MA 15: Poster:ThinFilms(1-33),Transp.(34-49),ExchBias(50-56), Spindynamics(57-70),Micro-nanostr.Mat.(71-82), Particles/Clust.(83-88), Mag.Imag./Surface(89-96), Spinelectronics(97-109), Theory/Micromag.(110-116), Spinstruct/Phasetr.(117-128),Magn.Mat.(129-139), Aniso.+Measuring(140-145), MolMag.(146-152), MSMA(153-156)

Time: Tuesday 15:00–19:00 Location: Poster A

MA 15.1 Tue 15:00 Poster A

Dynamic strain in epitaxial ferroic oxide films — •Orkidia Bilani, Martina Dekker, Christian Thiele, Kathrin Dörr, Konstantin Nenkov, and Ludwig Schultz — IFW Dresden, Postfach 270116, 01171 Dresden, Germany

Epitaxial strain is known or theoretically predicted to essentially influence the electronic properties of transition metal perovskite oxides like (Ba,Sr)TiO_3. One approach for reversible biaxial strain variation in epitaxial films fitting to a pseudocubic lattice parameter of about 4.0 Angstrom is the utilization of a ferro- and piezoelectric PMN-PT(001) substrate. (PMN-PT stands for $0.72PbMg_{1/3}Nb_{2/3}O_3$-$0.28PbTiO_3$.) The huge, homogeneous and nearly linear piezoelectric strain of PMN-PT(001) allows one to biaxially compress as-grown films by about 0.2 % by applying an electric voltage.

In this contribution, the structural properties of PMN-PT(001) substrates and of epitaxial perovskite films of $SrTiO_3$ and ferromagnetic manganites $R_{1-x}A_xMnO_3$ (R = rare earth metal or La, A = doping metal) grown on them are analysed. Atomic force microscopy and methods of four-circle x-ray diffraction have been employed for the measurements. Electric and magnetic properties like the ferroic ordering temperature as a direct function of the biaxial strain varied in-situ have been recorded and are discussed.

MA 15.2 Tue 15:00 Poster A

Growth and properties of epitaxial Sr_2CrReO_6 thin films — •F. Czeschka, S. Geprägs, S.T.B. Goennenwein, M. Opel, and R. Gross — Walther-Meißner-Institut, Bayerische Akademie derWissenschaften, Walther-Meißner-Str. 8, 85748 Garching

In the last couple of years a tremendous interest in new materials with high spin polarisation for spintronic devices has been emerged. One group of these materials are the ferromagnetic double perovskites $Sr_2BB'O_6$ (with B a magnetic transition metal ion, and B' a nonmagnetic ion). Among them, Sr_2CrReO_6 has the highest transition temperature ($T_C = 635\,K$) observed so far and band structure calculations predict a high spin polarisation of $P \approx 86\%$. We have prepared Sr_2CrReO_6 thin films by laser molecular beam epitaxy on (001) $SrTiO_3$ substrates. The films were grown in different atmospheres (Ar, O_2), at various pressures (6×10^{-4}mbar $\leq p_{O_2} \leq 5 \times 10^{-2}$mbar) and in a wide range of substrate temperatures (450°C $\leq T_S \leq$ 900°C). The films are c-axis oriented and coherently strained. We found, that thin films grown at $T_S = 700$°C in an oxygen atmosphere with $p_{O_2} = 6.6 \times 10^{-4}$mbar show optimal magnetic and crystallographic properties, as evident from the full width at half maximum of the rocking curves. Moreover, our films show a high degree of B site order. The hysteresis loops at 25K reveal a high saturation magnetization of $0.8\mu_B$ per formula unit and a high coercive field of 1.2T. We discuss these observations and compare them to results from magnetotransport measurements.

This work is supported by the DFG via SPP1157.

MA 15.3 Tue 15:00 Poster A

Multiferroic Materials Based on Artificial Thin Film Heterostructures — •S. Geprägs, M. Opel, S.T.B. Goennenwein, and R. Gross — Walther-Meißner-Institut, Bayerische Akademie derWissenschaften, Walther-Meißner-Str. 8, 85748 Garching

Recent advances in the understanding of the coexistence of different ferroic ordering phenomena (such as ferroelectricity and ferromagnetism) triggered a tremendous research activity on so-called multiferroic materials. Unfortunately, only very few multiferroics exist. A promising way to improve the situation is the use of layered thin film heterostructures. The double perovskite Bi_2CrFeO_6 (BCFO), for example, could be built up from $BiFeO_3$ (BFO) and $BiCrO_3$ (BCO). To realize such superlattices, one must be able to grow unit cell thin BCO and BFO layers in a two-dimensional growth mode. Here, we report the growth of c-axis oriented epitaxial BFO and BCO films by laser molecular beam epitaxy on (001) $SrTiO_3$ substrates. A two-dimensional growth mode could be achieved using an imposed layer-by-layer interval deposition technique. All BCO and BFO thin films show high crystalline quality with a mosaic spread below 0.04°. Furthermore, reciprocal space maps indicate no monoclinic or rhombohedral distortion up to a film thickness of 35nm. Magnetic measurements demonstrate a weak ferromagnetic phase in both material systems due to spin canting of the antiferromagnetic sublattices. However, we find no evidence of enhanced ferromagnetic properties stemming from epitaxial strain.

This work is supported by the DFG via SPP1157.

MA 15.4 Tue 15:00 Poster A

Scanning tunneling spectroscopy on $La_{0.75}Ca_{0.25}MnO_3$ thin films in external magnetic fields — •Sigrun A. Köster, Thomas Mildner, Vasily Moshnyaga, Bernd Damaschke, and Konrad Samwer — I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Perovskite manganites show the most intriguing and still far from understanding colossal magnetoresistance effect (CMR). The main effect is observed at the temperature induced transition from a ferromagnetic metallic to an insulating behavior. According to the percolation model of Dagotto et al.[1] two different phases, an insulating and conducting one, exist in parallel and lead to a percolative phase transition, the CMR. This coexistence is expected to depend on different material parameters, since the properties of manganites are very sensitive to lattice strain (e.g. Jahn-Teller strain) and disorder. We are able to very precisely tune the microstructure of our samples by the metallorganic aerosol deposition (MAD) technique. In our work we can show by scanning tunneling spectroscopy, that low resistivity and high resistivity regions exist in the samples, depending on the microstructure of the films, temperature and magnetic fields. Our study is aimed at achieving a more detailed picture of these electronic phases. Particularly we concentrated on STS measurements in magnetic fields at the transition temperature. This project was partially supported by the DFG in the course of SFB 602 Project A2.

[1] E. Dagotto, T. Hotta, A. Moreo, Physics Reports 344, (2001)

MA 15.5 Tue 15:00 Poster A

Synthesis, Structure, and Magnetism of the Electron-Doped Cobaltates $La_{1-x}Ce_xCoO_3$ — •Christian Pinta[1,2], Dirk Fuchs[1], Peter Adelmann[1], Thorsten Schwarz[1,2], Peter Schweiss[1], Stefan Mangold[3], and Stefan Schuppler[1] — [1]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, 76021 Karlsruhe, Germany — [2]Universität Karlsruhe, Fakultät für Physik, 76128 Karlsruhe, Germany — [3]Forschungszentrum Karlsruhe, Institut für Synchrotronstrahlung, 76021 Karlsruhe, Germany

Electron doping of lanthanum cobaltate, $LaCoO_3$, with doping levels exceeding minute values had been impossible until recently, when we succeeded in synthesizing epitaxial thin films of the system $La_{1-x}Ce_xCoO_3$ ($0.1 \leq x \leq 0.4$) using pulsed laser deposition. In these thin films, ferromagnetic order is observed within the entire doping range, with the maximum of the Curie temperature, T_C, occurring at $x \approx 0.3$. This results in a magnetic phase diagram similar to that of hole-doped lanthanum cobaltates. The measured spin values suggest an intermediate-spin state of the Co ions which has been also found in the hole-doped system. However, in contrast to the hole-doped material where T_C is well above 200 K, we observe a strong suppression of the maximum T_C to about 22 K. In order to study possible effects of distortions or disorder on T_C, the local spatial and electronic structure of the films was investigated in more detail by x-ray absorption spectroscopy (NEXAFS and EXAFS), illustrating that the material is

indeed electron-doped, and showing an increased structural distortion of $La_{1-x}Ce_xCoO_3$ compared to the undoped cobaltates.

MA 15.6 Tue 15:00 Poster A

Growth of $La_{1-x}Ca_xMnO_3$ and $BaTiO_3$ thin films and multilayers using PLD with in-situ RHEED — •Heiko Fasold, Alexander Hirsch, Ralf Koppert, Frank Ludwig, and Meinhard Schilling — Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, TU Braunschweig,Hans-Sommer-Straße 66, D-38106 Braunschweig, Germany

Multiferroics, materials with ferroelectric and ferromagnetic properties, are interesting for both basic research and applications. One way to design multiferroic materials for new sensor applications is to grow superlattices with alternating ferromagnetic and ferroelectric layers.

Using Pulsed Laser Deposition (PLD) $La_{1-x}Ca_xMnO_3$ (LCMO) and $BaTiO_3$ (BTO) thin films and multilayers were grown. The growth of the films is monitored by in-situ reflection high energy electron diffraction (RHEED). The characterization is supplemented by X-ray diffraction (XRD) and atomic force microscopy (AFM).

The LCMO films were grown with different calcium concentrations. Optimal growth conditions lead to high quality oriented crystalline magnetic films with a rms roughness less than 1nm for layer thicknesses up to 500 nm. Both LCMO and BTO were deposited on single terminated atomically flat $SrTiO_3$ (100) and $NdGaO_3$ (110) substrates. The influence of substrate and its surface quality on the growth conditions and properties of the thin films is analyzed. Superlattices with alternating LCMO and BTO layers were grown. RHEED intensity oscillations are used to determine and control the thickness of the multilayers.

MA 15.7 Tue 15:00 Poster A

Physical properties and microstructure of $La_{0,67}Ce_{0,33}MnO_3$ thin films — •Christian Stingl, Vasily Moshnyaga, Yuansu Luo, Bernd Damaschke, and Konrad Samwer — I. Physikalisches Institut der Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, D-37077 Göttingen

In the perowskite manganites $A_{1-x}B_xMnO_3$, the replacement of a trivalent A-ion by a divalent B-ion, which is the case in the majority of the compounds, is usually referred to as *hole-doping*. Cerium has been suggested as a tetravalent substituent to achieve *electron-doping* in PLD thin films of $La_{0,67}Ce_{0,33}MnO_3$ (LCeMO) [1]. However, LCeMO seems to be structurally unstable and the single-phase nature of the PLD films has been questioned [2].

We have therefore tried two other deposition techniques and prepared thin $La_{0,67}Ce_{0,33}MnO_3$ films by magnetron sputtering and MAD (metal-organic aerosol deposition) and investigated their microstructure with TEM. In both cases, a chemical phase separation is observed: The sputtered samples are insulating over a wide temperature range but show an interesting form of self-organized growth, with $\approx$ 10 nm thick cylindrical columns of a Ce-rich phase embedded in a manganite matrix. The MAD samples exhibit ferromagnetic metallic behavior for $T < T_{MI} \approx 260$ K due to self-doping by La vacancies.

[1] C. Mitra et al., J. Appl. Phys. **89** (2000), 524.
[2] T. Yanagida et al., Phys. Rev. B **70** (2004), 184437.

MA 15.8 Tue 15:00 Poster A

Magnetism and Magnetic Microstructure in Heusler Alloy Based Thin Film Systems — •Alexander Kaiser, Diana Rata, Stefan Cramm, and Claus M. Schneider — Institut für Festkörperforschung IFF-IEE, Forschungszentrum Jülich, Germany

Due to high spin polarization at the Fermi level and structural compatibility to compound semiconductors half-metallic Heusler alloys are promising materials for spintronic devices such as magnetic tunnel junctions and spin injection elements. For this study single films and magnetic tunnel junctions of the Heusler alloys Co_2MnSi and Co_2FeSi were sputter-deposited. The films have been magnetically characterized by SQUID and the micromagnetic structure has been studied by photoelectron emission microscopy. By microstructuring the films the influence of a magnetic stray field could be investigated. Ferromagnetic coupling of the $Co_2MnSi/MgO/Co_2FeSi$ trilayers was shown by exploiting the elemental selectivity of the X-PEEM technique.

MA 15.9 Tue 15:00 Poster A

Growth and characterization of Ni_2MnIn Heusler films — •Jan Michael Scholtyssek, Lars Bocklage, Rainer Anton, Ulrich Merkt, and Guido Meier — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg

Heusler alloys are interesting materials for spintronic devices. We grow thin Ni_2MnIn films by coevaporation of Ni and the alloy MnIn on a variety of substrates including amorphous carbon films and Si_3N_4 membranes for TEM studies as well as on Si and InAs for investigations of the electronic interface structure. The latter is especially interesting because of the predicted halfmetallicity of Ni_2MnIn in the $L2_1$ phase at the interface to InAs [1]. The almost perfect lattice match between InAs and Ni_2MnIn supports highly oriented growth, as we have proven by electron diffraction under grazing incidence [2]. We present morphologic and structural investigations performed during a post growth annealing process in which the sample grown at a substrate temperature of 100 °C is heated up to 400 °C. The formation of the $L2_1$ crystal structure presumably in coexsistence with the B2 phase is observed. Point contact Andreev-reflection spectroscopy on Ni_2MnIn thin films grown on Si and on (110)-surfaces of InAs, perpared by in-situ cleaving of the substrate, yields spin polarizations of up to 34% [3].

[1] K.A. Kilian and R.H. Victora, J. Appl. Phys. **87**, 7064 (2000).
[2] J.M. Scholtyssek et. al., J. Magn. Magn. Mat. accepted (2006).
[3] L. Bocklage et. al., J. Appl. Phys. accepted (2006).

MA 15.10 Tue 15:00 Poster A

Towards a full Heusler alloy showing room temperature half-metallicity at the surface — •Mirko Cinchetti[1], Jan-Peter Wüstenberg[1], Andrés Conca[2], Martin Jourdan[2], and Martin Aeschlimann[1] — [1]University of Kaiserslautern, Institute of Physics, Erwin-Schrödingerstr. 46, 67663 Kaiserslautern, Germany — [2]University of Mainz, Institute of Physics, Staudinger Weg 7, 55128 Mainz, Germany

The spin polarization at the surface region of a 100 nm $Co_2Cr_{0.6}Fe_{0.4}Al$ film grown epitaxially on MgO(100) with a 10 nm Fe buffer layer has been investigated by means of spin resolved photoemission. We show that a careful *in situ* preparation of the sample surface leads to reproducible values for the room temperature spin polarization up to 45% at the Fermi level. To our knowledge, this is the highest value measured so far at the surface region of a full Heusler alloy at room temperature.

MA 15.11 Tue 15:00 Poster A

Magneto-optical Kerr Effect Spectroscopy of Magnetic Nanoclusters in Organic Thin Films — •Wen Li[1], Roxana Pacurariu[2], Dietrich Zahn[1], and Georgeta Salvan[1] — [1]Chemnitz University of Technology, D-09107 Chemnitz, Germany — [2]Babes-Bolyai University, RO-400085 Cluj-Napoca, Romania

The magnetic properties exhibited by magnetic nanoparticles are of great importance in view of their applications such as e.g. biosensors or high-density recording media. The surrounding medium can have a significant influence on the magnetic properties. One of the methods used to fabricate thin films of magnetic nanoparticles in organic molecular matrices with a good control on the particle size is the co-evaporation of the metal and the organic molecules in vacuum. In this work Ni nanoparticles with an average size of about 5 nm are produced in matrices of fullerene and rubrene. The molecule of fullerene consists of C atoms and has an icosahedral symmetry, while the rubrene molecule contains also H atoms and has a lower symmetry. The magnetic properties of the hybrid films are studied by magneto-optical Kerr-effect (MOKE) spectroscopy in a spectral range from near infrared (1.5 eV) to near ultraviolet (5.5 eV).

Magneto-optical Kerr effect resides in the change in the polarisation state of the light upon reflection on a magnetized sample and is often exploited to record magnetic hysteresis loops of thin metallic films. In addition, MOKE spectroscopy is capable of providing an insight in the electronic properties of the nanoparticles and thus in the structure and size of the metallic clusters.

MA 15.12 Tue 15:00 Poster A

Magnetoelectric effects in Manganite-Titanate Composite Films — •Kai Gehrke, Vasily Moshnyaga, and Konrad Samwer — I.Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Multiferroic materials with coexistence of ferromagnetism and ferroelectricity are in the focus of modern fundamental and applied research. The coupling of order parameters is believed to be very strong in nanocomposite films, containing epitaxial co-grown and elastically coupled Manganite and Titanate phases. The strain induced by the piezo effect of the Titanate phase should alter the magnetization of

the CMR-Manganite phase and vice versa. Thin Manganite-Titanate films were grown on MgO and STO substrates by Metalorganic Aerosol Deposition (MAD) technique. Manganites like La-Mn-O, La-Ca-Mn-O and La-Sr-Mn-O where combined with ferroelectric Barium Titanate. XRD, AFM and TEM (EELS) where used to study the microstructure of the samples. M(H) and M(T) measurements show the magnetic properties of the manganite phase. Magnetoelectric effects were studied in terms of magnetocapacitance and magnetoloss measurements. The observed magnetocapacitance up to 1600% for H=70 kOe is discussed within CMR, Interface Magnetoresistance and Maxwell-Wagner model (see APL 88, 102902 (2006)). SFB 602 TP A2 is acknowledged.

MA 15.13 Tue 15:00 Poster A

X-ray magnetic circulardichroism in cobalt-doped ZnO — •Karl-Wilhelm Nielsen[1], Sebastian Bauer[1], Konrad Senn[1], Sebastian T. B. Goennenwein[1], Matthias Opel[1], Júlio Cezar[2], Dieter Schmeisser[3], and Rudolf Gross[1] — [1]Walther-Meissner-Institut, Bayerische Akademieder Wissenschaften, Garching, Germany — [2]EuropeanSynchrotron Radiation Facility, Grenoble Cedex, France — [3]Brandenburgische Technische Universität,Cottbus, Germany

Cobalt-doped ZnO is a diluted magnetic semiconductor with a reported Curie-temperature well above 300 K. Nevertheless, the origin of the ferromagnetic exchange still is under debate. To clearify this issue we have investigated cobalt-doped ZnO thin films with x-ray magnetic circular dichroism (XMCD). The (0001)-oriented $Zn_{0.95}Co_{0.05}O$ thin films were grown on (0001) ZnO, (0001) Al_2O_3, and (0001) $ScAlMgO_4$ substrates by pulsed laser deposition. The magnetic properties were measured by SQUID magnetometry and XMCD. Room temperature magnetization measurements by SQUID magnetometry and XMCD in the fluorescence yield mode reveal ferromagnetic behavior with similar shape of the magnetization curves, however, with different absolute values. XMCD magnetization in total electron yield, which is surface sensitive, show only small magnetic moments, most likely due to a magnetically dead surface layer.

This work is supported by the DFG via SPP1157.

MA 15.14 Tue 15:00 Poster A

No Co ferromagnetism in Co doped ZnO — •Thomas Tietze[1], Sebastian Brück[1], Eberhard Goering[1], Gisela Schütz[1], Milan Gacic[2], Gerhard Jakob[2], Christian Herbort[2], and Hermann Adrian[2] — [1]Max-Plank-Institute for Metal Research, Heisenbergstrasse 3, 70569 Stuttgart, Germany — [2]Institute of Physics, University of Mainz, Staudinger Weg 7, 55099 Mainz, Germany

Diluted magnetic semiconductors, doped with a few percent (<10%) of magnetic ions such as Co or Mn, have attracted recently enormous interest, due to the room temperature ferromagnetism observed in such systems. The original intention for doping is that localized magnetic moments couple with each other ferromagnetically via the semi conducting host material. We have investigated 5% Co doped ZnO prepared by pulsed laser deposition (PLD). X-ray magnetic circular dichroism provides element specific magnetic moments of Co, Zn an O. We have performed field and temperature dependent XMCD-measurements at the Co and Zn L2,3 edges and the O K edge. As expected, Zn does not contribute to the ferromagnetism, but Co exhibits only paramagnetic behavior at all temperatures and fields. But surprisingly we found magnetic polarization, related to a small orbital moment; at the O site, suspected to be responsible for room temperature ferromagnetism of ZnO.

MA 15.15 Tue 15:00 Poster A

Defect-induced Ferromagnetism in Co-doped ZnO Thin Films — •Gillian Mayer[1], Erwin Biegger[1], Mikhail Fonin[1], Nils Janssen[1], Markus Beyer[1], Rudolf Bratschitsch[1], Yury Dedkov[2], and Ulrich Rüdiger[1] — [1]Fachbereich Physik, Universität Konstanz, 78457 Konstanz — [2]Institut für Festkörperphysik, Technische Universität Dresden, 01062 Dresden

Ferromagnetic diluted magnetic oxides (DMOs) have been the subject of intense research due to their possible application in spintronic devices. Much attention has been paid to transition metals doped wide band-gap semiconductors such as ZnO.

