MA 18: Poster I : Bio Magn. (1-2); Mag.Imgaging (3-9); Magn. Semiconductors (10-16); Half Metals & Oxides (17-20); Coupl.Phenomena (21-27); Magn. Mat. (28-41); Micro & Nanostr. Magn. Materials (42-61); Micro Magn. (62-64); Surface Magnetism (65-70); Transport Phenomena (71-85)

Time: Tuesday 15:15–18:30 Location: Poster E

MA 18.1 Tue 15:15 Poster E

An Optimized Method for the Deposition of Mn_{12} Single-Molecule Magnets on the Au(111) Surface via a Short Acidic Linker — •Michael Burgert, Sönke Voss, Mikhail Fonin, Ulrich Groth, and Ulrich Rüdiger — Universität Konstanz, 78457 Konstanz

Mn_{12} single-molecule magnets (SMMs) have attracted much attention during the past decade due to their unique magnetic properties. At very low temperatures (∼2K) Mn_{12}-acetate and its derivatives exhibit a magnetic hysteresis of pure molecular origin without any magnetic long-range ordering effects. Quantum tunneling of magnetization shows up in terms of steps in the hysteresis loop of SMMs. The magnetic properties of bulk SMMs have been determined to a large extent during the past years. However, experiments using isolated Mn_{12} clusters are still rare. In this contribution we present a modified deposition technique, which offered the electronic characterisation of monolayers of Mn_{12}-clusters by scanning tunneling microcopy (STM), x-ray absorption (XAS) and scanning tunnelling spectroscopy (STS). This technique is based upon a two step procedure, in which the surface is functionalized with a short conducting linker like e.g. mercaptotetrafluorbenzoic acid. The Mn_{12}-complexes are fixed to the functionalized Au(111)-surface via a ligand-exchange-reaction. As an example for the common use of these technique we demonstrate the deposition of new Mn_{12} derivatives on the functionalized Au(111)-surface. Furthermore we present its chemical synthesis and the structural as well as magnetic characterisation

MA 18.2 Tue 15:15 Poster E

Raman-spectroscopic investigations of the Keplerates Mo_yM_x (M=V, Cr) — •Dietrich Wulferding[1], Peter Lemmens[1], Manash Ghosh[1,3], Patric Scheib[1], Ana Maria Todea[2], Tamoghna Mitra[2], and Achim Müller[2] — [1]IPKM, TU-Braunschweig, Germany — [2]Fakultät für Chemie, Uni Bielefeld, Bielefeld — [3]Department of Spectroscopy, IACS, Kolkata, India

We report on a Raman scattering investigations of the nanoscale magnetic cluster compounds Mo_yM_x, with M = transition metal ion (Cr and V). Phonon and magnetic scattering are observed and correlated with structural and electronic properties of the systems. Magnetic frustration is evident as a broadening of a shoulder with a high energy cut-off comparable to the magnetic exchange energy. Multiphonon scattering is observed up to third order.

MA 18.3 Tue 15:15 Poster E

Probing Magnetic Properties of (Ga,Mn)As by TEM — •Jürgen Gründmayer and Josef Zweck — Universität Regensburg, Germany

(Ga,Mn)As is a typical and highly interesting member of diluted magnetic semiconductors (DMS). These materials may lead to charge and spin sensitive electronics - known as spintronics - in the near future.

While the theoretical mechanism leading to ferromagnetism in (Ga,Mn)As is quite well known nowadays, the micromagnetic structure and behaviour of thin layers, small particles etc. are still to be determined in detail. We want to investigate domain formation, switching characteristics, stray fields and their temperature dependence at a sub micrometer scale which can only be done by transmission electron microscopy.

In order to do so, advanced TEM techniques like Electron Holography and Differential Phase Contrast (DPC) in combination with a field-free Lorentz lens are used and adapted for our material system.

We show first results obtained with our FEI TECNAI F30 microscope and discuss special techniques necessary for treating (Ga,Mn)As in the TEM.

MA 18.4 Tue 15:15 Poster E

Iron filled carbon nanotubes as probes for magnetic force microscopy — •Franziska Wolny, Thomas Mühl, Uhland Weissker, Albrecht Leonhardt, and Bernd Büchner — Leibniz-Institut für Festkörper- und Werkstoffforschung (IFW) Dresden

Iron filled carbon nanotubes (Fe-CNTs) were used to prepare probes for magnetic force microscopy (MFM) by attaching them to the tip of non-magnetic atomic force microscopy cantilevers.

These Fe-CNTs can be regarded as cylinder shaped single domain nanomagnets that are protected from oxidation by a carbon shell. Carbon nanotubes are known to possess both great mechanical stability and elasticity which lead to a much longer lifetime of these probes compared to conventional magnetically coated probes. They exhibit a very high aspect ratio leading to improved topographic imaging on the one hand and better magnetic resolution in MFM on the other hand. In the limit of very long iron nanowires, the lower wire end can be considered as an effective magnetic monopole moment which allows straightforward quantitative stray field measurements.

It has also been shown that attached Fe-CNTs can subsequently be tailored by electron-beam induced oxidation (e.g. to remove disturbing empty carbon shell parts or sharpen the tip) to better fit the requirements of an MFM tip.

MA 18.5 Tue 15:15 Poster E

Imaging of electric transport mechanisms in a ferromagnetic $Ga_{0.96}Mn_{0.04}As$ thin film by low-temperature scanning laser microscopy — •Jochen Tomaschko[1], Stefan Guenon[1], Sebastian T. B. Goennenwein[2], Andreas Brandlmaier[2], Matthias Althammer[2], Wladimir Schoch[3], Wolfgang Limmer[3], Reinhold Kleiner[1], and Dieter Koelle[1] — [1]Physikalisches Institut - Experimentalphysik II, Universität Tübingen, Germany — [2]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [3]Institut für Halbleiterphysik, Universität Ulm, Germany

Due to its possible applications in spintronic devices the diluted magnetic semiconductor (DMS) $Ga_{1-x}Mn_xAs$ has been the subject of intense research. Integral measurements revealed an anisotropic magnetoresistance (AMR) and magnetothermopower (AMTP). Thus, both resistivity and thermopower depend on the orientation of magnetization. By examining a 250nm thick epitaxially grown $Ga_{0.96}Mn_{0.04}As$ Hall-bar with scanning laser microscopy these two quantities (more precisely the bolometric signal dR/dT and the Seebeck-coefficient S_{xx}) could be imaged at temperatures down to 3K with a spatial resolution of $\sim 1\mu m$. We developed simple models to describe these signals and identified them as electric dipole and monopole plus quadrupole signals, respectively. Efforts to image ferromagnetic domains have been made. Furthermore, we discovered inhomogeneities, not visible with conventional optical microscopy and observed a signal possibly due to the diffusion of electron-hole-pairs created by the laser spot.

This work was supported by the DFG (KO 1303/8-1, GO 944/3-1).

MA 18.6 Tue 15:15 Poster E

Time-resolved PEEM measurements on single-crystalline Fe-structures — •Alexander Kaiser, Carsten Wiemann, Stefan Cramm, and Claus M. Schneider — Forschungszentrum Jülich, Institut für Festkörperforschung IFF-9, 52425 Jülich, Deutschland

Time-resolved photo-electron emission microscopy (TR-PEEM) provides a method for investigating the spatial and temporal magnetodynamics of micron-sized magnetic elements. By the use of e-beam evaporation thin films of (100)-oriented Iron in bcc-structure can be epitaxially grown on GaAs substrates with a Silver buffer layer. Due to their single-crystallinity the films exhibit a four-fold in-plane magnetocrystalline anisotropy. The films have been microstructured by lithographic techniques and the micromagnetic response on a short magnetic field pulse was investigated by the TR-PEEM technique. Compared to well-studied polycrystalline Permalloy samples the magnetocrystalline anisotropy gives rise to additional terms in the effective magnetic field, leading to different magnetodynamic behaviour. Results of the time-resolved measurements are presented and compared to those of anisotropy-free Permalloy structures.

MA 18.7 Tue 15:15 Poster E

Gated detector for time-resolved photoemission microscopy — •Carsten Wiemann, Alexander Kaiser, Stefan Cramm, and

Claus M. Schneider — Forschungszentrum Jülich

Photoemission microscopy in combination with X-ray circular dichroism is a well established tool to image magnetic domain patterns in micrometer sized structures. APart from imaging static magnetization patterns, the microscope can be integrated in a time-resolved setup. Here a magnetic field pulse is used to excite a dynamic response of the micromagnetic ordering in the structures, which is in turn imaged by pulsed x-ray illumination from a synchrotron source. With this technique, precession dynamics and domain wall movements in polycristalline permalloy structures have already been successfully investigated. However, the timing requirements make it necessary to use single-bunch beam conditions for these experiments.

Here, we present and compare two different approaches for fast switching of the imaging unit of the microscope in order to exploit the hybrid bunch in the normal injection pattern of Bessy II for time-resolved experiments.

MA 18.8 Tue 15:15 Poster E

Magnetic domain imaging of Co/Pt multilayers by soft x-ray holography — •Carsten Tieg[1], Robert Frömter[2], Christian Menk[2], Holger Stillrich[2], Daniel Stickler[2], Hans Peter Oepen[2], Christian Gutt[3], Olaf Leupold[3], Simone Streit-Nierobisch[3], Lorenz-M. Stadler[3], and Gerhard Grübel[3] — [1]European Synchrotron Radiation Facility, Grenoble, France — [2]Institut für Angewandte Physik, Universität Hamburg, Germany — [3]Deutsches Elektronen Synchrotron, Hamburg, Germany

Soft x-ray holography is a promising technique for magnetic domain imaging. This diffractive imaging technique is based on the interference of resonantly tuned soft x-rays through an ion beam patterned sample-mask assembly. Magnetic contrast is achieved by using the x-ray magnetic circular dichroism effect at the L_3 absorption edges of $3d$ metals. Magnetic domain images are reconstructed by a Fourier transform of the difference of two diffraction patterns recorded by illuminating the sample with coherent circularly polarised light of opposite helicities. We have adapted the concept to the beamline ID08 at the ESRF. Several design parameters like size and number of reference pinholes, size of beam-defining primary pinhole, and the sample to CCD sensor distance were systematically varied in order to study their effect on magnetic contrast and resolution. We present magnetic domain images of Co/Pt multilayer films prepared by sputtering onto a silicon nitride membrane. Applying an out-of-plane magnetic field we imaged the magnetic domain structure throughout the full hysteresis loop of a 8×[Co(0.7nm)/Pt(1.0nm)] multilayer system.

MA 18.9 Tue 15:15 Poster E

XRMR and ReMagX - New tools to tackle magnetic reflectivity — •Sebastian Brück, Bernd Ludescher, Sebastian Macke, and Eberhard Goering — Max Planck Institute for Metals Research, Heisenbergstrasse 3, D-70569 Stuttgart, Germany

Magnetic circular dichroism is one of the most versatile techniques for the investigation of magnetic samples. Especially its application to existing techniques like x-ray reflectivity (XRR) constitutes this claim. Resonant x-ray magnetic reflectivity with circularly polarized light (XRMR) adds an additional contrast to the reflectivity spectra and one can obtain chemical as well as magnetic depth profiles of the sample. Recently this technique has attracted much attention due to its outstanding ability to investigate element specific magnetic effects even at buried interfaces. We present a new experimental setup for the investigation of soft-x-ray magnetic reflectivity from thin-film samples. Optimized to be as versatile as possible its key features are: a temperature range from 30K up to 500K, magnetic fields up to 0.5T at a field resolution better 0.5mT, motor driven azimuthal sample rotation, and a fast load lock and UHV transfer. In terms of data analysis conventional XRR uses the so called Parratt algorithm. The additional resonant magnetic contrast, surface and magnetic roughness phenomena require a more sophisticated approach. In the last years we have developed a powerful software tool to simulate and fit magnetic reflectivity spectra, which has been extended on the basis of the 4x4 matrix formalism. We will present recent experimental and fit results of FeMn/Co and NiCoO/Co exchange bias systems.

MA 18.10 Tue 15:15 Poster E

STM investigation of MBE-grown GaMnAs — •Henning Gutzmann, Andrea Stemmann, Florian Adler, Jens Wiebe, Felix Marczinowski, Christian Heyn, Wolfgang Hansen, and Roland Wiesendanger — Hamburg University, Institute of Applied Physics, Jungiusstr. 9-11, D-20355 Hamburg, Germany

The detailed understanding of the hole mediated magnetic coupling in Mn doped III-V semiconductors is an important step towards room temperature ferromagnetism in semiconductors. Scanning tunneling spectroscopy (STS) has already been used to detect the exchange interaction between Mn acceptors in GaAs [1]. We want to extend this method and directly image the magnetization of Mn in GaAs using spin-polarized STS at low temperatures [2]. The (001) oriented samples are grown in the Hamburg molecular beam epitaxy (MBE) facility. We built a mobile ultra-high-vacuum (UHV) transfer-system which is used to transfer the samples from the MBE into our scanning tunneling microscope (STM) facility [3]. We present the concept of the UHV-transfer system and show first STM measurements at room temperature.

[1] D. Kitchen et al., Nature 442, 426 (2006)
[2] A. Wachowiak et al., Science 298, 577 (2002)
[3] J. Wiebe et al., Rev. Sci. Instrum. 75, 4871 (2004)

MA 18.11 Tue 15:15 Poster E

Influence of sputtering growth parameters on the conductivity of ion-implanted SnO_2:Co thin films — •Ali Awada[1], Dirk Menzel[1], Joachim Schoenes[1], Frank Ludwig[2], and Meinhard Schilling[2] — [1]Institut für Physik der Kondensierten Materie, TU Braunschweig — [2]Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, TU Braunschweig

Magnetic measurements of cobalt doped SnO_2 films show ferromagnetic ordering with Curie temperatures well above 300 K. The magnetic moment per Co ion varies between 0.1 μ_B and 1.5 μ_B [1,2]. Since the magnetic exchange is most likely mediated by free carriers, it is important to correlate the different magnetic moments with the free carrier concentrations. As the conductivity of the tin dioxide is presumably determined by a donor level originating from oxygen vacancies, it is anticipated that the stoichiometry of the sputtered SnO_2 plays a dominant role. In addition, increasing the cobalt concentration lowers the conductivity of the ion implanted SnO_2:Co, which can be interpreted as a charge carrier compensation effect [1]. Parameters like the sputtering power, oxygen partial pressure, total pressure or annealing temperatures have been varied to study the influences on the film growth and the results are correlated with the magnetism in doped SnO_2:Co.

