosity is studied as a function of the applied magnetic field and the shear rate with a piezo-membrane axial vibrator. Compared to spherical nanoparticles of conventional ferrofluids, the tubular structure-based solution is expected to suppress shear-thinning effects [2] at higher shear rates. [1] J. Bachmann *et al.*, J. Am. Chem. Soc., **129**, 9554 (2007). [2] S. Odenbach *et al.*, J. Magnet. Magnet. Mater., **183**, 188 (1998). The authors thank the DPG (SPP1165) for financial support.

MA 40.52 Fri 11:00 P1A

Novel concepts for anisotropic Heisenberg modelling of multiferroic oxides — •Tim Kunze and Sibylle Gemming — Forschungszentrum Dresden-Rossendorf, P.O. Box 51 01 19, D-01314 Dresden, Germany

Hexagonal manganites are oxides, in which structural, electronic, and magnetic degrees of freedom are coupled in a complex manner. Therefore, such materials have the potential for novel, nanoscale sensing and switching applications. Manganites are composed of dense-packed hexagonal manganese oxide layers with strong in-plane and weak interlayer coupling, thus the possible spin configurations may be studied with the help of a two-dimensional model Hamiltonian. Special focus is directed to the efficient sampling of the configuration space at low temperatures and concepts for improved importance sampling will be discussed.

MA 40.53 Fri 11:00 P1A

Spectromicrosopy of Ferroelectric and Magnetoelectric Nanostructures — •Ingo Krug[1,4], Nick Barrett[1], Adrian Petraru[2], Jean-Baptiste Moussy[1], Bertrand Vilquin[3], Hermann Kohlstedt[2], and Claus M. Schneider[4] — [1]CEA Saclay, DSM/IRAMIS/SPCSI, Gif-sur-Yvette, FRANCE — [2]FZ Jülich, IFF-6, Jülich, GERMANY — [3]Ecole Centrale de Lyon — [4]FZ Jülich, IFF-9, Jülich, GERMANY

We present a spectromicroscopy study (LEEM, XAS- and energy-filtered PEEM) of ferroelectric and magnetoelectric nanostructures written by Piezoforce Microscopy. In thin ferroelectric $PbZr_xTi_{1-x}O_3$ (PZT) and $BaTiO_3$ (BTO) layers, artificial ferroelectric 180° domains have been written by Piezoforce Microscopy. The opposite polarization states in the 180° domains produce strong changes in the surface electronic structure, which have directly been observed as lateral contrast in both threshold PEEM and LEEM in mirror and diffraction mode. Analyzing the energies of emitted/reflected electrons, the changes in the surface potential (workfunction) can be determined, allowing for a quantification of the ferroelectric state. Furthermore we present an energy-filtered PEEM study of nanostructured magnetoelectric BTO/CFO samples grown by MBE.

MA 40.54 Fri 11:00 P1A

Electric field-control of remanent magnetization in multifunctional hybrids — •Andreas Brandlmaier[1], Matthias Brasse[1], Matthias Opel[1], Georg Woltersdorf[2], Rudolf Gross[1], and Sebastian T. B. Goennenwein[1] — [1]Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching — [2]Universität Regensburg, 93040 Regensburg

Multifunctional ferromagnetic/ferroelectric hybrid structures allow for novel magnetization control schemes. In particular, an electric field-control of remanent magnetization orientation becomes possible.

We have fabricated ferromagnetic/ferroelectric hybrids by evaporating ferromagnetic Ni thin films onto commercially available piezoelectric actuators. Due to magnetoelastic coupling, the expansion/contraction of the actuator as a function of the applied voltage V_p allows for a voltage-control of the magnetization orientation. In addition, because the expansion/contraction of the actuator is hysteretic itself, there are two different strain states at zero applied voltage leading to two different magnetization orientations.

Using magneto-optical Kerr effect and anisotropic magnetoresistance measurements, we study the magnetization orientation as a function of strain. We demonstrate that upon the application of an appropriate voltage sequence to the actuator, the magnetization at $V_p = 0$ V can be deterministically switched between two distinct magnetization states without applying a magnetic field. This allows to realize an electrically controlled magnetic memory cell.

This work is supported by the DFG via SPP 1157 and GO 944/3.

MA 40.55 Fri 11:00 P1A

Topology of the electric order in multiferroic orthorhombic $DyMnO_3$ by SHG spectroscopy — •Tim Günter[1], Dennis Meier[1], Thomas Lottermoser[1], Dimitri Argyriou[2], and Manfred Fiebig[1] — [1]HISKP, University of Bonn, Germany — [2]Helmholtz Centre Berlin for Materials and Energy, Germany

Multiferroics where a spontaneous electric polarization forms as a direct consequence of magnetic spiral order are of great interest. However, essential aspects of their ferroicity and the precise nature of the large magnetoelectric effects displayed by these compounds remain unclear. One set of these so-called spin-spiral multiferroics are the perovskite manganites $R\mathrm{MnO_3}$ (R=Tb, Dy). Here we report on the investigation of orthorhombic $DyMnO_3$ by second harmonic generation (SHG) spectroscopy and topology. Due to its high absorption in the visible range a detectable SHG signal requires using femtosecond laser pulses in a reflection geometry. Performing SHG polarization analysis based on SHG selection rules allows the separation of crystallographic background and magnetically induced ferroelectric contributions. A clear evidence of the observation of the magnetically induced electric order below ≈ 19 K was given by the temperature dependence and the spectral distribution of the SHG contributions. In addition, first results on the imaging of magnetically induced ferroelectric domains are reported. A detailed investigation of $DyMnO_3$ allows to generalize results gained on other spin-spiral multiferroics displaying magnetically induced ferroelectricity like $MnWO_4$ and $TbMn_2O_5$.

MA 40.56 Fri 11:00 P1A

Microstructure and magnetic properties of $BaTiO_3$-(Ni,Zn)Fe_2O_4 multiferroics — •Michael R. Koblischka[1], Anjela Koblischka-Veneva[2], Michael Wick[1], Liliana Mitoseriu[3], and Uwe Hartmann[1] — [1]Experimental Physics, Saarland University, Campus C 6 3, D-66123 Saarbrücken, Germany — [2]Functional Materials, Saarland University, Campus C 6 3, D-66123 Saarbrücken, Germany — [3]Department of Solid State and Theoretical Physics, Al. I. Cuza University, Iasi 700506, Romania

The microstructures of $BaTiO_3$-(Ni,Zn)Fe_2O_4 (BT-NZF) multiferroics with various mixing ratios (70:30, 60:40 and 50:50) [1] are investigated by means of electron-backscatter diffraction (EBSD) [2] and magnetic force microscopy (MFM). The EBSD measurements reveal a change in the texture of the ferrite and the $BaTiO_3$ grains upon increasing the ferrite content in the sample. The 70:30 sample exhibits the best ferrite texture, where only some directions are present. Furthermore, the resulting grain sizes vary from several μm (50:50) to about 100 nm in the 70:30 sample. The MFM images reveal the presence of magnetic domains being extended over several adjacent grains, which according to the EBSD data may comprise different crystallographic orientations. In this way, we can explain the differences in the magnetic contrast obtained.

[1] L. Mitoseriu et al., JMMM 316, e603 (2007) [2] A. Koblischka-Veneva et al., IEEE Trans. Magn. 42, 2873 (2006)

MA 40.57 Fri 11:00 P1A

Raman spectroscopy of the multiferroic manganite Eu(1-x)Y(x)MnO3 — •Sven Issing[1], Andrei Pimenov[2], Alexander A. Mukhin[3], and Jean Geurts[1] — [1]Universität Würzburg, Physikalisches Institut, Experimentelle Physik III, Am Hubland, 97074 Würzburg — [2]Universität Würzburg, Physikalisches Institut, Experimentelle Physik IV, Am Hubland, 97074 Würzburg — [3]General Physics Institute of the Russian Acad. of Sciences, 119991 Moscow, Russia

Quite recently the existence of a strong magnetoelectric coupling in Eu(1-x)Y(x)MnO3 has been shown [1]. As follows already from the first principles, this coupling would lead to appearance of elementary excitations of magnetoelectric origin - the so called electromagnons [2].

Investigations of the Raman active phonons can provide important information on the coupling of the electromagnons to the phonons. This motivated us to carry out systematic measurements of the polarized Raman spectra in Eu(1-x)Y(x)MnO3 for several Y contents $x \leq 0.5$. Our results show a good agreement with Raman spectra of other orthorhombic rare earth manganites [3]. Tuning of the A-site cation radius by increasing the Y content leads to a shift of the phonon frequencies, which can be explained by an increasing distortion from the ideal cubic perovskite structure.

[1] J. Hemberger et al., PRB 75, 035118 (2007)
[2] A. Pimenov et al., PRB 77, 014438 (2008)
[3] M. N. Iliev et al., PRB 73, 064302 (2006)

MA 40.58 Fri 11:00 P1A

Anisotropy of antiferromagnetic 180° domains in magnetoelectric $LiMPO_4$ — •Anne Zimmermann[1], Bas B. van Aken[1], Jean-Pierre Rivera[2], Hans Schmid[2], and Manfred Fiebig[1] — [1]HISKP, University of Bonn, Germany — [2]Department of Inorganic, Analytical and Applied Chemistry, University of Geneva, Switzerland

The investigation of compounds forming 180° domains directly leads to the inherent magnetic effects determining the AFM domain topology. The group of lithium-orthophospates $LiMPO_4$ (M = Co, Fe, Mn, Ni) is a good system for studying the parameters determining the formation of 180° domains, because of its variety of magnetically similar but pronouncedly anisotropic compounds. The crystallographic symmetry of $LiMPO_4$ is mmm. As magnetic symmetry, mmm' (M = Co, Fe) and mm'm (M = Mn, Ni) are obtained.