In this study, Co-doped ZnO films have been prepared in order to investigate the structural, magnetic, optical, and electronic properties of the DMO. Control over the oxygen vacancy concentration in the ZnO host lattice was achieved by using different preparation conditions. Magnetization measurements indicate weak ferromagnetism at low temperature only for the samples prepared at oxygen poor conditions. X-ray absorption spectroscopy (XAS) and optical transmittance measurements have been performed to identify the oxidation state as well as site symmetry of Co in the ZnO host lattice. Comparison of O K XAS spectra show oxygen vacancies related features in case of ferromagnetic $Zn_{1-x}Co_xO$ samples. Our findings indicate that ferromagnetism of the Co-doped ZnO is strongly correlated to the presence of oxygen vacancies in the ZnO host lattice supporting the spin-split impurity band model [1].

[1] J.M.D. Coey *et al.*, Nat. Mater. **4**, 173 (2005)

MA 15.16 Tue 15:00 Poster A

Thermal spin-wave excitations in GaMnAs — Matthias Sperl, •Ursula Wurstbauer, Werner Wegscheider, Christian Back, and Günther Bayreuther — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, 93040 Regensburg

In conventional ferromagnets thermally excited spin waves determine the temperature dependence of magnetization well below the Curie temperature. The question, whether the distinct exchange interaction between Mn local moments mediated by holes in GaMnAs leads to a different $M_S - T$ relation compared to conventional ferromagnets with direct exchange interaction among 3d electrons, was investigated in this work. GaMnAs samples with thicknesses of 5-200 nm and (2-6%) Mn where grown on GaAs(100) and annealed under different conditions. M(T) was measured with a SQUID (superconduction quantum interference device) magnetometer at temperatures between 2 K and 30 K with regard to thermal spin excitations. It was found that for all samples $M_S(T)$ is in good agreement with Bloch's law, $M_S(T) = M(0) \cdot (1 - BT^{3/2})$. Interestingly, the spin wave parameter, B, we found is about two orders of magnitude higher than for Fe or FeCo films. This large difference cannot be understood by a reduced exchange interaction by a reduced Curie temperature alone. However, recent calculations [1,2] indicate that disorder and competing interactions in GaMnAs result in a strong thermal decay of the magnetization and can explain the order of magnitude of B found in the present experiment. [1] A. Singh et. al., cond-mat/0607633 [2] A. Singh et. al., cond-mat/0608474

MA 15.17 Tue 15:00 Poster A

Magnetotransport and magnetic anisotropy in (Ga,Mn)As thin films — •Matthias Althammer, Andreas Brandlmaier, Sebastian W. Schink, Matthias Opel, Rudolf Gross, and Sebastian T. B. Goennenwein — Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany

Magnetic anisotropy governs the magnetization orientation in ferromagnetic thin films, and therefore is relevant both for basic research as well as for applications. Using magnetotransport measurements, we investigate the magnetic anisotropy of the prototype ferromagnetic semiconductor (Ga,Mn)As. We patterned a 20 nm thick, (001)-oriented $Ga_{0.96}Mn_{0.04}As$ film into Hall-bar mesa structures with optical lithography and etching. The anisotropic magnetoresistance (AMR) is then measured with the external magnetic field applied in the film plane. We observe clear steps at magnetic fields $|H_1|$ and $|H_2|$ in both the longitudinal (sheet) and the transverse (planar Hall) magnetoresistance. This shows that the AMR is determined by one single, macroscopic magnetic domain, which abruptly switches from one easy axis to another. The fields H_1 and H_2 characteristically depend on the orientation of the externally applied magnetic field with respect to the current direction. We show that this dependence allows to quantitatively determine the orientation of the easy in-plane magnetic axes as well as the ratio of the magnetic anisotropy contributions. We furthermore discuss the influence of temperature, crystalline strain and specimen shape on the in-plane magnetic anisotropy.

MA 15.18 Tue 15:00 Poster A

Imaging magnetic structures in $Ga_{1-x}Mn_xAs$ films by low temperature laser scanning microscopy — •Stefan Guenon[1], Michael Wagenknecht[1], Sebastian Goennenwein[2], Rudolf Gross[2], Dieter Koelle[1], and Reinhold Kleiner[1] — [1]Physikalisches Institut-Experimentalphysik II, Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen, Germany — [2]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Walther-Meißner Straße 8, D-85748 Garching, Germany

Diluted magnetic semiconductor alloys, such as epitaxial $Ga_{1-x}Mn_xAs$ films, have attracted considerable interest. They are potentially useful for spintronics applications in which information processing and storage is achieved by utilizing the electron spin. We used low temperature laser scanning microscopy on a hall bar like structure made of a 20 nm thick $Ga_{0.96}Mn_{0.04}As$ film grown on a

(100)-oriented GaAs substrate by low-temperature molecular beam epitaxy. An unusual strong thermoelectric signal was observed as a response to the pulsed laser beam on the structure. The signal can be modeled by an electrical dipole induced in the area of the laser spot. In a temperature range well below the Curie temperature $T_C \approx 70K$ where the in-plane magnetic anisotropy of the ferromagnetic film is biaxial we were able to image structures that are similar to already observed ferromagnetic domains in $Ga_{1-x}Mn_xAs$ films by Kerr microscopy.

MA 15.19 Tue 15:00 Poster A

Magneto-optical Kerr effect of EuO Thin Films — •S. Altendorf, R. Sutarto, T. Haupricht, and L. H. Tjeng — II. Physikalisches Institut, Universität zu Köln, Zülpicher Str. 77, 50937 Köln, Germany

EuO is a ferromagnetic semiconductor with a Curie temperature (T_C) of 69 K [1]. Large magneto-optical effects such as a specific Faraday rotation of 5×10^5 degrees per cm [2] were reported making this compound an interesting starting material for research and applications in the field of magneto-optics.

We report on our measurements of the magneto-optical Kerr effect (MOKE) of EuO thin films. EuO thin films were grown on a 50 nm Cr layer on Al_2O_3 substrates by means of molecular beam epitaxy using a distillation technique which allows a precise control of the stoichiometry. The dependence of the Kerr rotation on the film thickness and temperature is investigated.

[1] A. Mauger and C. Godart, Phys. Rep. **141**, 51 (1986)
[2] K. Ahn and J. Suits, IEEE Trans. Mag. **3**, 453 (1967)

MA 15.20 Tue 15:00 Poster A

Preparation, Capping and Characterization of Gd doped EuO Thin Films — •T. Haupricht[1], R. Sutarto[1], H. Ott[1], N. Hollmann[1], H. Hartmann[1], T. Lorenz[1], Z. Hu[1], C. F. Chang[1], H. H. Hsieh[2], H. J. Lin[3], C. T. Chen[3], P. Nagel[4], S. Schuppler[4], and L. H. Tjeng[1] — [1]II. Physikalisches Institut, Universität zu Köln, Zülpicher Str. 77, 50937 Köln, Germany — [2]Chung Cheng Institute of Technology, National Defense University, Taoyuan 335, Taiwan — [3]NSRRC, 101 Hsin-Ann Road, Hsinchu 30076, Taiwan — [4]ANKA, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany

EuO belongs to the rare class of ferromagnetic semiconductors. By electron doping the Curie temperature (T_C) of 69 K for stoichiometric bulk EuO can be enhanced up to 160 K [1].

We report on the growth and characterization of Gd doped EuO thin films. We prepared samples by means of MBE under distillation conditions, which allows a very precise control of the oxygen stoichiometry. Using LEED and RHEED we show that the EuO films can be grown epitaxially and that the [100] directions of the films and MgO substrates are aligned. In order to perform *ex-situ* measurements we covered the samples with Au and Al capping layers. Using Vibrating Sample Magnetometry we investigated the dependence of T_C on Gd doping and O deficiency. We have observed record high T_C's of 170 K for a Gd concentration of about 4% [2].

[1] A. Mauger and C. Godart, Phys. Rep. **141**, 51 (1986)
[2] H. Ott et al., Phys. Rev. B **73**, 094407 (2006)

MA 15.21 Tue 15:00 Poster A

Spinresolved Photoemission Spectroscopy of Amorphous CoFeB — •Martin Sperlich[1], Coen Smits[1], Reza Gadhimi[4], Frank Matthes[2], Theodoros Dimopoulos[3], Joachim Wecker[3], Claus M. Schneider[2], and Gernot Güntherodt[1] — [1]II. Physik. Inst., RWTH Aachen — [2]Inst. für Festkörperforschung, FZ Jülich — [3]Siemens AG, Corporate Technology — [4]Gemeinschaftsinstitut für Elektronenmikroskopie, RWTH Aachen

Tunnel magnetoresistance (TMR) junctions of the system CoFeB/MgO/CoFeB based on amorphous CoFeB show the highest TMR values of all FM/MgO/FM junctions (FM = ferromagnet) of over 350% at room temperature [1]. This is very surprising since the highest TMR values have been theoretically predicted for epitaxial junctions. Due to annealing the TMR values increase which is attributed to a surface crystallisation of the amorphous CoFeB at the interface with MgO. By means of UV Spin-polarised Photoemission Spectroscopy (SP-PES) we have investigated the spin polarisation of amorphous CoFeB films. On a relative scale compared to tunneling the spin polarisation obtained from SP-PES gives an indication of the influence of annealing processes on the TMR values. Upon annealing at 275 °C the spin polarization of CoFeB increases by a factor of two. This is explained by the onset of surface crystallisation of CoFeB and a reduction of oxygen at its surface. We paid special attention to the metal/oxide interfaces by using Mg/MgO overlayers on CoFeB. The oxidation states of Mg were controlled by the position of the Mg 2p core levels. - [1] Y.M. Lee et al., Appl. Phys. Lett. 89, 042506 (2006)

MA 15.22 Tue 15:00 Poster A

Magnetic anisotropy in $Fe_{1-x}Co_x$ films on Pd(001), Pd/Cu(001) and Pd/GaAs(001) — •Xiuli Fu, Feng Luo, Jochen Barthel, Marek Przybylski, and Jurgen Kirschner — Max-Planck-Institut fur Mikrostrukturphysik, Halle, Germany

Tetragonally distorted $Fe_{1-x}Co_x$ alloy films were grown on Pd(001) at room temperature (RT) by molecular beam epitaxy using thermal evaporation from two effusion cells. First-principles calculations for such films predict a high uniaxial magnetic anisotropy energy for specific values of the lattice distortion and the alloy composition x. Magneto-optical Kerr effect measurements have shown that the magnetic anisotropy depends strongly on temperature. For example, the out-of-plane easy axis of magnetization is observed for $Fe_{0.5}Co_{0.5}$ films up to the thickness of 14 ML at 60 K, whereas at RT the films are magnetized in-plane. A thermal expansion and related changes of the tetragonal distortion are supposed to be responsible for this effect. The explanation is verified by a comparison to the $Fe_{1-x}Co_x$ alloy films grown on a Pd buffer layer on Cu(001) and GaAs(001). Such systems are characterized by different thermal expansion coefficients. Additionally, the tetragonal distortion can be controlled by the thickness of the Pd buffer layer. It decreases for the growth on Cu(001) and increases for the growth on GaAs(001) with decreasing Pd thickness.

MA 15.23 Tue 15:00 Poster A

Magnetic anisotropy in ultrathin Pd,Au/Fe bilayers on GaAs(001) — Oleksander Mosendz[1], Jan Zukrowski[2], Bartek Kardasz[1], Bret Heinrich[1], •Marek Przybylski[3], and Jurgen Kirschner[3] — [1]Simon Fraser University, Vancouver, Canada — [2]AGH University of Science and Technology, Krakow, Poland — [3]Max-Planck-Institut fur Mikrostrukturphysik, Halle, Germany

The role of the deposition technique on the magnetic anisotropies in Fe/GaAs(001) based structures was investigated by ferromagnetic resonance (FMR) and conversion electron Mössbauer spectroscopy (CEMS). The Fe layers were prepared by thermal deposition (TD) or by pulsed laser deposition (PLD) techniques. For CEMS experiments, the ^{57}Fe probe layer was placed either in the Fe/GaAs(001) interface, in the interface with the Au or Pd coating layers, or at various depth of the films. To assure film continuity and a Curie temperature well above room temperature (RT), the total film thickness was kept around 10 ML of Fe. CEMS spectra, measured ex situ at RT, show that TD samples have a better interface lattice structure than those deposited by means of PLD. Further, diffusion of As into the film volume is detected from the spectra. Interestingly, even the upper interface is affected by the deposition technique due to As floating on top of the Fe film. It is shown that perpendicular anisotropy is mostly increased at the Fe/Au(001) interface, and becomes maximum for the PLD-grown Fe films. PLD also increases the magnetic damping which is caused by two magnon scattering.

MA 15.24 Tue 15:00 Poster A

X-ray magnetic linear dichroism in reflection and absorption spectra measured in the vicinity of the $L_{2,3}$ edges of ultrathin cobalt films on W(110) — •Nagamony Ponpandian, Armin Kleibert, Stefan Gutzeit, Stefan Polei, and Karl-Heinz Meiwes-Broer — Institut für Physik, Universität Rostock, Universitätsplatz 3, D-18051 Rostock

X-ray magnetic linear dichroism (XMLD) is a valuable tool to measure the magnetocrystalline anisotropy energy (MAE) of thin films and multilayers in an element specific and even in laterally resolved manner. Normally, the XMLD in absorption is a quite weak effect in the important case of the 3*d* transition metals. However, recent experiments revealed a strong enhancement in XMLD-type effects when detecting the specular reflectivity instead of the absorption. In order to investigate the origin of this enhancement we studied the XMLD both in absorption and reflection in epitaxially grown Co films on W(110). These samples possess atomically flat interfaces and thus are well suited for reflectivity experiments. Moreover, they exhibit a thickness dependent MAE. In this contribution we will compare the experimentally observed effects in reflection with respective calculations based on a 4×4-matrix formalism. Furthermore, we will address the anisotropy in the shape of the XMLD spectra and its theoretically predicted relation

to the thickness dependent MAE of the Co films.

MA 15.25 Tue 15:00 Poster A

Thin magnetic Co-based films with perpendicular anisotropy — •Jens Brandenburg[1,2], Volker Neu[1], Ruben Hühne[1], and Ludwig Schultz[1] — [1]Leibniz Institut für Festkörper- und Werkstoffforschung Dresden, Institut für Metallphysik — [2]Max Planck Institut für Chemische Physik fester Stoffe

Epitaxial Cobalt films with high c-axis texture have been prepared by PLD either directly onto $Al_2O_3(0001)$ single crystal substrates or with an intermediate Ruthenium buffer layer. The influence of the substrate temperature on texture and crystal growth was investigated by XRD. The crystal structure and epitaxial growth relation was studied by XRD, pole figure measurements and 'reciprocal space mapping'. Detailed VSM analysis shows that the perpendicular anisotropy of highly textured Co films reaches the value reported for the magnetocrystalline anisotropy of Co bulk material. The preparation of very thin Co films ($20\,nm < t < 100\,nm$) gives the possibility to examine the stripe domain phase over a larger thickness range as was reported so far. The thickness dependence of the domain width of this periodic domain pattern was studied by magnetic force microscopy (MFM) and compared with different models of domain theory. Especially the discrepancies at smallest film thicknesses show that the system is in an intermediate state of in-plane and out-of-plane domains, which is not described by existing stripe domain models. The experiments are extended to materials with higher magnetocrystalline anisotropy. First results on $Co_{80}Pt_{20}$- and $SmCo_5$-films show evidence for epitaxial growth of these compounds on $Al_2O_3(0001)$ single crystal substrates.

MA 15.26 Tue 15:00 Poster A

10keV He ion bombardment of $Ni_{80}Fe_{20}$/Au/Co/Au multilayers with alternating in-plane and out-of-plane magnetization — •Tanja Weis[1], Dieter Engel[1], Arno Ehresmann[1], Maria Tekielak[2], Andrzej Maziewski[2], Bogdan Szymanski[3], Janusz Dubowik[3], and Feliks Stobiecki[3] — [1]Institute of Physics and CINSaT, University of Kassel, Heinrich-Plett-Str. 40, 34132 Kassel, Germany — [2]Institute of Molecular Physics, Polish Academy of Sciences, ul. Smoluchowskiego 17, 60-179 Poznan, Poland — [3]Institute of Experimental Physics, University of Bialystok, Lipowa 41, 15-424 Poland

Ion bombardment with light ions enables the alteration of the magnetic properties in magnetic thin film systems [1]. This technique was used to modify magnetic anisotropies in $Ni_{80}Fe_{20}$/Au/Co/Au multilayers. The as-prepared multilayers show prior to bombardment alternating in-plane (NiFe) and out-of-plane (Co) magnetization. We will present Kerr Microscopy images of 10keV He ion bombarded samples with either Au- or Co-wedges to show the dependence of the modifications of magnetic properties like anisotropy and interlayer coupling on the Au- and Co- thickness (t_{Au} and t_{Co}) and on the ion dose. Due to an increase of interface roughness the surface induced perpendicular anisotropy is reduced for $0.95nm \leq t_{Co} \leq 1.05nm$. On the other hand the ion bombardment heavily mixes ultrathin Co layers ($0.35nm \leq t_{Co} \leq$ nm) resulting in their superparamagnetic behavior.

[1] A. Ehresmann et al., Phys. Stat. Sol (b), 243, 29-36 (2006)
[2] F. Stobiecki et al., J. Magn. Magn. Mater., in press

MA 15.27 Tue 15:00 Poster A

Analysis of the structure and stoichiometry in iron/native iron oxide multilayers — •Thomas Diederich, Sebastien Couet, and Ralf Röhlsberger — Hamburger Synchrotron Strahlungslabor (HASYLAB) at Deutsches Elektronen-Synchrotron (DESY), Notkestr. 85, 22607 Hamburg

Recently we have found that multilayers consisting of iron and native iron oxide layers exhibit a magnetic superstructure [1]. It is clear that the mechanism leading to the observed coupling strongly depends on the multilayer structure and the properties of the native iron oxide. In order to characterize the multilayers in more detail we have used different X-ray techniques at the DORIS storage ring (DESY, Hamburg) such as X-ray absorption spectroscopy (XAS) and X-ray reflectometry (XRR). By using reference samples for XAS measurements at the Fe K-edge we have been able to extract the absorption profile resulting from the oxide in the multilayer. From this we conclude that the native oxide is a mixture of FeO and Fe_3O_4 with a ratio of about 1:1. The XRR experiments have been used to characterize the structure of the multilayer. Superstructure Bragg peaks in the reflectivity data arise due to the chemical periodicity. From a simulation of the data we found average thicknesses of 1.7 nm and 1.6 nm for the Fe and the Fe-oxide layers, respectively. The interface roughness is about 0.4 nm for the bottom layers and increases to roughly 0.7 nm for the upper layers.

[1] Th. Diederich, S. Couet, and R. Röhlsberger, submitted

MA 15.28 Tue 15:00 Poster A

Ultrathin magnetic films on rhodium substrates — •Ali Al-Zubi, Gustav Bihlmayer, and Stefan Blügel — Institut für Festkörperforschung, Forschungszentrum Jülich, D-52425 Jülich

Using density functional theory calculations we investigate relaxations, magnetic order, and the magnetic anisotropy energy (MAE) of Fe, Co, and Ni monolayers on Rh(001) and Rh(111) substrates. We employ the full-potential linearized augmented planewave method in thin film geometry. The Co and Ni films were found to order ferromagnetically, while for Fe a tendency towards antiferromagnetism is observed. We compare to the Fe/Ir(111) system, where more complicated spinstructures were observed in theory and experiment [1]. Especially for Co films we find very large induced moments in Rh, therefore we study the substrates influence on the MAE and compare also to the case of Co/Ir(111).

[1] K. von Bergmann et al. Phys. Rev. Lett. **96**, 167203 (2006)

MA 15.29 Tue 15:00 Poster A

Micromagnetic analysis of magnetization reversal in nanolayers with competing anisotropies and applications to layers of dilute magnetic semiconductor materials — Andrei A. Leonov[1], Igor E. Dragunov[1,2], Ulrich K. Rössler[2], and •Alexei N. Bogdanov[1,2] — [1]Donetsk Institute for Physics and Technology — [2]IFW Dresden

The interplay between intrinsic and surface/interface-induced magnetic anisotropies causes remarkable reorientation effects and strongly influences magnetization processes in nanomagnetic systems. We apply a phenomenological theory [1,2] to describe the field-driven reorientation in nanomagnets with cubic and uniaxial anisotropies. The equilibrium magnetization states are calculated as functions of the applied magnetic field for systems with misalignment between uniaxial and cubic easy axes. The magnetic phase diagrams classified through their topological features allow a detailed analysis of the magnetization processes in these system. Equilibrium parameters of multidomain structures have been derived as functions of applied field, the ratio between cubic and uniaxial anisotropy, and the field misalignment. The theory is applied to analyze switching processes and transformations of domain patterns for experimental observations on layers of dilute magnetic semiconductors as (Ga,Mn)As from the literature.

[1] U.K. Rößler, S.V. Bukhtiyarova, I.V. Zhikharev, A.N. Bogdanov, J. Magn. Magn. Mater. **290-291**, 772 (2005). [2] I.E. Dragunov, S.V. Bukhtiyarova, I.V. Zhikharev, A.N. Bogdanov, U.K. Rößler, Phys. Solid State **48** 1591 (2006).