[1] D. Menzel, A. Awada, J. Schoenes, F. Ludwig, M. Schilling, JAP 52th MMM Conference Proceedings (2008)
[2] J. Schoenes, U. Pelzer, D. Menzel, K. Franke, F. Ludwig, and M. Schilling, PSS C **3**, 4115 (2006)

MA 18.12 Tue 15:15 Poster E

Influence of sputtering growth parameters on the conductivity of ion-implanted SnO_2:Co thin films — •Ali Awada[1], Dirk Menzel[1], Joachim Schoenes[1], Frank Ludwig[2], and Meinhard Schilling[2] — [1]Institut für Physik der Kondensierten Materie, TU Braunschweig — [2]Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, TU Braunschweig

Magnetic measurements of cobalt doped SnO_2 films show ferromagnetic ordering with Curie temperatures well above 300 K. The magnetic moment per Co ion varies between 0.1 μ_B and 1.5 μ_B [1,2]. Since the magnetic exchange is most likely mediated by free carriers, it is important to correlate the different magnetic moments with the free carrier concentrations. As the conductivity of the tin dioxide is presumably determined by a donor level originating from oxygen vacancies, it is anticipated that the stoichiometry of the sputtered SnO_2 plays a dominant role. In addition, increasing the cobalt concentration lowers the conductivity of the ion implanted SnO_2:Co, which can be interpreted as a charge carrier compensation effect [1]. Parameters like the sputtering power, oxygen partial pressure, total pressure or annealing temperatures have been varied to study the influences on the film growth and the results are correlated with the magnetism in doped SnO_2:Co.

[1] D. Menzel, A. Awada, J. Schoenes, F. Ludwig, M. Schilling, J. Appl. Phys. 52th MMM Conference Proceedings (2008)
[2] J. Schoenes, U. Pelzer, D. Menzel, K. Franke, F. Ludwig, and M. Schilling, Phys. Stat. Sol. C **3**, 4115 (2006)

MA 18.13 Tue 15:15 Poster E

Investigations of different oxide diluted magnetic semiconductors — •Milan Gacic, Gerhard Jakob, and Hermann Adrian — Institut für Physik, Universität Mainz, Staudinger Weg 7, 55128 Mainz

Though many groups are working for years now on finding the origin of room temperature ferromagnetism in oxide diluted magnetic semiconductors as ZnO or TiO_2 doped with different transition metals, there is still no breakthrough in sight. The results are controversial and it is even not clear whether it is an intrinsic effect. However, the growth process and the growth conditions seem to play an important role.
We did extensive investigations on the wide bandgap semiconductors ZnO and ZrO_2 with different doping combinations. Here we present and compare our results concerning magnetic and transport properties of ZnO:Co, ZnO:(Co, Li), ZnO:C and ZrO_2:Mn thin films. All films were deposited by pulsed laser deposition on sapphire or ZrO_2 substrates at different growth conditions. The magnetic properties were extremely sensitive to the preparation condition. However, there is evidence that mostly defect rich films exhibit ferromagnetism. Most of the samples showed a small anomalous Hall effect as well as a clear and strongly temperature dependent magnetoresistance, which seems to be much more influenced by the doping than the magnetic properties.

MA 18.14 Tue 15:15 Poster E

XMCD study of doped ZnO and Si magnetic semiconductors — •Thomas Tietze[1], Sebastian Brück[1], Saroj Dash[1], Eberhard Goering[1], Milan Gacic[2], Gerhard Jakob[2], Christian Herbort[2], and Hermann Adrian[2] — [1]Max-Planck-Institue for Metal Research, Heisenbergstrasse 3, 70569 Stuttgart, Germany — [2]Institute of Physics, University of Mainz, Staudinger Weg 7, 55099 Mainz, Germany

Diluted magnetic semiconductors (DMS) doped with a few percent (<10%) of magnetic ions, as Co or Mn, have shown room temperature ferromagnetism transforming these to a promising candidate for spintronic devices. Previously, we have unexpectedly found pure paramagnetic behavior of the magnetic ion dopants. Additional Li doping has been used to enhance the ferromagnetic signature of the DMS. Therefore, we have investigated ZnO doped with 5% Co and co-doped with 10% Li thin films and pure Si doped with 5 % implanted Mn. Clear ferromagnetic room temperature properties have been found by SQUID magnetometry. In order to identify the element which is responsible for the ferromagnetic moment, we have performed X-ray Magnetic Circular Dichroism studies at the TM and Si L2,3 edges and the O K edge. We found only a paramagnetic XMCD-signal on the Co and Mn L2,3-edges. With a very high signal to noise ratio of better than 1/10000 we did not find any significant XMCD effect on neither the Si L2,3 nor the O K-edges. In order to clearly probe bulk properties, we have also investigated the resonant magnetic responses in reflection geometry and TFY mode, but no ferromagnetic signature has been found.

MA 18.15 Tue 15:15 Poster E

Magnetic properties of patterned (Ga,Mn)As films — •Matthias Sperl, Frank Hoffmann, Daniel Neumaier, Ursula Wurstbauer, Florian Götz, Christian H. Back, and Günther Bayreuther — Institut für Experimentelle Physik, Univ. Regensburg, D-93040 Regensburg

To study transport properties of the ferromagnetic semiconductors (Ga,Mn)As structures of sub-micron dimensions are frequently used. The question whether magnetic properties in laterally confined (Ga,Mn)As structures are different from extended films has been investigated in the present work.

(Ga,Mn)As films were epitaxially grown on GaAs (001) by means of molecular beam epitaxy. The films are patterned by electron beam lithography and ion etching into large area arrays of uniform circular dots with diameters between 500 nm and 10 micron. The magnetic properties of the dot arrays are measured with magnetooptical Kerr effect and superconducting quantum interference device (SQUID) magnetometry. Additionally, the magnetic anisotropy of single dots is studied with spatially resolved FMR. We find a large increase of the coercive field in patterned films. Furthermore, the influence of the dot size on the Curie temperature and on the magnetic anisotropy is discussed.

MA 18.16 Tue 15:15 Poster E

volume dependence of the curie temperatures in diluted magnetic semiconductors — •brahim belhadji[1], lars bergqvist[1], silvia picozzi[2], and peter h. dederichs[1] — [1]Institut fuer Festkoerperforschung, Forschungszentrum juelich, D-52425 juelich, germany — [2]Dipartimento di Fisica Universit degli Studi di L'aquila, Via Vetoio 10 L'aquila, Italy

Using electronic structure methods and statistical methods we have studied theoretically the volume dependence of the exchange interactions and Curie temperatutes in diluted magnetic semiconductors. In both Mn-doped GaAs and Mn-doped InAs, the calculated Curie temperatures from numerical exact Monte Carlo simulations are more or less constant for a large volume interval. We have compared the exchange mechanisms in Mn-doped GaAs using both the local density approximation (LDA) and the LDA+U method. It is demonstrated that the magnetic properties are determined within Zener's p-d exchange model for the LDA+U, while in LDA it is a mixture between double and p-d exchange mechanisms. Moreover, it is shown that the antiferromagnetic superexchange, which mostly affects the nearest neighbour exchange couplings, becomes more pronounced upon compression of the lattice.

MA 18.17 Tue 15:15 Poster E

Magnetic anisotropy of (100)− **and** (110)−**oriented CrO_2 thin films** — •Manuel J. Schwarz[1], Sebastian T.B. Goennenwein[1], Matthias Opel[1], Rudolf Gross[1], Arunava Gupta[2], Christoph Bihler[3], and Martin S. Brandt[3] — [1]Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]MINT Center, University of Alabama, Tuscaloosa, AL, USA — [3]Walter Schottky Institut, Technische Universität München, Garching, Germany

Ferromagnetic materials with high spin polarization P are very attractive for spin electronics. In this context, chromium dioxide (CrO_2) as a well established half-metallic ferromagnet with a spin polarization $P \approx 0.98$ and a Curie temperature $T_C \approx 390$ K well above room temperature is a promising material. Therefore its magnetic properties, in particular the magnetic anisotropy of strained thin film samples, have to be understood in detail.
We have investigated a series of thin CrO_2 films with thicknesses ranging from 10 nm to 100 nm grown by chemical vapor deposition (CVD) on either (100)−oriented or (110)−oriented TiO_2 single crystal substrates. Using ferromagnetic resonance (FMR) spectroscopy in the X-band (9.3 GHz), we have quantitatively determined the magnetic anisotropy of these samples at room temperature. We find a clear dependence of the magnetic anisotropy on both crystallographic orientation and film thickness. We discuss to which extent this evolution of magnetic anisotropy is linked to epitaxial strain, and compare our results to the literature.

MA 18.18 Tue 15:15 Poster E

An anisotropic Heisenberg model on the trigonal lattice for modelling multiferroic oxides — •Tim Kunze[1,3], Michael Schreiber[1], Carsten Olbrich[2], and Sibylle Gemming[3] — [1]Institut für Physik, Technische Universität, D-09107 Chemnitz, Germany — [2]Jacobs University, D-28725 Bremen, Germany — [3]Forschungszentrum Dresden-Rossendorf, D-01414 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. For this purpose a two-dimensionally periodic trigonal spin system is qualitatively studied with the help of an extended multiparameter Heisenberg model. The temperature dependence of the magnetisation is investigated with the help of a Metropolis-Monte-Carlo algorithm as a function of the anisotropy term and of an external magnetic field. Thermodynamic quantities such as the total energy, the heat capacity and the magnetization are determined by statistical evaluation.

MA 18.19 Tue 15:15 Poster E

Growth and magnetic properties of epitaxial $Fe_{3-x}Zn_xO_4$ thin films — •Deepak Venkateshvaran[1], Andrea Boger[1], Sebastian T. B. Goennenwein[1], Matthias Opel[1], M. S. Ramachandra Rao[2], and Rudolf Gross[1] — [1]Walther-Meissner-Institut, BayerischeAkademie der Wissenschaften, 85748 Garching, Germany — [2]Materials Science Research Centre, Indian Institute of Technology Madras,Chennai-600036, India

Fe_3O_4 is an interesting material for spintronic devices due to its high Curie temperature $T_C \approx 860$ K, and its predicted half metallicity. Doping magnetite with Zn allows to control T_C as well as the carrier concentration without losing mobility of the carriers [1]. In this work,

we investigated the influence of Zn-doping on the magnetic properties, particulary on saturation magnetization, coercivity and remanence.

We have grown epitaxial $Fe_{3-x}Zn_xO_4$ thin films with $x = 0$, 0.1, 0.05 and 0.5 on (001) oriented MgO substrates by pulsed laser deposition. The growth was monitored in situ by reflection high energy electron diffraction (RHEED). The observation of RHEED oscillations proves smooth layer by layer growth. We detected no impurity phases by X-ray diffractometry in combination with a high crystalline quality of the films indicated by a FWHM of the rocking curves of the (004) reflection down to 0.04°. The magnetic properties were investigated by SQUID magnetometry at temperatures between 5 K and 375 K at fields up to 7 T.

[1] J. Takaobushi et al., Appl. Phys. Lett. **89**, 242507 (2006)

This work is supported by DAAD and DFG via priority program 1285.

MA 18.20 Tue 15:15 Poster E

Electronic Structure of shandite $Co_3Sn_2S_2$ — •Matthias Holder[1], Yuri S. Dedkov[1], Serguei L. Molodtsov[1], and Helge Rosner[2] — [1]Institut für Festkörperphsik, Technische Universität Dresden, 01062 Dresden, Germany — [2]Max-Planck Institut für Chemische Physik fester Stoffe, 01187 Dresden, Germany

From theoretical calculation within LSDA method the ground state of shandite $Co_3Sn_2S_2$ is predicted to be ferromagnetic with a tiny gap in the minority spin channel. Previous experimental results from magnetic susceptibility, specific heat, and resistivity measurements on powder samples showed a phase transition to a ferromagnetic metallic state at 177 K with a saturation moment of 0.87μB/f.u. Here we present the results of studies of its electronic structure by means of spin- and angle- resolved photoemission on poly- and singlecristalline $Co_3Sn_2S_2$ samples. Experimental results are discussed in the framework of existing spin- resolved band- structure calculations.

MA 18.21 Tue 15:15 Poster E

Soft x-ray resonant magnetic scattering from magnetic multilayers showing a field induced transition from weak to strong ferromagnetic coupling — •Daniel Lengemann[1], Tanja Weis[1], Dieter Engel[1], Arno Ehresmann[1], Feliks Stobiecki[2], Maciej Urbaniak[2], Bogdan Szymanski[2], Janusz Dubowik[2], Piotr Kuswik[2], I. Sevklo[3], and Andrzej Maziewski[3] — [1]Department of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str.40, D-34132 Kassel — [2]Institute of Molecular Physics, Polish Academy of Sciences, ul. Smoluchowskiego 17, 60-179 Poznan, Poland — [3]Laboratory of Magnetism, Institute of Experimental Physics, University of Bialystok, ul. Lipowa 41, 15-950 Bialystok, Poland

As for sputter deposited multilayers $(Ni_{80}Fe_{20}/Au/Co/Au)_{10}$ with alternating out-of-plane (Co) and in-plane (NiFe) magnetization anisotropy and negligible exchange coupling we found a stripe domain structure in remanence due to a specific magnetostatic coupling.