Here we report on the observation of AFM 180° bulk domains in $LiMPO_4$ (M = Co, Fe, Ni) by optical second harmonic generation (SHG). SHG coupling linearly to the AFM order parameter was identified in spectroscopy measurements and used for imaging domains. In spite of their similar crystallographic and magnetic structure the three compounds display drastically different domain patterns. Possible explanations for this unexpected diversity are discussed. In addition, we observed domains of a magnetic vortex (so-called ferrotoroidic) state that coexist with the AFM domains in $LiCoPO_4$. For $LiNiPO_4$ we showed that a magnetic field is sufficient to orient the AFM 180° domains via the magnetoelectric effect. - Work supported by the SFB 608 of the DFG.

MA 40.59 Fri 11:00 P1A

Investigation of the magnetic configuration of $LuFe_2O_4$ by means of XMCD and multiplet calculations — •Christine Derks[1], Michael Raekers[1], Christian Taubitz[1], Karsten Kuepper[2], Stephen J. Blundell[3], Dharmalingam Prabhakaran[3], and Manfred Neumann[1] — [1]Universität Osnabrück, FB Physik, Osnabrück — [2]FZ Dresden-Rossendorf, Dresden — [3]Clarendon Laboratory, University of Oxford, Oxford, UK

The use of magneto electric coupling and multi ferroics in spintron-

ics has led to an intense research of ferro electric magnets. The spinel $LuFe_2O_4$ is a very promising candidate for such applications. This compound exhibits giant room temperature magneto dielectric response, which suggests a strong coupling between spin moment und electric dipole. The resulting giant magneto capacitance is due to charge ordering of mixed valent iron ions. A complex two dimensional ferri magnetism plays an important role for the multi ferroic properties of $LuFe_2O_4$. We determine the magnetic configuration by means of XMCD. Experimental data are compared with multiplet calculations, which are performed with the TT multiplet program [1]. The trigonal bipyramidal crystal symmetry was included in these calculations. We suggest a local charge order with a ferrimagnetic structure as found by Mössbauer and neutron diffraction; The minority spin sub lattice exhibits 2/3 of total Fe^{3+} ions whereas the majority spin subband contains 1/3 of Fe^{3+} and all the Fe^{2+} ions. [1] F.M.F. de Groot, High resolution x-ray emission and x-ray absorption spectroscopy, Chem. Rev., vol. 101, pp. 1779-1808, (2001).

MA 40.60 Fri 11:00 P1A

Multiferroic hysteresis in $MnWO_4$ — •Thomas Finger[1], Alexander Komarek[1], Daniel Senff[1], Petra Becker-Bohaty[2], Ladislav Bohaty[2], Louis-Pierre Regnault[3], Karin Schmalzl[4], Wolfgang Schmidt[4], and Markus Braden[1] — [1]II. Physikalisches Institut, Universität zu Köln — [2]Institut für Kristallographie, Universität zu Köln — [3]CNG-Grenoble / ILL, Grenoble — [4]JCNS / ILL, Grenoble

Multiferroic materials or compounds with a strong magnetoelectric effect posses a large application potential in data storage techniques: one would like to replace the common magnetic writing by an electric process, as the generation of the magnetic fields is energy expensive. Quite recently, systems with a peculiar spiral magnetic order were shown to directly induce a spontaneous electric polarization and to exhibit giant magnetoelectric and magnetocapacitance effects, among them $MnWO_4$, which crystallizes in a monoclinic structure and undergoes several magnetic phase transitions as a function of temperature. From these phases only the incommensurate non-collinear ordering in the "AF2"-phase induces an electric polarization and large magnetoelectric effects, fully consistent with recent theories. We have succeeded for the first time to observe a chirality hysteresis curve driven by the electric field. These data can give important information about the pinning of the multiferroic order, which is relevant in view of future applications. We want to present our temperature dependent studies on the multiferroic hysteresis as well as a characterization of the second harmonics of the spiral.

MA 40.61 Fri 11:00 P1A

Magnetic structure in multiferroic pyroxenes: (Na, Li)FeSi2O6 — •Max Baum[1], Alexander C. Komarek[1], Navid Qureshi[1], Petra Becker[2], Ladislav Bohatý[2], Martin Meven[3], M. Teresa Fernandez Diaz[4], Paul Steffens[4], and Markus Braden[1] — [1]II. Phys. Inst., Universität zu Köln, Zülpicher Str. 77, 50937 Köln, Germany — [2]Inst. für Geologie und Mineralogie, Universität zu Köln, Zülpicher Str. 49b, 50674 Köln, Germany — [3]Forschungsneutronenquelle Heinz Maier-Leibnitz (FRM II), Lichtenbergstr. 1, 85747 Garching, Germany — [4]Institut Laue-Langevin, BP 156, 6 rue Jules Horowitz, 38042 Grenoble Cedex 9, France

(Na,Li)FeSi2O6 exhibit multiferroic properties. Previous neutron diffraction experiments on powder samples of both compounds were interpreted in a commensurate model with antiferromagnetically coupled FeO6 chains of anti- or ferromagnetic character. Our triple-axis result of a single crystal is at odds with the former published commensurate model for magnetic ordering: magnetic ordering is incommensurate in NaFeSi2O6 with a temperature independent modulation. Magnetic satellites appear at q-positions corresponding to an incommensurate modulation vector (0,0.23,0). Based on powder neutron diffraction data, Redhammer et al. propose the Shubnikov group P21/c as the magnetic space group for LiFeSi2O6. This corresponds in antiferromagnetic ordering within and between the FeO6 chains. Our measurement on a single crystal reveals the Shubnikov group P21/c' which is equivalent to ferromagnetic coupling within the chains and antiferromagnetic coupling between the chains.

MA 40.62 Fri 11:00 P1A

Pulsed laser deposited $TbMnO_3$ thin films on $YAlO_3$ with high crystalline quality — •Artur Glavic[1], Jürgen Schubert[2], Jörg Voigt[1], and Thomas Brückel[1] — [1]Institut für Festkörperforschung, Forschungszentrum Jülich GmbH, 52425 Jülich — [2]Institut für Bio- und Nanosysteme, Forschungszentrum Jülich GmbH, 52425 Jülich

We have chosen to deposit $TbMnO_3$ on $YAlO_3$ substrates because it has almost the same lattice parameters in plane as $TbMnO_3$ and a large difference in out of plane direction. Additionally the propagation vector of the magnetic spiral in the multiferroic state points out of plane. These two properties are advantageous for the use of scattering methods as the substrate- and filmpeaks are separated from each other and the magnetic structure can be probed by neutron diffraction easier. Multiferroic thin films of $TbMnO_3$ have already been fabricated using PLD on other Substrates as $SrTiO_3$ and $LaAlO_3$ in the orthorhombic and for example on ZrO_2 in the hexagonal phase.

We will present data from X-Ray diffraction experiments which show high crystalline quality (FWHM of less than 0.1 degree) and the obtained lattice constants of the epitaxial grown films. Rutherford back scattering with channelling of 2% could be observed, too. The temperature dependent magnetic properties have been probed with a SQUID magnetometer and an enhancement of the features compared to bulk has been found. The surface quality has been investigated by X-Ray reflectometry and atomic force microscopy.

MA 40.63 Fri 11:00 P1A

Propagating and standing acoustic waves in Oxide multilayers — •Marc Herzog[1], Mareike Kiel[1,2], Ionela Vrejoiu[3], Marin Alexe[3], Dietrich Hesse[3], and Matias Bargheer[1,2] — [1]Institute of Physics and Astronomy, University of Potsdam, 14476 Potsdam-Golm, Germany — [2]Max Planck Institute of Colloids and Interfaces, Research Campus Golm, 14476 Potsdam-Golm, Germany — [3]Max Planck Institute of Microstructure Physics, 06120 Halle, Germany

We investigate the ultrafast optical response of oxide multilayers composed of ferromagnetic metals ($SrRuO_3$ = SRO and $(La,Sr)MnO_3$ = LSMO), ferroelectrics ($Pb(Zr,Ti)O_3$ = PZT and $BaTiO_3$ = BTO) and the dielectrics ($SrTiO_3$ = STO). Typically 10 double layers (superlattice) of approx. 10 nm thickness are sufficient to define a mini-Brillouin zone, giving rise to the zone-folding of phonons and phonon band gaps. A tunable femtosecond pulse (IR, vis or UV) excites coherent phonons (strain waves) with the wavevector given by the artificial periodicity. An ultrashort whitelight continuum probes the transient reflectivity and transmission. The spectral and temporal information is used to disentangle standing and propagating strain waves and, moreover, to understand the fundamental processes driving the strain waves, such as electron-phonon coupling. In particular, we study the temperature dependence of the ultrafast response when tuning through ferroelectric and ferromagnetic phase transitions. These studies may be relevant for devices exploiting the coupled dynamics of several functional nanolayers.

MA 40.64 Fri 11:00 P1A

Structural investigations of complex perovskite oxide films with X-ray diffraction — •Ksenia Boldyreva, Diana Rata, Andreas Herklotz, Orkidia Bilani-Zeneli, Ruben Hühne, Ludwig Schultz, and Kathrin Dörr — IFW Dresden, Postfach 270116, 01171 Dresden, Deutschland

The electronic and magnetic properties of many complex oxides are highly sensitive to external parameters which include mechanical deformation or strain. Thus, X-ray diffraction methods such as reciprocal space mapping are powerful and indispensable for the characterization of thin films, particularly for evaluating the in-plane strain state. The direct influence of strain on the magnetization of epitaxial $La_{1-x}Sr_xMnO_3$ (LSMO) films has been studied utilizing piezoelectric PMN-PT substrates [1]. On the other hand, $La_{1-x}Sr_xCoO_3$ (LSCO) films also reveal large strain-induced changes of the magnetization and the electrical conductivity [2]. Since the in-plane lattice parameter of the piezoelectric substrate, PMN-PT, of ∼4.02 Å is larger than that of most correlated oxides, $LaSc_{1-x}Al_xO_3$ (LSAO) has been explored as a buffer layer showing a lattice parameter that is tunable by the composition x. The lattice structure of (i) LSAO buffers depending on the composition and (ii) of magnetic films (LSMO, LSCO) grown in various strain states will be discussed.