MA 15.30 Tue 15:00 Poster A

Theory of stripe domains in ferromagnetic multilayers with perpendicular anisotropy — Igor E. Dragunov[1,2], Nicolai S. Kiselev[1], Ulrich K. Rössler[2], and •Alexei N. Bogdanov[1,2] — [1]Donetsk Institute for Physics and Technology — [2]IFW Dresden

Exchange coupled multilayer systems with perpendicular anisotropy, as [CoPt]/Ru, [CoPt]/NiO, Co/Ir, Fe/Au, display magnetic stripe phases as regular equilibrium multidomain states [1]. In contrast to other bulk and nanomagnetic systems, the formation of these multidomain structures is due to the interplay between interlayer exchange and dipolar couplings [2]. We have derived effective micromagnetic equations to calculate the existence regions and geometrical parameters of equilibrium stripe domains and their evolution in a bias field. In multilayers with ferromagnetic exchange coupling the equilibrium parameters can vary in a broad range depending on relative values of the magnetic layer and spacer thicknesses. In superlattices with antiferromagnetic exchange coupling three different ground states can be realized in the system depending on the materials parameters, namely the homogeneous antiferromagnetic state, and multidomain antiferromagnetic and ferromagnetic modes. These results on ground states are represented by magnetic phase diagrams in terms of the materials parameters describing strengths of interlayer exchange coupling, thickness of the ferromagnetic single layer, and number of layers.

[1] O. Hellwig et al., Nature Mater. 2 (2003) 112. [2] U. K. Rößler, A. N. Bogdanov, J. Magn. Magn. Mater. 269 (2004) L287; A. N. Bogdanov, U. K. Rößler, cond-mat/0606671.

MA 15.31 Tue 15:00 Poster A

Green Function theory vs. Quantum Monte Carlo Cal-

culation for thin magnetic films — •Sören Henning[1], Fritz Körmann[1], Stefan Schwieger[2], Jochen Kienert[1], and Wolfgang Nolting[1] — [1]Lehrstuhl Festkörpertheorie, Institut für Physik, Humboldt-Universität zu Berlin, Newtonstrasse 15, 12489 Berlin, Germany — [2]Technische Universität Ilmenau, Theoretische Physik I, Postfach 100565, 98684 Ilmenau, Germany

Up to now comparison between numerically exact Quantum Monte Carlo (QMC) calculations and Green function (GF) theory of thin magnetic films including second order anisotropies are only available for easy axis systems, i.e. for systems that favour a magnetization perpendicular to the film plane. Unfortunately there are no QMC data available for easy plane systems for which the anisotropy favours the magnetization parallel to the film plane. In this work we will discuss these systems. We present temperature and field dependent transitions and obtain good agreement between QMC results and Green function theory. Besides that we found an interesting magnetic disorder-order transition for increasing temperature.

MA 15.32 Tue 15:00 Poster A

Tunable strain in MgO single crystals — •Mathias Weiler, Andreas Brandlmaier, Stephan Geprägs, Matthias Opel, Sebastian T. B. Goennenwein, and Rudolf Gross — Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany

Crystalline strain affects many properties of solid state materials, e.g. the electronic band structure or the magnetic anisotropy of ferromagnets. The application of controllable strain thus is interesting for the realization of multifunctional materials. We discuss how the expansion of a piezoelectric actuator alters the strain in a MgO crystal at room temperature. Using two-component epoxy, we glued a $2 \times 2 \times 0.1\,\mathrm{mm}^3$ piece of a (001)-oriented MgO single crystal onto a piezoelectric actuator. The main elongation axis of the actuator is aligned in the platelet plane, along a MgO [100] direction. We measure the modification of the MgO crystalline structure as a function of the voltage V_{piezo} applied to the actuator, using high-resolution x-ray diffraction. From 2Θ-ω scans, we find that the MgO lattice constant c along [001] (perpendicular to the platelet plane) can be linearly and reversibly tuned by up to $\Delta c/c = 3 \times 10^{-5}$ upon applying $-30\,\mathrm{V} \leq V_{\mathrm{piezo}} \leq +90\,\mathrm{V}$. According to elasticity theory, this implies that only about 10% of the actuator stroke is transferred into the MgO crystal. We discuss this observation, and compare our results to the effect of V_{piezo} on the magnetic anisotropy of Fe_3O_4 thin films grown onto MgO and then attached to a piezoelectric actuator.

MA 15.33 Tue 15:00 Poster A

Electric-Field Induced Modification of Magnetism in Thin Film Ferromagnets — Martin Weisheit[1,2], •Sebastian Fähler[1,2], Alain Marty[3], Yves Souche[1], Christiane Poinsignon[4], and Dominique Givord[1] — [1]Laboratoire Louis Néel, CNRS, Grenoble, France — [2]IFW Dresden, Germany — [3]DRFMC / SP2M / NM, CEA Grenoble, France — [4]LEPMI / ENSEEG, Saint Martin d'Hères, France

A large electric field at the surface of a ferromagnetic metal is expected to appreciably change the electron density. In particular, the intrinsic magnetic properties, which commonly are regarded as fixed material constants, will be affected. This requires, however, that the surface has a strong influence on the material*s properties, as is the case in ultrathin films. We show that the magnetocrystalline anisotropy of ordered FePt and FePd intermetallic compounds can be reversibly modified by an applied electric field when immersed in an electrolyte. A voltage change of -0.6 V on 2 nm thick films altered the coercivity by -4.5% and +1% in FePt and FePd, respectively. The modification of the magnetic parameters was attributed to a change in the number of unpaired d-electrons in response to the applied electric field. Our device structure is general and should be applicable for characterisation of other thin film magnetic systems.

Science, forthcoming 19.1.2007

MA 15.34 Tue 15:00 Poster A

Magnetoresistive effects in ultrathin permalloy films — •Stephen Krzyk, Mathias Kläui, and Ulrich Rüdiger — Fachbereich Physik, Universität Konstanz, 78457 Konstanz

Inspired by the successful industrial application of the giant magnetoresistance effect (GMR), magnetoresistance properties of nanoscale structures are the subject of intense research. Recent experiments [1] have shown that decreasing the cross section of a nanocontact leads to a significantly increased magnitude of the anisotropic magnetoresistance.

A possible approach to small contact sizes are ultrathin films near the percolation threshold. We investigate magnetotransport through permalloy ($Ni_{80}Fe_{20}$) films grown in between the gaps of Au leads. Permalloy films in the monolayer range were deposited via molecular beam epitaxy in ultra high vacuum conditions. A magnetic field of up to 100 mT was applied in the sample plane, and the conductance of the contact region was measured during depostion as a function of the field angle.

[1] K. I. Bolotin et al., Phys. Rev. Lett. **97**, 127202 (2006)

MA 15.35 Tue 15:00 Poster A

Current-induced magnetic vortex dynamics: micromagnetic simulations and time-resolved x-ray microscopy — •A. Drews[1], M. Bolte[1], B. Krüger[2], G. Meier[1], U. Merkt[1], B. Van Waeyenberge[3], A. Puzic[4], K. W. Chou[4], and H. Stoll[4] — [1]Institut für Angewandte Physik, 20355 Hamburg. — [2]I. Institut für Theoretische Physik, 20355 Hamburg — [3]Department of Subatomic and Radiation Physics, Ghent University, 9000 Gent, Belgium — [4]Max-Planck-Institut für Metallforschung, 70569 Stuttgart

We investigated the current-driven vortex and antivortex dynamics in permalloy rectangles by time-resolved x-ray microscopy and micromagnetic simulations. Experimentally, the vortex rotation was excited by electric ac currents passing directly through the samples. The dynamics was observed by time-resolved x-ray microscopy at beamline 11.0.2. at the Advanced Light Source in Berkeley. From the direction of gyration of the vortices, we determine the polarization of the vortices and the phase of the rotation. We show that in the present experiments only the spin torque and not the Oersted field causes the vortex rotation. We also observe the current-induced rotation of an antivortex at higher frequencies. Micromagnetic simulations were performed for the samples' geometries with OOMMF, extended by the spin-torque term of Zhang and Li. From the simulations we deduce the eigenfrequencies of the vortex motion. We find that two vortices and one antivortex are excited to rotation in a 2x3 μm^2 permalloy rectangle, in agreement with the experiments. Simulations with higher current densities yield a flipping of the polarization of both vortices and antivortex.

MA 15.36 Tue 15:00 Poster A

Impedance of ferromagnetic microrings up to 120 MHz — •Thomas Kamionka, Toru Matsuyama, Ulrich Merkt, and Guido Meier — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg (Germany)

The interaction between a spin-polarized current and the magnetization in a ferromagnetic micro- or nanostructure is of great interest. It will offer new opportunities to design magnetic memory and logic devices. We will analyze the resonant interaction between a spin-polarized current and a magnetic domain wall using a ferromagnetic microring. Using the shape anisotropy of the ring a domain wall can be prepared. This is proven by magnetic-force microscopy and by measuring the anisotropic magnetoresistance. In a magnetic field in the plane of the microring an alternating current forces a transverse domain wall to oscillate like a particle with finite mass [1]. At resonance the oscillation should effect a detectable increase of the ring impedance. At a critical external magnetic field the domain wall becomes unstable and the magnetization of the ring switches to the global vortex state. Concomitantly we detected a sharp increase of the anisotropic magnetoresistance. We varied the amplitude and the frequency of the current and found indications of current-assisted magnetization switching.

[1] E. Saitoh et al., Nature **432**, 203 (2004).

MA 15.37 Tue 15:00 Poster A

Magnetoresistive effects in single LSMO:MgO grain-boundaries — •Markus Esseling, Vasily Moshnyaga, and Konrad Samwer — I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, D-37077 Göttingen

The LSMO:MgO nanocomposite system shows a low-field magnetoresistance up to 30% at low temperatures which is due to the spin polarized tunneling of the conducting electrons across the insulating MgO, which separates individual LSMO grains [1]. Up to now it is still unclear whether the interesting properties of the nanocomposites are a result of the averaging process over all involved grain-boundaries (GB) or are intrinsic to every GB. Therefore we prepared single LSMO:MgO grain-boundaries using $SrTiO_3$- and MgO-bicrystal substrates. Junctions of different width (50μm - 300nm) were defined by e-beam lithog-

raphy and focussed ion beam etching across the GB. A strong influence of the junction width is observed on both the resistance and the magnetoresistance, indicating an inhomogeneous GB. Moreover we show that smallest structures across the GB offers a possibility to study current-induced switching effects in lateral systems, which can be compared to heterostructures.

[1] M. Esseling et al., Appl. Phys. Lett. 87 (2005) 082509

Supported by SFB 602, TP A2 and DFG Sa337/9-1

MA 15.38 Tue 15:00 Poster A

Temperature dependence of current induced domain wall motion in NiFe — •Markus Laufenberg, Wolfgang Bührer, Pascal Dagras, Pierre-Eric Melchy, Mathias Kläui, Lutz Heyne, Dirk Backes, Daniel Bedau, and Ulrich Rüdiger — Universität Konstanz, 78457 Konstanz

Recently reversal by current-induced domain wall motion (CIDM) has become the focus of intense research [1], but quantitative agreement between experiment and theory is often poor. Since so far theory does not consider temperature whereas experiments are often carried out at room temperature, that might be one reason for the observed discrepancies.

In this work we present an experimental study of domain wall motion induced by current pulses as well as by conventional magnetic fields at temperatures between 2 and 300 K in $Ni_{80}Fe_{20}$ rings. The rings are contacted by gold pads to allow for current injection and magnetoresistance measurements. Via the AMR-effect a change in the magnetic configuration can be detected.

Whereas field-induced domain wall motion is a thermally activated process it turns out that CIDM at higher temperatures is less effective than at lower temperatures [2]. The effect of Joule heating due to the current pulses is measured and taken into account to obtain critical fields and current densities at constant sample temperatures. This allows for a comparison of our results with theory.

[1] M. Kläui, *et.al.*, Phys. Rev. Lett. **94**, 106601 (2005).

[2] M. Laufenberg, *et.al.*, Phys. Rev. Lett. **97**, 046602 (2006).

MA 15.39 Tue 15:00 Poster A

AlZr tunnel barriers in magnetic tunnel junctions — •Andrea Niemeyer[1], Andy Thomas[1], Hubert Brückl[2], and Günter Reiss[1] — [1]Bielefeld University, Thin Films & Nanostructures, Bielefeld, Germany — [2]ARCS research GmbH, Nano System Technologies, Vienna, Austria

Magnetic tunnel junctions are due to various possible applications interesting for research and development. Different electrode and barrier materials were used for preparation. During the last ten years the most commonly used barrier material was aluminum oxide. AlZr compositions form a very homogenous and amorphous barrier which is important for a good quality tunneling barrier. This might as well lead to higher tunneling magneto resistance. CoFeB as an electrode material provides high tunneling magneto resistance, about 70% at room temperature with commonly used aluminum oxide. The combination of CoFeB and a Zr alloyed barrier promises even higher TMR amplitudes. The magnetoresistance was measured in dependence on the barrier thickness for several AlZr alloy compositions.

MA 15.40 Tue 15:00 Poster A

Spin transfer torque in granular films AgCo and spin-valve structure Co/Cu/CoNiFeSiB — •Yuansu Luo[1], Markus Esseling[1], Markus Münzenberg[2], and Konrad Samwer[1] — [1]I. Phys. Institut — [2]IV. Phys. Insitut, Universität Göttingen, Friedrich-Hund Platz 1, 37077 Göttingen

We explore spin transfer torque (STT) effect in granular films $Ag_{70}Co_{30}$ and spin-valve structure $Co/Cu/(CoNiFe)_{74}(SiB)_{26}$ by means of point contact technique. Several special properties, such as single-domain properties of Co nanoparticles, a large GMR effect (55% measured at 4.2K) in AgCo, a small coercivity ($H_c \approx 1$ Oe) and a low magnetization ($M_s \approx 0.7$ kG) of the amorphous free layer $(CoNiFe)_{74}(SiB)_{26}$, are convenient for STT observations. A novel STT effect is observed in the granular film, as the current rises above a threshold value I_c. It is accompanied with an abrupt decrease in resistance (R), presumably due to further alignment of small size Co granules. The behavior is polar and I_c disproportional to the magnetic field. For the spin-valve structure a normal current-induced magnetization switching was measured under a standard condition, i.e. an electron flux from the fixed Co-layer to the amorphous free layer $(CoNiFe)_{74}(SiB)_{26}$ stabilizes the parallel alignment (low R), while an opposite current results in the antialignment of two magnetic layers (high R). *Supported by DFG-project, SA 337/9-1*

MA 15.41 Tue 15:00 Poster A

Analysis of the oscillatory tunnel magnetoresistance caused by antiferromagnetic Mn Layers — •Peter Bose[1], Jürgen Henk[2], and Ingrid Mertig[1] — [1]Martin-Luther-Universität Halle-Wittenberg, FB Physik, FG Theoretische Physik, D-06099 Halle (Saale), Germany — [2]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle (Saale), Germany

It is well-established that interfaces determine essentially the transport properties of spintronic systems [1]. However, the essence of this phenomenon is not clarified until now and is still a subject of lively debates. By considering the effect of well-defined magnetic interfaces, the present theoretical investigation provides additional arguments to this discussion.

The ballistic magnetoresistance of tunnel junctions that comprise Mn films is found to exhibit oscillations with increasing Mn-film thickness, as is investigated by means of first-principles electronic-structure and transport calculations. The period of two monolayers is directly related to the layer-wise antiferromagnetic structure of the Mn films, in particular to the alternating magnetization at the interfaces [2]. These findings substantiate unequivocally the effect of the electronic and magnetic structure of interfaces on the conductance of tunnel junctions.

[1] C. Heiliger, P. Zahn, B. Yu. Yavorsky and Ingrid Mertig, Phys. Rev. B **72**, 180406 (2005)

[2] U. Schlickum, W. Wulfhekel, J. Henk, P. Bruno, and J. Kirschner, Phys. Rev. B **74**, 054409 (2006)

MA 15.42 Tue 15:00 Poster A

Structural properties and transport behaviour of polycrystalline $Co_2Cr_{0.6}Fe_{0.4}Al$ films as electrode materials in MTJs — •Rainer Kaltofen[1], Hartmut Vinzelberg[1], Dieter Elefant[1], Ingolf Mönch[1], Joachim Schumann[1], and Rainer Grötzschel[2] — [1]IFW Dresden, P.O.Box 27 01 16, D 01171 Dresden — [2]Institute of Ion Beam Physics and Materials Research, FZ Dresden-Rossendorf, P.O. Box 51 01 19, D 01314 Dresden, Germany

Owing to the high spin polarization predicted for ferromagnetic half-metallic Heusler alloys many experimental attempts are known to verify this feature on real systems. The present work studies polycrystalline $Co_2Cr_{0.6}Fe_{0.4}Al$ (CCFA) films prepared by dc magnetron sputtering. The film composition checked by RBS and PIXE is in good correspondence with the target composition. X-ray studies showed a disordered B2 structure characterized by Co-Al antisite defects. Saturation magnetization measurements by SQUID magnetometry at T=4K showed the number of Bohr magnetons per formula unit to vary between N_B/FU=2...3 in dependence on the deposition substrate temperature and annealing treatments. A strong influence of these treatments on the magnetization temperature dependence is observed. The TMR results exhibit a marginal influence of preparation conditions (T_S,p_{Ar},T_{ann}), however the best values did not exceed $\sim$ 30% at 4.2 K indicating that half-metallic behaviour of the CCFA films is not observed. The main reason of the failure of high spin polarization predicted for CCFA seems to be the imperfect crystalline structure suppressing the formation of a half-metallic band structure.

MA 15.43 Tue 15:00 Poster A

Concept of a Metal Single-Electron Transistor as Spin-Valve Structure — •Markus Kasper, Saskia Fischer, and Ulrich Kunze — Werkstoffe und Nanoelektronik,Ruhr-Universität Bochum, D-44780 Bochum

The generation, manipulation and investigation of spin-polarized currents still need to be improved to make new spintronic components reality. In this contribution we present a concept for a metal single-electron transistor that exploits the combination of Coulomb Blockade and spin-dependent tunneling processes between ferromagnetic leads and a metallic quantum dot [1]. Spin-polarized electrons tunneling through the quantum dot will lead to a non-equilibrium spin accumulation, i.e. a finite polarization of the quantum dot spin. The state of the quantum dot spin is reflected in the transport characteristics of the device. This structure is probably feasible to provide new insights into the mechanisms of spin controlled electron transfer and might actually show new effects resulting from the interaction of both phenomena. We present preliminary results for a metal single-electron transistor with an aluminium quantum dot and tunneling barriers formed by plasma oxidation.

[1] J. König and J. Martinek, PRL 90, 166602 (2003)

MA 15.44 Tue 15:00 Poster A

Magnetotransport Properties of Cobalt-doped ZnO — •Konrad Senn, Karl-Wilhelm Nielsen, Sebastian T. B. Goennenwein, Matthias Opel, and Rudolf Gross — Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching

Cobalt-doped ZnO, which is predicted to be a diluted magnetic semiconductor (DMS) with a Curie-temperature well above room temperature, is a promising candidate for application in spintronics. We have grown (0001)-oriented $Zn_{0.95}Co_{0.05}O$-films on (0001) Al_2O_3 and (0001) $ScAlMgO_4$ substrates by pulsed laser deposition. The growth was monitored by high pressure RHEED. The structural quality of the films was characterized by x-ray diffraction and the magnetic properties have been analyzed by SQUID magnetometry, it revealed room temperature ferromagnetism with magnetic moments up to $0.7\,\mu_B$/Co. To study the relation between magnetism and electrical transport, we measured their magnetotransport properties in applied magnetic fields up to 14 T in the temperature range between 3 K and 300 K. We observed an anomalous Hall effect in samples grown on both Al_2O_3 and $ScAlMgO_4$. We discuss our results in terms of an intrinsic ferromagnetic exchange coupling and the possible presence of cobalt precipitates.

This work is supported by the DFG via SPP 1157.

MA 15.45 Tue 15:00 Poster A

Transport properties of magnetic Co doped ZnO thin films — •Milan Gacic, Gerhard Jakob, and Hermann Adrian — Institut für Physik, Universität Mainz, Staudinger Weg 7, 55128 Mainz

Diluted magnetic semiconductors (DMS) have recently attracted much interest because of their potential application in spintronics. Thereby ferromagnetism above room temperature is essential for practical applications, as found in Co doped ZnO. We have investigated magnetic and transport properties of 5% Co doped and undoped ZnO thin films deposited on r-plane Al2O3 substrates by pulsed laser deposition. The Co doped films showed paramagnetic and ferromagnetic behaviour as well as a high magnetoresistance and a small anomalous Hall effect. In a range of 0 to 5 Tesla at low temperatures we observed a double sign change of the magnetoresistance. For undoped ZnO films, prepared by the same conditions, only a negative MR was observed, but suprisingly also a very small anomalous Hall effect. We explain our results by applying a semiempirical fit consisting of a positive and a negative contribution to the magnetoresistance.

MA 15.46 Tue 15:00 Poster A

Structural and electrical characterization of magnetic tunnel junctions with ultrathin MgO-barriers — •Gerrit Eilers, Tore Niermann, Michael Seibt, and Markus Münzenberg — IV. Phys. Inst., Universität Göttingen

Ultrathin barriers are necessary to provide sufficient high tunnel current densities, which are required for spin current induced switching experiments. For future MRAMs with high read and write performance a high room-temperature tunnelling magnetoresistance (TMR) is also necessary. The thinner the barrier, the more important become the interfaces between the ferromagnetic electrodes and the insulating barrier.