We present first results of several complementary studies, e.g. element specific soft x-ray resonant magnetic scattering (SXRMS) hysteresis measurements, which indicate, that the reversal of the NiFe magnetization is strongly affected by magnetostatic coupling due to domain stray fields. We will discuss the behaviour of this magnetostatic coupling in dependence of the Co thickness in these multilayers.

MA 18.22 Tue 15:15 Poster E

Dominant role of thermal magnon excitation in the temperature dependence of interlayer exchange coupling — •Kilian Lenz, Sangita S. Kalarickal, Xiaoying Xu, Klaus Baberschke, and Wolfgang Kuch — Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany

Ultrathin Ni/Cu/Co trilayers were deposited on Cu(001) in ultrahigh vacuum (UHV) and the ferromagnetic resonance (FMR) measured *in situ* as a function of both, temperature and out-of-plane angle of the external field. The interlayer exchange coupling J_{inter} can then be unambiguously extracted at various temperatures, entirely from the angular dependence of the resonance field positions [1]. The temperature dependence of $J_{\text{inter}}(T)$ was found to follow an effective power law AT^n, $n \approx 1.5$. Analysis of the scaling parameter A shows an oscillatory behavior with spacer thickness, as does the strength of the coupling at $T = 0$. The results clearly indicate that the dominant contribution to $J_{\text{inter}}(T)$ is due to the excitation of thermal spin waves and that it follows closely recently developed theory [2].

[1] S.S. Kalarickal, X.Y. Xu, K. Lenz, W. Kuch, and K. Baberschke, Phys. Rev. B **75**, 224429 (2007).

[2] S. Schwieger, J. Kienert, K. Lenz, J. Lindner, K. Baberschke, and W. Nolting, Phys. Rev. Lett. **98**, 057205 (2007).

MA 18.23 Tue 15:15 Poster E

Local magnetization study of exchange bias in patterned Co/CoO dots — •Ulrike Wolff[1], Sarah Suck[2], Dominic Givord[2], Jeffrey McCord[1], Ludwig Schultz[1], and Volker Neu[1] — [1]IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany — [2]Institut Néel, CNRS-UJF, 25 avenue des Martyrs, F-38042 Grenoble, Cedex 9, France

It is well known that exchange-bias (EB) originates from symmetry breaking at the interface between a ferromagnet (FM) and an antiferromagnet (AFM). However, due to the presence of complex disordered structural and magnetic configurations at the FM/AFM interfaces, a clear description of this phenomenon is still missing. The role of structural and magnetic defects is expected to be considerably reduced at the nanosize when the single crystalline and single domain state is entered [1]. Therefore, the present work focuses on the study of the local magnetization process in arrays of small (120 x 360 nm^2) Co/CoO dots by magnetic force microscopy at low temperatures (50 K) and in an applied in-plane field. The dots behave as magnetic dipoles where the magnetization reversal mainly occurs in a single switching event explained by a coherent rotation process modified by the exchange bias. Nevertheless, in some dots multidomain formation is observed upon reversal. This behaviour is compared with global magnetization measurements and with additional Kerr microscopy experiments, which probe the magnetization reversal on an intermediate mesoscopic scale.

[1] J. Nogués, J. Sort, V. Langlais, V. Skumryev, S. Surinach, J.S. Munoz, M.D. Baro, Phys. Rep. 422 (2005) 65

MA 18.24 Tue 15:15 Poster E

Time dependent changes of the exchange bias field in MnIr/CoFe bilayers after ion bombardment with 10keV He ions — •Christoph Schmidt[1], Tanja Weis[1], Dieter Engel[1], Volker Höink[2], Günter Reiss[2], and Arno Ehresmann[2] — [1]Department of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str.40, D-34132 Kassel — [2]University of Bielefeld, Department of Physics, Nano Device Group, P.O. Box 100131, D-33501 Bielefeld

The strength and direction of the unidirectional anisotropy of thin magnetic layer systems, showing the exchange bias effect, can be tailored by ion bombardment with e.g. He ions. Some of these systems show a drift of the exchange bias field after ion bombardment in an applied magnetic field with time to a finite value. Depending on the ion dose and the direction of the applied magnetic field relative to the direction of the unidirectional anisotropy before ion bombardment this drift could be to positive or negative exchange bias field values. We will present results demonstrating the time dependence of the exchange bias field for MnIr/CoFe bilayers for different ion doses and different CoFe layer thicknesses, as well as the dependence of the exchange bias field drift on the storing conditions between the magnetic characterization measurements.

MA 18.25 Tue 15:15 Poster E

Positive exchange bias in NiFe/IrMn bilayer — •S. K. MISHRA, F. RADU, H. A. DÜRR, and W. EBERHARDT — BESSY GmbH, Albert Einstein Str. 15, D-12489 ,Berlin, Germany

The microscopic origin of the positive exchange bias, i.e. the shift of the ferromagnetic hysteresis in the opposite direction compared to conventional exchange bias, remains elusive.Recently we observed positive exchange bias in a $Ni_{80}Fe_{20}/Ir_{19}Mn_{81}$ polycrystalline thin-film bilayer system. We have employed soft X-ray Resonant Magnetic Scattering (XRMS) to study element specifically the magnetic properties of the bilayer. After field cooling through the Neel temperature (470K) the system exhibits the conventional negative exchange bias. By training, i.e. repeated magnetization reversals, the positive exchange bias is induced starting at about 420K up to the blocking temperature (450K). This indicates that increasing interfacial magnetic disorder might be the microscopic driving force of the positive exchange bias in the bilayer system.

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MA 18.26 Tue 15:15 Poster E

Training and temperature effects of epitaxial and polycrystalline $Ni_{80}Fe_{20}/Fe_{50}Mn_{50}$ exchange biased bilayers — •Marian Fecioru-Morariu[1], Jerzy Wrona[2], Cristian Papusoi[3], and Gernot Güntherodt[1] — [1]Physikalisches Institut (IIA), RWTH Aachen University, 52056 Aachen, Germany — [2]AGH University of Science and Technology, 30-059 Krakow, Poland — [3]SPINTEC, CEA/CNRS, 38054 Grenoble Cedex 9, France

For exchange biased bilayers of $Ni_{80}Fe_{20}/Fe_{50}Mn_{50}$, the effects of crystalline structure on the training effect of the exchange bias field (H_{EB}) and of the coercive field (H_C) have been investigated for (001) and (110) epitaxial as well as polycrystalline thin film samples [1]. The training effect of H_{EB} and H_C at 5 K is strongest for the polycrystalline sample as compared to the (110)-oriented sample. The training effect is found to originate from the hysteresis cycle-number dependence of H_1, the switching field of the descending branch of the hysteresis loop. A very good qualitative agreement is observed between the cycle-number dependence of H_{EB} and of the fraction of uncompensated spins of the AFM. In the temperature range between 5 K and 300 K, H_{EB} and H_C are found to depend strongly on the crystalline structure and orientation of the FM/AFM bilayers. // The financial support through the EU Research Training Network NEXBIAS (HPRN-CT-2002-00296) is gratefully acknowledged. [1] M. Fecioru-Morariu, et al., submitted.

MA 18.27 Tue 15:15 Poster E

Interfacial magnetic domain coupling study in single-cristalline Fe/CoO bilayers — •Jorge Miguel[1], Radu M. Abrudan[1,2], Matthias Bernien[1], Marten Piantek[1], Carsten Tieg[2], Jürgen Kirschner[2], and Wolfgang Kuch[1] — [1]Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, D-14195 Berlin, Germany — [2]Max-Planck-Institut für Mikrostruktur, Weinberg 2, D-06120 Halle, Germany

X-ray absorption spectroscopy and spectromicroscopy were employed to probe the magnetic and electronic properties of Fe/CoO bilayers with elemental selectivity. The use of a photoelectron emission microscope (PEEM) in connection with x-ray magnetic circular and linear dichroisms (XMCD and XMLD) allows the layer-selective imaging of ferromagnetic (FM) and antiferromagnetic (AFM) domains. Absorption spectra taken from bilayers with different Fe thicknesses show only a weak indication for the formation of Fe oxide at the Fe/CoO interface, and a parallel coupling between the Fe magnetization and the CoO spin axis. XMCD- and XMLD-PEEM images were used to laterally probe both magnetic layers. A magnetic coupling between the layers can be deduced by comparing the magnetic domains in Fe and CoO. In addition to the AFM domains in CoO, which are imaged by XMLD, XMCD images at the Co $L_{2,3}$ edges yield a magnetic contrast due to induced magnetic moments. A perfect overlap in the domain walls of the Fe and CoO layers is observed. Furthermore, Fe layers with thicknesses below the onset of ferromagnetism have an effect on the size of the CoO AFM domains.

MA 18.28 Tue 15:15 Poster E

Magnetic properties of rare earth transition metal borides $R_{2-x}Ni_{21}B_6$ (R = Sc, Zr, Lu) and $Lu_{1.65-x}R_xNi_{21-y}M_yB_6$ (R = Y, Zr; M = Cu) — •Roman Gumeniuk, Walter Schnelle, Helge Rosner, Yuri Prots, Igor Veremchuk, Andreas Leithe-Jasper, and Yuri Grin — Max-Planck-Institut für Chemische Physik fester Stoffe, Dresden, Germany

The crystal structures of the compounds $R_{2-x}Ni_{21}B_6$ (R = Sc, Zr, Lu) have been determined by means of single crystal refinement and belong to the $Cr_{23}C_6$ type. The temperature dependence of the magnetic susceptibility of these compounds is described by a modified Curie-Weiss law. The unexpectedly large paramagnetic moment ($\mu_{\rm eff}$ = 1.49 μ_B/f.u.) for $Lu_{1.65}Ni_{21}B_6$ could indicate that the compound is close to ferromagnetic ordering. LSDA band structure calculations suggest a ferromagnetic ground state where only the Ni atoms at the crystallographic 4a position exhibit a sizable magnetic moment. Experimentally no magnetic order was observed down to 1.8 K. Substitution of Lu by Y or Zr, or Ni by Cu in the crystal structure leads to the suppression of the tendency towards ferromagnetism.

MA 18.29 Tue 15:15 Poster E

Crystal electric field levels in Ho_2PdSi_3 studied by inelastic neutron scattering in magnetic fields — •Fei Tang[1], Matthias Frontzek[1], Michael Loewenhaupt[1], Astrid Schneidewind[1,2], Peter Link[2], Holger Bitterlich[3], and Günter Behr[3] — [1]IFP, TU Dresden, D-01062 Dresden, Germany — [2]FRM-II, TU München, D-85375 Garching, Germany — [3]IFW Dresden, D-01069 Dresden, Germany

The series R_2PdSi_3 (R = rare earth), has been found to exhibit rich magnetic phenomena resulting from the interplay between $RKKY$ interaction, crystal-electric field effects and geometric frustration. Except for the Ho_2PdSi_3 compound the second order crystal electric field parameter dominates the magneto-crystalline anisotropy .

The Ho_2PdSi_3 compound which orders antiferromagnetically at T_N = 7.7K offers therefore the opportunity to study the influence of the higher order crystal electric field parameters. We performed inelastic neutron scattering experiments on a large Ho_2PdSi_3 single crystal in magnetic fields up to 13T at the cold triple axis spectrometer (PANDA, FRM-II). In applied magnetic fields above the critical field for the transition into FM induced state, the crystal electric field levels undergo Zeeman splitting; and the energy shift varies from approx. 0.1meV/T to 0.3meV/T, implying the influence of the higher order crystal field parameters.

In this contribution we will present and discuss the results of the inelastic neutron scattering experiments and give a proposal for the crystal electric field level scheme.

MA 18.30 Tue 15:15 Poster E

Properties of ternary rare earth $REXY$ compounds with 18 valence electrons — •Frederick Casper and Claudia Felser — Institute of Inorganic and Analytical Chemistry, Johannes Gutenberg - University, 55099 Mainz

Ternary rare earth compounds $REXY$, where RE is a lanthanide element, Y a transition element and Z is an sp element, offer a large variety of structure types. Our research focuses on compounds LiGaGe and MgAgAs ($C1_b$) structure which all have 18 valence electrons. Magnetic and resistivity measurements were used to examine some of these compounds. Most of the compounds order antiferromagnetic at low temperatures. While compounds with LiGaGe structure are metallic, many of the compounds with MgAgAs structure are semiconducting. Additionally for some of these compounds a metal-insulator transition was found. The metal - insulator transition temperature depends strongly on the preparation conditions. Both the magnetic ground states and the resistance behavior are in good agreement with electronic band structure calculations.

This work was supported by DFG grant FE633/1-1 within SPP1166.

MA 18.31 Tue 15:15 Poster E

Mößbauer spectroscopy of $Fe_{2-x}Co_{1+x}Si$ Heusler alloys — •Verena Jung, Benjamin Balke, Gerhard H. Fecher, and Claudia Felser — Institute of Inorganic and Analytical Chemistry, Johannes Gutenberg - University, 55099 Mainz

This work reports about the properties of the solid solutions of $Fe_{2-x}Co_{1+x}Si$ Heusler alloys. Generally the X_2YZ Heusler compounds crystallise in the cubic $L2_1$ structure (space group no. 225: $F\,m\bar{3}m$). The cubic X_2YZ compounds are not only found with the $AlCu_2Mn$ type structure but also with the $CuHg_2Ti$ type structure. This formal $XYXZ$-type structure exhibits T_d symmetry (space group no. 216: $F\bar{4}3m$). In that structure the two X atoms occupy non equivalent positions in contrast to the $L2_1$ structure. This structure is frequently observed if the nuclear charge of the Y element is larger than the one of the X element from the same period, that is $Z(Y) > Z(X)$ for two 3d transition metals. However, the two structures may be hardly distinguishable by X-ray diffraction as both have the general fcc-like symmetry. Therefore, ^{57}Fe Mößbauer spectroscopy was performed to determine the local environment and hyperfine magnetic fields of the iron atoms. Two different hyperfine magnetic fields were clearly detected due to the two different local environments of the Fe atoms in $Fe_{2-x}Co_{1+x}Si$ Heusler alloys crystallising in the $CuHg_2Ti$ type structure.