[1] C. Thiele *et al.*, PRB **75**, 054408 (2007); [2] A. D. Rata *et al.*, PRL **100**, 076401 (2008).

MA 40.65 Fri 11:00 P1A

Cobalt-InAs-hybrid-structures operated at ferromagnetic resonance — •Philippe Klemm[1], Sebastian Neusser[1], Bernhard Botters[1], Andreas Wittmann[1], Christian Heyn[2], and Dirk Grundler[1] — [1]Lehrstuhl für Physik funktionaler Schichtsysteme,

— [2]Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Jungiusstraße 11, Hamburg D-20355, Germany

It has been predicted that a ferromagnet operated in ferromagnetic resonance emits a spin current into adjacent nonmagnetic contacts, i.e. spin battery effect [1]. Recent experiments on multilayers of magnetic and non-magnetic metals have shown a corresponding spin precession effect, the so called spin pumping [2]. We present our approach on measuring a spin-precession induced voltage using a hybrid system of Al-Co-InAs (high mobility two-dimensional electron gas [3]). Samples are prepared using optical lithography and cleaved edge overgrowth. We discuss characterization measurements on the Co and InAs heterostructure. Furthermore, we present our broadband probe station setup used for GHz measurements. We acknowledge financial support through the German Excellence Cluster "Nanosystems Initiative Munich".

[1] A. Brataas et. al., Phys. Rev. B 66, 060404 (2002)
[2] B. Heinrich et al., Phys. Rev. Lett. 90, 187601 (2003)
[3]C. H. Möller et al., Appl. Phys. Lett. 80, 3988 (2002)

MA 40.66 Fri 11:00 P1A

Magnetic and nonmagnetic states in graphene — •Zhen Gang Zhu[1], Kai He Ding[2], and Jamal Berakdar[1] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, Nanotechnikum-Weinberg, Heinrich-Damerow-Strasse 4, D-06120 Halle (Saale), Germany — [2]Department of Physics and Electronic Science, Changsha University of Science and Technology, Changsha 410076, People's Republic of China

We investigate the conditions necessary for the presence or absence of localized magnetic moments on adatoms in graphene by using the equation of motion method for the Green's function. After decoupling to the third order, a self-consistent integral equation can be obtained. Its analytical properties are discussed. A compact analytical solution for the Green*s function is derived from the integral equations in the infinite interaction limit, giving rise to a set of self-consistent equations for the occupation numbers with different spins. Magnetic and nonmagnetic states of the impurity are discussed accordingly.

MA 40.67 Fri 11:00 P1A

Fabrication and analysis of Fe and Fe/MgO films on the GaAs(110) cleaved edge of an LED structure for spin injection — •Hasmik Harutyunyan[1], Carsten Godde[1], Sani Noor[1], Ulrich Köhler[1], Arne Ludwig[2], Dirk Reuter[2], and Andreas D. Wieck[2] — [1]Institut für Experimentalphysik IV, AG Oberflächen, Ruhr-Universität Bochum, Germany — [2]Lehrstuhl für angewandte Festkörperphysik, Ruhr-Universität Bochum, Germany

This project's aim is the spin injection via Fe and Fe/MgO on the GaAs(110) cleaved edge which can be detected optically by an LED structure in the sample. The geometry of cleaved edge samples allows a spin injection perpendicular to the quantum well in the LED structure using an in plane magnetized Fe film. The conductivity mismatch is minimized either by the Schottky barrier of the Fe/GaAs interface or by use of MgO as a tunnelling barrier. This contribution focuses on the technical aspects of the cleaving and evaporation processes which are not trivial especially due to the dangers of short-circuiting the LED structure. Structured samples are cleaved in UHV. Cleaved edge overgrowth (CEO) is carried out under variable angles with respect to the cleavage surface. Angular dependent MOKE measurements have been performed in both cases. For Fe/GaAs, the easy axis is [001] with a high remanence. However, under the use of an MgO tunnelling barrier, the easy axis rotates by 90° into the $[1\bar{1}0]$. Photoluminescence has been shown for electrons travelling from the ferromagnetic contact into the semiconductor. Optical and therewith spin polarisation has yet to be demonstrated.

MA 40.68 Fri 11:00 P1A

Elliott-Yafet spin relaxation mechanism in metals: an ab initio approach — Martin Gradhand[1,2], Dmitry Fedorov[1], Michael Czerner[1], •Peter Zahn[1], and Ingrid Mertig[1,2] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, D-06099 Halle, Germany — [2]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany

In metals the spin scattering is dominated by the Elliott-Yafet mechanism. The electronic structure of the host and the perturbation of the potential in the vicinity of the defects were calculated in the framework of the density-functional theory using a multiple scattering Green's function Korringa-Kohn-Rostoker scheme. Treating the spin-flip transition matrix in Born approximation provides a good agreement with conduction electron spin resonance experiments for Cu containing different types of substitutional non-magnetic impurities [1]. Nevertheless, this approach neglects the spin-orbit interaction in the host and is not suitable for materials which show spin hot spots on the Fermi surface, like Al, Mg, and Be. To investigate such systems, we calculated the electronic wave functions and the solution of the impurity problem in the framework of the Dirac theory. First results obtained for defects in Al are discussed.

[1] D.V. Fedorov, P. Zahn, M. Gradhand, and I. Mertig, Phys. Rev. B **77**, 092406 (2008)

MA 40.69 Fri 11:00 P1A

Spin dynamics in ferromagnetic antidot lattices — •Sebastian Neusser, Bernhard Botters, Georg Dürr, and Dirk Grundler — Lehrstuhl für Physik funktionaler Schichtsysteme, Technische Universität München, Physik Department,James-Franck-Str. 1, D-85747 Garching b. München, Deutschland

Our recent work on spin dynamics in antidot lattices is presented. We present a semi-analytical approach allowing the identification of the distinct eigenmodes of antidot lattices [1]. We find, both, extended modes spanning through the lattice and localized modes residing in individual unit cells. The influence of these modes on spin-wave propagation is discussed in the light of the emerging research field of magnonics; we find for antidot lattices that propagation is tailored by the orientation of the external field. Furthermore, we present experimental data of broadband ferromagnetic resonance performed on such systems [2] in good agreement with our theoretical predictions. Mode localization for different angles of the external field with the antidot lattice unit cell axis is discussed.

[1] S. Neusser, B. Botters, and D. Grundler "Localization, confinement, and field-controlled propagation of spin waves in antidot lattices" Phys. Rev. B, 78, 054406 (2008).

[2] S. Neusser, B. Botters, M. Becherer, D. Schmitt-Landsiedel, and D. Grundler, "Spin wave localization between nearest and next-nearest neighboring holes in an antidot lattice" Appl. Phys. Lett. 93, 122501 (2008).

MA 40.70 Fri 11:00 P1A

Magnetization dynamics of nanoparticles subject to continuous magnetic fields or ultra short magnetic pulses — •Alexander Sukhov[1,2] and Jamal Berakdar[2] — [1]Max-Planck-Institut für Mikrostrukturphysik, Halle/Saale — [2]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, Halle/Saale

We study the magnetization dynamics of a Stoner nanoparticle using the Landau-Lifshitz-Gilbert equation of motion extended for finite temperatures. In case of continuous static or time-dependent magnetic fields we are interested in switching properties of the nanoparticles: Critical fields and the corresponding reversal times as a function of damping and temperature for various anisotropy types [1]. In the scheme proposed for ultra short magnetic pulses we show both analytically and numerically that not only switching but also a certain stabilization of the magnetization ("freezing") can be achieved regardless the anisotropy type and temperature. In contrast to the continuous fields additional parameters arise: Dynamics and control strongly depend upon an angle shift between the magnetization and the pulse, the duration and the form of pulses.

[1] A. Sukhov and J. Berakdar, J. Phys.: Condens. Matter **20**, 125226 (2008).

MA 40.71 Fri 11:00 P1A

Spin-transfer torque in tunnel junctions: Comparison of ab initio and simple models — •Asma H. Khalil[1], Arne G. Christen[1], Paul M. Haney[2], Mark D. Stiles[2], and Christian Heiliger[1] — [1]I. Physikalisches Institut, Justus Liebig University Giessen, D-35392, Germany — [2]Center for Nanoscale Science and Technology, National Institute of Standards and Technology, Gaithersburg, MD 20899-6202, USA

Our reported ab initio calculations of the spin-transfer torque in Fe/MgO/Fe tunnel junctions are in excellent agreement with experimental results [1]. Simple model calculations give different results [2]. In particular, they show strong deviations from a linear bias voltage dependence of the in-plane torque even for small biases. In this contribution we analyze simple single band models for a large number of parameters to point out the difference between them and first principles calculation. With our results we show the importance of ab initio calculations. This work has been supported in part by the

NIST-CNST/UMD-NanoCenter Cooperative Agreement.