We have prepared magnetic tunnel junctions (MTJs) with trilayers of CoFeB/MgO/CoFeB by means of e-beam evaporation of stoichiometric MgO and magnetron sputtering CoFeB. After characterizing the transport properties (I/V characteristics, TMR) the structural analysis was made by cross-sectional TEM. Aim is to correlate structurel defects and quality of the interfaces with the transport properties.

In future experiments we are planning to integrate the MTJs into a strip line with a photoconductive switch in order to study the dynamics of spin current induced switching effect.

Research was funded by DFG, SFB 602

MA 15.47 Tue 15:00 Poster A

Low-temperature tunneling magneto-resistance on LSMO-based junctions with organic barrier — •Hartmut Vinzelberg, Dieter Elefant, Joachim Schumann, Kathrin Dörr, Ramesh Gangineni, and Bernd Büchner — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

In analogy to the initiative work [1] on giant magneto-resistance in organic spin-valves LSMO-based junctions with an Alq_3-spacer were investigated with the aim to understand the transport behaviour in these new magnetic switching elements. The field and temperature dependence of the magneto-resistance of the prepared elements confirm the experimental observations in [1]. The described spin-valve effects at 4.2 K have been observed in a broad resistance interval from kΩ to MΩ-range without systematic area dependence. In some samples the magneto-resistance changes sign as a function of the bias voltage.

The observed similarity in the bias voltages dependences in comparison with (i) conventional MTJs with Al_2O_3 or MgO barriers and (ii) ferromagnetic contacted carbon nanotubes as well as the insulating nature of Alq_3 characterized by trapped-charge-limited conductivity [2] suggest to describe the found effects within a classical tunnelling concept. The proposed model implies the realization of the spin-dependent transport via local tunnelling paths embedded in the LSMO/Alq_3/Co sandwich structure.

[1] Z.H. Xiong et al., Nature 427, 821(2004)
[2] P.E. Burrows et al., J. Appl. Phys. 79, 7991(1996)

MA 15.48 Tue 15:00 Poster A

Investigation of Spin Polarization by Point Contact Spectroscopy — •Christoph Jurecka, Martin Jourdan, and Hermann Adrian — Institut für Physik, Johannes Gutenberg Universität Mainz, 55099 Mainz

Materials with high spin polarization play a key role in modern magnetoelectronic devices. However, the experimental investigation of the spin polarization is in general a complex task. One possible method is Point Contact Spectroscopy (PCS) employing a superconducting tip [Sou98]. Intending to study the possibilities and limitations of PCS we realised a setup for PCS allowing variable tip pressure and tested our setup on conventional magnetic and non-magnetic materials. For non magnetic materials (e.g. Copper) we where able to identify Andreev Reflection by clear fits employing Mazin*s theory [Maz2001] and excluding any spin-polarization. Spectra of magnetic materials (Ni, Fe) showed a qualitatively different behaviour. However, only an upper limit for the spin polarization could be defined, which corresponds approximately to literature values measured by tunnel spectroscopy. Measurements on the Heusler compound Co2Cr0,6Fe0,4Al, for which a high spin polarization is predicted by band structure calculations, showed an upper limit for the spin polarisation of 40-50%. This is less than indicated by results of tunnel spectroscopy. The main reason for this apparently reduced spin polarization measured by ex-situ PCS could be surface oxidation effects. [Sou98] R. J. Soulen et al., Science 282, 85 (1998); [Maz2001] I. I. Mazin et al., Phys. Rev. B 68, 104430 (2003)

MA 15.49 Tue 15:00 Poster A

Comparison between MgO and AlO_x barriers in $Co_2Cr_{0.6}Fe_{0.4}Al$-Tunnel Junctions — •Christian Herbort, Andres Conca, Martin Jourdan, and Hermann Adrian — Institut für Physik, Johannes Gutenberg Universität, Staudinger Weg 7, 55128 Mainz, Germany

In magnetic tunnel junctions with conventional ferromagnetic electrodes MgO proved to be a superior barrier material concerning the achievable tunnel magnetoresistance effect (TMR). Alternatively, large TMR effects could be obtained by employing novel materials with high spin polarisation. On example for such a material is the Heusler compound $Co_2Cr_{0.6}Fe_{0.4}Al$ (CCFA). We compare the TMR effect of CCFA based tunnel junctions with amorphous AlOx and epitaxial MgO barriers. Whereas we have already optimized junctions with AlO_x barriers and obtained TMR effects which can be associated to a spin polarization of the CCFA > 50 %, the process of MgO deposition requires further improvement. The interface at the barriers is characterized by in situ RHEED and LEED as well as by STM investigations. It is shown that epitaxial MgO can be grown by rf-magnetron sputtering on epitaxial (100) oriented CCFA thin films. The barrier morphology of AlO_x and MgO is compared by transmission electron microscopy (TEM) and related to the TMR effect. The dependence of the TMR effect on the major preparation parameters is shown.

MA 15.50 Tue 15:00 Poster A

A study on the influence of nano-oxide layer on magneto-transport properties of NiMn based giant magnetoresistive spin valve sensors — Anoop Gupta[1], •Senthilnathan Mohanan[1], Ulrich Herr[1], Zaoli Zhang[2], and Ute Kaiser[2] — [1]Institute for Micro and Nanomaterials, University of Ulm, Ulm-89081, Germany — [2]Electron Microscopy Group of Material Science, University of Ulm, Ulm-89069, Germany

NiMn with L1o structure is one of the good antiferromagnetic materials that can be used for exchange bias in giant magnetoresistive spin valve (GMR-SV) sensors. However, as-deposited NiMn exists in

FCC phase which exhibits paramagnetic behaviour. So it has to be annealed at around 300°C in order to achieve FCC to FCT structural phase transformation. Annealing leads to interdiffusion, but this can be controlled by using a nano-oxide layer (NOL). The main aim of this study is to investigate the influence of NOL on the magnetotransport and the structural properties of NiMn/Co/Cu/Co GMR-SV sensors. An increase in the GMR has been observed with the inclusion of NOL in the pinned layer, which is due to the reduced diffusion of Ni and Mn on to the GMR active region. However, we observed a decrease in exchange bias field of the pinned Co layer. A detailed investigation of the influence of the position of NOL in the pinned layer on exchange bias and magnetotransport properties has been done. The optimum position for the NOL is found to be in the middle of the pinned Co layer. The structural phase transformation of NiMn upon annealing has been studied using x-ray diffractometer and HR-TEM.

MA 15.51 Tue 15:00 Poster A

Influence of ion bombardment induced patterning of exchange bias in pinned artificial ferrimagnets on the interlayer exchange coupling — Volker Höink[1], •Jan Schmalhorst[1], Günter Reiss[1], Tanja Weis[2], Dieter Engel[2], and Arno Ehresmann[2] — [1]Thin Films and Nanostructures, Department of Physics, University of Bielefeld, P.O. Box 100131, D-33501 Bielefeld, Germany — [2]Institute of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), Kassel University, Heinrich-Plett-Str.40, D-34132 Kassel, Germany

Artificial ferrimagnets (AFi) have many applications as, e.g., pinned reference electrodes in magnetic tunnel junctions. It is known that the application of ion bombardment induced magnetic patterning with He ions on a single layer reference electrode of magnetic tunnel junctions is possible. For some applications a combination of ion bombardment induced magnetic patterning and artificial ferrimagnets as a reference electrode is desirable. The effect of ion bombardment induced magnetic patterning on pinned artificial ferrimagnets with a Ru interlayer which is frequently used in magnetic tunnel junctions as well as pinned AFis with a Cu interlayer has been tested. Special attention has been given to the question whether the antiferromagnetic interlayer exchange coupling can withstand the ion dose necessary to turn the exchange bias.

MA 15.52 Tue 15:00 Poster A

Blocking temperature distribution of magnetically diluted exchange biased systems — •Marian Fecioru-Morariu, Mohammad Reza Ghadimi, Bernd Beschoten, and Gernot Güntherodt — Physikalisches Institut (IIA), RWTH Aachen, 52056 Aachen, Germany

We have systematically investigated the blocking temperature distribution (BTD) of two different exchange bias systems: the epitaxial system $Co(111)/Co_{1-y}O(111)$ with the insulating high-anisotropy antiferromagnet (AFM) CoO and the polycrystalline system $CoFe/(IrMn)_{1-x}Cu_x$ with the metallic intermediate-anisotropy AFM IrMn. The effects of Co deficiencies in $Co_{1-y}O$ and of nonmagnetic Cu defects in $(IrMn)_{1-x}Cu_x$ on the exchange bias field (H_{EB}) and BTD are analyzed by reversing the AFM domains at successively higher temperatures in the reverse cooling fields. For both systems, the nonmagnetic defects give rise to an enhancement of H_{EB}. Additionally, a broadening of the BTD is observed for the system $Co_{1-y}O$. For the AFM IrMn, with increasing Cu dilution, the AFM grain size decreases and therefore the BTD shifts to lower temperatures. The BTD is correlated with the domain and grain size distribution within the AFM. Further influences of dilution, temperature, time and reversal fields on H_{EB} and BTD will be discussed. We acknowledge the financial support from NEXBIAS Research Training Network (Contract No. HPRN-CT-2002-00296) financed by the EU.

MA 15.53 Tue 15:00 Poster A

Antiferromagnetic thickness dependence of exchange bias — •Shrawan Mishra, Florin Radu, Bernd Heitkamp, Jaime Sanchez-Barriga, Hermann Dürr, and Wolfgang Eberhardt — BESSY GmbH, Albert-Einstein Strasse 15, D-12489,

We have studied systematically the dependence of exchange bias and coercive fields as function of antiferromagnetic (AF) layer thickness. A series of $Si(100)/SiO_2/Cu(5\ nm)/Ni_{81}Fe_{19}(20\ nm)/Ir_{20}Mn_{80}(x)/Cu(2.5\ nm)$ bilayers were grown at MAGSSY magnetron sputtering system of BESSY. For each AF thickness the coercive and exchange bias fields were extracted from the azimuthal dependent hysteresis loops measured by Magneto Optical Kerr Effect(MOKE). It is observed that at the critical thickness for the AF layer, the EB bias field exhibits a sudden jump increasing monotonically as a function of the AF thickness towards a saturation value. The coercivity in this region is equal to the coercive field of the ferromagnetic layer measured separately. On the other hand, below the critical AF thickness the exchange bias vanishes with effective enhanced coercivity. The coercive field is maximum close to the critical AF thickness and decreases with decreasing the AF layer thickness. Therefore, at room temperature the phase diagram for exchange bias and coercivity can be described using a Meiklejohn and Bean mechanism for exchange bias. This is further demonstrated by comparing numerical simulations with experimental data.

MA 15.54 Tue 15:00 Poster A

Magnetization reversal processes in patterned exchange biased NiO/Ni and Fe/CoO layers — •Pablo Asshoff[1], Florin Radu[2], Katharina Theis-Bröhl[1], and Hartmut Zabel[1] — [1]Department of Physics, Ruhr-University Bochum, D-44780 Bochum, Germany — [2]BESSY GmbH, Albert-Einstein-Str. 15, D-12489 Berlin, Germany

We have investigated the magnetization reversal of arrays of exchange biased NiO/Ni and Fe/CoO squares with SQUID magnetometry. The edges of the squares were 0.5, 1.5 and 3.0 μm long. When the sizes of the structures are reduced, for the Fe/CoO structures both the exchange bias field and the slope of the hysteresis loops decrease continuously.

The NiO/Ni structures exhibit hysteresis loops typical of a vortex state. In a micromagnetic simulation of the system this special shape of the hysteresis loop was reproduced and a vortex state was observed. The exchange bias field behaves very unusual: for the arrays with NiO/Ni structures of 1.5 μm edge length the sign of the exchange bias field changes, as compared to the same continuous NiO/Ni layer. We attribute this to the interplay between shape and unidirectional anisotropy. In the exchange biased microstructures the unidirectional anisotropy causes a deformation of the whole hysteresis and not merely a uniform shift.

Support by SFB 491 is acknowledged.

MA 15.55 Tue 15:00 Poster A

Resonant magnetic x-ray reflectivity on Co/Cu/Co — •Valeriano Ferreras Paz, Sebastian Brück, Eberhard Goering, and Gisela Schütz — Max Planck Institut für Metallforschung, Heisenbergstr. 3, 70569 Stuttgart

The interaction between ferromagnetic layers across a nonmagnetic or isolating spacer layer has reached great technological importance during the last years, i.e. GMR sensors. A Co/Cu/Co has been grown epitaxially on a Cu (100) single crystal substrate by molecular beam epitaxy. The quality of the film is controlled by LEED and TEM. On this system resonant magnetic x-ray reflectivity measurements were performed at BESSY II, which allows the determination of the magnetic depth profile in an element selective way. This has been done on the Co and Cu L_3 edge in order to learn more about the origin of the oscillatory exchange coupling in such systems.

References:

J. Geissler et al. Phys. Rev. B 65, 020405 (2001)
P. Bruno J. Phys.: Condens. Matter 11 9403-9419 (1999)
M. G. Samant et al. Phys. Rev. Lett. 72, 1112 - 1115 (1994)

MA 15.56 Tue 15:00 Poster A

Exchange bias in Fe/Cr bilayers — •Syed Rizwan Ali, Marian Fecioru-Morariu, Bilal Janjua, Coen Smits, and Gernot Güntherodt — Physikalisches Institut (IIA), RWTH Aachen, 52056 Aachen, Germany

Exchange coupling in Fe/Cr bilayers have been studied in either molecular beam epitaxy (MBE) grown or sputtered samples. Our sputtered samples show exchange bias which changes its sign as a function of temperature. This temperature was found to increase with the thickness of the Cr layer. The positive part of the exchange bias shows a maximum and decreases with temperature up to the blocking temperature of the Cr thin film. The coercivity was also found to vary in close correlation with the exchange bias. In order to exclude the possibility of antiferromagnetic oxide formation at the interface, samples were also grown in ultra high vacuum using MBE. We have found a similar qualitative behaviour of exchange bias and coercivity in the

MBE grown samples as compared to the sputtered ones. However, the sign change effect was more pronounced in MBE grown samples.

MA 15.57 Tue 15:00 Poster A

Current-driven domain walls in nanowires — •Benjamin Krüger[1], Daniela Pfannkuche[1], Markus Bolte[2], Guido Meier[2], and Ulrich Merkt[2] — [1]I. Institut für Theoretische Physik, Universität Hamburg, Jungiusstrasse 9, 20355 Hamburg — [2]Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstrasse 11, 20355 Hamburg

Current-induced motion of a domain wall in a semicircle nanowire with an applied Zeeman field is investigated. Starting from the micromagnetic equation of motion extended by the adiabatic as well as the non-adiabatic current-induced spin torque introduced by Zhang and Li [1], we derive an analytical solution characterizing the domain-wall motion as a harmonic oscillation. This solution relates the micromagnetic simulation parameters with the dynamical characteristics of a harmonic oscillator. The results are compared to numerical calculations. For these calculations we extended the Object Oriented Micromagnetic Framework (OOMMF) [2] with the current-induced spin torques. The numerical calculations confirm our analytical solution. Our calculations disclose a strong dependence of the motion and the structural changes of the wall on the Gilbert damping and the non-adiabatic spin torque. For wires with strong curvature the dipole moment of the wall as well as its geometry influence the eigenmodes of the oscillator. Based on these results we suggest experiments for the determination of material parameters which otherwise are difficult to access.

[1] S. Zhang and Z. Li, PRL **93**, 127204 (2004).
[2] M. J. Donahue and D. G. Porter, http://math.nist.gov/oommf

MA 15.58 Tue 15:00 Poster A

Domain wall motion in perpendicularly magnetized (Co/Pt)$_n$-multilayer-wires — •Christoph Hassel[1], Jan Rhensius[2], Theo Kleinefeld[2], Jürgen Lindner[1], and Günter Dumpich[1] — [1]Fachbereich Physik, AG Farle, Universität Duisburg-Essen, Lotharstrasse 1, 47048 Duisburg — [2]Fachbereich Physik, Angewandte Physik, Universität Duisburg-Essen, Lotharstrasse 1, 47048 Duisburg

We prepare (Co/Pt)$_n$-multilayer wires by means of a two step electron beam lithography process. The magnetization reversal process of (Co/Pt)$_n$-multilayer-wires with perpendicular magnetic anisotropy is investigated with an optical Kerr Microscope. Different structures are used so that we can nucleate domain walls in the wire using the application of external magnetic fields. The wires are contacted with nonmagnetic gold wires, which allows us to inject currents into the wire. To move the domain walls we use pulsed currents with current densities of up to 10^8 A/cm^2. Sample heating is controlled my measuring the resistance during the application of the pulses. We carried out experiments as well with additional application of small magnetic fields as without external magnetic field. Results are discussed in terms of the spin-transfer-torque effect.

This work is financially supported within SFB 491.

MA 15.59 Tue 15:00 Poster A

Stray Fields and Anisotropic Magnetoresistance of Domain Walls in Permalloy Nanowires — •Peter Lendecke, Hannah Ziehlke, René Eiselt, Ulrich Merkt, and Guido Meier — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Germany

Magnetic domain walls in nanowires have attracted a lot of interest because of their application in logic [1] and memory devices [2]. We present Hall micromagnetometry and anisotropic magnetoresistance (AMR) measurements of domain walls in wires of 100 – 500 nm width and 30 nm thickness. In our experiments domain walls are induced into the wires at well defined positions either at a lithographically defined notch or in the curved region of a wire. In both geometries a suitable sequence of applied magnetic fields serves to generate the domain walls. AMR measurements are performed in order to verify the presence and movement of the wall in an external magnetic field. The AMR contribution of the wall is small, of the order of 0.1 %. For the realization of the proposed "racetrack" memory, a quantitative determination of stray-field strenghts for different domain-wall types is crucial. The high sensitivity and non-invasive nature of Hall micromagnetometry allow for the determination of the stray field as well as the nucleation and the depinning field of the walls [3].

[1] D. A. Allwood et al., Science **309**, 1688 (2005)
[2] S. S. P. Parkin, U. S. Patent No. US 6834005 (2004)
[3] G. Meier et al., J. Appl. Phys. **92**, 7296 (2002)

MA 15.60 Tue 15:00 Poster A

Single shot measurement of current- and field-induced domain wall motion in a Permalloy nanowire — •Philipp Möhrke[1], Thomas Moore[1], Mathias Kläui[1], Dirk Backes[2], Laura Heyderman[2], and Ulrich Rüdiger[1] — [1]Fachbereich Physik, Universität Konstanz, 78457 Konstanz, Germany — [2]Paul Scherrer Institut, 5232 Villingen PSI, Switzerland

In order to obtain full information about the stochastic nature of current-induced domain wall (DW) motion [1] in ferromagnetic nanowires, single shot measurements are necessary. We use a focused magneto-optic Kerr effect (MOKE) technique to capture single DW movements in a 500 nm-wide, ∼30 nm-thick $Ni_{80}Fe_{20}$ wire. A DW is prepared at a specified position, as in [2]. By applying fields $H < H_p$ (depinning field) along the wire direction and concurrently injecting a 50 μs current pulse of ∼2 x 10^{12} A/m^2 to depin the domain wall, we probe the interplay between field- and current-induced domain wall motion, as well as inducing wall motion by current pulses alone (H = 0). Subsequently the wall passes through the focused MOKE laser spot (∼1 μm diameter), which covers a straight section of the wire a few micrometres from the wall's initial position. The wall motion is detected with sub-nanosecond time resolution, and the experiment is repeated to gather statistics on the wall motion. Depending on the field and current densities applied, wall velocities of 10-100 m/s are observed.

[1] M. Kläui et al., Appl. Phys. Lett. 88 (2006) 232507
[2] M. Kläui et al., Phys. Rev. Lett. 95 (2005) 026601

MA 15.61 Tue 15:00 Poster A

Spin waves in semi-circular Permalloy ring segments in the presence of domain walls — •Christian Sandweg, Helmut Schultheiss, Sebastian Hermsdörfer, Peter Andreas Beck, Britta Leven, and Burkard Hillebrands — Fachbereich Physik and Forschungsschwerpunkt MINAS, TU Kaiserslautern, Germany

Semi-circular $Ni_{81}Fe_{19}$ ring segments are interesting systems to investigate spin wave properties in confined dimensions. The ring segments have a radius of 10 μm, a width of 500 nm and a thickness of 10 nm. A 200 nm wide protrusion has been added in the pole of the ring segment in order to create a nucleation site for a domain wall if an external field in radial direction is applied. Thereby it is possible to study spin wave spectra in the structure both in the presence and the absence of a domain wall just by applying an external magnetic field in radial or tangential direction, respectively. The ring segments have been prepared employing a combination of electron beam lithography using a lift-off process and molecular beam epitaxy. The spin waves have been detected with a spatial resolution of 300 nm by means of micro-focus Brillouin light scattering spectroscopy. The experiments reveal the typical spin wave quantization effects as expected in confined structures. However, in the presence of a domain wall the quantized wave profile is distorted in its vicinity as a result of the variation of the internal magnetic field. The authors acknowledge support of the Nano+Bio Center of the TU Kaiserslautern during sample preparation and financial support by the DFG within the SPP1133 and the NEDO project No 2004IT093 funded by the Japanese government.