MA 18.32 Tue 15:15 Poster E

Metallurgical Investigations of the Crystal Growth of $Co_2FeAl_{1-x}Si_x$ Heusler Compounds — •Christian G. F. Blum[1], Benjamin Balke[1], Sabine Wurmehl[2], Gerhard H. Fecher[1], Claudia Felser[1], and Armin Reller[3] — [1]Johannes Gutenberg - Universität, 55099 Mainz — [2]Eindhoven University of Technology, 5600 MB Eindhoven, The Netherlands — [3]Universität Augsburg, 86135 Augsburg

The structure of the crystallites of $Co_2FeAl_{1-x}Si_x$ Heusler compounds with $0 \leq x \leq 1$ were investigated. The influence of the annealing process on the crystallisation was studied by annealing the samples for

1-3 weeks at 873-1273 K. Discs were cut from the bulk samples resulting in surfaces with different orientation compared to the direction of the cooling gradient. After polishing, the surfaces of the discs were etched with different acids in order to colour different crystallites differently. The best results were obtained with a solution of 2 mol/L Fe_2Cl_3 in 12% to 8% concentrated HCl. This particular concentrations tinted different crystallites in a different tone while the surface of the sample was not destroyed very deep. Using this approach, different types of crystallites were found: needle-like ones for the Si-rich compounds and block-like for the Al-rich compounds.

The authors gratefully acknowledge financial support by the DFG (Research Unit 559).

MA 18.33 Tue 15:15 Poster E

X-ray Diffraction studies on $RFe_3(BO_3)_4$ — •Jorge Hamann Borrero[1], Martin Philipp[1], Olga Kataeva[2], Rüdiger Klingeler[1], Christian Hess[1], Bernd Büchner[1], Martin von Zimmermann[3], Alexander Vasiliev[4], and Leonard Bezmaternykh[5] — [1]Leibniz Institute for Solid State and Materials Research IFW Dresden, 01171 Dresden — [2]A.E.Arbuzov Institute of Organic and Physical Chemistry of the Russian Academy of Sciences, Arbuzov Str. 8, Kazan, 420088, Russia — [3]HASYLAB@DESY, Notzkestr. 85, 22603 Hamburg — [4]Faculty of Physics, Moscow State University, Moscow, 119992 Russia — [5]Institute of Physics, Siberian Division, Russian Academy of Sciences, Krasnoyarsk, 660036 Russia

Mo X-ray radiation and hard X-rays diffraction experiments, with and without external magnetic field, were made on single crystalline $RFe_3(BO_3)_4$ compounds (R = Tb, Gd, Nd, Dy and Y) in order to elucidate the various interesting crystal structures and phase transitions, with a special focus on $TbFe_3(BO_3)_4$. The crystal structure of this compound is of space group $R32$ at room temperature and undergoes a symmetry reduction at $T < 192K$ to space group $P3_121$ involving slight distortions of the TbO_6 prisms and FeO_6 octahedra. Distinct field dependent structural features were observed on $TbFe_3(BO_3)_4$ when applying a magnetic field parallel to the c axis at T=2K. At fields higher than around 3T, a superstructure peak (0 0 1.5) appears as an indication of a new field induced structure which involves doubling of the unit cell along the c axis. These results are compared with the structures of the other rare earth and Y compounds.

MA 18.34 Tue 15:15 Poster E

Evolution of the crystal structure of $YMn_{2-x}Fe_xO_5$ due to iron doping and DFT calculations for the x=1 compound — •Torsten Weissbach[1], Dmitri Souptel[2], Günter Behr[2], Thomas Führlich[1], Falk Wunderlich[1], Dirk C. Meyer[1] und Sibylle Gemming[3] — [1]Institut für Strukturphysik der TU, Dresden, Germany — [2]Institut für Festkörper-und Werkstoffforschung (IFW), Dresden, Germany — [3]FZ Dresden-Rossendorf, Dresden, Germany

$YMnFeO_5$ is a ferrimagnet below 165 K[1]. Its crystal structure is derived from that of the ferromagnetic and low-temperature ferroelectric YMn_2O_5 by occupation of the Mn position possessing pyramidal oxygen environment with Fe; the other Mn site is coordinated by oxygen in an octahedral manner. Powder samples for x = 0, 0.25, 0.5, 1 [2] were inspected by X-ray powder diffraction and EXAFS, single crystals (x = 0.07, 0.25) by single-crystal X-ray diffraction methods. The structure data show a significant displacement of Fe within the oxygen pyramid, while the Mn position remains nearly constant with respect to the surrounding oxygen atoms. All-electron density-functional calculations in the LSDA+U approximation for the x = 1 compound [3] are in good agreement with the collinear, commensurate ferrimagnetic ordering of the magnetic moments as proposed in [1].

[1] Munoz, A. et al., Chem. Mater. 16, 4087 (2004); [2] all materials prepared by D. Souptel at IFW Dresden; [3] FPLO: Koepernik, K. et al., Phys. Rev. B 59, 1743 (1999)

MA 18.35 Tue 15:15 Poster E

Investigation of the electronic structure of $LuFe_2O_4$ by means of XPS, XAS, XES and calculations — •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, Barbarastr.7, 49069 Osnabrück, Germany — [2]FZ Dresden-Rossendorf, Dresden, Germany — [3]Clarendon Laboratory, University of Oxford, Oxford, UK

The use of magneto electric coupling and multi ferroics in spintronics has led to an intense interest in ferro electric magnets. The spinel $LuFe_2O_4$ is a very promising candidate for such applications because of its giant room temperature magneto dielectric response, which suggests a strong coupling between spin moment and electric dipole. The resulting giant magneto capacitance is due to charge ordering of iron ions. A complex two dimensional ferri magnetism plays an important role for the multi ferroic properties of $LuFe_2O_4$. We determine the electronic structure by means of XPS, XAS and XES. Experimental data is compared with multiplet calculations, which are performed with the TT multiplet program taking into account charge transfer and the crystal field. The comparison with the experiment shows the occupation of tetrahedral and octahedral sites of the crystal.

MA 18.36 Tue 15:15 Poster E

Raman study of FeSi under high pressures up to 15 GPa — •Ivan Jursic, Ana Maria Racu, Dirk Menzel, and Joachim Schoenes — Institut für Physik der Kondensierten Materie, TU Braunschweig, Mendelsohnstr. 3, 38106 Braunschweig, Germany

Single crystals of FeSi which were grown by the Czochralski technique have been investigated by Raman spectroscopy up to pressures of 15 GPa. The measurements were performed at room temperature in a diamond anvil cell (DAC) using Daphne7373 oil as a pressure transmitting medium.

FeSi crystallizes in the B20 structure for which the factor group analysis predicts 9 Raman active modes. Measurements on larger crystals outside of the DAC allowed the assignment of all vibrations.[1] In the DAC only the stronger E-mode vibrations at 182 cm^{-1} and 313 cm^{-1} and the T-mode vibration at 310 cm^{-1} could be observed.

With increasing pressure the frequencies of the vibrations shift to higher wave numbers. For all the observed modes the Grüneisen parameters are calculated and compared to the values from temperature dependent measurements at ambient pressure. The data are discussed in terms of both localized and itinerant models of FeSi.

[1]A.-M. Racu et. al., Phys. Rev. B 76, 115103(2007)

MA 18.37 Tue 15:15 Poster E

Modification of magnetic order in Mn_5Si_3 and Mn_5Ge_3 by C ion implantation — •Christoph Sürgers[1], Niraj Joshi[1], Richard Montbrun[1], Hilbert v. Löhneysen[1,2], Kay Potzger[3], and Wolfhard Möller[3] — [1]Physikalisches Institut and Center for Functional Nanostructures, Universität Karlsruhe, D-76128 Karlsruhe — [2]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe — [3]Institute for Ion Beam Physics and Materials Research, Forschungszentrum Dresden-Rossendorf, Bautzner Landstraße 128, D-01328 Dresden

Antiferromagnetically ordered Mn_5Si_3 can be driven ferromagnetic by incorporation of carbon into the voids of Mn octahedra of the hexagonal structure. While for $Mn_5Si_3C_x$ polycrystals the Curie temperature saturates for $x > 0.22$ at $T_C = 152$ K [1], sputtered $Mn_5Si_3C_{0.8}$ films exhibit a T_C above room temperature [2]. An enhancement of T_C is also found after C doping of the isostructural compound Mn_5Ge_3 which is currently in the focus of possible spintronic applications. In an alternative approach, $Mn_5Si_3C_x$ and $Mn_5Ge_3C_x$ films were prepared by implantation of 45 - 195 keV C^+ ions into Mn_5Si_3 or Mn_5Ge_3 films at elevated temperatures. The carbon-implanted samples exhibit magnetic properties very similar to their respective magnetron-sputtered counterparts as inferred from magnetization and resistivity measurements.

[1] J. P. Sénateur et al., Bull. Soc. Fr. Mineral. Cristallogr. **90**, 537 (1967)

[2] C. Sürgers et al., Phys. Rev. B **68**, 174423 (2003)

MA 18.38 Tue 15:15 Poster E

Local measurement of magnetic anisotropy in (Ga,Mn)As — •Frank Hoffmann, Matthias Sperl, Georg Woltersdorf, Ursula Wurstbauer, and Christian Back — University Regensburg, Germany

The magnetic properties of the ferromagnetic and semi-conducting material (Ga,Mn)As can be accessed by means of static and dynamic experimental approaches (e.g. SQUID, FMR). In contrast to these integrative methods we present a dynamic approach which combines FMR and Kerr microscopy. This local technique enables us to investigate magnetic anisotropies within the laser spot diameter (submicron resolution). Microwaves in the GHz range which are synchronized to the laser probe pulses are used for the excitation of the magnetization. The magnitude of the precessional motion of the magnetization is measured by means of the magneto-optic Kerr effect. By sweeping the magnetic bias field at a fixed excitation frequency both resonance field and linewidth can be obtained. From the angular dependence of

the resonance fields, the anisotropy constants can be determined.

Our results of (Ga,Mn)As on GaAs(001) at low temperatures can be explained by a superposition of several anisotropies: A cubic anisotropy due to the zinc-blende crystal structure, a uniaxial out of plane anisotropy attributed to the compressive strain of (Ga,Mn)As on GaAs and an additional uniaxial in-plane anisotropy in agreement with standard FMR results [1]. At higher temperatures a spin reorientation due to the vanishing of the cubic anisotropy was found.

[1] Liu et al., PRB 67, 205204 (2003)

MA 18.39 Tue 15:15 Poster E

Magnetization measurements of Co-coordinated fullerene-porphyrin dyads under pressure — •Klaus Gieb[1], Konstantin Pethukov[1], Jörg Dannhäuser[2], Andreas Hirsch[2], and Paul Müller[1] — [1]Institut für Physik der Kondensierten Matherie, Universität Erlangen-Nürnberg — [2]Institut für Organische Chemie LS II, Universität Erlangen-Nürnberg

In this report we present the development of a small titanium alloy pressure cell that enables measurements of the magnetic moment under pressure. It can produce a pressure of 0.5 GPa, and is suitable for use in any Quantum-Design SQUID magnetometer. The pressure is established by the solidification of gallium inside the cell. Pressure calibration was established by the shift of the critical temperature of lead. A special background subtraction procedure has been developed. Susceptibility measurements of Co-coordinated fullerene-porphyrin dyads are presented. The samples show a pressure induced shift of the antiferromagnetic ordering temperature.

MA 18.40 Tue 15:15 Poster E

In-situ photoemission and electron microscopy from ferrofluids and nanoparticles dissolved in ionic liquids. — •Siham Ouardi[1], Gerhard H. Fecher[1], Andrei Gloskowskii[1], Lubna Basit[1], Claudia Felser[1], Bert Mallik[2], and Anja Mudring[2] — [1]Institute of Inorganic and Analytical Chemistry, Johannes Gutenberg - University, 55099 Mainz — [2]Inorganic Chemistry I, Ruhr - University, 44801 Bochum

This work reports on in-situ electron spectroscopy on fluids. Photo emission spectroscopy from liquids is a challenging task because the experiments have to be carried out in vacuum. It becomes, however, simplified for ionic liquids due to the low vapour pressure. Results are presented for the ferrofluid $[bmim]_4Dy[SCN]_7[H_2O]$ exited by photons of 4.5 keV. Ionic liquids allow to separate ferromagnetic nano particles that otherwise stick together. Results will be presented for magnetic nanoparticles in [bmpyr][OTf] and Pt nanoparticles in the ferrofluid $[bmim]FeCl_4$ investigated by photo emission excited by laboratory sources for X-rays as well as synchrotron radiation. SEM combined with EDX analysis was used to image the nanoparticles dissolved in the liquid.

MA 18.41 Tue 15:15 Poster E

Magnetoresistance and magnetization of magnetically ordered proton irradiated graphite — •Jose Barzola-Quiquia[1], Martin Rothermel[2], Daniel Spemann[2], Tilman Butz[2], Michael Ziese[1], and Pablo Esquinazi[1] — [1]Division of Superconductivity and Magnetism, University of Leipzig, Leipzig, Germany — [2]Division of Nuclear Solid State Physics, University of Leipzig, Leipzig, Germany

Defect induced magnetic order is a new phenomenon in material science that refers to the triggering and manipulation of magnetic order and magnetic moments in nominally non-magnetic materials by lattice defects and/or non-magnetic add atoms. A noticeable example of this effect is the magnetic order produced by proton irradiation of graphite. In this contribution we present SQUID measurements of the magnetization showing a fluence dependent Curie temperature as well as magnetoresistance and Hall effect measurements showing irreversible behavior similar to that found in ferromagnetic films. This indicates the presence of spin/domain reorientation effects in irradiated graphite. The observed magnetoresistance effects and Curie temperatures above room temperature are promising facts that may lead to useful carbon-based devices in the near future.