[1] C. Heiliger and M.D. Stiles, Phys. Rev. Lett. **100**, 186805 (2008)
[2] I. Theodonis, N. Kioussis, A. Kalitsov, M. Chshiev, and W. H. Butler, Phys. Rev. Lett. **97**, 237205 (2008)

MA 40.72 Fri 11:00 P1A

Tunneling of spin waves through a mechanical gap — •Thomas Schneider[1], Alexander A. Serga[1], Andrii V. Chumak[1], Mikhail P. Kostylev[2], and Burkard Hillebrands[1] — [1]FB Physik und Forschungszentrum Optimas, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]School of Physics, M013, University of Western Australia, Crawley, WA 6009, Australia

We report on the investigation of spin-wave tunneling through a mechanical gap. Tunneling in this case happens due to the long range dipolar field created by the spin waves. Experiments were performed in yttrium iron garnet waveguides where gaps of different sizes were created perpendicular to the waveguide axis by chemical etching. Spin-wave excitation was performed using microwave pulses that were applied to a microstrip transducer. Brillouin light scattering spectroscopy as well as a conventional microwave technique were used to detect the spin waves. The use of two microstrip antennas allowed us to simultaneously observe the spin waves that tunnel through the gap as well as a reference spin wave that propagates in the continuous part of the same sample. By comparing the intensities of this two waves one can precisely determine the tunneling transmission coefficient. Realizing interference between them provides the possibility to measure the additional phase shift induced by the tunneling process.

Financial support by the DFG (Graduiertenkolleg 792 and SE 1771/1-1) and the Australian Research Council is gratefully acknowledged.

MA 40.73 Fri 11:00 P1A

Spin wave generation by photon coupled exchange magnons — •Vitaliy I. Vasyuchka, Christian Sandweg, Alexander A. Serga, and Burkard Hillebrands — FB Physik and Forschungszentrum OPTIMAS, TU Kaiserslautern, Germany

The behavior of a parametrically driven magnetic medium after the pumping source is switched off defines the important problem of pumping-free evolution of a non-equilibrium magnon gas.

A parallel electromagnetic pumping process creates pairs of photon coupled exchange magnons at half of the pumping frequency. These pairs induce a microwave magnetic field which is coherent with the pumping one but is shifted in phase. Thus the net pumping is effectively reduced in a stationary state. Switching the pumping source off is accompanied by an increase of the net magnetic field at the pumping frequency.

We report on the first observation of the energy transfer in the magnon gas caused by the influence of this field. The experiment was performed using a tangentially magnetized yttrium-iron-garnet (YIG) film. A microwave pumping pulse was supplied to the microstrip transducer. The signal irradiated by the YIG sample at half of the pumping frequency was picked up by the same microstrip. Just after the pumping pulse is switched off we detected a sharp peak at the end of this signal. The appearance of the peak is interpreted as a result of the parametric generation of long-wave spin waves by the non-compensated internal field, which acts as a pump.

Financial support by the DFG (SFB/TRR 49) is acknowledged.

MA 40.74 Fri 11:00 P1A

Multiple spin-wave pulse recovery by parallel pumping — •Volker Kegel, Sebastian Schäfer, Alexander A. Serga, and Burkard Hillebrands — FB Physik und Forschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

We have studied the storage and parametrically stimulated recovery of microwave signals in a tangentially magnetized yttrium-iron-garnet (YIG) ferrite film. The microwave signal carried by a packet of magnetostatic surface spin waves (MSSW) is stored due to the excitation of dipolar-exchange standing spin-wave modes across the film thickness. A recovered MSSW packet appears in the film as a result of parametric amplification of one of these standing modes [1]. The recovery delay time as well as the duration and amplitude of the recovered signal are mostly controlled by the power of the pumping signal. Here we report on the behaviour of the spin-wave system under influence of multiple pumping pulses applied per one MSSW signal pulse. We demonstrate the ability of a multiple recovery process and discuss the dependence of its characteristics on the time interval between pumping pulses. Financial support by the DFG (SFB/TRR 49) is acknowledged.

[1] A.A. Serga, A.V. Chumak, A. Andre, G.A. Melkov, A.N. Slavin, S.O. Demokritov, and B. Hillebrands, PRL 99, 227202 (2007).

MA 40.75 Fri 11:00 P1A

Improvement of the spin torque reversal by resonant microwave currents — •Lukas Fricke, Santiago Serrano-Guisan, and Hans-Werner Schumacher — Physikalisch-Technische Bundesanstalt, Braunschweig, Germany

We study ultra fast spin torque (ST) magnetization reversal in magnetic tunnel junctions by numerical simulations in the macrospin (single-domain) approximation. Magnetization reversal by pulsed currents under a hard axis bias field is studied. We find optimized low current switching for low fields inducing a tilt of the free layer magnetization out of the easy axis by about 6°. Similar results are obtained with tilted pinned layer devices. Furthermore ST reversal assisted by resonant microwave currents is considered. Here, an AC oscillation with frequency close to the ST precession frequency of the free layer is superimposed on the DC current pulse. The efficiency and reversal time of such AC assisted ST reversal schemes is investigated.

MA 40.76 Fri 11:00 P1A

Trajectory imaging of current-induced gyrotropic vortex motions — •Martin Müller, Christian Dietrich, Christian Back, Dieter Weiss, and Josef Zweck — Institut für Experimentelle und Angewandte Physik der Universität Regensburg, Germany

Transmission Electron Microscopy (TEM) can be used to study current induced excitations in low dimensional magnetic systems. Lorentz microscopy, a special operating mode with switched-off objective lens, using a long focal length lens instead, yields information about domain wall structures and/or the vortex position of magnetic disk samples. In this work we investigate magnetic specimens with different geometries (Landau structures in thin-film square elements/vortex structures in disks) and lateral dimensions in the micrometer range. It is possible to excite the gyrotropic eigenmode of the vortex structure by a spin-polarized ac current with frequencies in the range between 40 to 400 MHz. Lorentz microscopy enables us to image the trajectory of the vortex motion. We demonstrate that the resonantly excited vortex core has a circular trajectory whereas in off-resonance the motion of the vortex core is elliptical as predicted by analytical calculations[1]. The shape and the size of the trajectory and its frequency distribution depends on the ratio of spin transfer torque and Oersted field and therefore on the spin polarization of Permalloy.

Modifications in the magnetic specimen, such as an artificially created hole or other defects have been investigated and show a different vortex motion.

[1] Ki-Suk Lee, Sang-Koog Kim, Phys. Rev. B **78**, 014405 (2008)

MA 40.77 Fri 11:00 P1A

Spatially and Time-Resolved Scanning Kerr Microscopy on Permalloy Microstructures — •Andreas Krohn, Sebastian Mansfeld, Felix H. R. Balhorn, Detlef Heitmann, and Stefan Mendach — Institut für Angewandte Physik, Universität Hamburg, Jungiusstrasse 11, 20355 Hamburg

We report on microwave induced spin waves in narrow permalloy wires with typical thicknesses and widths of 20 nm and 5 μm, respectively. We have set up a novel experiment, where the microwave frequency is synchronized with the pulses of the laser used to detect the magnetization in the sample via the magneto optical Kerr effect. This enables time and spatially resolved measurements of spin waves in the permalloy structures. Due to the geometric boundary conditions in our samples spin waves underlie quantization effects and spin-wave modes are formed. We investigate the propagation of these spin-wave modes for several resonance conditions and find frequency dependant propagation velocities in the region of 100.000 m/s. We compare our findings with an analytical model based on spin waves in ferromagnetic films combined with quantization rules and micromagnetic simulations performed by OOMMF.

We thank the Deutsche Forschungsgemeinschaft for financial support via SFB 668 and 508.

MA 40.78 Fri 11:00 P1A

Spin-wave excitation in Permalloy by oscillating pinned domain walls — •Christopher Rausch, Sebastian Hermsdörfer, Helmut Schultheiss, Sebastian Schäfer, Philipp Pirro, Britta Leven, and Burkard Hillebrands — FB Physik und Landesforschungszentrum OPTIMAS, Erwin-Schrödinger-Str. 56, TU Kaiser-

slautern, 67663 Kaiserslautern, Germany

This poster presents a new mechanism for the spin-wave excitation. The excitation of spin waves by oscillating pinned domain walls is an alternative approach to the well-known excitation via an antenna or, as another example, via vortex-anti-vortex-annihilation. The investigations have been carried out using micromagnetic simulations (LLG-code). The basic idea of the mechanism is to deflect a pinned domain wall out of its equilibrium position within the limits of the domain wall pinning. The following relaxation caused by the pinning potential which is driving the wall back towards the equilibrium position occurs as a damped oscillation with characteristic eigenfrequency. In case that the domain wall is excited by an external field with this eigenfrequency, a "steady-state" oscillation forms out with the eigenfrequency and an amplitude determined by the energy balance between the dissipation processes due to damping and the external triggering by the applied field. The energy pumped into the system by the external field leads not only to the compensation of the damping but also to the radiation of spin waves.

Financial support by the DFG within the SPP1133 is gratefully acknowledged.

MA 40.79 Fri 11:00 P1A

2D approach to the k-vector resolution of the Brillouin light scattering spectroscopy — •Benjamin Jungfleisch, Christian W. Sandweg, Vitaliy I. Vasyuchka, Alexander A. Serga, and Burkard Hillebrands — FB Physik und Forschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

In this poster we report on our progress towards k vector sensitivity using Brillouin light scattering spectroscopy which enables us to detect and resolve the whole range of magnon wave vectors occurring during the formation of magnon gases and condensates. We overcome this challenge by varying the angle of incident light with respect to the orientation of magnetization. The improvement of our approach consists of expanding this k-vector sensitivity to two dimensions such that spin-wave wave vectors oriented both parallel and perpendicular to the external field can be resolved and measured. The proper operation of this setup is demonstrated by showing the results both for directly excited spin waves near the ferromagnetic resonance and for magnons at the lowest energy state of a parametrically driven magnon gas in yttrium-iron-garnet ferrimagnetic film.