MA 15.62 Tue 15:00 Poster A

Nonlinear spin dynamics and microwave assisted switching in nanostructured rings — •Jan Podbielski[1], Kristina Reckwell[1], and Dirk Grundler[2] — [1]Institut für Angewandte Physik und Zentrum für Mikrostukturforschung, Universität Hamburg, Jungiusstr. 11, D-20355 Hamburg — [2]Physik Department E10, Fakultät für Physik, Technische Universität München, James-Franck-Str. 1, D-85748 Garching

We report a method to induce large angle spin precession in nanostructured ferromagnets. For this we have fabricated coplanar wave guides (CPWs) with a width of only 3 μm. We have patterned mesoscopic Permalloy rings with an outer diameter of 2 μm directly on top of such CPWs. Using a broadband network analyzer we generate a microwave magnetic field to induce large angle spin precession phenomena. We observe shifts of the ring's spin wave eigenfrequencies as a function of microwave magnetic field amplitude. In particular we find both shifts to higher and to lower frequency. The behavior depends on the ring segment where the spin wave eigenmode is localized. Increasing the microwave power further leads to irreversible jumps in the spin wave spectrum. We attribute this to microwave assisted switching. The dynamically induced switching reveals a resonant behavior, i.e. the

efficiency for switching depends on not only the amplitude but also the frequency of the irradiated microwave. We will discuss possible microscopic mechanisms for these intriguing observations. The work is supported by the DFG via SFB668 and via the excellence cluster "Nanosystems Initiative Munich (NIM)".

MA 15.63 Tue 15:00 Poster A

Spin-wave quantization in nanoscaled magnetic rings — •Sebastian Schäfer[1], Helmut Schultheiss[1], Patrizio Candeloro[1], Hans T. Nembach[2], Peter Andreas Beck[1], Britta Leven[1], Andrei N. Slavin[3], and Burkard Hillebrands[1] — [1]FB Physik and Forschungsschwerpunkt MINAS, TU Kaiserslautern, Erwin-Schrödinger-Str. 56, 67663 Kaiserslautern — [2]NIST, Boulder, Colorado, USA — [3]Oakland University, Rochester, Michigan, USA

Spin dynamics in small confined structures is interesting with respect to fundamental understanding as well as in view of applications in, e.g. magnetic memory or logic devices. The eigenmode spectra of small magnetic elements were discussed extensevily in the past. Yet the question of (de-)coherence of spin waves was not adressed so far, even though this is an essential requirement for an eigenmode system. Spin wave spectra in mesoscopic magnetic ring structures made of Permalloy with a thickness of 15 nm, diameters ranging from 1 to 3 μm and radii from 100 to 300 nm respectively, are investigated by means of micro focus Brillouin light scattering spectroscopy. The two predominant remanent magnetic configurations of the ring structures, the so called onion and the vortex state, and their switching behavior were studied extensively. Model calculations and dynamic micromagnetic simulations using the OOMMF code reveal excellent agreement with our experimental results. This work is supported by the DPG within the SPP1133 and the Japanese government within the NEDO project 2004IT093.

MA 15.64 Tue 15:00 Poster A

Wellenlänge von Konzertina-Mustern in Permalloy-Schichten — •Holm Wieczoreck[1], Rudolf Schäfer[1], Jeffrey McCord[1], Ludwig Schultz[1], Jutta Steiner[2], Ruben Cantero-Alvarez[2], Antonio Capella[2] und Felix Otto[2] — [1]Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden, Helmholtzstraße 20, 01069 Dresden — [2]Universität Bonn, Wegelerstraße 10, 53115 Bonn

Ein äußeres magnetisches Feld sättigt rechteckige weichmagnetische Schichten. Wird das Feld reduziert, zerfällt unterhalb einer bestimmten Feldstärke die einheitliche Magnetisierung in ein Konzertinamuster[1]. In [2] wird für anisotropiefreie Schichten mit Hilfe eines mathematischen Modells die Abhängigkeit der Konzertinawellenlänge von der Breite und Dicke lateral strukturierter Schichtelemente gezeigt. Wir untersuchen die Abhängigkeiten der Wellenlänge von Konzertina-Mustern jeweils in Permalloy-Schichten (10 - 300 nm) mit einer Streifenbreite von 10 bis 200 μm. Die Anisotropie der Probenserien beträgt ca. 5 Oe bzw. 2 Oe. Unsere Untersuchungen erfolgen mit Hilfe der Kerrmikroskopie und FFT. Dabei interessiert die Periodizität entlang der Längsrichtung der Proben. Das äußere Magnetfeld zeigt in Richtung der leichten bzw. schweren Achse. Wir beschreiben die Wellenlängenabhängigkeit von Schichtdicke und Streifenbreite und vergleichen mit [2]. Außerdem gewinnen wir statistische Angaben zu den interessierenden Abhängigkeiten. [1] A. Hubert, R. Schäfer, Magnetic domains, Springer, 1998 [2] A. DeSimone, R. V. Kohn, S. Müller and F. Otto. Recent analytical developments in micromagnetics. in: Science of Hysteresis, Elsevier, G. Bertotti and I Magyergyoz, Eds., 2005.

MA 15.65 Tue 15:00 Poster A

Magnetization dynamics of iron thin film triggered by photoconductive switches — •Zhao Wang[1], Anne Parge[1], Malte Scherff[1], Markus Münzenberg[1], and Mihail Ion Lepsa[2] — [1]IV. physikalische Institut Universität Göttingen — [2]Forschungszentrum Jülich(IBN-1)

The photoconductive switches are based on a coplanar waveguide with a metal-semiconductor-metal contact pad using low temperature grown GaAs (LT-GaAs). The carriers in the semiconductor are excited by a Ti:Sapphire Laser with the pulse length 80fs. Because of the short relaxation time of the LT-GaAs, the generated current pulse corresponding magnetic field pulse is in ps range. the pulse length can be defined by the autocorrelation measurenments. the amplitude of the created current pulse can be up to some Ampere corresponding to a magnetic field over 150mT.

The field pulse is used to trigger the magnetization dynamics in an iron thin film on top of the coplanar waveguide, structured wth the help of e-Beam lithography. The dynamic measurements are compared to micromagnetic simulations.

Research supported by DFG SPP 1133.

MA 15.66 Tue 15:00 Poster A

Charge and magnetization dynamics in correlated solids observed with THz time-domain spectroscopy — •Tobias Kampfrath, Jan Nötzold, Luca Perfetti, Christian Frischkorn, and Martin Wolf — Fachbereich Physik der Freien Universität Berlin, Arnimallee 14, D-14195 Berlin

THz pulses covering the spectral range from 8 to 30 THz have been employed to measure the dielectric function of carbon nanotube and graphite films which were excited with a 10-fs, 780-nm laser pulse. In contrast to graphite, the nanotube sample does not show a free-carrier response which clearly demonstrates that strongly bound excitons are the main product of photoexcitation in semiconducting nanotubes.

In case of ferromagnetic Fe, Co, and Ni films, we have detected the THz waveform that is emitted upon excitation of these samples with an intense 20-fs, 800-nm laser pulse. We discuss the origin of the emitted radiation and its relationship to the ultrafast magnetization dynamics of the sample.

MA 15.67 Tue 15:00 Poster A

Magnetization dynamics in interlayer exchange coupled NiFe/Ru/NiFe thin films at high excitation amplitudes — •Tobias Martin, Mohamed Belmeguenai, Markus Maier, Georg Woltersdorf, and Günther Bayreuther — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, 93040 Regensburg

The technological applications of interlayer exchange coupling are manifold, e.g. to bias GMR and TMR elements in read heads of hard disk drives. Furthermore it is used to produce synthetic antiferromagnets acting as soft layers in toggle MRAM cells. In order to further increase the data rates in such applications, it is of importance to understand the dynamic magnetization motion.

Here, coupled NiFe/Ru/NiFe film systems with varying Ru thickness are examined with static and dynamic techniques. The static characterization and determination of coupling constants is done by means of magneto optic Kerr effect and vibrating sample magnetometer. The precessional motion is investigated with a pulsed inductive microwave magnetometer (PIMM) and with vector network analyser FMR (VNA-FMR). The PIMM allows for excitation pulse fields of up to 150 Oe. Both dynamic techniques show optic and acoustic modes, although the VNA-FMR method was able to excite both modes simultaneously over a larger bias field range. At high excitation amplitudes additional pulse field dependent modes were observed. A large part of the modes can be explained by simulations using the simple macrospin model, which also helped to identify optical and acoustical mode.

MA 15.68 Tue 15:00 Poster A

Electronic control of magnetization in magnetic diluted quantum dots — Tobias Voigt, •Peter Moraczewski, and Daniela Pfannkuche — I. Institut für Theoretische Physik, Universität Hamburg, Jungiusstraße 9, 20355 Hamburg

Recent investigations have suggested precise control of ferromagnetism in diluted magnetic (II,Mn)VI semiconductor quantum dots by variation of electron numbers [1]. The spins of the itinerant electrons couple the spins of the localized manganese ions leading to dilute ferromagnetism. We study effects of electron-electron interaction on the magnetization of the localized Mn impurities in these systems. Due to e. g. Hunds rule coupling we expect deviations from the electron number dependence of the magnetization observed in [1].

Manganese atoms in GaAs act as acceptors. In contrast to electron systems a striking difference in the behaviour of the hole states is expected because of the degeneracy in the valence bands of GaAs. We examine the impact of the localized Mn impurities on the hole states in the quantum dot.

[1] J. Fernández-Rossier and L. Brey, PRL 93, 117201 (2004)

MA 15.69 Tue 15:00 Poster A

Kerr microscopical investigations of domain wall dynamics in ultrathin trilayers of Pt/Co/Pt — •Jan Rhensius[1], Theo Kleinefeld[1], Wolfgang Kleemann[1], Jacques Ferré[2], Jean-Pierre Jamet[2], and Harry Bernas[3] — [1]Angewandte Physik, Universität Duisburg-Essen, 47048 Duisburg, Germany — [2]LPS, Université Paris-Sud, 91405 Orsay, France — [3]CSNSM, Université Paris-Sud, 91405 Orsay, France

The dynamics of ferromagnetic domain walls in ultrathin trilayers Pt/Co(0.5 nm)/Pt with perpendicular anisotropy is investigated by polar Kerr microscopy. The coercive field has been reduced to a few mT by irradiation with a dose of $1.5x10^{16}cm^{-2}$ He^+ ions at 30 keV energy [1]. Magnetization reversal processes are recorded with a temporal resolution of about 0.8 s. Field-induced domain growth and domain wall velocities are analyzed by treating the differences of subsequent images. Apart from the dependence of the velocity on a perpendicularly applied static magnetic field, the change of wall conformations and their average velocities are also determined in sinusoidally modulated external fields. The results are related to linear magnetic *ac* susceptibility spectra being excited under similar conditions [2]. They help understanding the role of the different dynamic domain wall modes - creep, slide and switching - observed in disordered ferroic materials [3].
[1] C. Chappert, H. Bernas, J. Ferré et al., Science **280**, 1919 (1998). [2] O. Petracic, A. Glatz, W. Kleemann, Phys. Rev. B **70**, 214432 (2004). [3] W. Kleemann, Ann. Rev. Mat. Res. **37** (2007) in press.

MA 15.70 Tue 15:00 Poster A

Ultrafast Demagnetization Probed by Femtosecond X-Ray Pulses — •Marko Wietstruk, Torsten Kachel, Niko Pontios, Christian Stamm, Hermann A. Dürr, and Wolfgang Eberhardt — BESSY m.b.H., Albert-Einstein-Straße 15, 12489 Berlin, Germany

The energy of an intense fs laser pulse exciting a ferromagnetic sample is absorbed by the electronic system. The subsequent transfer of energy to the lattice and spin systems leads to a demagnetization of the sample within a few 100 fs. However, the total angular momentum previously carried by the ordered spins has to be conserved and consequently transferred to the other reservoirs on the same time scale.

Using X-ray magnetic circular dichroism (XMCD), we observe the evolution of the magnetization as a function of time delay between the laser pump and the x-ray probe pulse. The contribution of the spin and orbital moments can be obtained by XMCD sum rules. Our goal is to get new insight into the energy and angular momentum transfer mechanisms during the ultrafast demagnetization of ferromagnetic thin films.

The experiments were done at the femtosecond slicing source at BESSY have a temporal resolution better than 150fs. It provides circularly polarized synchrotron radiation at energies in the range of absorption edges of 3d transition metals and rare earths (L and M edges, respectively), covering important ferromagnetic elements like Fe, Ni and Gd.

MA 15.71 Tue 15:00 Poster A

Spin structure investigations of domain walls in nanoscale constrictions — •Dirk Backes[1,2], Laura Heyderman[1], Christian David[1], Mathias Kläui[2], Friederike Junginger[2,4], Henri Ehrke[2,4], Ulrich Rüdiger[2], Caros Vaz[3], Tony Bland[3], Cheng-Shi Chen[4], Takeshi Kasama[4], and Rafal Dunin-Borkowski[4] — [1]Laboratory for Micro- and Nanotechnology, Paul Scherrer Institut, Switzerland — [2]FB Physik, Universität Konstanz — [3]Cavendish Laboratory, University of Cambridge, UK — [4]Department of Materials Science and Metallurgy, University of Cambridge, UK

Domain walls of ferromagnetic curved-line elements exhibit two spin-configurations - the vortex and the transverse wall type. If a notch is included forming a constriction, transverse walls get pinned inside of the constrictions and vortex walls in the vicinity of the notch [1]. We report on the fabrication of such elements on membranes with constrictions as small as approx. 30 nm [2]. Electron holography is the ideal technique to study the spin-structure near and in these constrictions because it is able to visualize the magnetic induction with a resolution below 5 nm. Concentrating on transverse walls we systematically determine the shape which could be either symmetrical or asymmetrical depending on the geometry. We characterize the transverse wall by its opening angle and compare the experimental data with simulations.

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

MA 15.72 Tue 15:00 Poster A

Room temperature magnetic order in proton irradiated graphite: latest results — •Kristian Schindler[1], Jose Barzola-Quiquia[1], Martin Rothermel[2], Annette Setzer[1], Pablo Esquinazi[1], and Tilman Butz[2] — [1]Division of Superconductivity and Magnetism, Institute for Experimental Physics II, University of Leipzig, Linnéstr. 5, 04103 Leipzig, Germany — [2]Division of Nuclear Solid State Physics, Institute for Experimental Physics II, University of Leipzig, Linnéstrasse 5, 04103 Leipzig, Germany

We discuss recent results concerning the magnetic properties of proton irradiated micro-spots produced on highly oriented pyrolytic graphite (HOPG) samples. A proton microbeam of 2.25MeV energy was used to create micrometer spots on HOPG. We have used specially made sample holders that allow us to irradiate the samples and to measure them in the SQUID without any change in their positions. The SQUID resolution and reproducibility enable the measurement of relative changes in the magnetic moment of the sample of the order of 2×10^{-7} emu. We discuss the influence of parameters like proton current and irradiation under low temperature conditions on the measured magnetic order. We compare and combine the results obtained by SQUID and scanning probe microscopy measurements. The electrostatic and thus material changes at the irradiated area are discussed. We compare our results with recently obtained results of X-rays magnetic circular dichroism (XMCD) measurements (at the carbon K-edge) on irradiated spots in carbon films that support the ferromagnetic order observed in SQUID measurements.

MA 15.73 Tue 15:00 Poster A

Geometrically Confined Domain Walls — •Daniel Bedau[1], Mathias Kläui[1], Ulrich Rüdiger[1], Dirk Backes[2], and Laura Heyderman[2] — [1]Universität Konstanz — [2]PSI Villigen

Magnetic domain walls (DWs) that are geometrically confined exhibit unique quasi-particle features. Depending on the geometry two basic spin configurations for head-to-head domain walls exists, which are called vortex walls and transverse walls. We present phase diagrams for the domain wall types [1] and demonstrate thermally activated transformations between the wall types, from which we estimate the energy barrier separating the two types [2].

Using magnetic rings in an external rotating field the domain wall can be positioned at any position along the ring, and the position of the domain wall can be accurately determined using magnetoresistance measurements. Applying this method we determine the wall propagation fields and the details of pinning at geometrical variations. [3-5]

Using electron holography we map the stray field of transverse and vortex walls and find that transverse walls can strongly interact for sufficiently small spacings leading to a shift in the phase boundary [6]. Quantitative measurements allow us to determine the statistical distribution of energy barriers for the vortex core nucleation [6].

[1] M. Kläui et al., Appl. Phys. Lett. **85**, 5637 (2004) [2] M. Laufenberg et al., Appl. Phys. Lett. **88**, 052507 (2006) [3] M. Kläui et al., Phys. Rev. Lett. **90**, 97202 (2003) [4] M. Kläui et al., Appl. Phys. Lett. **87**, 102509 (2005) [5] D. Bedau et al., J. Appl. Phys., (in press 2007) [6] M. Laufenberg et al., Appl. Phys. Lett. **88**, 212510 (2006)

MA 15.74 Tue 15:00 Poster A

Preparation and characterization of periodic two-dimensional two-phase magnets — •Sven Schnittger[1], Sebastian Dreyer[1], Christian Jooss[1], and Sibylle Sievers[2] — [1]Institut für Materialphysik, Universität Göttingen — [2]Physikalisch-Technische Bundesanstalt, Braunschweig

Two-phase magnets play an important role in the production of permanent magnet applications; especially the interplay of the different magnetostatic interactions is of great interest.

In this contribution, a model system for the study of a two-dimensional two-phase ferromagnet is presented. The sample consists of arrays of hard magnetic squares ($L1_0$-CoPt) embedded in a soft magnetic film (Permalloy, $Fe_{19}Ni_{81}$). Arrays with different distances of the square elements are prepared.

The fabrication process is done as follows: a magnetron-sputtered CoPt film on a (100)-MgO substrate is structured by electron beam lithography. Electron-resist and exposure parameters of the RAITH electron lithography system have been optimized with respect to straight edges and the realization of well-defined interfaces. The negative structure is etched into the film by reactive ion etching using an aluminum mask. The Permalloy film is deposited by ion beam sputtering.

The magnetic characterization is accomplished by a magneto-optical indicator film technique using the Faraday Effect and by magnetic force microscopy.

MA 15.75 Tue 15:00 Poster A

Magnetization processes in highly coercive, epitaxial $SmCo_5$ elements — •Volker Neu, Ulrike Wolff, Aarti Singh, Felix Fleischhauer, Sebastian Fähler, and Ludwig Schultz — IFW Dresden, P.O. Box: 270116, 01171 Dresden, Germany

Highly coercive, epitaxial $SmCo_5$ films with unique in-plane alignment

of the easy magnetization axis were prepared by pulsed laser deposition on Cr buffered MgO(110) single crystal substrates ($\mu_0 H_c$ = 2 to 3 T). Despite the good orientation of neighboring grains, these films possess a very small scaled domain structure in the as prepared state. Magnetic force microscopy (MFM) studies have been performed in the remanent state on structured 10μm x 10μm elements after applying increasingly higher magnetic fields. The magnetization process proceeds slowly and without the formation of larger domains until fields exceed 1 T. Changes are most pronounced between 1.2 T and 1.6 T, i.e. about 0.6 H_c. Close to saturation, the element is almost fully magnetized, as seen from contrast free inner areas and charge build-up at the element edges, but for small isolated areas. We interpret this behavior as a pinning dominated magnetization process with a large pinning density. The defect distance is estimated from the size of the smallest observable isolated magnetic domains and is of the order of 50 nm for a film thickness of likewise value. This observation offers an explanation for the high coercivities of these well textured films and is of importance for the possible use in magnetic recording applications. There, a new concept of percolated media is based on granular, exchange coupled materials with high pinning density.

MA 15.76 Tue 15:00 Poster A

Patterned Fe/Cr/Co spin valve structures — •Frank Brüssing, Gregor Nowak, Hartmut Zabel, and Katharina Theis-Bröhl — Department of Physics, Ruhr-University Bochum, D-44780 Bochum

Weakly antiferromanetically coupled Fe/Cr/Co films were grown via molecular beam epitaxy on MgO (001). We designed the samples such that both magnetic layers (Fe and Co) have similar magnetization by adjusting their thicknesses. The structural quality of these multilayers was studied by X-ray reflectometry. The magnetic properties were measured by MOKE and SQUID.

The films were patterned into stripes using e-beam lithography with a negative photo resist. Subsequently the structure was etched via ion beam. Vektor-MOKE was performed as a function of the azimuthal angle. For the easy axis (stripes || external field) an extend plateau region is observed, which decreases by rotating the sample to the hard axis. These results were compared with Fe and Co stripes.

This project was supported by the DFG via SFB491.