MA 18.42 Tue 15:15 Poster E

X-ray and Neutron Scattering on a Ni dot array — •Wolfgang Kreuzpaintner, Dieter Lott, Michael Störmer, and Andreas Schreyer — GKSS Forschungszentrum GmbH, Max-Planck-Str. 1, 21502 Geesthacht

Since some time elastic and inelastic neutron scattering on magnetic bulk and thin layer materials has proven as a reliable analysis method and has even allowed for collecting spin wave information from rare earth super lattice samples with multilayer periods below the μm-scale.

However, for on the sub-μm scale laterally structured magnetic samples, these inelastic experimental possibilities are still not that far developed and, consequently, not that well established. Nevertheless, theoretical calculations show, such experiments should be possible and could yield essential information for the further development of higher density magnetic data storage devices and new technologies like magnetic random access memory as not only magnetic switching behavior but also the spin wave dispersion could be probed in regions of the Brillouin zone which by other means are not accessible.

The middle to long term goal of measuring quantized spin waves on magnetic nanostructures by inelastic neutron scattering is an ambitious task and requires the optimization of a variety of parameters of both, instrumental and specimen sides.

We here present recently performed x-ray and neutron test measurements on Ni dots with 200nm diameter arranged in a 2D square lattice array with 700nm periodicity.

MA 18.43 Tue 15:15 Poster E

Magnetic Quantum Dots — •Peter Moraczewski and Daniela Pfannkuche — 1. Intitut für Theoretische Physik, Universität Hamburg, Jungiusstraße 9, 20355 Hamburg

In semiconductor quantum dots electrons and holes are confined in all three spatial directions. Their eigenstates can be tailored by the used materials, the size and the shape of the dot and also by applied electric and magnetic fields. When we insert atoms with a large magnetic moment, like Mn, into the quantum dot they interact with the electrons or holes via electric and magnetic interactions. We can now expect to manipulate the alignment of the Mn-spins by changing the states of electrons or holes. In III-V semiconductors such as GaAs the Mn atom is an acceptor, so holes will be the main charge carriers. We calculate the eigenstates of several holes in a quantum dot by k*p-theory-, under the influence of a magnetic field and with many-body interaction. Then we examine the interplay between the hole states and the magnetic impurities and calculate the resulting magnetization of the dot.

MA 18.44 Tue 15:15 Poster E

FMR study of ordered submicronscale permalloy antidot arrays — •Stephan Martens, Kornelius Nielsch, and Detlef Görlitz — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstrasse 11, 20355 Hamburg

Antidot arrays, consisting of lattices of holes in continuous magnetic films, exhibit periodic demagnetization field distributions, which effect the magnetic structure and properties in these films. Our almost squarely ordered 180 nm period antidot arrays with a mesh aperture of $\sim$ 80 nm have been prepared by vapor deposition of permalloy on porous anodic alumina substrates. We investigate the anisotropy field of our samples by means of ferromagnetic resonance (FMR) measurements, carried out at 9.2 GHz. The magnetic spectra reveal one uniform and multiple spin wave modes depending on the alignment of the film plane relative to the external field. These angle dependencies are compared with those of the coercive fields, previously observed via vibrating sample magnetometry [1].

[1] F. J. Castaño et al., Appl. Phys. Lett. **85**, 2872 (2004)

MA 18.45 Tue 15:15 Poster E

Analytic formulae for multipole moments of general ellipsoids, elliptic cylinders and prisms — •Nikolai Mikuszeit, Matthias Schult, Elena Vedmedenko, and Roland Wiesendanger — Institute of Applied Physics, University of Hamburg, Jungiusstrasse 11, 20355 Hamburg, Germany

The multipole moments of different homogeneously polarised/charged geometries are calculated analytically. The general shapes include important limits: spheroid and sphere, cylinder or disc, and cube. It is shown that all multipole moments can be expressed as polynomials. The polynomial functions depend on the particle shape and the aspect ratios. Even the solutions for the general ellipsoid, where hypergeometric functions appear, can be expanded in finite polynomials of the semi-axes [1]. The calculations are valid up to every order of the multipole expansion. Some results are extended to symmetric two-/multidomain states.

The results allow to calculate potentials as well as interaction energies within the framework of multipole expansion. It is therefore

easy to consider important higher order interactions—corrections to dipole-dipole energies—in systems of interacting particles, where the interparticle distance is of the order of the particle size [2].

[1] M. Schult, N. Mikuszeit, E. Y. Vedmedenko, and R. Wiesendanger, 2007, J. Phys. A, *accepted*

[2] E. Y. Vedmedenko, N. Mikuszeit, H. P. Oepen, and R. Wiesendanger, 2005, Phys. Rev. Lett. **95**, 207202

MA 18.46 Tue 15:15 Poster E

Preparation of anti-vortex configurations in Permalloy micromagnets — •Christian Dietrich, Christian Back, and Josef Zweck — Institut für Experimentelle und Angewandte Physik der Universität Regensburg, Germany

Permalloy magnets with lateral dimensions in the micron range or below show several (quasi)-stable magnetic configurations depending on thickness, precise shape and size. The static and dynamic properties of single-domain and vortex configurations are numerously published. On the way to do current-induced anti-vortex excitations we investigate how to experimentally prepare a preferably single anti-vortex. In general anti-vortex configurations in patterned magnetic films are characterised by a local energy minimum and only for specific shapes or dimensions these configurations reach an absolute energy minimum. The energy landscapes were studied by micromagnetic simulations. Rectangles with a particular aspect ratio and thickness show an anti-vortex configuration as most stable state in remanence. Micromagnetic simulations were also used to optimize the shape of the micromagnets to enhance the probability for the creation of an anti-vortex in remanent state for a given direction of the saturating magnetic field. To verify the simulations we investigated Permalloy rectangles with a constant width of 1 micron and different thicknesses and lengths by Lorentz transmission electron microscopy using the Fresnel mode, which allows a fast and simultaneous evaluation of many rectangles. Different magnetic configurations can be observed, with their frequency related to the energy distribution.

MA 18.47 Tue 15:15 Poster E

Hall micromagnetometry of magnetic vortices and single domain walls — •Lena Breitenstein, Peter Lendecke, René Eiselt, Ulrich Merkt, and Guido Meier — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstrasse 11, 20355 Hamburg, Germany

Hall micromagnetometry is a powerful tool for the investigation of the magnetization of nanostructures. We apply the technique to study magnetic vortices [1] and domain-wall depinning [2] in Permalloy squares and wires. Both sample geometries are investigated in the temperature range between 1.6 and 50 K. In the square elements the vortex core is nucleated and driven through the sample by an external magnetic field. Because of the high sensitivity of the Hall sensor to the local stray fields we identify vortex core nucleation and displacement as well as minor loops. Thus the vortex state can be separated from other micromagnetic configurations. Furthermore we investigate the temperature dependence of the vortex core nucleation and displacement. In the wire geometry we examine the temperature dependence of depinning fields of single domain walls to gain knowledge about the pinning potential. The observations are well described by a model with a single energy barrier. Magnetic-force microscopy and micromagnetic simulations round out the low temperature experiments.

[1] M. Rahm, J. Stahl, W. Wegscheider, and D. Weiss, Appl. Phys. Lett. **85**, 1553 (2004).

[2] P. Lendecke, R. Eiselt, U. Merkt, and G. Meier, submitted.

MA 18.48 Tue 15:15 Poster E

Understanding the behaviour of mesoporous Co3O4 using TRM-IRM curves as fingerprints of magnetic systems — •María José Benítez Romero[1], Oleg Petracic[1], Yuriy Yanson[1], Elena Lorena Salabas[2], Ferdi Schüth[2], and Hartmut Zabel[1] — [1]Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universität, Bochum, Germany — [2]Max-Planck Institut für Kohlenforschung, Mülheim an der Ruhr, Germany

Antiferromagnetic mesoporous Co3O4 exhibits interesting magnetic properties at low temperatures: bifurcation of the FC and ZFC susceptibilities at 30 K and shifted hysteresis loops after field cooling. This anomalous behavior originates due to the exchange interaction between the AFM core and the surface spins. To understand the nature of the surface spins in the nanostructured Co3O4 we propose to study the thermoremanent magnetization (TRM) and isothermal remanent magnetization (IRM) curves in this AFM as well as in other magnetic systems. The ordered mesoporous Co3O4 has been synthesized using the nanocasting method. The nanowires were characterized using X-ray diffraction, N2 adsorption-desorption isotherms, transmission electron microscopy and a superconducting quantum interference device magnetometer. We report measurements of thermoremanent moments and isothermal remanent moments in spin glass, exchange bias, superparamagnetic and antiferromagnetic systems. The analysis of thermal and isothermal remanence curves suggest that the mesoporous Co3O4 consists of antiferromagnetically aligned core spins and a spin-glass-like surface layer.

MA 18.49 Tue 15:15 Poster E

XMCD studies of FePt nanocrystals — •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 bi-magnetic FePt hybrid nanocrystals, prepared in a "one-pot" technique, using X-ray magnetic circular dicroism (XMCD). These hybrid nano crystals consist of a metallic FePt core with fcc structure and an iron oxide shell with inverse spinell crystal structure, which is a mixture of magnetite (Fe3O4) and maghemite (γ-Fe2O3). The investigations were performed both surface-sensitive in total electron yield mode (TEY) and bulk-sensitive in transmission.

These spectra have been analysed in terms of a linear superposition of suitable reference data. So we could determine the radial composition of the nanocrystals and the contributions of the constituents to the overall magnetic moment. A comparison between TEY and transmission measurements shows that the iron oxide shell is mainly maghemite like, while the surface magnetisation has predominantly magnetite character. With decreasing temperature the XMCD transmission results are in perfect agreement to bulk sensitive SQUID-measurements, while the surface exhibits a stronger increased magnetic moment at low temperatures.

MA 18.50 Tue 15:15 Poster E

Structure and magnetic properties of iron-platinum particles with iron oxide shell. — •Lubna Basit[1], Ibrahim Shukoor[1], Vadim Ksenofontov[1], Wolfgang Tremel[1], Gerhard H. Fecher[1], Claudia Felser[1], Sergei A. Nepijko[2], Gerd Schönhense[2], and Michael Klimenkov[3] — [1]Institut of Inorganic and Analytical Chemistry, Johannes Gutenberg - University, 55099 Mainz — [2]Institut of Physics, Johannes Gutenberg - University, 55099 Mainz — [3]Institut of Materials Research I, Forschungszentrum Karlsruhe, 76021 Karlsruhe

Nanoparticles of solid solution Fe_xPt_{1-x}, where $0.25 \geq x \geq 0$ with Fe_2O_3 shell were synthesized and characterized by high-resolution transmission electron microscopy, energy dispersive X-ray analysis, electron energy loss spectroscopy, Mößbauer spectroscopy and magnetometry. The magnetic properties, of such two-phase particles are interesting because their core is antiferromagnetic or paramagnetic (at very small values of x) whereas the shell is ferrimagnetic. The size of the particles was in the range of several nanometers. ^{57}Fe Mößbauer spectroscopy revealed a blocking temperature of about 100 K above which the particles are superparamagnetic. Towards lower temperatures, the magnetic characteristics showed an increase of magnetic rigidity. The saturation magnetization increases by a factor of 1.4 between room temperature and 5 K.

MA 18.51 Tue 15:15 Poster E

Investigations of confined domain walls in nanoscale constrictions — •Jan Rhensius[1,2], Dirk Backes[1,2], Laura Heyderman[1], Christian David[1], Mathias Kläui[2], Christine Schieback[2], Peter Nielaba[2], Friederike Junginger[2,3], Henri Ehrke[2,3], Ulrich Rüdiger[2], Takeshi Kasama[3], and Rafal Dunin-Borkowski[3] — [1]Laboratory for Micro- and Nanotechnology, Paul Scherrer Institut, Switzerland — [2]FB Physik, Universität Konstanz — [3]Department of Materials Science and Metallurgy, University of Cambridge, UK

Magnetic domain walls in curved-line elements can exhibit a vortex or transverse wall spin structure. A notch forms a constriction, which pins TW inside the constriction and the VW adjacent to the notch [1]. Such elements were fabricated on membranes with constrictions as narrow as 30 nm [2]. Electron holography is used to study the spin-structure around the constriction with a spatial resolution below 5 nm. The shape of the walls depends on the geometry which we characterize systematically. In total three different spin configurations were found,

depending on the size of the constriction and the element width. Symmetric and asymmetric TW were found for narrow constrictions, VW were found for wider constrictions. The width of the domain walls was found to depend on the constriction and decreases with decreasing constriction width super linearly [3]. The experimental data was compared with micromagnetic simulations using a Heisenberg model.

[1] M. Kläui et al., Appl. Phys. Lett. 87, 102509 (2005)
[2] D. Backes et al., Microelectron. Eng. 83, 1726 (2006)
[3] D. Backes et al., Appl. Phys. Lett. 91, 112502 (2007)

MA 18.52 Tue 15:15 Poster E

Structural and magnetic properties of thin CoCrPt-SiO_2 films and their application to patterned media — •Felix Springer[1], Christoph Brombacher[2], Hartmut Rohrmann[3], Marco Sauer[3], and Manfred Albrecht[2] — [1]University of Konstanz, Department of Physics, 78457 Konstanz, Germany — [2]Chemnitz University of Technology, Institute of Physics, 09107 Chemnitz, Germany — [3]OC Oerlikon Balzers AG, 9496 Balzers, Liechtenstein

Thin granular films of CoCrPt-SiO_2 are used as storage layer in perpendicular magnetic recording media. In order to investigate the properties of the storage layer only, we reduced the layer stack of a conventional hard disk to a system consisting of substrate/Ta/Ru/CoCrPt-SiO_2. We studied the properties of this system deposited under various growth conditions and observed a strong relationship between structural and magnetic properties. The formation of small grains in the hcp (0001) oriented Ru intermediate layer supported the formation of hcp (0001) oriented columnar CoPt grains in the magnetic layer. With increasing segregation of SiO_2 and Cr to the grain boundaries the exchange coupling between single CoPt grains was reduced and the coercivity increased. The application of those CoCrPt-SiO_2 films to patterned media might be a promising candidate to achieve areal densities of more than 1Tbit/in^2. Thus we deposited film systems onto arrays of SiO_2 nano spheres. Particles with diameter down to 10nm have been coated by reducing the overall film thickness and adjusting the deposition conditions of the different layers.