MA 40.80 Fri 11:00 P1A

Laser-Induced Generation and Quenching of Magnetization on FeRh Investigated with Time-Resolved X-ray Magnetic Circular Dichroism — •Ilie Radu[1,2], Christian Stamm[2], Niko Pontius[2], Torsten Kachel[2], Paul Ramm[1], Jan-Ulrich Thiele[3], Hermann Dürr[2], and Christian Back[1] — [1]Regensburg University, Regensburg, Germany — [2]BESSY GmbH, Berlin, Germany — [3]Hitachi Global Storage, San Jose, CA, USA

Upon heating, the equiatomic FeRh alloy exhibits a first-order magnetic phase transition from the antiferromagnetic (AFM) to the ferromagnetic (FM) state around room temperature. Here, we study the fs laser-induced AFM-FM phase transition as well as the transition from FM towards the paramagnetic state by employing the time-resolved X-ray magnetic circular dichroism. Both Fe and Rh elements show a gradual growth of the magnetic moment within 200 ps after laser excitation. Temperature-dependent data, measured at intermediate temperatures between AFM and FM state, provide evidence for the rapid nucleation and subsequent slow expansion of the FM regions within an AFM matrix, supporting the magnetization growth model proposed in [1]. Once in the FM state, FeRh can be optically demagnetized on a few ps time scale (limited by the X-ray probing pulse). Further time-resolved magneto-optics measurements done in the visible spectral range reveal a demagnetization time constant of ˜200 fs. For the photo-induced demagnetization process we consider a mechanism that follows the transient electronic structure of the system.

[1] B. Bergmann et al., PRB 73, 060407(R) (2006)

MA 40.81 Fri 11:00 P1A

Current induced switching of MgO-based MTJs at different temperatures — •Markus Schäfers, Andy Thomas, Karsten Rott, and Günter Reiss — Bielefeld University, Universitätsstrasse 25, D-33615 Bielefeld, Germany

A spin-polarized current injected into a nanomagnet applies a torque to the magnetization and induces a precession or even a reversal of the magnetization direction. This spin-torque effect has generated much interest because it can be used as writing mechanism to store information in magnetic random access memory (MRAM). An extensive understanding of the switching process is necessary to produce high performance memory cells.

Here, we prepared sub-μm-sized MTJs with different free layer thicknesses based on CoFeB/MgO/CoFeB by e-beam lithography and argon ion beam etching. We compare the critical current densities for switching the free layer of these samples at different temperatures.

Samples were provided by Singulus Nanodeposition Technologies GmbH.

MA 40.82 Fri 11:00 P1A

Interdigital transducers for surface acoustic wave radiation onto ferromagnetic films — •Rupert Huber, Bernhard Botters, Sebastian Neusser, and Dirk Grundler — Lehrstuhl für Physik funktionaler Schichtsysteme Technische Universität München, Physik Department, James Franck Straße 1, 85747 Garching

We introduce our work on the design and fabrication of an emitter-receiver configuration of interdigital transducers (IDT). This system is assembled on the piezoelectrical crystal Lithium Niobate as substrate material, radiating surface acoustic waves (SAW). Encouraged by simulations with SYNC [1] we design IDTs matched to a 50 Ohm circuit. We test them at frequencies from 100 MHz up to the GHz regime by a vector network analyzer (VNA). In the propagation path of the SAWs we introduce a ferromagnetic film. We control the magnetic state with an external magnetic field. The SAWs are expected to distort the ferromagnetic film. We aim at measuring the transmitted SAWs depending on the magnetization state oft he film. We acknowledge support from the German Excellence Cluster "Nanosystems Initiative Munich".

[1] http://www.sawlab.te.chiba-u.ac.jp/˜ken/freesoft.html

MA 40.83 Fri 11:00 P1A

Observation of reversible current-induced vortex core displacements in magnetic disks — •Lutz Heyne, Jan Rhensius, Dennis Ilgaz, Mathias Kläui, and Ulrich Rüdiger — Universität Konstanz, Germany

The understanding of the interplay between spin-polarized currents and the magnetization is of high scientific interest and many proposed applications relay on the ability of controlled manipulation of the magnetization by currents. Here especially the influence of the so called non-adiabatic contribution on the interaction is to the present point poorly understood. Vortex cores exhibit large magnetization gradients and it has been predicted that the non-adiabatic contribution will be large in these systems. Thus their study can reveal important information concerning the non-adiabatic term.

We present new results on the interaction between injected current and magnetic vortex cores. Moreover we calculate the vortec core response theoretically as well as numerically to compare with the experimental results.

With direct imaging using X-ray photo emission electron microscopy we directly measure the current-induced vortex core displacement as a function of the current density. The results allow us to estimate the influence of the non-adiabatic term to the magnetization dynamics.

MA 40.84 Fri 11:00 P1A

Electron Spin Resonance in 2D triangular Cr-spin lattices — •Mamoun Hemmida, Hans-Albrecht Krug von Nidda, and Alois Loidl — Experimentalphysik V, Elektronische Korrelationen und Magnetismus, Universität Augsburg, 86135 Augsburg, Germany

The spin dynamics in some two-dimensional (2D) triangular Cr-antiferromagnetic lattices, i.e. the rock salt compounds $HCrO_2$, $LiCrO_2$, and $NaCrO_2$ as well as the delafossite compounds $CuCrO_2$ and $AgCrO_2$, have been investigated by electron spin resonance (ESR). In these oxides, the divergence of the temperature dependent linewidth, on approaching the Néel temperature T_N from above, is well described in terms of a Berezinskii-Kosterlitz-Thouless (BKT) scenario [1-3] due to magnetic vortex-antivortex pairing. Except for $LiCrO_2$, where T_{KT} is close to T_N, the broad fluctuation regime $T_{KT} < T < T_N$ suggests an intermediate 2D liquid antiferromagnetic state in analogy to the melting scenario of a 2D triangular lattice described by Nelson, Halperin, and Young in the framework of a modified Kosterlitz-Thouless model [4,5].

[1] V. L. Berezinskii, Sov. Phys. JETP **32**, 493 (1971).
[2] J. M. Kosterlitz and D. J. Thouless, J. Phys. C **6**, 1181 (1973).
[3] J. M. Kosterlitz, J. Phys. C **7**, 1046 (1974).
[4] B. I. Halperin and D. R. Nelson, Phys. Rev. Lett. **41**, 121 (1978).
[5] A. P. Young, Phys. Rev. B **19**, 1855 (1979).

MA 40.85 Fri 11:00 P1A

Dissipation and coupling of spin-wave eigenmodes in nanoscaled magnetic ring structures — •Katrin Vogt, Helmut Schultheiss, Björn Obry, Christian Sandweg, Sebastian Hermsdörfer, Sebastian Schäfer, Britta Leven, and Burkard Hillebrands — Fachbereich Physik and Research Center OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

Small magnetic ring structures magnetized in the onion state exhibit two spin-wave eigenmode systems confined at the pole and equatorial positions, respectively. With time-resolved Brillouin light scattering microscopy we analyzed the decay of these spin-wave eigenmodes after the resonant excitation with a microwave pulse. A strong dependency on the position within a single ring was found for the lifetime of the excited spin-wave eigenmodes showing that the damping of the magnetization dynamics is not constant within a single magnetic element. Furthermore, we demonstrate that the eigenmode frequencies can be tuned by means of an externally applied field. For certain frequency ratios of the eigenmode frequencies at the pole and equatorial position a nonlocal coupling of spin-wave eigenmodes is observed. Energy is transferred from spin-wave eigenmodes confined in the poles of the ring to spin waves at the equator if the frequency ratio is an integer number. Financial support by the DFG (SPP1133) is acknowledged.

MA 40.86 Fri 11:00 P1A

Time resolved field induced domain wall excitations in permalloy wires — •Jan Rhensius[1,2], Lutz Heyne[2], Dirk Backes[1,2], Stephen Krzyk[2], Dennis Ilgaz[2], Mathias Kläui[2], Laura J. Heyderman[1], Ulrich Rüdiger[2], Frithjof Nolting[1], and Arantxa Fraile-Rodriguez[1] — [1]Paul Scherrer Institut, 5232 Villigen, Switzerland — [2]Universität Konstanz, 78457, Germany

Micromagnetic systems are predicted to be useful for future magnetic storage devices. Therefore the investigation of the fundamental mechanisms of magnetization dynamics is essential. Field induced domain wall excitations are investigated with time and spatially resolved XMCD-PEEM (X-ray Magnetic Circular Dichroism - Photoemmission Electron Microscopy). We study the domain configurations in permalloy wires with a width of 2 μm, fabricated by electron beam lithography. Using a 10 *m wide stripline, connected to a laser triggered diode, well defined sub-ns field pulses were applied to move the domain wall. By triggering the channel plate of the PEEM at a well defined delay time, this pump-probe experiment achieves a time resolution of below 100 ps and a spatial magnetic resolution of about 50 nm. With this we can quantitatively analyze the response of the domain wall to the field pulse and we find domain wall displacements with velocities of hundreds of m/s. To understand the results, we compare the experimental data with results of micromagnetic simulations and find good agreement.

MA 40.87 Fri 11:00 P1A

Field- and Current-induced Domain Wall Motion in Ho-doped Permalloy Nanowires probed by single shot Kerr-microscopy — •Philipp Möhrke[1], Thomas A. Moore[1,2], Mathias Kläui[1], Stephen Krzyk[1], Jan Rhensius[1,3], Dirk Backes[1,3], Laura J. Heyderman[3], and Ulrich Rüdiger[1] — [1]Universität Konstanz, Fachbereich Physik, Universitätsstraße 10, 78457 Konstanz, Germany — [2]SPINTEC, CEA Grenoble, 17 rue des Martyrs, 38054 Grenoble Cedex 9, France — [3]Paul Scherrer Institut, 5232 Villingen PSI, Switzerland

We present single shot measurements of field- and current-induced DW dynamics in pure and Holmium-doped Permalloy ($Ni_{80}Fe_{20}$) nanowires (thickness 20-25 nm, width $\geq$ 500 nm) by nanosecond time-resolved Kerr-microscopy. We probe the velocity of single DW displacements across a 1 μm spot size located at various positions along the wire and determine the depinning fields and currents.
Results obtained from 1500 nm-wide and 25 nm-thick pure and Ho-doped Py-wire with the laser focused at a position 10 μm away from the starting point of the DWs are presented. DWs were repeatedly prepared at the kinks in the wire, the field ramped from 0 G with a speed of in 1 G/μs and the arrival times / depining fields measured. Measurements on samples, which by doping with Ho, have a different damping constant α show a significant drop of the average velocity with increasing α. These velocities are compared by results obtained from micromagnetic simulations.