MA 15.77 Tue 15:00 Poster A

Nanoscale surface ripples on ferromagnetic films with correlated magnetic — Kun Zhang[1], Frank Rotter[1], Michael Uhrmacher[1], Carsten Ronning[1], Hans Christian Hofsäss[1], Johann Krauser[2], and •Klaus Jesiek[1] — [1]II.Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Fachbereich Automatisierung und Informatik, Hochschule Harz, Friedrichstrasse 57-59, 38855 Werningerode, Germany

The correlation between nanoscale surface ripple patterns and the magnetic texture of polycrystalline iron and nickel thin films was investigated. The ripple patterns were created by ion beam sputter erosion of films evaporated on Si substrates with 5 keV Xe ions under grazing incidence and fluences between $10^{15}$and $10^{17} cm^{-2}$. The as-deposited films with an rms roughness of about 1 nm are magnetically isotropic. MOKE measurements reveal a pronounced uniaxial magnetic anisotropy of the only 1-2 nm thin irradiated surface region of the films with an orientation parallel to the ripple orientation and also to the ion beam direction. Sputter erosion reduced the coercive field of the films for all erosion conditions investigated. Sputter erosion at an incidence angle of 80° with respect to the surface normal produces rather smooth films and for ion-fluences exceeding $10^{16} cm^{-2}$ formation of ripples parallel to the ion beam direction with wavelength between 30 nm and 80 nm is observed. Almost complete sputter erosion of Fe films resulted in the formation of Fe nanorods oriented parallel to the ion beam direction with 100% uniaxial magnetic texture.

MA 15.78 Tue 15:00 Poster A

Structural and magnetic characterization of FePt films deposited onto SiO_2 spherical particle arrays — •Christoph Brombacher[1], Denys Makarov[1], Mireille Maret[2], Fabiola Liscio[2], Guenter Schatz[1], and Manfred Albrecht[1] — [1]University of Konstanz, Department of Physics, D-78457 Konstanz, Germany — [2]Laboratoire de Thermodynamique et Physico-Chimie Métallurgiques, ENSEEG, Saint Martin d'Heres, France

The growth of FePt films at 450°C on a Pt/Cr buffer layer deposited onto SiO_2 spherical particle arrays and for comparison on flat thermally oxidized Si(001) substrates has been studied. The structural properties of the FePt films, such as the orientation and size of the crystalline grains and the degree of $L1_0$-type chemical ordering, were investigated by in-situ RHEED and ex-situ XRD. Magnetic characterization was performed by MFM, polar MOKE and SQUID. Increasing the Cr buffer underlayer thickness favors the formation of the FePt chemically ordered $L1_0$ phase. An out-of-plane coercivity of the FePt alloy about 4 kOe was thus obtained for a Cr thickness of 50 nm. While the continuous films on oxidized Si(001) substrates show magnetic domain patterns with domain sizes in the range of 50-100 nm, multi-domain states are observed for the FePt alloy grown on the particle arrays. The influence of the Cr underlayer thickness and Pt buffer layer on the magnetic properties of FePt are discussed for various particle arrays and compared to micromagnetic simulations, providing a description of magnetization reversal. Project is funded by the DFG through the Emmy Noether program at the University of Konstanz.

MA 15.79 Tue 15:00 Poster A

Structural, magnetic and magneto-optical properties of novel nanocrystalline face centered cubic Co1-xCrx/Pt multilayers with perpendicular anisotropy — •Evangelos Papaioannou[1], Christoph Rüdt[1], Paul Fumagalli[1], Panagiotis Poulopoulos[2], Makis Angelakeris[3], and Nikolaos Flevaris[3] — [1]Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14,D-14195 Berlin-Dahlem, Germany — [2]Materials Science Department, University of Patras, 26504 Patras, Greece — [3]Department of Physics, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece

Co1-xCrx alloyed layers are combined with extremely thin Pt layers in order to produce novel face centered cubic multilayered films to be considered as a potential perpendicular magnetic recording medium. The films were grown on Si, glass and polyimide substrates by e-beam evaporation at a temperature slightly higher than the room temperature. The multilayered structure of the films was checked by x-ray diffraction experiments. Plane view transmission electron microscopy images have revealed the formation of very small grains in the range of 7-9 nm. Hysteresis loops as a function of temperature were recorded by means of the magneto-optical Kerr effect. It was found perpendicular magnetic anisotropy, which increases as temperature decreases. Values like squareness = 1 and coercivity = 1.45 kOe, at 10 K were obtained. Furthermore, the complete magneto-optical spectra of the films are recorded, showing a strong magneto-optical enhancement in the ultraviolet region at around 4.5 eV.

MA 15.80 Tue 15:00 Poster A

Thermal Switching Behavior of Superparamagnetic Nanoislands: SP-STM on Fe/W(110) — •Gabriela Herzog[1], Stefan Krause[1], Luis Berbil-Bautista[1,2], Elena Vedmedenko[1], Matthias Bode[1], and Roland Wiesendanger[1] — [1]Institute of Applied Physics, University of Hamburg, Germany — [2]Department of Physics, University of California at Berkeley, USA

Recently it has been shown that spin-polarized tunneling microscopy (SP-STM) can be applied to investigate the dynamic thermal magnetization switching processes of individual superparamagnetic nanoislands in real time [1]. While the experiments of Ref. [1] were performed only for a very limited temperature range, we have now used a home-built variable-temperature STM for detailed temperature-dependent investigations to examine the so-called Néel-Brown law, which predicts an Arrhenius-like behavior of coherently switching nanomagnets.

Our sample consists of in-plane magnetized uniaxial Fe monolayer islands on W(110). For islands with an area of approximately 20 nm^2 we find a blocking temperature of about 45 K. The high stability of our experimental setup allows the observation of the same islands over a temperature range between 40 K and 50 K, causing a variation of the switching rate by three orders of magnitude. The experimental data as well as Monte-Carlo simulations reveal that within this temperature range a crossover from coherent rotation to the nucleation of domain walls occurs.

[1] M. Bode *et al.*, Phys. Rev. Lett. **92**, 067201 (2004).

MA 15.81 Tue 15:00 Poster A

Manipulating the dipolar magnetic interactions in FePt square arrays: The role of edge roughness — •Jonas Norpoth[1], Sebastian Dreyer[1], Christian Jooss[1], and Sibylle Sievers[2] — [1]Institut für Materialphysik, Friedrich-Hund-Platz 1, 37077 Göttingen — [2]Physikalisch-Technische Bundesanstalt,Bundesallee 100, 38116 Braunschweig

The high magnetocrystalline anisotropy energy in hard magnetic materials may sustain magnetization distributions in the remanent state which exhibit a high number of magnetic surface charges and thus

significant magnetic stray fields . Here, we focus onto the stray field distribution in the exterior and the demagnetization field distribution in the interior of hard magnetic FePt elements without and with artificial saw tooth edge roughness. The square elements are patterned by a focused ion beam. Magnetic stray field distributions are quantitatively measured by magnetic force microscopy (MFM) and a magneto-optic indicator film technique (MOIF). The demagnetization field distribution is calculated by magnetostatic methods. Our experiments and calculations reveal that external stray fields and internal demagnetization fields are considerably modified by the artificial edge roughness. Although the remagnetization process is dominated by nucleation of reverse domains at microstructural inhomogeneities, the inhomogeneous demagnetization field at rough sample edges significantly affects the remagnetization behaviour via the domain wall propagation.

MA 15.82 Tue 15:00 Poster A

Magnetic multilayer films on template-assisted particle arrays — •Judith Moser, Vojko Kunej, Denis Makarov, Günther Schatz, Elke Scheer, and Manfred Albrecht — University of Konstanz, Department of Physics, D-78457 Konstanz, Germany

We present a technique of template-assisted self-assembly of polystyrene particles forming one-dimensional arrangements induced by linear groove structures which were fabricated by e-beam lithography and reactive ion etching. After the particle assembly magnetic Co/Pt multilayer films with perpendicular magnetic anisotropy are grown onto the particle chain. The so-formed magnetic caps are single-domain and magnetically exchange decoupled [1] but provide a metal contact between the particles. The magnetic domain configuration along the particle chain is investigated by magnetic force microscopy and compared to micromagnetic simulations. First results on magneto-resistance along the chain structure and on comparable two-dimensional particle arrays are presented and discussed.

This project is funded by the DFG through the Emmy Noether program at the University of Konstanz.

[1] M. Albrecht, G. Hu, I. L. Guhr, T. C. Ulbrich, J. Boneberg, P. Leiderer, and G. Schatz, Nature Materials 4, 203 (2005).

MA 15.83 Tue 15:00 Poster A

Magnetism in confined geometry: Magnetic critical scattering of MnO nanoparticles — •Mikhail Feygenson[1], Werner Schweika[1], Serguei Vakhrushev[2], Alexander Ioffe[1], and Thomas Brückel[1] — [1]Institut für Festkörperforschung, Forschungszentrum Jülich GmbH, D-52425 Jülich — [2]A. F. Ioffe Physico-Technical Institute, 194021, St. Petersburg, Russia

We studied the magnetic order and phase transition of MnO embedded in a porous glass by polarized neutron scattering using the DNS-instrument at the research center in Jülich. The nanopores filled with MnO are wormlike structures with a typical diameter of 70 Å. From the temperature dependence of the magnetic $(\frac{1}{2}\ \frac{1}{2}\ \frac{1}{2})$ Bragg intensity we obtained that for the MnO nanoparticles the phase transition is continuous with a Néel temperature $T_N = 122K$. This is in contrast to bulk MnO, which exhibits a first order phase transition at $118K$. Furthermore, we observed that a part of the MnO nanoparticle material remains disordered even at $2K$, which indicates frustration at the interface MnO to glass. We interpret the higher T_N to be due to strain on MnO embedded in nanopores. The change in T_N can be related to an effective pressure of $23GPa$ according to the (p,T)-phasediagram of bulk MnO [1]. The continuous character of the transition and the unusual temperature dependence with a reduced order parameter can be described and modeled by surface induced disorder [2,3].

[1] C.S.Yoo et. al., PRL 94 115502 (2005) [2] R.Lipowsky, Ferroelectrics 73(1987) [3] W.Schweika et. al., PRB 53, 8937 (1996)

MA 15.84 Tue 15:00 Poster A

Structural properties of magnetic $Fe_{50}Co_{50}$ alloy Clusters — •Furkan Bulut[1], R. Kerstin Gebhardt[1], Daniela Sudfeld[2], Joachim Bansmann[3], Armin Kleibert[4], and Mathias Getzlaff[1] — [1]Institut für Angewandte Physik, Universität Düsseldorf — [2]Fachbereich Physik, Universität Duisburg-Essen — [3]Insitut für Oberflächenchemie und Katalyse, Universität Ulm — [4]Institut für Physik, Universität Rostock

$Fe_{50}Co_{50}$ alloy clusters were produced by a continuously working arc cluster ion source (ACIS) and subsequently mass-filtered by means of an electrostatic quadrupol. Their diameter is in the range between 6 and 12nm. We discuss the structural properties of such alloy clusters by means of high resolution transmission electron microscopy (HR-TEM). The alloy clusters were deposited on a W(110) surface under UHV condition. The structural properties of supported clusters were determined by in-situ scanning tunneling microscopy (STM) and compared to that of free clusters. Element specific magnetic studies performed by means of X-ray magnetic circular dichroism (XMCD) have shown that magnetic moments of $Fe_{50}Co_{50}$ alloy clusters are in good agreement with the theoretically expected values in the bulk. Our former investigations have shown that magnetic behaviour of clusters in this size regime becomes size and shape dependent, which makes structure analysis indispensable [1,2].

[1] J. Bansmann and A. Kleibert, Appl. Phys. A 80 (2005) 957
[2] M. Getzlaff et al., Appl. Phys. A 82 (2006) 95

MA 15.85 Tue 15:00 Poster A

Synthesis of magnetic nanoparticles with pronounced shape anisotropy and characterisation via small angle x-ray scattering — •Frank Döbrich, Andreas Michels, and Rainer Birringer — Universität des Saarlandes, Technische Physik, Geb. D22, 66041 Saarbrücken, Germany

Ferrofluids (FF) are stable colloidal suspensions of magnetic particles in a nonmagnetic carrier fluid. This fact renders a FF sensitive to an external magnetic field, which leads to a coupling of magnetic and rheological properties. A prominent example is the magnetoviscous effect, i.e. the increase of the FF's viscosity due to an externally applied magnetic field. It is expected that a dispersion of highly anisometric particles such as rods or chains reveals a large enhancement (compared to spherical particles) of the magnetoviscous effect. This contribution reports on the synthesis of a highly anisometric FF containing stable chains of iron nanoparticles and on the microstructural characterization by means of transmission electron microscopy (TEM) and small-angle X-ray scattering (SAXS). The SAXS measurements develop a pronounced anisotropy of the scattering pattern as a function of increasing external magnetic field. Evaluation of the radially averaged SAXS curves in terms of basic scattering functions is discussed.

MA 15.86 Tue 15:00 Poster A

Magnetzation of Ni_xPt_{1-x}-Nanoparticles — •Ole Albrecht[1], Detlef Görlitz[1], Kirsten Ahrenstorf[2], and Horst Weller[2] — [1]Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg — [2]Institut für Physikalische Chemie, Universität Hamburg

We present SQUID-measurements of chemically disordered Ni_xPt_{1-x}-nanoparticles having a spherical shape (d_{mean} = 4.7 nm), embedded in an organic matrix[1]. These particles are the missing link in the series of 3d-transition-metal/platinum alloys. Zero-field-cooled magnetization reveals superparamagnetic behavior with a characteristic blocking-temperature T_b=7.9 K. Below this temperature the particles show hysteretic behavior with coercive field of H_C(T=5 K)=320 Oe and remanent magnetization of M_{rem}(T=5 K)=0.293 emu/g. Above T_b the magnetization can be described by the isotropic Langevin superparamagnetic model (ISPM) with a Curie-temperature of T_C=108 K and particle moment of μ_p(T=0)=104 μ_B. The ISPM-behavior contrasts to the anisotropic superparamagnetism (ASPM) previously found in FePt- and CoPt-nanoparticles[2].

[1] K. Ahrenstorf et al., small-journal, DOI:10.1002/smll.200600486
[2] F. Wiekhorst et al., Phys. Rev. B 67, 224416(2003)

MA 15.87 Tue 15:00 Poster A

Synthesis of homo- and heterometallic two-layer nanoparticles as labels for magnetic biochips — •Nadezhda Kataeva[1,2], Sergey Pavlovich Gubin[2], Joerg Schotter[1], and Hubert Brückl[1] — [1]Austrian Research Centers GmbH - ARC, Nano-System-Technologies, Tech Gate Vienna, Donau-City-Strasse 1, 1220 Vienna, Austria — [2]N.S. Kurnakov Institute of General and Inorganic Chemistry RAS, Leninskii pr. 31, Moscow, 119991 Russia

We will present our results on the development of ferromagnetic nanoparticles with properties optimized for the application as labels for magnetic biochips. This application requires functionalized magnetic nanoparticles that are stabilized in aqueous solutions and posses high magnetic moments. Thus, we synthesize magnetic nanoparticles from materials with high saturation magnetization (e.g. CoFe alloys) and plan to increase the diameter of the particles from our initial value of about 10 nm up to about 50 nm, which poses a good compromise between high magnetic moment of the nanoparticles and good binding properties to surface-immobilized molecules. We obtain magnetic nanoparticles of complex composition with different functional groups by the reduction of water-soluble salts of cobalt or iron by NaBH4. Ethylenediamine, different amino acids, surfactants, polyacrylic acid,

polyvinyl alcohol, polydimethylsiloxane and other lyophylic coatings are employed as functional shells of the nanoparticles. For the synthesis of steady suspensions in organic solvents, the reaction was carried out in a two-phase system of hexane/water and with surfactants.

MA 15.88 Tue 15:00 Poster A

Temperaturabhängige Magnetrelaxometrie an magnetischen Nanopartikeln im Temperaturbereich von 4 K bis 325 K — •Markus Büttner[1], Frank Schmidl[1], Thomas Müller[1], Stefan Prass[1], Michael Mans[1], Christoph Becker[1], Dimitri Berkov[2] und Paul Seidel[1] — [1]Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena, Germany — [2]Innovent e.V., Jena, Germany

Um magnetische Nanopartikel im Hinblick auf ihre Anwendung charakterisieren zu können, ist es von grundlegender Bedeutung, Aussagen über die Verteilung der Energiebarrieren zu gewinnen, die wesentliche Aussagen über das magnetische Verhalten der Partikel liefern. Im weiteren Verlauf sind Angaben zum mittleren Durchmesser der Partikel bei entsprechenden Maxima der Energiebarrierenverteilung unter Verwendung weiterer magnetischer Messverfahren zur experimentellen Bestimmung der Aniosotropiekonstante möglich. Bei Vorliegen geeigneter Proben lassen sich außerdem magnetische Wechselwirkungen der Partikel in Abhängigkeit von deren mittlerem Abstand untersuchen.

Das magnetische Signal der Nèel-Relaxation der zu untersuchenden Probe wird mit einem axialen SQUID-Gradiometer zweiter Ordnung (Arbeitstemperatur 4,2 K) detektiert. Das ermöglicht die Charakterisierung der Proben in magnetisch und elektrisch unabgeschirmter Laborumgebung. Die Probentemperatur kann dabei durch einen entsprechenden Antikryostaten im Bereich von 4,2 K bis 325 K variiert werden. Aus der gemessenen Temperaturabhängigkeit des Relaxationssignals erhält man die Energiebarrierenverteilung der untersuchten Proben. Förderung durch das EU- Projekt Biodiagnostics Nr. 017002.

MA 15.89 Tue 15:00 Poster A

Quantitative Magnetic Imaging using Combined Magnetooptics and Magnetic Force Microscopy — •Sibylle Sievers[1], Sebastian Dreyer[2], Joachim Lüdke[1], Martin Albrecht[1], Uwe Siegner[1], and Christian Jooss[2] — [1]Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig, Germany — [2]Institut für Materialphysik, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

We present our results on the stray field calibration of a magnetic force microscope (MFM) based on a combination of MFM with magnetooptics using indicator films (MOIF). The MFM stray field measurements are not quantitative unless the measured signal is calibrated. The mosts general calibration ansatz based on a transfer function is pursued by Hug and coworkers [1]. Our groups are working on a transfer function based calibration ansatz using reference samples with well defined stray field distribution. As reference samples patterned hard magnetic FePt films which exhibit out-of-plane easy magnetization axes were produced. MOIF in combination with inverse and forward magnetostatic calculation techniques and micromagnetic simulations allows for a complete characterization of the magnetization and the stray field of the reference samples. This is the prerequisite for a calibration of the MFM signal. The results on the combined MFM and MOIF characterization of reference samples will be presented.

[1] P.J.A. van Schendel, H.J. Hug, B. Stiefel, S. Martin, and H.J. Güntherodt, J. Appl. Phys. 88 (2000) 435.

MA 15.90 Tue 15:00 Poster A

Magnetic domain structures in [Co/Pt]/Ru multilayers studied by MFM in magnetic field — •Cristina Bran[1,2], Ulrike Wolff[1], Ludwig Schultz[1], and Volker Neu[1] — [1]IFW Dresden, Institute for Metallic Materials, P.O. Box 270116, D-01171 Dresden, Germany — [2]IMPRS "Dynamical Processes in Atoms, Molecules and Solids", Nöthnitzer Str. 38, Dresden, Germany

The detailed study of the magnetization process is important for the understanding of the coupling mechanism of the recently developed AF-coupled [Co/Pt]/Ru multilayers [1]. The field-dependent domain structure of a $[(Co(4Å)/Pt(7Å))_8/Ru(9Å)]_{18}$ multilayers was investigated by magnetic force microscopy (MFM). Measurements were performed using a DI Dimension 3100, upgraded for measurements with an external magnetic field applied perpendicular to the sample. In the zero field state, band domains with average domain width of 300 nm are observed. Upon increasing the external magnetic field, the domains first modify gradually, without changing the general configuration, until they transform into a bubble domain structures at 0.4 T, which is about 80% of the saturation field of the sample. An analysis of individual field dependent line scans represents the first attempt towards finding a quantitative correlation between domain structure and net magnetization. [1]O. Hellwig et al, Nature Materials, vol. 2, pp. 112-116, 2003

MA 15.91 Tue 15:00 Poster A

Spin-polarized scanning tunneling microscopy applied to nanoscale Fe islands — •Dinesh Subramaniam, Marco Pratzer, and Markus Morgenstern — II. Institute of Physics B, RWTH Aachen, 52056 Aachen

The magnetic properties of single-crystal nanoscale Fe islands on W(110) have been studied by spin-polarized scanning tunnelling microscopy. All measurements have been done at room temperature by a modified commercial Omicron "AFM/STM" using a 5 monolayer iron covered tungsten tip with an in-plane magnetic sensitivity. Preparation has been done by molecular beam epitaxy in UHV. We investigated islands with lateral dimensions of 200 by 400 nm^2 and different heights from 3 to 8 nm. The observed domain structures are in line with previous results [1] and with theoretical analysis. Variation of the thickness leads to different magnetic domain structures of the islands, which are dominated by the surface anisotropy with an easy axis along the $[1\bar{1}0]$ direction [1,2]. For islands with a thickness of 3.5 nm, the uniaxial surface anisotropy of Fe/W(110) leads to a single domain state. For thicker islands the magnetostatic energy becomes dominant due to the reduced anisotropy energy. This results in a multi domain configuration.

[1] M. Bode, A. Wachowiak, J. Wiebe, A. Kubetzka, M. Morgenstern, R. Wiesendanger, Appl. Phys. Lett. 84 (2004) 948.
[2] A.Wachowiak, J. Wiebe, M. Bode, O. Pietzsch, M. Morgenstern, R. Wiesendanger, Science 298 (2002) 577.