MA 18.53 Tue 15:15 Poster E

Magneto-optic investigations on the dynamics of the switching behavior of CoFeB TMR structures — •Georg Wolf, Patrizio Candeloro, Patricia Martin Pimentel, Helmut Schultheiss, Britta Leven, and Burkard Hillebrands — FB Physik and FSP MINAS, TU Kaiserslautern, Erwin-Schrödinger-Str. 56, 67663 Kaiserslautern, Germany

For technical applications of TMR structures like magnetic random access memory or magnetic logic devices the dynamics of the switching behavior is of great importance. Optimizing the switching process is a major task in the development of these devices. We report on time-resolved Kerr microscopy investigations on the dynamics of 3 x 6 μm^2 ellipsoidal CoFeB-TMR structures under the influence of two orthogonal magnetic field pulses [1]. The TMR stack has been prepared in collaboration with the group of Guenter Reiss, University of Bielefeld. This study is focused on the dynamic behavior of the free magnetic layer. The field pulses were oriented in 45° geometry with respect to the easy magnetic axis of the system in the so called Savtchenko-geometry [2]. The field response of the different magnetization components is presented and compared with simulations in a macro spin approximation. These simulations yield a good agreement with the measurements. Financial support by the EU-IST Project MAGLOG (510993) is gratefully acknowledged.

[1] P.Martin Pimentel et al, Appl. Phys. Lett., **88**, 122510, (2006).
[2] L. Savtchenko et al. US Patent 6,545,906 B1, Apr. 8 (2003).

MA 18.54 Tue 15:15 Poster E

Magnetic interactions and anisotropies present in ferromagnetic nanotubes of manganites — •Rodolfo D. Sanchez[1,2], Javier Curiale[1], Horacio Troiani[1], Alejandro Butera[1], Ana G. Leyva[3], and Pablo Levy[3] — [1]Centro Atómico Bariloche (CNEA), Av. Bustillo 9500 Bariloche (RN-8400), Argentina — [2]I Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, D-37077 Göttingen, Germany — [3]Centro Atómico Constituyentes (CNEA), Av. Gral Paz 1499 (B1650KNA), Buenos Aires, Argentina

We present a work about FM manganites with tubular morphology at the nanoscale. Although their FM transition temperatures (Tc) are close to the bulk, the rest of their magnetic properties are notably affected. These tubes have an external diameter of 800nm and their walls are constituted by an assembly of nanoparticles with size of 25nm. The wall thicknesses are 45 nm for LSMO and 60 nm for LCMO. Our previous study[1] shows that each grain is a single magnetic domain, with a thick dead layer on the surface and dipolar magnetic interactions between them. In order to characterize completely the interactions between the magnetic nanograins, we show First-Order Reversal Curves (FORC) diagrams. We also discuss the role of the interaction in the configuration of the magnetic moments. FM resonance results on aligned LSMO nanotubes complete this study, with information about the magnetic anisotropies present in the system.

[1] J. Curiale,et al. Phys. Rev. B 75, 224410 (2007) RDS acknowledges financial support of DFG (via its Leibniz-Program) during his stay in Göttingen.

MA 18.55 Tue 15:15 Poster E

Preparation and characterisation of Ni and Ni/Ag nanowire arrays in alumina — •Gesa Beck and Kerstin Petrikowski — Forschungsinstitut Edelmetalle und Metallchemie, Katharinenstr. 17, 73525 Schwäbisch Gmünd, Germany

Magnetic nanowires, fabricated by various methods, represent an important family of magnetic nanostructures. Imbedding magnetic nanowires in a regular matrix yields systems which are promising candidates for magnetic storage media. One example for such systems are magnetic nanowire arrays in alumina.

Nanoporous alumina with a self-organised hexagonal arrangement of the nanopores can be formed by anodic oxidation of aluminium. In the nanopores metallic nanowires can be electrodeposited, resulting in a nanowire array in alumina.

We prepared alumina with highly ordered nanopores by two-step anodisation and subsequently electrodeposited both Ni and Ni/Ag-layered nanowires in the nanopores. The systems were characterised by X-ray diffraction, high resolution scanning electron microscopy, magnetic hysteresis and magnetoresistance measurements.

MA 18.56 Tue 15:15 Poster E

Growth parameters and transport properties of WC and PdC nanowires prepared in a Dual Beam Microscope — •Detlef Spoddig[1], Kristian Schindler[1], Peter Rödiger[1], Jose Barzola-Quiquia[1], Holger Motzkau[1], Katharina Fritsch[1], Hans Mulders[2], and Pablo Esquinazi[1] — [1]Abteilung für Supraleitung und Magnetismus, Institut für Experimentelle Physik II, Universität Leipzig, Linnéstr. 5, D-04103 Leipzig, Germany — [2]FEI Electron Optics, Achtseweg Noord 5, 5651GG AE Eindhoven, The Netherlands

Here we present investigations on the growth conditions and the electrical transport properties of Tungsten Carbon (WC) and Palladium Carbon (PdC) nanostructures on Si substrates using a focused ion beam and a scanning electron microscope. In-situ energy dispersive x-ray characterizations reveal that electron beam induced WC and PdC nanostructure depositions (EBID) show a lower metal concentration (below 3 at.%) than in ion beam induced deposition (IBID) (above 20). For PdC the growth pattern and the Pd/C content were optimized by adjusting the deposition temperature of the precursor material. In-situ measurements of the resistivity as a function of thickness reveal a minimum at 200 nm. The lowest resistivity obtained for the PdC and WC is two orders of magnitude higher than the bulk values. The EBID samples show a non-metallic behaviour due to the low metal content. The temperature and magnetic field dependence of the IBID structures reveal a behaviour similar to disordered or granular conductors. The upper critical field and current density of the WC structures were measured below the superconducting critical temperature of 5 K.

MA 18.57 Tue 15:15 Poster E

Remagnetization patterns in 2-d arrays of hard magnetic elements embedded in a soft magnetic matrix — •Sven Schnittger[1], Jonas Norpoth[1], Christian Jooss[1], Sybille Sievers[2], and Uwe Siegner[2] — [1]Institut für Materialphysik, Universität Göttingen — [2]Physikalisch-Technische Bundesanstalt, Braunschweig

In a regular array of moderately hard magnetic elements, the stray field coupling between neighbouring elements may become important. In this contribution, the influence of a surrounding soft magnetic matrix on this magnetostatic interaction is investigated [1]. The remagnetization behaviour of 2-d artificial dot arrays is examined by means of Magnetic Force Microscopy (MFM) and Magneto-Optic Indicator Film-Technique (MOIF). (001)-L10 CoPt and Co-ferrite provide regularly arranged elements with different magnetocrystalline anisotropy; the mediating soft magnetic matrix consists of Permalloy. A Permalloy antidot array is investigated as reference sample. Additionally,

straightforward stray field calculations are performed to determine characteristic features of the corresponding stray field distributions.

[1] S. Schnittger, S. Dreyer, Ch. Jooss, S. Sievers, and U. Siegner, APL 90, 042506 (2007)

MA 18.58 Tue 15:15 Poster E

Investigation of permalloy nanowire-based NOT gates in the microwave regime using crossed coplanar waveguides — •Andres Conca, Patricia Martin Pimentel, Britta Leven, and Burkard Hillebrands — FB Physik + FSP MINAS, TU Kaiserslautern, Erwin Schrödinger-Str. 56, 67633 Kaiserslautern, Germany

Serious obstacles must be confronted in order to reduce the dimensions and power consumption of Si-based logic devices. In this context, alternative possibilities exploiting the magnetic properties of materials have triggered a large research effort.

Recently, Allwood *et al.* [1] proved logic operations by domain wall motion at low frequencies (27 Hz) in structures consisting of nanometric permalloy wires under a rotating static magnetic field.

In collaboration with the Imperial College London, similar gates are patterned with focused ion beam on top of a crossed coplanar waveguides (cpw's) scheme previously developed by P. Martín Pimentel [2]. Microwave currents phase-shifted by $\pi/2$ are sent through two cpw's in order to achieve a rotating microwave field. Main aim of this research is the investigation of the behavior of the NOT gates at larger frequencies (20MHz-1GHz) in order to find the maximal operating speed of the devices. For this purpose, a time-resolved Kerr microscope is used. Here, results concerning the magnetic response of the NOT gates in the mentioned frequency range are shown and discussed.

Support by MAGLOG (IST-FET-510993) is acknowledged.

[1]D. A. Allwood *et al*, *J. Appl. Physics*, **95**, 8264 (2004).

[2]P. Martín Pimentel *et al*, *Appl. Phys. Lett.*, **88**, 122510 (2006).

MA 18.59 Tue 15:15 Poster E

Magnetization reversal in a twodimensional two-phase magnet — •Sibylle Sievers[1], Sven Schnittger[2], Sebastian Dreyer[2], Christian Jooss[2], Kai-Felix Braun[1], and Uwe Siegner[1] — [1]Physikalisch-Technische Bundesanstalt, Braunschweig — [2]Institut für Materialphysik, Universität Göttingen

We characterized the remagnetization behaviour of a two-dimensional two-phase ferromagnet. For the fabrication of the two phase magnet hard magnetic structures (CoPt) were patterned and embedded in a soft magnetic film (Permalloy). The magnetic characterization has been done by a magneto-optical indicator film technique using the Faraday Effect and by magnetic force microscopy. The remagnetization process was investigated at increasing reversal fields. In the soft magnetic matrix a long range ordered symmetry breaking domain pattern was found. Furthermore, a correlation between reversal domains in the hard magnetic structures and the matrix was observed. The mechanisms of the magnetization reversal will be discussed.

MA 18.60 Tue 15:15 Poster E

Direct laser interference patterning of magnetic thin films — •Sebastian Fischer, Philipp Leufke, Stephen Riedel, Manfred Albrecht, Paul Leiderer, and Johannes Boneberg — University of Konstanz, Department of Physics, D-78457 Konstanz, Germany

We report on direct laser interference patterning of magnetic thin films. When exposed to nanosecond laser pulses the films are annealed locally. Thus, the magnetic behaviour is locally altered. The direct laser interference patterning is performed using two, three and four beams of a ns-Nd: YAG laser system at wavelengths of 532 and 266 nm. Different patterns of light intensity can be created by varying the angle of incidence or polarization of the beams. The received magnetic patterns were locally investigated with magnetic force microscopy and compared with the hysteresis loops measured by polar magneto-optical Kerr effect and superconductive quantum interference device magnetometry.

MA 18.61 Tue 15:15 Poster E

Microfluidic Separation System for Magnetic Beads — •Frank Wittbracht, Alexander Weddemann, and Andreas Hütten — Bielefeld University, Universitätsstraße 25, 33615 Bielefeld

Lab-on-a-chip technologies and the μTAS have gained importance in recent years. The ultimate goal is the integration of all functions and components needed for the analysis of a sample on microfluidic chips. Magnetic materials are used widely in these systems for different applications such as magnetohydrodynamic pumps and magnetic valves. Especially in terms of separation and detection of biological samples magnetic materials are suitable.

In this work a microfluidic separation system for magnetic beads was experimentally realized according to theoretical simulations. The separation of magnetic beads is achieved by magnetic gradient fields resulting from conducting lines that are structured on the fluidic chip. Silicon wafers are used as a substrate and enable the integration of XMR sensors into the microfluidic device. Microfluidic structures are built with SU-8 negative photo resist due to its excellent mechanical and chemical stability.

MA 18.62 Tue 15:15 Poster E

Simulation of the magnetization dynamics of ferromagnetic layers on nano-spheres — •Daniel Mutter and Peter Nielaba — Physics Department, University of Konstanz, 78457 Konstanz, Germany

In this work we investigated the magnetization-dynamics of ferromagnetic caps on nano-spheres with computer simulations. These caps are regarded as a promising approach for a further reduction of the magnetic storage density in hard-disks [1]. In our calculations, the magnetic volume was modeled by magnetic moments, arranged on a discrete lattice, which interact with each other due to exchange and dipole-dipole coupling [2]. Additionally, there is an anisotropy in the system, which is directed perpendicular to the surface of the sphere. The dynamics was analyzed by numerical solving of a stochastic extension of the Landau-Lifshitz-Gilbert equation to include temperature effects. We present results concerning hysteresis-effects for different cap- and cell-sizes in the presence of external magnetic fields under various angles. The dynamics of the magnetization reversal at the coercive field strength is analyzed, and a comparison with the behavior of classical Stoner-Wohlfahrt particles shows significant differences in the reversal mechanisms.

[1] M. Albrecht, G. Hu et al., *Magnetic multilayers on nanospheres*, Nature Materials, **4**, 203 (2005).

[2] U. Nowak, *Thermally activated reversal in magnetic nanostructures*, Annual Reviews of Computational Physics, **IX**, 105-151 (2001).

MA 18.63 Tue 15:15 Poster E

Numerical investigation of geometrically confined domain walls and spin torque using the Heisenberg model — •C. Schieback[1], U. Nowak[2], M. Kläui[1], D. Backes[1,3], L. J. Heydermann[3], U. Rüdiger[2], and P. Nielaba[1] — [1]Department of Physics, University of Konstanz, 78457 Konstanz, Germany — [2]Department of Physics, University of York, York YO10 5DD, UK — [3]Laboratory for Micro- and Nanotechnology, Paul Scherrer Institut, CH-5232 Villingen PSI, Switzerland

Computer simulations are preformed on a classical spin model. Thermal activation of the system is taken into account by numerically solving the Landau-Lifshitz-Gilbert equation with Langevin dynamics.