MA 40.88 Fri 11:00 P1A

Current induced domain wall motion in out-of-plane magnetized magnetic nanowires characterized by high resolution magnetic imaging — •Olivier Boulle, Lutz Heyne, Jan Heinen, Jan Rhensius, Mathias Kläui, and Ulrich Rüdiger — Fachbereich Physik, Universität Konstanz, Universitätsstrasse 10, 78457 Konstanz, Germany

Current driven domain motion (CIDM) in perpendicularly magnetized multilayers attracts currently much interest due to the simple and narrow Bloch DWs observed in these materials and the more efficient spin transfer compared to previously studied in-plane magnetized permalloy nanowires. Here we report on current induced DW propagation in promising out-of-plane magnetized materials, such as low coercivity $(CoFeB(0,6nm)/Pt)_n$ multilayers and highly spin polarized $(Co/Ni)_n$ multilayers. Current-induced magnetization switching was studied in these materials for the first time by high resolution magnetic imaging using XMCD-PEEM. In $(CoFeB(0,6nm)/Pt)_n$, for wide wires (2 μm) and/or high current densities, current induced domain nucleation is observed. The analysis of the domain patterns indicate that the Oersted field plays a major role in the domain nucleation. In particular, the domain structure can be reversibly switched from one domain configuration to another by current by the sole effect of the Oersted field [1]. For smaller wire width and lower current, current induced DW motion is observed and the interplay between Oe field and spin torque results in a strongly geometry-dependent behaviour.
[1] Boulle et al, Jour. of Appl. Phys., (in press 2008)

MA 40.89 Fri 11:00 P1A

Microwave-Assisted Magnetization Reversal in $Ni_{80}Fe_{20}$ Nanowires: Reduced Critical Fields in Arrays with sub 100 nm Spacing — •Jesco Topp[1], Stefan Mendach[1], Detlef Heitmann[1], and Dirk Grundler[2] — [1]Institut für Angewandte Physik, Universität Hamburg, Jungiusstraße 11, 20355 Hamburg, Germany — [2]Physik-Department E10, Technische Universität München, James-Franck-Straße, 84747 Garching b. München, Germany

We studied microwave-assisted switching (MAS) in densely packed arrays of $Ni_{80}Fe_{20}$ nanowires. We used electron-beam lithography and lift-off processing to prepare arrays of 300 nm wide and 20 nm thick ferromagnetic nanowires with an edge-to-edge spacing of 90 nm. To study MAS the nanomagnets were irradiated with a microwave (rf) of fixed frequency and power and the linear eigenmode spectrum was used to probe the magnetization configuration inside the array.

We observe microwave-assisted switching for rf fields of less than 2 mT, a factor 3 lower than reported previously for individual nanowires of similiar dimensions. The phase-diagram of the switching efficiency is a complex function of rf amplitude and frequency. The switching process is most efficient at frequencies below linear eigenfrequency, which we attribute to the non-linear nature of the precession that leads to the magnetization reversal. For higher rf amplitude the regime of MAS is severely broadened by several GHz. Under optimal conditions the switching field can be reduced by more than 50%.

This work is supported by the DFG via "SFB 668"and the "Nanosystems Initiative Munich"(NIM).

MA 40.90 Fri 11:00 P1A

Magnetization dynamics in curved permalloy nanowires — •Sandra Motl-Ziegler, Lars Bocklage, Toru Matsuyama, Jesco Topp, Markus Bolte, and Guido Meier — Universität Hamburg, Institut für Angewandte Physik, Jungiusstr. 11, D-20355 Hamburg

Magnetization dynamics in nanostructures is an interesting field of research as magnetization patterns like domain walls and vortices form on these length scales. We investigate field-induced magnetization dynamics in curved permalloy nanowires placed on a waveguide. The dependence of spin-wave modes on an external magnetic field and on the excitation frequency is studied by a broadband ferromagnetic resonance setup [1]. After saturating a nanowire the field is reduced resulting in a domain wall in the curved part of the wire. In magnetic fields between -90 mT and 90 mT the frequency is swept from 45 MHz to 20 GHz by a network analyzer. Spectra are normalized with a reference measurement at a saturating field to improve the visibility of the spin-wave modes. For a wire of 6 μm length, 200 nm width, and 20 nm thickness with an outer radius of 3 μm we identify five modes. The measurements are compared with numerical simulations based on the Landau-Lifshitz-Gilbert equation to support the experimental results. Permalloy stripes and wires with different radii are also studied.
[1] J. Podbielski et al., Phys. Rev. Lett. **96**, 167207 (2006)

MA 40.91 Fri 11:00 P1A

Inductive detection of spin wave propagation in permalloy thin films — •Georg Dürr, Sebastian Neusser, Bernhard

Botters, and Dirk Grundler — Lehrstuhl für Physik funktionaler Schichtsysteme, Technische Universität München, Physik Department, James-Franck-Str. 1, D-85747 Garching b. München, Germany

Spin wave propagation in permalloy thin films is investigated, both in the frequency and the time domain. Different configurations of two coplanar waveguides used as emitter and receiver of spin waves are presented. Using a broadband vector network analyzer we measure the spin wave eigenfrequencies in the frequency domain. In a further experiment the transmission of pulsed induced spin waves in the time domain is detected using a digital sampling oscilloscope. All measurements are performed at room temperature with an external field applied in different directions. We discuss the data in the light of the spin wave propagation based on dispersion relations of permalloy thin films. We acknowledge financial support through the German excellence cluster "Nanosystems Initiative Munich".

MA 40.92 Fri 11:00 P1A

Effect of a DC current on the magnetization dynamics in spin-valve nanocontacts — •Abdelghani Laraoui[1], Florin Ciubotaru[1], Helmut Schultheiss[1], Alexander Serga[1], Sebastian Hermsdörfer[1], Maarten van Kampen[2], Liesbet Lagae[2], Britta Leven[1], Andrei N. Slavin[3], and Burkard Hillebrands[1] — [1]Fachbereich Physik and Forschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]IMEC, Kapeldreef 75, Leuven, Belgium — [3]Oakland University, Rochester, Michigan, USA

We have studied the magnetization dynamics in spin-valve nanocontact devices under the influence of an applied microwave ac and dc current by means of Brillouin light scattering (BLS) microscopy. To obtain an idea of the possible modes of spin waves that can be excited, the 80 nm point contact was subjected to an ac current of varying frequencies and powers. The BLS spectra of the extended Py free layer of the spin-valve stack were recorded at a fixed position near to the point contact (˜ 200 nm) and for various amplitudes of an external magnetic field. Strong nonlinear spin waves are excited with the ac current and discussed within the framework of three magnon scattering. In the presence of a dc current the efficiency of the direct excited modes is enhanced. This effect can be explained by both spin transfer torque and Oersted field effects. In addition, the threshold properties for nonlinear spin-waves (non-integer modes) excitation are mainly controlled by the Oersted field created by the dc current injected through the nanocontact. Support by EU-MRTN SPINSWITCH (MRTN-CT-2006-035327) and by the Deutsche Forschungsgemeinschaft (SPP1133).

MA 40.93 Fri 11:00 P1A

Anisotropy dependence of domain structure and magnetization dynamics in magnetic thin film elements — •Claudia Patschurek, Jeffrey McCord, Rainer Kaltofen, Rudolf Schäfer, and Ludwig Schultz — IFW Dresden, Inst. f. Metallische Werkstoffe, Helmholtzstr. 20, 01069 Dresden

Patterned multilayered samples of polycrystalline Ni81Fe19 and amorphous Co60Fe20B20 with and without a 5 nm MgO interlayer were deposited under an applied field using dc magnetron sputtering. While the total stack thickness of 80 nm was kept constant, the thickness ratio of the individual layers was systematically varied in order to achieve a linear change of magnetic anisotropy. Static and dynamic properties were investigated by quasi-static magnetometry and pulsed inductive microwave magnetometry (PIMM).

Magneto-optical Kerr microscopy studies reveal that the patterning leads to the formation of characteristic, anisotropy-dependent non-Landau closure domain structures in the non-laminated elements, while no anisotropy dependence is obvious for the domain structure of laminated thin film elements. Irregular contributions to the effective field and thus the dynamic magnetic response, originating from the domain structures, were identified.

MA 40.94 Fri 11:00 P1A

Tunnel magnetoresistance and spin dependent shot noise in carbon nanotube quantum dot in the Kondo regime — •Stanislaw Lipinski and Damian Krychowski — Institute of Molecular Physics, Polish Academy of Sciences, Poznan, Poland

The out of equilibrium transport properties of carbon nanotube quantum dot coupled to ferromagnetic electrodes are studied by means of the non-equilibrium Green functions using equation of motion method. Polarization of electrodes introduces the spin dependence of tunneling rates and exchange splitting of the dot level. We point out on the possibility of achieving giant values of tunnel magnetoresistance in the Kondo range and discuss a prospect of gate control of this quantity. Change of the gate enables a control of the value and sign of polarization of conductance. For parallel orientation of polarizations of electrodes a significant decrease of the Fano factor is observed for gate potentials corresponding to vanishing exchange splitting. The exchange induced Kondo satellites reflect in the bias or gate dependences of spin resolved Fano factors.