MA 15.92 Tue 15:00 Poster A

Spin-resolved PEEM study of a single crystal Heusler alloy — •Ruslan Ovsyannikov[1], Florian Kronast[1], Andrei Gloskovskii[2], Gerhard H. Fecher[2], Claudia Felser[2], Hermann A. Dürr[1], and Wolfgang Eberhardt[1] — [1]BESSY GmbH, Albert-Einstein-Straße 15, 12489 Berlin, Germany — [2]Institut für Anorganische Chemie und Analytische Chemie, Johannes Gutenberg - Universität Mainz, D-55099 Mainz, Germany

Heusler compounds are of the general formula X_2YZ. X and Y are usually transition metals and Z is either a non-magnetic metal or a non-metal. The crystal structure of a Heusler is marked by four interpreting fcc-lattices. Certain Heusler like Co_2FeSi have been theoretically predicted to be half-metallic ferromagnets. The high spin polarization at the Fermi level in combination with a high Curie temperature makes those materials promising candidates for applications in spintronics. Because of the difficult surface preparation and a complex domain pattern in remanence a direct experimental prove of half-metallicity e.g. by spin-resolved photoemission is still missing. A new spin-resolved photoemission electron microscope (S-PEEM) at BESSY helps to overcome at least one of this problem since it combines spatial resolution with spin analysis. The S-PEEM at the UE49 microfocus beamline is based on a commercial Elmitec PEEM with integrated energy analyzer, additionally equipped with two Mott polarimeter for spin analysis. Thus it allows to record spin resolved photoemission spectra from selected area e.g. a single magnetic domain. In this poster we present spin-resolved photoemission measurements from selected magnetic domains of a Co_2FeSi single crystal.

MA 15.93 Tue 15:00 Poster A

Heterogeneous mixed valence of a Sm/Gd(0001) monolayer revealed by scanning tunneling spectroscopy — •Daniel Wegner and Günter Kaindl — Freie Universität Berlin, Institut für Experimentalphysik, Arnimallee 14, 14195 Berlin

Many photoelectron spectroscopy studies show that low coverages of the lanthanide metal Samarium on various substrates are mostly mixed-valent. Due to the spatial averaging of this technique, the nature of the mixed valence – whether it is homogeneous or heterogeneous – could not be shown directly. Moreover, a lot of effort is necessary to rule out artifacts, e.g. structural disorder and nonuniform layer or island growth. We show that STS of a well-ordered monolayer of Sm on a Gd(0001) substrate proves a heterogeneous mixed valence, while islands of a second layer are divalent. The determination by STS is possible, because the Sm monolayer exhibits a localized surface state that indicates the valence state indirectly through a splitting. The results can be understood by comparison with STS on Sm(0001) and on Eu/Gd(0001).

MA 15.94 Tue 15:00 Poster A

Circular magnetic dichroism in x-ray absorption of $Co_2Cr_{0.6}Fe_{0.4}Al$ and $Co_2FeSi(110)$ alloy films — •Michael Kallmayer[1], Horst Schneider[1], Andres Conca[1], Gerhard Jakob[1], Martin Jourdan[1], Hans-Joachim Elmers[1], Benjamin Balke[2], Andrei Gloskovskii[2], and Stefan Cramm[3] — [1]Institut für Physik, Johannes Gutenberg-Universität, D-55099 Mainz, Germany — [2]Institut für Anorganische und Analytische Chemie Johannes Gutenberg-Universität, D-55099 Mainz, Germany — [3]Institut für Festkörperforschung, Forschungszentrum Jülich GmbH, D-52425 Jülich, Germany

Theory predicts complete spin polarization for $Co_2Cr_{0.6}Fe_{0.4}Al$ and Co_2FeSi. We investigated epitaxial films of these materials using x-ray circular dichroism (XMCD). Properties of the interfaces and the core of the films could be determined separately using total electron yield and transmission signals. We find a strong correlation of structural properties and the Cr moment for $Co_2Cr_{0.6}Fe_{0.4}Al$. Moreover the Co absorption spectra reveal an extra peak at 4 eV above the L_3 edge increasing with increasing local order, in agreement with theory. For Co_2FeSi films we could determine a decreased magnetization at both interfaces corresponding to an effective number of dead layers of 0.15 nm at the top interface an 0.55 nm at the bottom interface.

MA 15.95 Tue 15:00 Poster A

Structural, electronic and magnetic properties of ultrathin epitaxial AuFe/Mo(110) films — •Andrei Kukunin[1], Jacek Prokop[1,2], and Hans Joachim Elmers[1] — [1]Johannes Gutenberg-Universität Mainz, Institut für Physik, Staudingerweg 7, D-55099 Mainz — [2]Max-Planck Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle (Saale)

Structural, electronic and magnetic properties of epitaxial Fe monolayers (ML) grown on a single crystalline Mo(110) surface coated by a monolayer coverage of Au were studied by low temperature (5K) spin polarized scanning tunneling microscopy (SP-STM) and spectroscopy (SP-STS). We observed a magnetic contrast on the Fe nanowires through a Au monolayer. The Au coverage provokes a loss of magnetic contrast for Au coverages exceeding 0.1 ML, suggesting an instantaneous spin reorientation transition of the Fe ML from an out-of-plane easy axis for up to 0.1 ML Au to an in-plane easy axis for higher Au coverages. The magnetic contrast of the Au coated Fe ML is similar to the contrast observed for the uncovered Fe/Mo(110) ML. Annealing of an ultrathin Au/Fe/Mo(110) film completely destroys the Fe nanowire structure resulting in circular shaped islands of double layer (DL) height surrounded by a homogeneous monolayer coverage. The DL islands reveal a perpendicular magnetization, while the surrounding ML areas appear non-magnetic. Spectroscopic data suggests that the DL islands consist of an Fe layer at the Mo(110) substrate and a Au coating layer.

MA 15.96 Tue 15:00 Poster A

Thickness dependent spin wave properties in ultrathin Fe films — •Yu Zhang, Wen Xin Tang, Ioan Tudosa, Jacek Prokop, and Jürgen Kirschner — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany

The spin wave excitations were investigated by spin polarized electron energy loss spectroscopy (SPEELS) in ultrathin epitaxial Fe/ W(110) films. In this report, the spin wave spectra vs. the thickness of Fe films on W (110) with different wave vectors are presented. The iron films, from 2 to 12 monolayers (ML) thick, are deposited using molecular beam epitaxy in ultra high vacuum at room temperature. The spin wave peaks appear clearly in the spectra of 2 ML Fe films, however for thicker films ($\geq$4 ML), the spin-wave excitations show broad peaks in the spectra, and it is difficult to extract the dispersion relation. The reason for obscuring the spin-wave dispersion for the thicker films will be discussed according to the increase of film thicknesses. The obtained results are also compared and discussed with calculations known from the literature.

MA 15.97 Tue 15:00 Poster A

Transport properties of magnetic tunnel junctions with Co2MnSi electrode: influence of temperature-dependent interface magnetization and electronic band structure — •Jan Schmalhorst[1], Andy Thomas[1], Oliver Schebaum[1], Daniel Ebke[1], Marc Sacher[1], Andreas Hütten[1], Andrej Turchanin[2], Armin Gölzhäuser[2], Elke Arenholz[3], and Günter Reiss[1] — [1]Thin Films and Nano Structures, Department of Physics, Bielefeld University, 33501 Bielefeld, Germany — [2]Department of Physics, Bielefeld University, 33501 Bielefeld, Germany — [3]Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA

The investigation of the temperature-dependent magnetic and chemical properties of the Co2MnSi / Al-O interface in Co2MnSi / Al-O / Co-Fe MTJs showed, that with increasing degree of disorder, interfacial magnetic moments are reduced and their temperature dependences are more pronounced. Magnon excitation is stronger at the Co2MnSi / Al-O interface compared with Co-Fe-B based tunnel junctions and bulk Co2MnSi. We suggest, that mainly this contributes to the larger bias voltage and temperature dependence of the TMR in the Co2MnSi based junctions by means of enhanced magnon-assisted tunneling. Furthermore, several fingerprints of the ideal Co2MnSi bandstructure of atomically ordered Co2MnSi films are revealed by the XAS-, XMCD- and XPS-investigations in accordance with SPR-KKR calculations. Finally, we suggest that the observed inversion of the TMR effect occuring when electrons are tunneling from the Co-Fe into the atomically ordered Co2MnSi electrode is the most striking bandstructure effect.

MA 15.98 Tue 15:00 Poster A

Chemical and magnetic interface properties of tunnel junctions with Co2MnSi / Co2FeSi multilayer electrode — •Daniel Ebke[1], Jan Schmalhorst[1], Marc Sacher[1], Ning-Ning Liu[1], Andy Thomas[1], Andreas Hütten[1], Elke Arenholz[2], and Günter Reiss[1] — [1]Thin Films and Nanostructures, Department of Physics, Bielefeld University, 33501 Bielefeld, Germany — [2]Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA

Transport as well as chemical and magnetic interface properties of two kinds of magnetic tunnel junctions (MTJs) with Co2FeSi electrode, Al-O barrier and Co-Fe counter electrode are investigated. For junctions with Co2FeSi single layer electrode a tunnel magnetoresistance of up to 52% is found for an optimal Al thickness of 1.5nm, whereas the room temperature bulk magnetization of the Co2FeSi film reaches only 75% of the expected value. By using a [Co2MnSi / Co2FeSi] multilayer electrode the magnetoresistance can be increased to 114% and the full bulk magnetization is reached. For Al thickness smaller than 1nm the TMR of both kinds of MTJs decreases rapidly to zero. On the other hand for 2 to 3nm thick Al the TMR decreases only slowly. The Al thickness dependence of the TMR is directly correlated to the element-specific magnetic moments of Fe and Co at the Co2FeSi / Al-O interface for all Al thickness. Especially, for optimal Al thickness and annealing, the interfacial Fe moment of the single layer electrode is about 20% smaller than for the multilayer electrode indicating smaller atomic disorder at the barrier interface for the latter MTJ.

MA 15.99 Tue 15:00 Poster A

Absence of ferromagnetism in V-implanted ZnO single crystals — •Shengqiang Zhou, Kay Potzger, Helfried Reuther, Karsten Kuepper, Wolfgang Skorupa, Manfred Helm, and Juergen Fassbender — Institute for Ion Beam Physics and Materials Research, Forschungszentrum Rossendorf, POB 510119, 01314 Dresden, Germany

Diluted magnetic semiconductors (DMS) have recently attracted huge research attention because of their potential application for spintronics devices [1]. ZnO doped with V was found to be ferromagnetic at room temperature [2]. However, the origin of the observed ferromagnetism in transition metal doped ZnO is still controversial, e.g. ferromagnetic clusters [3], or extrinsic reasons [4]. In this paper the structural and magnetic properties of V doped ZnO are presented. V ions were introduced into hydrothermal ZnO single crystals by ion implantation with fluences of 1.2*10ˆ16 to 6*10ˆ16 cmˆ-2. Post-implantation annealing was performed in high vacuum from 823 K to 1023 K. The ZnO host material still partly remains in a crystalline state after irradiation, and is partly recovered by annealing. The V ions show a thermal mobility as revealed by depth profile Auger electron spectroscopy. Synchrotron radiation x-ray diffraction revealed no secondary phase formation which indicates the substitution of V onto Zn site. However in all samples no pronounced ferromagnetism was observed down to 5 K by a superconducting quantum interference device magnetometer.

1.T. Dietl, et al., Science 287, 1019 (2000). 2.N. H. Hong, et al., J. Phys.: Condens. Matter 17, 199 (2005). 3.J. H. Park, et al., APL 84, 1338 (2004). 4.D. W. Abraham, et al., APL 87, 252502 (2005).

MA 15.100 Tue 15:00 Poster A

Magnetic and structural properties of Co-implanted ZnO films — •Numan Akdogan[1], Alexei Nefedov[1], Werner Becker[2], Rustam Khaibullin[3], Lenar Tagirov[3,4], and Hartmut Zabel[1] — [1]Institut für Experimentalphysik IV, Ruhr-Universität Bochum —

[2]Institut für Physik mit Ionenstrahlen, Ruhr-Universität Bochum — [3]Kazan Physical-Technical Institute of RAS — [4]Kazan State University

The ZnO-based dilute magnetic semiconductors (DMSs), which can be formed by doping 3d transition metals in ZnO, offers an interesting combination of electrical, optical, and magnetic properties. Moreover, according to suggestion of Dietl [1], the ZnO-based DMSs can order ferromagnetically at room temperature. In this contribution we report on structural and magnetic properties of Co-doped ZnO. ZnO films were grown on sapphire via rf-sputtering and doped with Co-ions via ion implantation with energy of 40 keV and implantation dose in the range of 0.25-1.50*1017 ions/cm2. The structural characterization was carried out using synchrotron radiation at the HASYLAB and the DELTA. The magnetic properties were investigated using x-ray resonant magnetic scattering at BESSY. Magnetic dichroism was observed at the Co L2,3 edges, as well as at the O K edge at room temperature for the highest dose doped sample, indicative of a spin polarization of oxygen atoms in the host matrix. - Partial support by SFB 491, by RFBR (grant 04-02-97505), and by TUBITAK (project 104T176) is acknowledged. N. Akdogan acknowledges a fellowship through IMPRS-SurMat. 1. T. Dietl et al., Science 287, 1019 (2000).

MA 15.101 Tue 15:00 Poster A

Growth and properties of Fe_3O_4(111) thin films on ZnO* — •Andrea Boger[1], Jürgen Simon[2], Andreas Brandlmaier[1], Matthias Opel[1], Sebastian T. B. Goennenwein[1], Werner Mader[2], and Rudolf Gross[1] — [1]Walther-Meissner-Institut der BayerischenAkademie der Wissenschaften, 85748 Garching — [2]Institut für Anorganische Chemie der Universität Bonn, 53117 Bonn

Fe_3O_4, a ferrimagnet with a Curie temperature of about 860 K, is an attractive candidate for direct spin injection into a semiconductor. Compared to metallic 3-*d* ferromagnets, its electrical conductivity is lower, which reduces conductivity mismatch issues [1]. Furthermore, a high spin polarization of $P = -(80\pm5)$ % and $P = -(55\pm10)$% has been measured for (111) and (001) oriented Fe_3O_4 surfaces, respectively [2]. Therefore (111)-oriented films are desirable for spin injection.

We have grown 30 nm thick Fe_3O_4 films on ZnO(0001) substrates by pulsed laser deposition. X-ray diffractometry shows, that the films are relaxed and grow (111)-oriented ($Fe_3O_4(1\bar{1}0) \parallel ZnO(2\bar{1}\bar{1}0)$) with high crystalline quality, as demonstrated by a FWHM of the rocking curves of the Fe_3O_4(222) reflection of only 0.02°. High-resolution TEM proves homogeneous growth and good interface quality. SQUID magnetometry reveals ferromagnetic behavior with a saturation magnetization of $3.2\,\mu_B$/f.u. at 300 K, about 80 % of the theoretical value. Epitaxial Fe_3O_4 electrodes thus appear promising for spin injection into ZnO.

[1] G. Schmidt et al., Phys. Rev. B **62**, R4790 (2000)
[2] M. Fonin et al., Phys. Rev. B **72**, 104436 (2005)

* This work is supported by the DFG via SPP 1157.

MA 15.102 Tue 15:00 Poster A

Magnetic and electronic properties of half-metallic ferromagnetic Mn-stabilised zirconia — •Igor Maznichenko[1], Arthur Ernst[2], Lars Bergqvist[3], Sergey Ostanin[2,4], Leonid Sandratskii[2], Patrick Bruno[2], Markus Däne[1], Ian Hughes[4], Julie Staunton[4], Wolfram Hergert[1], Ingrid Mertig[1], and Josef Kudrnovsky[2,5] — [1]Martin-Luther-Univ Halle-Wittenberg, Inst Phys, 06099 Halle, Germany — [2]Max-Planck-Inst Mikrostrukturphys, Weinberg 2, 06120 Halle, Germany — [3]Dept Phys, Uppsala Univ, Box 530, 751 21 Uppsala, Sweden — [4]Dept Phys, Univ Warwick, Coventry CV4 7AL, UK — [5]Inst Phys, Acad Sci of the Czech Republic, Na Slovance 2, 18221 Prague 8, Czech Rep.

The investigations of the manganese stabilised cubic zirconia (Mn-SZ) show that this dilute magnetic semiconductors possess unique magnetic properties. Based on *ab-initio* electronic structure calculations which include the effects of thermally excited magnetic fluctuations, the autors predict Mn-SZ to be ferromagnetic for a wide range of Mn concentration up to high T_C. It was found that this material, which is well known both as a diamond imitation and as a catalyst, is half-metallic with majority and minority spin states of the Mn impurities lying in the wide band gap of zirconia. The high T_C ferromagnetism is robust against oxygen vacancies and against the distribution of Mn impurities on the Zr fcc sublattice. This work responds to the question concerning the key electronic and structure factors behind an optimal doping. The autors propose this stable half-metallic ferromagnet to be a promising candidate for future spintronics applications.

MA 15.103 Tue 15:00 Poster A

Exchange constants in Mn doped Ge and GaAs: a first principles study of the environment effects — •Marjana Ležaić[1], Silvia Picozzi[2], Phivos Mavropoulos[1], Yuriy Mokrousov[3], and Stefan Blügel[1] — [1]IFF, Forschungszentrum Jülich, Jülich, Germany — [2]CNR-INFM CASTI Regional Lab., L'Aquila, Italy — [3]Institute for Applied Physics, University of Hamburg, Hamburg, Germany

Ab-initio calculations have been performed for [001]-ordered Mn/Ge and Mn/GaAs "digital alloys", focusing on the effects of the band-gap width and the semiconducting host on the exchange constants of the Mn atoms. Our results for Mn/Ge, obtained using a frozen-magnon scheme [1], show that a larger band-gap tends to give a stronger nearest-neighbor ferromagnetic coupling and an overall enhanced in-plane ferromagnetic coupling even for longer-ranged coupling constants. Mn/GaAs shows a smaller nearest-neighbor ferromagnetic coupling than Mn/Ge, but exchange constants for higher Mn-Mn distance show an overall increased ferromagnetic behavior in Mn/GaAs [2]. The environmental dependence of the exchange constants in Mn-doped Ge was also investigated. We find that while the exchange constants in [001] and [111] direction remain small and practically unaffected by the different arrangements of the Mn atoms in Ge matrix, the coupling along [110] direction shows a strong environmental and concentration dependence. We discuss the exchange mechanisms and their consequences to the Curie temperature of the alloys.

[1] As implemented in the `FLEUR` code, `http://www.flapw.de`
[2] S.Picozzi, M.Ležaić, S.Blügel, Phys.Stat.Sol.(a) **203**, 2738 (2006)

MA 15.104 Tue 15:00 Poster A

Spin-Pump-Effekt in Co/Cu/Py Pillars untersucht mit ferromagnetischer Resonanz — •Oliver Posth, Jürgen Lindner und Günter Dumpich — Fachbereich Physik, AG Farle, Universität Duisburg-Essen, Campus Duisburg

In verschiedenen Arbeiten wurde gezeigt, dass ein spin-polarisierter Strom im Ferromagneten ein Drehmoment auf die Magnetisierung ausübt [1,2]. Dieser Strom kann z.B. dazu verwendet werden die Magnetisierung einer ferromagnetischen Schicht in einer Ferromagnet/Nichtmagnet/Ferromagnet (FM/NM/FM) spin-valve Struktur zu schalten [3]. Wir haben den Einfluss eines spin-polarisierten Stromes auf das Dämpfungsverhalten der ferromagnetischen Schichten in Pillar-Strukturen mit Hilfe der ferromagnetischen Resonanz (FMR) untersucht. Die Strukturen werden mit hochauflösender Elektronenstrahllithographie (HR-EBL) und Elektronenstrahlverdampfung in einem drei-Schritt-Prozess hergestellt und kontaktiert. Die Lagenstruktur und die Grenzflächen zwischen den Metallen, welche entscheidenden Einfluss auf den Transfer des spin-polarisierten Stromes haben, werden mit einem Tunnelmikroskop (TEM) anhand von Querschnittspräparaten und mit der FMR untersucht. Zusätzlich wird das Schaltverhalten der ferromagnetischen Lagen der Pillars mit Hilfe von Magnetowiderstandsmessungen (MR) studiert.

Diese Arbeit wird im Rahmen des SFB 491 gefördert.

[1] J. C. Slonczewski, J. Magn. Magn. Mater. **159**, 1 (1996)
[2] L. Berger, Phys. Rev. B **54**, 9353 (1996)
[3] J. A. Katine *et al.* Phys. Rev. Lett. **84**, 3149 (2000)

MA 15.105 Tue 15:00 Poster A

Bulk sensitive HX-PES study of chemically etched $Ga_{1-x}Mn_xAs$ — •Andreas Müller[1], Benjamin Schmid[1], Michael Sing[1], Jan Wenisch[2], Karl Brunner[2], Laurens Molenkamp[2], Wolfgang Drube[3], and Ralph Claessen[1] — [1]Experimentelle Physik IV, Universität Würzburg — [2]Experimentelle Physik III, Universität Würzburg — [3]HASYLAB DESY, Hamburg

Diluted magnetic semiconductors (DMS) have gained particular interest in the last years due to their potential in spintronic applications. One promising candidate for future devices is $Ga_{1-x}Mn_xAs$ ($0.04 < x < 0.07$) with Curie temperatures up to 170 K. However, the origin of the ferromagnetic properties is still far from clear.