Using this model, we study systematically the influence of lateral constrictions on the spin structure of transverse domain walls in permalloy nano-structures. The domain wall width is strongly correlated with the constriction width. Reduced constriction width leads to a superlinear scaling of the wall width [1]. Furthermore we calculate the response of a domain wall to a current due to a spin transfer torque resulting in current-induced domain wall motion. We compute the behavior of domain walls in a one dimensional chain when currents are injected using adiabatic and non-adiabatic spin torque terms [2]. Our results are compared to analytical calculations and are found to agree very well for small current density predictions.

[1] D. Backes et al., APL 91, 112502 (2007). [2] C. Schieback et al., EPJ B, DOI:10.1140/epjb/e2007-00062-2

MA 18.64 Tue 15:15 Poster E

Thermodynamically Extended Preisach Modeling of Magnetic Properties of Ni-Nanoparticles in Fullerene Films — •Sven Schubert and Günter Radons — Chemnitz University of Technology, D-09107 Chemnitz

For developing high-density recording memories decreasing the particle size and optimizing their packing is necessary. Therefor, small molecules, e.g. fullerene (C_{60}), are used as a matrix for metallic magnetic nanoparticles. As the scales are shrinking the interaction between particles and the properties of the interface to the surrounding medium are enhanced.

To avoid a complicated surface dependency and gain a more general model a thermodynamically extended Preisach approach is used for modeling the magnetic behavior of Ni nanoparticles embedded in

fullerene matrices.

The achieved results are compared to experimental data [1]. Among other things, it is shown that taking into account small particle hysteresis leads to a better agreement with SQUID measurements than using a standard practice Preisach distribution function. This suggests a physical picture consisting of a large number of small particles with small coercive fields within the matrix.

[1] G. Salvan et al. J. Appl. Phys. submitted.

MA 18.65 Tue 15:15 Poster E

Observation of a spin spiral state in the Mn monolayer on W(001) — Kirsten von Bergmann, Paolo Ferriani, Elena Vedmedenko, •André Kubetzka, Stefan Heinze, and Roland Wiesendanger — Institute of Applied Physics, University of Hamburg, Germany

The magnetism of single atomic layers is a fascinating topic. Due to the reduced symmetry, changed nearest neighbor distances, and hybridization with the substrate the magnetic properties can be quite distinct from the respective bulk systems. A variety of magnetic structures can be observed, ranging from collinear ferro- or antiferromagnetic states to complex non-collinear spin structures. Spin-polarized scanning tunneling microscopy (SP-STM) combines magnetic sensitivity with high lateral resolution and therefore grants access to such complex magnetic order with unit cells on the nanometer scale. Recently, different intricate magnetic structures have been observed in pseudomorphic $3d$ atomic layers on $5d$ transition metal substrates [1,2].

Here we present SP-STM data of the pseudomorphic Mn layer on W(001). We observe a spin spiral with a periodicity on the nanometer-scale. Due to the four-fold symmetry of the surface, two rotational domains are possible. Via spin-orbit interaction the spin-spiral and the rotational domains can also be imaged with non-magnetic probe tips [3].

[1] K. von Bergmann *et al.*, Phys. Rev. Lett. **96**, 167203 (2006).
[2] M. Bode *et al.*, Nature **447**, 190 (2007).
[3] M. Bode *et al.*, Phys. Rev. Lett. **89**, 237205 (2002).

MA 18.66 Tue 15:15 Poster E

Spin-dependent surface electronic structure of Gd(0001) near the Fermi-level: An angle-resolved (I)PE study — •Michael Budke, Alexander Wittkowski, Juliet Correa, and Markus Donath — Physikalisches Institut, WWU Münster, Wilhelm-Klemm-Str. 10, 48149 Münster

A widely accepted picture for the surface electronic structure of Gd(0001) comprises a spin-split surface state (SS) with its mayority part 0.2 eV below E_F and its minority part 0.5 eV above E_F with a finite exchange splitting of 0.4 eV at T_C [1]. The discussion about this SS remains controversially because spin-resolved inverse photoemission identified a SS with both minority and majority components above E_F [2]. The reason for these conflicting results might be found in different sample conditions since the Gd films are usually grown on W(110), a material with considerably different lattice constant than Gd. To overcome this suspicion, we performed both, spin- and angle-resolved direct (PE) and inverse photoemission (IPE) on the same sample preparation of a 30 ML Gd film grown on Y(0001). We were able to identify two SSs with their minority and majority components well separated from E_F. While the occupied SS shows spin-mixing behaviour as observed in other PE experiments, the unoccupied SS exhibits an exchange splitting of 250 meV that vanishes at T_C. To identify the nature of the unexpected SS, we performed angular-resolved IPE measurements that support the interpretation as d-like SS above E_F and reveal a variety of additional spectral features. [1] Getzlaff *et al.*, JMMM **184**, 155 (1998). [2] Donath *et al.* PRL **77**, 5138 (1996).

MA 18.67 Tue 15:15 Poster E

XMCD and Spin-Resolved Photoemission on Ce/Fe Interfaces — •Matthias Holder[1], Yuri S. Dedkov[1], Yuri Kucherenko[2], Mikhail Fonin[3], Sönke Voss[3], Alexei Preobrajenski[4], Serguei L. Molodsov[1], and Clemens Laubschat[1] — [1]Institut für Festkörperphysik, Technische Universität Dresden, 01062 Germany — [2]Institute for Metal Physiscs, National Akademie of Science Ukraine, 03142 Kiev, Ukraine — [3]Fachbereich Physik, Universität Konstanz, 78457 Konstanz, Germany — [4]MAX-lab, Lund University, 22100 Lund, Schweden

The correlation effects of the Ce $4f$ shell with extended valenz-band electrones are usually described in the framework of the Anderson model. These correlations are the most importend mechanism for description of magnetic properties of Ce- compounds. Here the electronic as well as the magnetic properties of Ce/Fe interface were studied by means of magnetic dicroism and Spin-resolved Photoemission. Obtained experimental results were treated by LSDA calculations and periodic Anderson model.

MA 18.68 Tue 15:15 Poster E

Combined study of topography and electronic structure of Co/Cu(001) — •Tobias Allmers, Michael Budke, and Markus Donath — Physics Institute, University of Münster, Wilhelm-Klemm-Str. 10, 48149 Münster

In this contribution we report on results for fcc Co thin films on Cu(001). Our experimental setup allows the combined study of the topography (via scanning tunneling microscopy) and the spin-dependent electronic structure below and above the Fermi-level (via spin- and angle-resolved direct and inverse photoemission) [1]. The influence of different growth conditions on the topography and the electronic structure was investigated. With the possibility to dose adsorbates onto the surface, we were able to distinguish between surface and bulk contributions to the spectral features. We studied quantum-well states, which show up as well defined spectral features for flat interfaces and therefore serve as a sensor for the quality of interfaces [2], as well as the influence of the topography *and* the adsorbate sensitivity of surface resonance states of Co/Cu(001) [3].

[1] M. Budke, T. Allmers, and M. Donath, Rev. Sci. Instrum., in press (2007)
[2] D.H. Yu, M. Donath, J. Braun, and G. Rangelov, Phys. Rev. B **65**, 155415 (2003)
[3] K. Miyamoto *et al.*, 19th International Colloquium on Magnetic Films and Surfaces (2006)

MA 18.69 Tue 15:15 Poster E

Exchange interaction between magnetic nanowires on stepped and flat Cu surfaces: ab initio study — •Hossein Hashemi[1], Pavel A. Ignatiev[2], Wolfram Hergert[1], and Valeri S. Stepanyuk[2] — [1]Institute of Physics, Martin Luther University Halle-Wittenberg, Von-Seckendorff-Platz 1, 06120 Halle — [2]Max Planck Institute of Microstructure Physics, Weinberg 2, 06120 Halle

We report on the ab initio study of the indirect exchange interaction between magnetic nanowires on flat and stepped Cu(111) surfaces. Several geometrical arrangements of Fe nanostructures on stepped and flat surfaces are considered. The exchange interaction is found to exhibit an oscillatory behavior and depends on the chain-chain separation. We compare the exchange interaction between magnetic nanowires on stepped and flat Cu surfaces.

MA 18.70 Tue 15:15 Poster E

Investigation of higher-order exchange interactions in magnetic nanostructures — •Samir Lounis, Peter H. Dederichs, and Stefan Blügel — IFF, Forschungszentrum Jülich, D-52425 Jülich, Germany

A realistic description of the complex magnetic phases in nanosystems on the basis of model Hamiltonians requires the exchange interactions beyond the standard Heisenberg term [1]. These are difficult to calculate by common DFT based first-principles methods. To calculate the biquadratic interactions by the Korringa-Kohn-Rostoker Green function (KKR-GF) method, a formula based on the magnetic force theorem is derived. Moreover, the full-potential KKR-GF method for non-collinear magnetism [2,3,4] has been used to investigate the complex magnetic structures of small Mn and Cr clusters of different sizes and shapes on the Cu(111) surface. Here, the importance of these additional interactions will be illustrated and discussed.

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MA 18.71 Tue 15:15 Poster E

Current induced domain wall motion in perpendicularly magnetized wires — •Johannes Kimling, Olivier Boulle, Mathias Kläui, and Ulrich Rüdiger — Fachbereich Physik, Universität Konstanz, Universitätsstraße 10, 78457 Konstanz, Germany

The recent discovery that a spin polarized current can move a domain wall (DW) through a transfer of spin angular momentum opens a new path to manipulating magnetization without any external magnetic field. So far, current induced DW motion (CIDM) has been experimentally investigated in details for in-plane magnetized wires with a large DW width ($\geq$ 100 nm) where spin transfer is expected to occur in the "adiabatic limit". Here, we will present experiments on $(Pt/Co)_n$ thin films with perpendicular magnetic anisotropy in which a very narrow DW is expected (width $\approx$ 10 nm). This allows the investigation of the non adiabatic part of the spin transfer torque, a key parameter in CIDM, which is expected to be larger for narrower DWs. The CIDM was studied in $(Pt/Co)_n$ films patterned in 200-500 nm wide nanowires. Using the extraordinary Hall effect, we have observed small displacements of a domain wall pinned in the Hall cross induced by current pulses of the order of 10^{11} A/m^2 at low field, in agreement with previous works. In order to correct for the significant temperature rise caused by the Joule heating while injecting current pulses, a systematic study of current induced depinning under various field and temperature has been carried out. By taking into account the role of the Joule heating in CIDM, this allows a true evaluation of the efficiency of the spin transfer in this material.

MA 18.72 Tue 15:15 Poster E

Current-induced domain-wall and vortex motion — •Thomas Kamionka[1], Michael Martens[1], Stellan Bohlens[2], Toru Matsuyama[1], Ulrich Merkt[1], and Guido Meier[1] — [1]Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiustr. 11, 20355 Hamburg, Germany — [2]I. Institut für Theoretische Physik, Universität Hamburg, Jungiustr. 9, 20355 Hamburg, Germany

The interaction of spin-polarized currents with the magnetization of a ferromagnet opens new opportunities to design magnetic memory and logic devices. We investigate the harmonic excitation of a vortex in a square permalloy thin-film element with spin-polarized currents. A rotation of the vortex around its equilibrium position has been predicted [1]. The experimental challenge is to design a square with a low resonance frequency of the vortex, i.e. a weak confining potential, and to ensure the existence of the vortex state. The low resonance frequency is obtained for a small ratio t/l of thickness t and width l. We analyze the micromagnetic behavior of our permalloy squares by magnetic-force microscopy and the anisotropic magnetoresistance (AMR). Supported by micromagnetic simulations, we can determine possible magnetization patterns. A current induced excitation increases the electrical resistance because of the energy dissipation [2] and should be measurable using a LCR-Tester and scalar network analysis.

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MA 18.73 Tue 15:15 Poster E

Experiments and theoretical description of spin precession in lateral all-metall spin valves — •Jeannette Wulfhorst, Andreas Vogel, Alexander van Staa, Ulrich Merkt, and Guido Meier — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Jungiusstrasse 11, 20355 Hamburg (Germany)

Via transport measurements at low temperatures and with an external magnetic field we examine spin valves which consist of two ferromagnetic permalloy electrodes and a normal metal strip. Due to the shape anisotropy the electrodes are quasi-single domain and can be oriented parallel or antiparallel to each other. To obtain the coercive fields of the electrodes we have measured the anisotropic magnetoresistance of both. The nonlocal spin-valve effect is determined by using the first electrode to inject a spin-polarized current into the normal metal and to detect it with the aid of the other electrode [1]. With an out-of-plane external magnetic field spin precession, i.e. the Hanle-effect, is observed. The measured data is described by spin-dependent transport including spin diffusion, spin relaxation, spin precession, and tunnel barriers at the interfaces between the electrodes and the normal metal strip [1]. We estimate a spin-diffusion length in aluminum of 1034 nm, and a spin-relaxation time of 111 ps. The aluminum oxide tunnel barrier inbetween those films can enlarge the spin polarization of the injected current [2].

[1] A. van Staa, J. Wulfhorst, U. Merkt and G. Meier, submitted
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MA 18.74 Tue 15:15 Poster E

Interaction of pure diffusive spin currents with magnetic domain walls — •Dennis Ilgaz[1], Lutz Heyne[1], Dirk Backes[1,2], Stephen Krzyk[1], Mathias Kläui[1], Laura J. Heyderman[2], and Ulrich Rüdiger[1] — [1]Universität Konstanz, 78462 Konstanz, Deutschland — [2]Paul Scherrer Institut, 5232 Villigen, Schweiz

Diffusive pure spin currents received increasing attention in the last years, due to their novel physics and possible applications. In the non-local spin valve geometry diffusive spin currents can be locally seperated from charge currents. These spin currents induce no Joule heating. It has been shown that pure spin currents can interact with a second magnetic system, e.g. switch the magnetization of a small magnetic particle [1].