MA 40.95 Fri 11:00 P1A

AC Transport in thin manganite films — •Sebastian Hühn, Kai Gehrke, Vasily Moshnyaga, and Konrad Samwer — I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37707 Göttingen

We have studied the metal-insulator (MI) transition in perovskite manganite films by means of a.c. electric transport technique. The films of $La_{1-x}Sr_xMnO_3$ (LSMO), $La_{1-x}Ca_xMnO_3$ (LCMO) and $(La_{1-y}Pr_y)_{1-x}Ca_xMnO_3$ (LPCMO) were prepared by a metalorganic aerosol deposition technique. The linear R_ω and nonlinear 3rd harmonic resistance $R_{3\omega}$ were measured simultaneously as a function of temperature (4-300K), current (1-1000μA), frequency (1-1000Hz) and magnetic field (0-7T). We show that the MI transition temperature (T_{MI}) is frequency dependent. The nonlinear resistance $R_{3\omega}$ is strongly enhanced mostly in the vicinity of T_{MI} and shows a peculiar magnetic field dependance. The results on LPCMO film are compared with LCMO and LSMO and discussed within correlated polarons approach and phase separation scenario.

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MA 40.96 Fri 11:00 P1A

Electronic structure in mesoscopic systems under finite bias — •Steven Walczak[1,2], Michael Czerner[2], Christian Heiliger[3], and Ingrid Mertig[2] — [1]Max Planck Institute of Microstructure Physics, D-06120 Halle (Saale), Germany — [2]Institute of Physics, Martin Luther University Halle-Wittenberg, D-06120 Halle (Saale), Germany — [3]I. Physikalisches Institut, Justus Liebig University, D-35392 Giessen, Germany

The understanding of the I-V-characteristics is a key issue in ballistic transport. In particular, the voltage drop within the scattering region depends strongly on the geometry of the system. For example in a tunnel junction one expects a simple linear voltage drop over the barrier but for atomic contacts, nanowires, or molecules the voltage drop is expected to be more complicated. To account for these systems we extend our implementation of the Keldysh formalism in the Korringa-Kohn-Rostoker Green's function method [1]. Furthermore, a real space formulation of the Keldysh equation is used to describe open systems which exhibit broken translational symmetry like atomic contacts or nanowires.

Our extension includes the self-consistent treatment of the system under applied bias using the non-equilibrium density between the chemical potentials of the left and the right lead. The voltage drop within the system is then proportional to the difference of the densities with and without an applied voltage.

[1] C. Heiliger, M. Czerner, B. Yavorsky, I. Mertig, M. Stiles, J. Appl. Phys. 103, 07A709 (2008)

MA 40.97 Fri 11:00 P1A

Direct measurement of the spin polarization of Co-Fe and Co-Fe-B — •Savio Fabretti[1], Oliver Schebaum[1], Andy Thomas[1], Günter Reiss[1], and Jagadeesh Moodera[2] — [1]Universität Bielefeld — [2]MIT Cambridge

We investigated the spin polarization of Co-Fe and Co-Fe-B thin films with the Meservey-Tedrow method. Superconductor/insulator/ferromagnet (S/I/F) structures were fabricated using shadow masks and DC- and RF-magnetron sputtering in an automatic sputtering system. The samples have been post annealed in a vacuum furnace. The superconducting electrode consists of $Al_{95}Si_5$ while the insulator is MgO. For optimization of the superconducting tunnel junctions the properties of the Al-Si films on MgO buffer layers have been investigated in dependence of the Al-Si thickness and the annealing temperature. The dI/dV measurements were done in a ^{3}He cryostat at a temperature of 0.46K with magnetic fields applied in the range of 2T to 2.8T. Finally, the results were compared with conventional MgO magnetic tunnel junctions with Co-Fe and Co-Fe-B electrodes.

MA 40.98 Fri 11:00 P1A

Measurement of the spin polarisation of the current

through nanostructured Al/Fe and Nb/Fe point contacts — •Konstantin Mirlin[1], Samuel Bouvron[1], Michael Marz[1,2], Gernot Goll[1], Christoph Sürgers[1,2], and Hilbert v. Löhneysen[1,2,3] — [1]Physikalisches Institut, Universität Karlsruhe, 76128 Karlsruhe — [2]DFG-Zentrum für funktionelle Nanostrukturen der Universität Karlsruhe, 76128 Karlsruhe — [3]Institut für Festkörperphysik, Forschungszentrum Karlsruhe, 76021 Karlsruhe

Point-contact spectroscopy can be used to determine the spin polarisation P of the current through a S/F point contact. We used this method to study nanostructured Al/Fe and Nb/Fe contacts produced by electron-beam lithography. We measured the differential conductance spectra $G(V) = dI/dV(V)$ of the Nb/Fe contacts in a ^{4}He cryostat down to 1.5 K and described the spectra within two different theoretical models, the Mazin model [1] and the Cuevas model [2]. The first one considers the current through the F/S contact as composed of a fully polarised and an unpolarised part. The second one is based on the Landauer-Büttiker formalism with spin dependent transmission coefficients $\tau_{\uparrow(\downarrow)}$ with a single $P = (\tau_\uparrow - \tau_\downarrow)/(\tau_\uparrow + \tau_\downarrow)$. P depends on the contact size and is reduced with increasing contact size, possibly due to spin-orbit scattering in the contact region [3]. This scenario is supported by a larger decrease of P for Nb/Fe contacts compared to Al/Fe contacts, as expected for spin-orbit scattering.
[1] I.I. Mazin, PRL 83(7), 1427 (1999); [2] J.C. Cuevas et al., PRB 69, 140502 (2004); [3] M. Stokmaier et al., PRL 101(14), 147005 (2008)

MA 40.99 Fri 11:00 P1A

In-situ Preparation and Characterization of Tailored Magnetic Nanocontacts — Stephen Krzyk, Ajit Patra, •Andre Bisig, Mathias Kläui, and Ulrich Rüdiger — Fachbereich Physik, Universität Konstanz, 78457 Konstanz

It has been shown that magnetoresistance measurements can be used to investigate domain walls spin structure and pinning characteristics [1], and that the type and pinning behavior of domain walls is strongly dependant on the geometry of the investigated structures [2]. So far, the accessible lateral size regime has been limited by the finite resolution of the lithographic preparation process. An innovative approach to overcome this limitation and leading down to atomic size of a contact is the electromigration technique [3].

We use a combination of electron- and focussed-ion-beam lithography to pre-pattern nanoscale ring-structures with notches on a Si_3N_4 surface, and Permalloy ($Ni_{80}Fe_{20}$) films are grown on the structures in UHV. Controlled electromigration is used to reduce the size of the notch. By alternating deposition and electromigration, the resistance and correspondingly the cross-section of the notch can be reversibly changed by several orders of a magnitude. In-plane magnetic fields are used to nucleate and move magnetic domain walls in the nanostructure and magnetoresistance measurements are used to probe the influence of the notch geometry on the behavior of the domain wall.

[1] D. Bedau et al., J. Appl. Phys. 101, 09F509 (2007).
[2] M. Laufenberg et al., Appl. Phys. Lett. 88, 052507 (2006).
[3] R. Hoffmann et. al., Appl. Phys. Lett. 93, 043118 (2008).

MA 40.100 Fri 11:00 P1A

Annealing behaviour of CoFeB/MgO/CoFeB magnetic tunnel junctions — Sebastian Ringer[1,2], Michael Vieth[2], Ludwig Bär[2], Manfred Rührig[2], and •Günther Bayreuther[1] — [1]Universität Regensburg, 93040 Regensburg, Germany — [2]Siemens AG, Corporate Technology CT T MM1, 91050 Erlangen, Germany

With CoFeB/MgO/CoFeB magnetoresistive tunnel junctions, annealing is commonly used to increase the TMR ratio. The annealing process simultaneously affects the antiferromagnetic pinning layer as well as the tunnel barrier and the ferromagnetic contacts. In particular, the role of diffusion of B into the MgO barrier has been considered recently. By a systematic variation of annealing time and temperature the present study aims to achieve a better understanding of the relevant diffusion processes and an optimization of the annealing procedures. Junctions with a barrier thickness of 1.5 nm showed a TMR ratio of 30% at room temperature before annealing which increased to a maximum value of 150% after annealing for 4 h at 350° C. Measurement of the high resistance state (i.e. for antiparallel magnetizations), the low resistance state (parallel magnetizations) and the TMR ratio versus annealing time at different temperatures allows for the calculation of temperature dependent time constants and activation energies of the processes involved. A comparison of room temperature and low temperature resistance values is used to separate different effects of the annealing process.

MA 40.101 Fri 11:00 P1A

Magnetoresistance and electroresistance in $BiMnO_3$ based tunnel junctions — •Nicki Hinsche[1], Michael Fechner[1,2], Igor Maznichenko[1], Peter Bose[1,2], Sergei Ostanin[2], Arthur Ernst[2], Juergen Henk[2], Peter Zahn[1] und Ingrid Mertig[1,2] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, D-06099 Halle, Germany — [2]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany

The tunneling magnetoresistance (TMR) and electroresistance (TER) of $BiMnO_3$ based tunnel junctions are investigated by means of a combined ab initio and model calculation. The structural relaxation of the barrier material was performed using the VASP package. The electronic structure, and especially the complex band structure of the barrier, are calculated within density functional theory in self-interaction-corrected local density approximation (SIC-LDA) using a KKR multiple scattering scheme. The potential profile in the barrier is determined by the material polarization and the different screening lengths in the electrodes. We assumed a half-metallic and a nobel metal electrode. The influence of the barrier polarization, the $BiMnO_3$ complex band strucure, and the screening properties of the electrodes on the TMR and TER will be discussed.

MA 40.102 Fri 11:00 P1A

Dielectric Breakdown and inelastic electron tinneling spectroscopy of top pinned and bottom pinned Co-Fe-B/MgO/Co-Fe-B magnetic tunnel junctions — •Ayaz Arif Khan, Jan Schmalhorst, Karsten Rott, Andy Thomas, and Günter Reiss — Thin films and physics of Nano structures, Department of Physics, Bielefeld university, P. O. Box 100131, 33501 Bielefeld germany.

We present a detailed investigation into the intrinsic tunnel barrier reliability in Co-Fe-B/MgO/Co-Fe-B magnetic tunnel junctions (MTJ). The intrinsic reliability is measured as the ramped breakdown voltage (V_{bd}) at room temperature for both positive and negative polarity. The measurements were done for two types of junctions: one set of junctions had exchange biased (pinned) bottom electrodes, one set exchange biased (pinned) top electrodes with an additional artificial ferrimagnet. We found a significant polarity dependence in the dielectric breakdown: top as well as bottom pinned tunnel junctions showed higher breakdown voltage when the top electrode was biased positively compared to negative bias. In contrast to this the differential resistance $\frac{dV}{dI} - V$ spectra revealed an asymmetry for the top pinned junctions which was reversed in comparison to the bottom pinned system. This indicates that both asymmetries have different origins. Additionally the bottom pinned junctions showed in general slightly lower breakdown voltages and stronger magnon excitation in the inelastic electron tunneling $\frac{d^2I}{dV^2} - V$ spectra than the top pinned junctions.Possible reasons for these correlations are discussed.

MA 40.103 Fri 11:00 P1A

Preparation and characterization of sputtered CoFeB/MgO/CoFeB based TMR magnetic tunnel junctions (MTJs) — •Neda Sadrifar[1], Senthilnathan Mohanan[1], Sören Selve[2], Ute Kaiser[2], and Ulrich Herr[1] — [1]Institut für Mikro- und Nanomaterialien, Universität Ulm, 89081 Ulm — [2]Materialwissenschaftliche Elektronenmikroskopie, Universität Ulm

MTJs with amorphous aluminum oxide tunnel barrier are currently used in magnetoresistive random access memory (MRAM) and the read heads of hard disk drives. MTJs with crystalline MgO tunnel barrier and body centered cubic (bcc) Fe, Co or CoFe ferromagnetic electrodes are predicted to exhibit over 1000% magnetoresistance due to coherent tunneling of fully spin polarized electrons. MTJs with MgO barrier sandwiched between CoFeB electrodes are recently developed for practical applications and found to have TMR ratios up to 500% at RT. Crystallization of amorphous CoFeB into (001)-oriented bcc structure results in a good lattice matching with (001)-oriented MgO and a very sharp and smooth interface and consequently to highly spin polarized tunneling current and high TMR effect. In this study, CoFeB/MgO/CoFeB-based MTJs were prepared by magnetron sputtering and characterized with respect to their microstructure and roughness by XRD, AFM, SEM and TEM. The main focus is on the effect of underlayers on the morphology of the MTJ stack and formation of (001)-oriented MgO and bcc-CoFeB.

MA 40.104 Fri 11:00 P1A

Properties of ferromagnetic tunnel junctions with organic

spacer layers — •Hartmut Vinzelberg, Joachim Schumann, Dieter Elefant, Jürgen Thomas, and Bernd Büchner — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

Within the spintronics/optoelectronics communities the search for alternative materials with improved properties for coherent spin transport recently has initiated strong activities in the field of organic spintronics and related materials. The realization of spin injection into organic semiconductors and the coherent spin transport over distances on the nanometer scale are discussed controversy in the literature. [1-3] Therefore, in this work ferromagnetic sandwich devices with Alq_3-spacer are prepared and studied in order to find out which mechanism controls the observed spin-dependent transport effects: spin propagation in the organic film or tunneling over a barrier between the ferromagnetic electrodes. Spin-valve effects at low temperatures have been observed in a broad resistance interval from kΩ to MΩ-range without systematic area dependence. In some samples the magneto-resistance changes the sign as a function of the bias voltage. Additional SQUID and TEM studies suggest as transport mechanism tunneling processes between ferromagnetic electrodes separated by an organic barrier.

[1] J.S. Jiang, et al., Phys. Rev. B 77, 035303 (2008)
[2] H. Vinzelberg, et al., J. Appl. Phys., 103, 093720 (2008)
[3] V. Dediu, et al., Phys. Rev. B 78, 115203 (2008)

MA 40.105 Fri 11:00 P1A

Tunnel magnetoresistance in Al_2O_3 – MgO composite magnetic tunnel junctions — •Oliver Schebaum, Volker Drewello, Alexander Auge, Andy Thomas, and Günter Reiss — Bielefeld University, Germany

In the recent years TMR ratios of up to 500% at room temperature (RT) have been observed for magnetic tunnel junctions with MgO tunnel barriers, while the TMR ratio of Al_2O_3 based MTJs seems to be limited to 70% to 80%. This has been explained by coherent tunneling in the crystalline FM/MgO/FM systems. With our investigation we wanted to find out, if also an increased spin polarization could be the reason for this high TMR ratios. We therefore investigated MTJs with MgO, Al_2O_3 and MgO – Al_2O_3 composite tunnel barriers and Co-Fe-B magnetic electrodes. The samples have been prepared by DC and RF magnetron sputtering and optical UV lithography. The characteristics of these tunnel junctions have been investigated for different annealing temperatures by transport measurements. The highest observed TMR ratio for the composite barrier MTJs is 74% at room temperature. The prepared reference MTJs with an MgO tunnel barrier exhibit a maximum TMR ratio of 176% at room temperature. The highest observed TMR ratio for the composite tunnel barrier MTJs is in the range of the highest reported values for amorphous single layer Al_2O_3 tunnel barriers, but still much lower than the observed and reported values for MgO based MTJs. This gives evidence that the high tunnel magnetoresistance ratios obtained in MgO based tunnel junctions might be attributed to coherent tunneling.

MA 40.106 Fri 11:00 P1A

Inelastic electron tunneling spectroscopy of magnetic tunnel junctions with different electrode designs and barrier materials — •Volker Drewello, Markus Schäfers, Oliver Schebaum, Andy Thomas, and Günter Reiss — Bielefeld University, 33615 Bielefeld, Germany

MgO based magnetic tunnel junctions with up to 230 % tunnel magneto resistance ratio at room temperature and up to 345 % at 13 K are prepared. The lower electrode is either exchange biased or free, while the top electrode is free or an exchanged biased artificial ferrimagnet, respectively. Additionally, a pseudo spin valve (hard soft switching) design with two unpinned electrodes is used. Inelastic electron tunneling spectra for each of these systems show a strong variation of the zero bias anomaly with a reduced peak for some of the junctions. At voltages around 200 mV additional structures are found which are not known from junctions with lower magneto resistance, such as alumina based junctions. We discuss the spectra for the different electrode types and compare our findings with respect to barrier material and magneto resistance ratio.

MA 40.107 Fri 11:00 P1A

Investigation of thermally evaporated Fe/MgO/Fe MTJs and NaCl layers — •Jan Rogge, Anna Regtmeier, and Andreas Hütten — Thin Films and Physics of Nanostructures, Department of Physics, Bielefeld University, Universitätsstr. 25, 33615 Bielefeld, Germany

A high tunnel magnetoresistance effect (TMR) in magnetic tunnel junctions (MTJs) is the key for developing new spinelectronic devices like MRAM or magnetic sensors.

In order to enhance the level of crystalinity and epitaxy, we have fabricated Fe/MgO/Fe MTJs using molecular beam epitaxy (MBE). By applying the Brinkman fit to the investigated IV-curves a very low barrier height can be observed, which indicates oxygen vacancy defects in the thermally evaporated MgO barrier. Further electrical transport properties will be discussed considering the MTJs' crystal features obtained from XRD measurements.

Due to the recently predicted huge MR ratio of up to 600% for Fe/NaCl/Fe MTJs [1], we will also show preliminary results of growth studies on NaCl thin films deposited by MBE regarding its practicability as a barrier in MTJs.

[1] P. Vlaic, Third Seeheim Conference on Magnetism, (2007)

MA 40.108 Fri 11:00 P1A

Magnetic properties of Co_2FeSi thin films deposited by magnetron sputtering using different target compositions — •Daniel Ebke, Jan Schmalhorst, Andy Thomas, Andreas Hütten, and Günter Reiss — Bielefeld University, Thin Films and Physics of Nanostructures, D-33615 Bielefeld, Germany

The Heusler alloy Co_2FeSi is predicted to show 100% spin polarization at the Fermi energy E_F and a high magnetic moment of $6\mu B$ as well as a high Curie temperature of 1100K [1]. Therefore it is a promising material for spintronic applications. In experiments a lower spin polarization and a lower magnetic moment are reported by different groups [2,3].

Sputtered thin films from stoichiometrical targets show off-stoichiometrical layers which might be the reason for lowering the spin polarization of the Heusler alloy. However, a correct film composition is required to enhance the spin polarization and so the tunneling magneto resistance (TMR) ratio.

We have studied the growth conditions and the magnetic properties of Co_2FeSi thin films which were deposited by using different target compositions. The electrical transport properties were investigated and will be discussed in combination with the magnetic properties and XRD measurements.

[1] S. Wurmehl et al., Phys. Rev. B, 72, 184434 (2005)
[2] Z. Gercsi et al., Appl. Phys. Lett., 89, 082512 (2006)
[3] T. Daibou et al., IEEE Trans. on Magn., 42, 2655-2657 (2006)