We employ pure diffusive spin currents to support current and field-induced domain wall motion. We present new results on the combined influence of pure diffusive spin currents and magnetic fields on magnetic domain walls studied via magnetic resistance measurements in a cryostat at variable temperature.

References [1] T. Kimura et al., Phys. Rev. Lett. 96, 037201 (2006).

MA 18.75 Tue 15:15 Poster E

Magnetoresistive Effects in Co/Pd Multilayers on Self-assembled Nanospheres — •Judith Moser[1], Hans-Fridtjof Pernau[1], Vojko Kunej[1], Martina Suty[1], Günter Schatz[1], Elke Scheer[1], and Manfred Albrecht[2] — [1]University of Konstanz, Department of Physics, D-78457 Konstanz, Germany — [2]Chemnitz University of Technology , Institute of Physics, D-09107 Chemnitz, Germany

The deposition of Co/Pd multilayers on self-assembled spherical particles provides a system with unique magnetic properties. The magnetic caps on 200nm polystyrene spheres have perpendicular anisotropy, are single-domain, and magnetically decoupled, but in electrical contact. By applying an external magnetic field, the individual caps can be switched separately. This makes the system an interesting candidate for magnetoresistance measurements.

First results on a two dimensional array are reminiscent of GMR behaviour. We believe that the resistivity change is caused by spin dependent scattering in the magnetic caps. For a better understanding of the observed effects we developed a method based on template-assisted self-assembly that provides the possibility to contact a few magnetic caps only.

The system might be of interest for both fundamental aspects and technological application.

MA 18.76 Tue 15:15 Poster E

Noncollinear magnetic order in transition-metal nanowires — •Michael Czerner[1], Bogdan Yu. Yavorsky[1], Laszlo Szunyogh[2], and Ingrid Mertig[1] — [1]Department of Physics, Martin Luther University, Germany — [2]Department of Theoretical Physics, Budapest University of Technology and Economics, Hungary

The progress in nanotechnology during the last two decades stimulated interest in ferromagnetic nanocontacts [1,2]. The transport properties of the nanocontacts depend strongly on the details of the magnetic structure. In particular, in the presence of a domain wall the magnetic configuration becomes noncollinear. On the other hand there are experimental indications [3], that the magnetic anisotropy has considerable effect on the magnetic structure of the nanocontact. A direct measurement of the magnetic configuration is difficult. In this respect first-principle calculations of the magnetic structure of the nanocontact are of primary importance. We present ab initio calculations of ferromagnetic nanowires suspended between two semi-infinite leads of the same material. The system was treated without adjustable parameters. We calculated the electronic and magnetic structure by means of the screened Korringa-Kohn-Rostoker (KKR) Greens function method in the relativistic formulation. We demonstrate that the ground state shows noncollinear magnetic order in Ni, Co and Fe nanowires. The influence of the magnetic anisotropy on the magnetic order is discussed.

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[3] M. Viret et.al. , cond-mat/0602298

MA 18.77 Tue 15:15 Poster E

Magnetotransport measurements on epitaxial Fe nanostructures — •Markus Wahle[1], Björn Wilke[1], Saskia F. Fischer[1], Ulrich Kunze[1], Ellen Schuster[2], Werner Keune[2], Dirk Sprungmann[3], and Kurt Westerholt[3] — [1]Werkstoffe und Nanoelektronik, Ruhr-Universität Bochum, D-44780 Bochum — [2]Angewandte Physik, Universität Duisburg-Essen, D-47048 Duis-

burg — [3]Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, D-44780 Bochum

To investigate spin dependent transport in nanoscale ferromagnetic cross-junctions we performed temperature dependent (2 K to 300 K) non-local measurements. The examined structures consist of thin ($\leq$ 50 nm) epitaxial Fe-films grown on intrinsic GaAs and capped by Cr. The growth and film quality has been controlled by means of RHEED images. Nanostructuring was done by e-beam lithography and subsequent Ar-ion etching. The widths of the cross-junctions vary from 200 to 500 nm. Non-local measurements constrain the observed area to the innermost part of the cross-junctions thus giving detailed information on magnetic switching processes/domain wall motion without the contribution of the leads towards resistance changes. Four different geometries of leads providing different domain structures and switching fields have been fabricated. We also present OOMMF simulations showing the switching behavior of such leads. The work is supported by the DFG within the SFB491.

MA 18.78 Tue 15:15 Poster E

Spin-polarized current through organic molecules — •Daungruthai Jarukanont, Samuel Baltazar Rojas, Alan Kalitsov, and Martin E. Garcia — Institut für Physik Universität Kassel

The study of molecular electronics has attracted a lot of interest in recent years. In this field, one attempts to make electronic devices using organic molecules. In order to manipulate such devices, it's very important to have a good understanding of the molecular transport properties. We study the tunneling of spin-polarized electrons through molecules that are weakly coupled to ferromagnetic electrodes.

We model our system by sandwiching molecules in between two magnetic electrodes, where a small bias is applied to see the I-V characteristics. The calculations are based on the non-equilibrium Green's function and the Keldysh formalism. The electronic states are described by the tight-binding model. We have studied a dependence of the tunneling current on the relative orientation of the magnetizations of the electrodes. We hope that these studies will allow us to suggest an appropriate choice for molecules for molecular electronics devices.

MA 18.79 Tue 15:15 Poster E

Tunneling magnetoresistance in all-oxide $La_{0.7}Sr_{0.3}MnO_3$/ MgO/ $La_{0.7}Sr_{0.3}MnO_3$ tunnel junctions — •Stephanie Raabe, Vasily Moshnyaga, Kai Gehrke, and Konrad Samwer — I. Physikalisches Institut der Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, D-37077 Göttingen

Half-metallic $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) looks very promising for spintronic applications. We have studied all-oxide structures LSMO(100) / MgO(100) / LSMO(100) prepared by means of Metalorganic Aerosol Deposition (MAD). Epitaxial LSMO films on MgO(100) substrate with T_C=360K and residual resistance $\rho = 16 \cdot 10^{-5} \Omega cm$ were obtained. Additionally we have shown that MgO grows also epitaxially on LSMO, which gave us the opportunity to prepare epitaxial tunneling LSMO/MgO/LSMO trilayers. Results on tunneling magnetoresistive effects will be presented.

MA 18.80 Tue 15:15 Poster E

Magnetic tunnel junctions with TiO barrier — •Zoe Kugler, Andy Thomas, and Günter Reiss — Bielefeld University, Universitätsstraße 25, D-33615 Bielefeled

We investigated magnetic tunnel junctions based on TiO and TiO/AlSiO-composite barriers.

Tunnel junctions with these barriers were prepared by dc- and rf-magnetron sputtering in a vacuum system with a base pressure of $1 \cdot 10^{-7}$ mbar and postoxidation of the barrier materials.

We have investigated the influence of different oxidation times, barrier thickness and annealing temperatures. Futhermore, we will present the results of our measurements for TiO based tunnel junctions with different magnetic electrodes such as CoFeB, CoFe and NiFe.

For the TiO/AlSiO-composite barriers we have investigated the TMR- and the area-resistance ratio with respect to the TiO and AlSiO thickness.

MA 18.81 Tue 15:15 Poster E

Magnetic tunnelling junctions with Co_2MnSi, Co_2MnSn and Cu_2MnAl- Heusler alloy electrodes — •Mohamed Obaida[1,2], Hasan Inam[1], Erik Verdijun[1], Kurt Westerholt[1], and Hartmut Zabel[1] — [1]Institute für Experimentalphysik IV Ruhr-Universität Bochum, 44780 Bochum, Germany — [2]National Research Center, Cairo, Egypt

We fabricated magnetic tunnelling junctions (MTJs) using Heusler half metallics Co_2MnSi, and Co_2MnSn as base electrodes and Al_2O_3 or MgO as barrier material. As the counter electrode we used Co. The Heusler layers were deposited by UHV magnetron sputtering on oxidized SiO_2 substrates, the barriers were prepared by plasma oxidation of Al or direct sputtering of MgO, respectively. For Co_2MnSi we get a tunnelling magnetoresistance (TMR) of 27% at low temperatures, for the case of the Co_2MnSn electrode the maximum value we observed was 12%, however for this junction we could not avoid Neel coupling between the ferromagnetic electrodes so that the antiferromagnetic orientation was not well defined. We have also tried to grow MgO barriers on the Heusler alloy half metallics, however it turned out to be very difficult to get pinhole free barriers on this electrodes by direct sputtering of MgO. We have also started to grow MgO barriers on the Heusler phase Cu_2MnAl, which actually is not half metallic but is perfectly lattice matched to MgO and could serve as a reference material for Heusler MTJs. On this material we get high quality, pinhole free barriers, but the TMR we observed until now is still small.

MA 18.82 Tue 15:15 Poster E

Current induced diffusion in magnetic tunnel junctions with ultra-thin MgO tunnel barriers — •Patryk Krzysteczko[1], Xinli Kou[1,2], Karsten Rott[1], Andy Thomas[1], and Günter Reiss[1] — [1]Bielefeld University, Universitätsstraße 25, D-33615 Bielefeld — [2]Lanzhou University, 73000 Lanzhou, China

We apply high current-pulses ($j \sim 10^6\ A/cm^2$) to thin MgO barriers in a CoFeB/MgO/CoFeB TMR element prepared of magnetron sputtering and subsequent electron beam lithography. The samples are charactarized by a low area resistance ($AR \sim 20\,\Omega\mu m^2$) and a high spin polarization ($TMR \sim 100\,\%$). We observe reversible resistance changes when a critical electrical current is applied. Depending on the current polarity, the resistance decreases monotonically or non-monotonically with one or two distinct relaxation times, respectively. These different relaxation processes suggest independent physical mechanisms acting simultaneously inside the TMR element. The physical origin of these effects is discussed.

MA 18.83 Tue 15:15 Poster E

Interface-dependent sign of tunneling magnetoresistance in CrO_2/MgO/CoFe junctions — •Martin Sperlich[1], Marcel Mathissen[1], Titus Leo[2], Christian Kaiser[3], Hyunsoo Yang[3], Stuart S. P. Parkin[3], David J. Smith[4], and Gernot Güntherodt[1] — [1]II. Physikalisches Institut, RWTH Aachen — [2]School of Materials, Arizona State University, Tempe, USA — [3]IBM Almaden Research Center, San Jose, USA — [4]Department of Physics, Arizona State University, Tempe, USA

Half-metallic ferromagnets (FMs) such as CrO_2 are potentially useful as electrodes in magnetic tunnel junctions (MTJs) because of the possibility for 100% spin polarization near the Fermi energy. We show the tunneling magnetoresistance (TMR) behavior of MTJs using epitaxial CrO_2(100) as one electrode and a counterelectrode containing CoFe, with MgO as the tunnel barrier. When CrO_2 is exposed to air, a few monolayers of the intrinsic surface decompose and negative TMR is observed. Conversely, sample surfaces protected by a thin Mg interlayer show small but positive TMR consistent with intrinsic spin polarization. Thus, the sign of the TMR can be reversed simply by subtle modifications to the CrO_2/MgO interface. High resolution transmission electron microscopy confirms that we can remove the natively decomposed Cr_xO_y layers by gentle Ar-ion sputtering and produce a good quality interface between MgO und CrO_2.
T. Leo et al., APL 2007 (accepted).

MA 18.84 Tue 15:15 Poster E

An investigation of bcc-Co thin-film and bulk properties and their influence on tunneling magnetoresistance — •Marjana Ležaić, Frank Matthes, Phivos Mavropoulos, Stefan Blügel, and Claus M. Schneider — Institut für Festkörperforschung, Forschungszentrum Jülich, D-52425 Jülich, Germany

We report on the electronic band structure modifications of metastable bcc Co films introduced by tetragonal distortion of the lattice along the [001] direction. Density functional calculations were performed to find the equilibrium lattice distortion and the resulting electronic structure, predicting, for individual bands, a shift in binding energy dependent on the sign and size of the tetragonal distortion. Under

certain tetragonalisation, a minority band with Δ_1 symmetry along $\Gamma - X$ shifts to lower energies and intersects the Fermi level. The effect can severely reduce the tunneling magnetoresistance ratio (TMR) of Co/MgO/Co junctions. This is supported by spin-resolved photoemission spectroscopy measurements on bcc-Co thin films stabilized on bcc Fe. We also investigated, both theoretically and experimentally [1], the modification of the electronic structure of Co at the surface and interface to MgO. Furthermore, we calculated the influence of tetragonal distortion on exchange interactions and the Curie temperature of bcc Co, Fe and their alloys [2], as these quantities are related to the temperature stability of TMR in Co- and Fe-based junctions.

[1] L.-N. Tong *et al.*, Phys. Rev. B **73**, 214401 (2006).
[2] M. Ležaić *et al.*, Appl. Phys. Lett. **90**, 082504 (2007).

MA 18.85 Tue 15:15 Poster E

Bias dependence in mesoscopic systems using non-equilibrium Green's functions — •Steven Walczak[1], Christian Heiliger[2,3], Michael Czerner[1], and Ingrid Mertig[1] — [1]Department of Physics, Martin Luther University,D 06099 Halle, Germany — [2]Center for Nanoscale Science and Technology, National Institute of Standards and Technology, Gaithersburg, MD 20899-6202 — [3]Maryland NanoCenter, University of Maryland, College Park, MD, 20742

The understanding of bias dependencies 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]. This 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 the difference of the densities with and without an applied voltage. We compare ab initio results of voltage drops in different geometries. This work has been supported in part by the NIST-CNST/UMD-NanoCenter Cooperative Agreement.

[1] C. Heiliger, M. Czerner, B. Yavorsky, I. Mertig, M. Stiles, J. Appl. Phys. (in press), arXiv:0711.2082