We investigated the electronic structure of $Ga_{1-x}Mn_xAs$ using hard x-ray photoelectron spectroscopy (HX-PES). For analysing the intrinsic physical properties it is on the one hand essential to remove any surface oxides and adsorbates, since PES is a comparable surface sensitive technique. On the other hand, bulk information can be increased significantly by performing PES in the hard x-ray regime.

Wet chemical etching was used to clean the surface. This technique widely used in the semiconductor industry yields surfaces with controllable roughness and preserved stoichiometry. The samples were etched either in HCl or H_2SO_4 followed by rinsing with deionized water. Information on the depth profile of the composition was gained

by measurements under different emission angles at a photon energy of 4.5 keV. Results on all relevant core levels and the valence band depending on the chemical treatment are presented.

MA 15.106 Tue 15:00 Poster A

Transport properties of ion-implanted ferromagnetic SnO_2:Co from van-der-Pauw measurements — •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, Mendelssohnstr. 3, 38106 Braunschweig, Germany — [2]Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, TU Braunschweig, Hans-Sommer-Str. 66, 38106 Braunschweig, Germany

In the field of diluted magnetic semiconductors, transition metal doped oxides have attracted much interest because of a Curie temperture which, in contrast to GaAs:TM, is beyond 300 K. In this work, magnetron-sputtered SnO_2 thin films on fused silica substrates were doped with Co using the ion implantation technique. Thereby, the risk of Co clustering in the host material is minimized. The implanted films order ferromagnetically at room-temperature exhibiting a saturation moment of 1.2 μ_B per Co at 300 K. Since it is still under discussion whether the magnetic exchange is mediated via free electrons or by a polaron-assisted mechanism, the conductivity of the pure and implanted SnO_2 films is determined by transport measurements in van-der-Pauw geometry. Results from Hall-effect investigations yield the polarity and the concentration of the carriers. The transport data are discussed in the view of the magnetic properties.

MA 15.107 Tue 15:00 Poster A

Chemical and magnetic interface properties of Co-Fe-B / MgO / Co-Fe-B tunnel junctions — •Jan Schmalhorst[1], Xinli Kou[1,2], Andy Thomas[1], Elke Arenholz[3], and Günter Reiss[1] — [1]Thin Films and Nanostructures, Department of Physics, Bielefeld University, 33501 Bielefeld, Germany — [2]Lanzhou University, 222 South Tianshui Road, Lanzhou 7300000, China — [3]Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA

The chemical and magnetic properties at the lower Co-Fe-B / MgO interface of Co-Fe-B /MgO / Co-Fe-B magnetic tunnel junctions is investigated by X-ray absorption spectroscopy and X-ray magnetic circular dichroism. The influence of the annealing temperature and of a thin (0.5nm or 0.75nm) metallic Mg interlayer between the lower electrode and the RF-sputter deposited MgO barrier is studied. The room temperature tunnel magnetoresistance increases strongly with annealing temperature for both Mg interlayer thicknesses. Starting at 20% after annealing at 200°C it reaches a maximum value of 112% after annealing at 350°C. The annealing temperature dependent influence of the thermally induced reduction of interfacial Fe-O, the simultaneous increase of the Fe magnetic moment and the boron concentration in the electrode and in the Mg-O barrier on the TMR amplitude will be discussed.

MA 15.108 Tue 15:00 Poster A

High TMR ratio in Fe/MgO/Fe junctions with even one atomic Fe layer — Christian Heiliger, Martin Gradhand, •Peter Zahn, and Ingrid Mertig — Institut für Physik, Martin-Luther-Universität Halle/Wittenberg, D-06099 Halle, Germany

Recent experiments based on epitaxially grown Fe/MgO/Fe samples shed light on the microscopic origin of tunneling magnetoresistance (TMR). The obtained TMR ratios exceeded the predictions by Julliere's model by far. A screened Korringa-Kohn-Rostoker (KKR) method based on density-functional theory was applied to calculate the electronic and magnetic structure of the junctions self-consistently. The conductance was calculated in the limit of coherent transport using the Landauer formula by means of Green's functions.

Positive and negative TMR ratios are obtained as a function of interface structure and even a sign reversal of TMR as a function of bias was found [1]. It will be demonstrated how the structure of the electrodes, and especially the finite thickness of the Fe layers influence the TMR ratio and the corresponding bias voltage dependencies. It will be shown that the leads have just to provide states of Δ_1 symmetry which tunnel most efficiently across the barrier and the spin-filter effect is generated by even one monolayer of Fe [2].

[1] C. Heiliger et al., Phys. Rev. B **72**, 180604(R) (2005), C. Heiliger et al., Phys. Rev. B **73**, 214441 (2006).
[2] C. Heiliger et al., in preparation (2006).

MA 15.109 Tue 15:00 Poster A

Magnetic tunnel transistor with epitaxial FeCo/Au/FeCo base — •Alexander Spitzer, Julien Vigroux, and Günther Bayreuther — Universität Regensburg, Institut für Experimentelle und Angewandte Physik, Regensburg

The magnetic tunnel transistor (MTT) is a promising candidate for a highly sensitive magnetic sensor. In the present MTT structure hot electrons are injected into a spin valve base from a metallic emitter across a tunnel barrier. They cause a ballistic current, I_C, across the Schottky barrier with the GaAs substrate as the collector. By epitaxial growth of the spin valve the transfer ratio of collector current I_C to emitter current I_E is expected to increase because of less structural defects [1]. We present MTTs with a fully epitaxial $Fe_{34}Co_{66}$/Au/$Fe_{34}Co_{66}$ spin valve base grown on a n-GaAs(001) substrate, capped with an Al_2O_3 tunnel barrier and a Ta emitter. The samples are characterized by STM, XPS, TEM and temperature dependent MOKE. For electron energies above 0.8 eV a clear magnetic field-dependent ballistic current is measured in the collector. The temperature dependence of the magneto-current ratio (MCR), i.e. normalized difference of I_C between parallel and antiparallel alignment of both FeCo layers, is discussed.

[1] T. Hagler, C. Bilzer, M. Dumm, W. Kipferl, G. Bayreuther, J. Appl. Phys. 97, 10D505 (2005)

MA 15.110 Tue 15:00 Poster A

Ferromagnetic multiband Kondo lattice model — •Anand Sharma and Wolfgang Nolting — Institut fuer Physik, Humboldt Universitaet zu Berlin, Lehrstuhl Festkoerpertheorie, Newtonstr.15, D-12489, Berlin.

The spin exchange interaction between the itinerant electrons and localized moments on a periodic lattice, studied within the so-called Kondo lattice model (KLM), is considered for multiband situation where the hopping integral is a matrix in general. The modified RKKY theory (PRB **65**, 144419 (2002)), wherein one can map such a model onto an effective Heisenberg-like system, is extended to a two band situation with a finite bandwidth and hybridization on a simple cubic lattice. As an input for the evaluation of the effective exchange integrals, one requires the multiband electronic self energy which is taken from an earlier proposed ansatz (PSSB **243**, 641 (2006)). Using the above procedure, we determine the magnetic properties of the system like Curie temperature (within Random Phase Approximation) while calculating the chemical potential and magnetization within a self consistent cycle for various values of system parameters. The results are discussed in detail and the model is also considered for the study of the electronic and magnetic properties of real materials like GdN.

MA 15.111 Tue 15:00 Poster A

Disordered Correlated Kondo-lattice model — •Vadym Bryksa and Wolfgang Nolting — Institut für Physik, Humboldt-Universität zu Berlin, Theoretische Festkörperphysik, Newtonstraße 15, D-12489 Berlin

We propose a self-consistent approximate solution of the disordered Kondo-lattice model (KLM) to get the interconnected electronic and magnetic properties of 'local-moment' systems like diluted ferromagnetic semiconductors. Aiming at compounds $(A_{1-x}M_x)$, where magnetic (M) and non-magnetic (A) atoms are distributed randomly over a crystal lattice, we present a theory which treats the subsystems of itinerant charge carriers and localized magnetic moments in a homologous manner. The coupling between the localized moments, being mediated by itinerant electrons (holes), is treated by a modified RKKY-theory which maps the KLM onto an effective Heisenberg model. The exchange integrals turn out to be functionals of the electronic selfenergy guaranteeing selfconsistency of our theory. The disordered electronic and moment systems are both treated by CPA-type methods. We discuss in detail the dependencies of key-terms such as the long range and oscillating effectice exchange integrals, 'the local-moment' magnetization, the electron spin polarization, the Curie temperature as well as the electronic and magnonic quasiparticle densities of states on the concentration x of magnetic ions, the carrier concentration n, the exchange coupling J, and the temperature. The disorder causes anomalies in the spin spectrum especially in the low-dilution regime, which are not observed in the mean field approximation.

MA 15.112 Tue 15:00 Poster A

Magnetocrystalline anisotropy of 5d-transition-metal chains — •Alexander Thiess, Yuriy Mokrousov, and Stefan Heinze — Institute of Applied Physics, University of Hamburg, Jungiusstrasse 11, 20355 Hamburg, Germany

The magnetic properties of monoatomic linear chains consisting of 5d transition-metal atoms are investigated using *ab initio* density functional theory [1]. Ferromagnetic as well as antiferromagnetic configurations are considered in order to find the ground state of the system. Due to the large atomic number and reduced dimensionality the spin-orbit coupling is extremely important and influences the electronic and magnetic properties of these systems significantly. We study the correlation of the spin- and orbital moments with the magnetocrystalline anisotropy energy (MAE), the total energy difference between the configurations with magnetization parallel and perpendicular to the chain axis. Giant values of the MAE up to 40 meV per atom are reached already for the equilibrium interatomic distance, even larger than for 4d-chains [2]. Stretching the chain leads to even higher values of the MAE (up to 120 meV per atom). The nontrivial behavior of the anisotropy energy, and the spin- and orbital moments with respect to the interatomic distance is discussed in detail in terms of the band filling [3].

[1] Y. Mokrousov et al., Phys. Rev. B **72**, 045402 (2005)
[2] Y. Mokrousov et al., Phys. Rev. Lett. **96**, 147201 (2006)
[3] G. van der Laan, J. Phys.: Condens. Matter **10**, 3239-3253 (1998)

MA 15.113 Tue 15:00 Poster A

Spin-wave excitations from time-dependent density-functional theory — Manfred Niesert, •Arno Schindlmayr, Christoph Friedrich, and Stefan Blügel — Institut für Festkörperforschung, Forschungszentrum Jülich, 52425 Jülich, Germany

Spin waves constitute an important class of low-energy excitations in magnetic solids with a characteristic material-specific dispersion and a direct relation to magnetization dynamics. Until now most theoretical studies are based on the Heisenberg model of localized spins or on the frozen-magnon method, but neither is applicable to investigate the dynamics of spin waves in metallic systems with itinerant electrons. As a possible solution, time-dependent density-functional theory gives access to the full frequency-dependent transverse spin susceptibility, from which the lifetimes of spin-wave excitations as well as related spectral information can be extracted. We develop a practical scheme to calculate spin-wave spectra from first principles within this framework and illustrate its performance by applications to prototype ferromagnetic transition metals. Our implementation uses the full-potential linearized augmented-plane-wave method, and dynamic exchange-correlation effects are in the first instance described by the adiabatic local-density approximation. This work is funded by the Deutsche Forschungsgemeinschaft through the Priority Programme 1145.

MA 15.114 Tue 15:00 Poster A

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], F. Junginger[1], R. E. Dunin-Borkowski[4], 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 — [4]Department of Material Science and Metallurgy, University of Cambridge, Cambridge CB2 3QZ, UK

We study systematically the influence of lateral dimensions on the spin structure of domain walls. Computer simulations on a classical spin model are performed for ferromagnetic permalloy nano-structures with lateral constrictions. Thermal activations of the system are taken into account by the numerical solution of the Landau-Lifshitz-Gilbert equation with Langevin dynamics. The domain wall width is found to be strongly correlated with the constriction width. The smaller the constriction width the smaller the domain wall width.

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. Our results are compared to analytical calculations and are found to agree very well for small current density predictions. The work was supported by the Landesstiftung Baden-Württemberg.

MA 15.115 Tue 15:00 Poster A

Evolution of magnetization from the vortex state in soft magnetic square platelets — Manfred Wolf, •Ulrich K. Rössler, and Rudolf Schäfer — IFW Dresden

The zero-field ground state of magnetically soft films (with lateral dimensions above the single-domain limit) is governed by the demagnetization energy, which causes flux-closure. The quasistatic magnetization process in an external field is obtained by minimizing the micromagnetic free energy. Much like domains, the magnetization patterns in these structures are determined by the sample geometry and the applied field H. These patterns can display regions with homogeneous magnetization separated by walls and can be understood with a scaling analysis of the different energy contributions in the micromagnetic energy, which is valid for films of vanishing thickness $t \to 0$.

Here we investigate the magnetization process and the evolution of the vortex pattern in square Permalloy platelets with edge lengths $l = 1$ μm and finite $t = 8$, 12, 16 and 20 nm and for a field applied along the square's diagonal by numerical computation using a standard micromagnetism code. The results can be semi-quantitatively understood by a modified phase theory approximation that describes the magnetization process in terms of the position of the vortex as single parameter. This approach gives a good explanation, as a function of the film thickness, of (i) the critical field, at which the vortex is expelled, (ii) the initial slope of the magnetization-vs-field curve $m(H)$, (iii) the dependence of the field energy on m, and (iv) the dependence of the demagnetization energy.

MA 15.116 Tue 15:00 Poster A

Current-induced magnetic vortex core reversal in a permalloy nanodisk — •Yaowen Liu, R. Hertel, and Claus M. Schneider — Institut für Festkörperforschung IFF-9 "Elektronische Eigenschaften", Forschungszentrum Jülich GmbH, D-52425 Jülich, Germany

Magnetic vortex structures in ferromagnetic thin-film elements contain a nanometric core magnetized perpendicular to the film plane [1]. It has recently been demonstrated that a vortex core can be switched by short, resonant magnetic field pulses applied in the film plane [2]. In this work, we use micromagnetic finite-element simulations to demonstrate that vortex cores can also be switched by in-plane sub-ns electric current pulses. The vortex core of a permalloy nanodisk of 200 nm size and 20 nm thickness can be switched, e.g., by a 200 ps polarized current pulse with a peak value of $5{\times}10^8$ A/cm^2. In the simulations, both the spin transfer torque (adiabatic) term and the force (non-adiabatic) term due to the current have been considered. The simulations show that the core switching process is mediated by a rapid vortex-antivortex pair creation and annihilation mechanism [3]. For stronger current pulses, multiple core reversals are observed. By changing the strength of the current pulse, the number of the reversal times can be controlled.

[1] Shinjo et al. Science 289, 930 (2000).
[2] B. Van Waeyenberge et al., Nature 444, 461 (2006).
[3] R. Hertel and C.M. Schneider, PRL 97, 177202 (2006).

MA 15.117 Tue 15:00 Poster A

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

Transition-metal nanowires are very attractive systems to study the interplay of low dimensionality and magnetism. The results of recent experiments indicate the existence of noncollinear order in ferromagnetic nanowires [1,2]. However, for systems with a large number of magnetic degrees of freedom a direct unambiguous measurement of the magnetic configuration is quite impossible without preliminary theoretical considerations. In this respect the predictive role of first-principles calculations is of great importance. We have developed a new version of the screened Korringa-Kohn-Rostoker (KKR) method that can suitably be applied to noncollinear magnetic systems. In terms of this method we calculate both the diagonal and the off-diagonal elements of the spin density matrix from which we obtain information for both the magnitudes and the directions of the local moments. We performed *ab initio* calculations for magnetic nanowires suspended between two semi-infinite leads. These three parts of the system were treated on the same footing without adjustable parameters. We point out the possibility of the formation of noncollinear magnetic states in Ni, Co and Fe nanowires. In addition, the influence of the magnetic anisotropy on the magnetic order will be discussed.

[1] V. Rodrigues et al., Phys.Rev.Lett. **91**, 096801 (2003)
[2] M.R. Sullivan et al., Phys.Rev.B **71**, 024412 (2005)

MA 15.118 Tue 15:00 Poster A

Thermal Expansion and Thermal Transport in $NdMnO_3$ and $TbMnO_3$ — •Kai Berggold[1], Thomas Lorenz[1], Jörg Baier[1],

John Mydosh[1], Dennis Meier[2], Joachim Hemberger[3], and Dimitri Argyriou[4] — [1]II. Physikalisches Institut, University of Cologne, Germany — [2]Helmholtz - Inst. f. Strahlen und Kernphysik, University of Bonn, Germany — [3]Inst. f. Physik, University of Augsburg, Germany — [4]Hahn-Meitner-Institut, 14109 Berlin, Germany

We present measurements of the thermal expansion α and the thermal conductivity κ of $NdMnO_3$ and $TbMnO_3$. $NdMnO_3$ is an A type antiferromagnet with $T_N = 88\,K$, whereas $TbMnO_3$ is known for its multiferroic properties, leading to complex magnetic and electric ordering phenomena at low temperatures. In $NdMnO_3$, the Néel transition causes large anomalies in α as well as in κ. At low temperatures the crystal-field splitting of the Nd^{3+} ground state causes a Schottky-type contribution to the thermal expansion. The thermal conductivity at low temperatures is strongly suppressed by this splitting, as a consequence of resonant phonon-scattering processes. In $TbMnO_3$, we show that the main factor determining κ is also given by resonant scattering between different crystal-field split states of the $4f$ multiplet of the Tb^{3+} ions. In contrast to $NdMnO_3$, the suppression acts in a much wider temperature range. The various transitions at low temperatures observed by anomalies of the thermal expansion have no significant influence on the thermal conductivity.

Supported by the DFG through SFB 608

MA 15.119 Tue 15:00 Poster A

Magnetic field dependent structure of $TbFe_3(BO_3)_4$ resolved by x-ray diffraction — •Martin Philipp[1], Olga Kataeva[1,2], Christian Hess[1], Rüdiger Klingeler[1], Natalia Tristan[1], Bernd Büchner[1], Martin von Zimmermann[3], Alexander Vasiliev[4], and Elena Popova[4] — [1]Leibniz-Institute for Solid State and Materials Research, IFW-Dresden, 01171 Dresden, Germany — [2]A.E.Arbuzov Institute, Russian Academy of Sciences, Arbuzov Str. 8, 420088 Kazan, Russia — [3]HASYLAB@DESY, Notkestr. 85, 22603 Hamburg, Germany — [4]Physics Faculty, Moscow State University, 119992 Moscow, Russia

Recently, rare earth iron borates $RFe_3(BO_3)_4$ (R: Rare Earth) attracted attention as candidates for possible multiferroic behavior. $TbFe_3(BO_3)_4$ exhibits antiferromagnetic order below ~ 39 K. In this ordered phase a spin flop-like transition occurs when a magnetic field is applied parallel to the crystallographic c-axis. This involves the reorientation of the antiferromagnetic ordered Fe and the polarized Tb magnetic moments. We have studied this magnetic transition by means of hard x-ray diffraction ($h\nu \approx 100$ keV). In the high field phase we observed superlattice reflections which indicate a doubling of the unit cell along the c-axis. We compare the field and temperature dependence of these superlattice reflections with results from thermodynamics.

MA 15.120 Tue 15:00 Poster A

Spin-flop transition in uniaxial antiferromagnets — •Alexei N. Bogdanov[1,2], Alexander V. Zhuravlev[2], and Ulrich K. Rössler[1] — [1]IFW Dresden — [2]Donetsk Institute for Physics and Technology

A comprehensive phenomenological theory of the spin-flop reorientation in easy-axis antiferromagnets has been developed [1]. The characteristic hierarchy of exchange and relativistic interactions in this class of antiferromagnets causes a strongly pronounced *two-scale* character of their magnetic properties. In contrast to the major part of the magnetic phase diagram, near the spin-flop field magnetic properties are determined by weak higher-order intrinsic interactions. In this region the system can be described by an effective model akin to uniaxial ferromagnets. The analysis of magnetic-field-driven reorientation and the concomitant multidomain states provides a consistent picture of the magnetization processes near the spin-flop field. We elucidate such remarkable spin-flop phenomena as reentrance of phases in the coexistence region, enhanced magnetic susceptibility, and complex magnetization processes. The validity of the theoretical results has been demonstrated by experimental investigations of the spin-flop transition in the orthorhombic layered antiferromagnet $(C_2H_5NH_3)_2CuCl_4$ [1,2]. The theory developed in this work can be adopted for investigations on synthetic antiferromagnets and exchange-biased systems [3].

[1] A. N. Bogdanov, A. V. Zhuravlev, U.K. Rößler, cond-mat/0609648. [2] A. N. Bogdanov, A. V. Zhuravlev, I.V. Zhikharev, U.K. Rößler, J. Magn. Magn. Mater. **290-291**, 768 (2005). [3]. A. N. Bogdanov, U. K. Rößler, Appl. Phys. Lett. **89** (2006) 163109.

MA 15.121 Tue 15:00 Poster A

Crystal structure and magnetic fluctuations in $La_{1-x}A_xCoO_3$ (A = Ca, Sr, Ba) — •Thomas Finger[1], Marco Reuther[1], Daniel Senff[1], Matthias Cwik[1], Thomas Lorenz[1], Klaudia Hradil[2], Anatoliy Senychyn[3], and Markus Braden[1] — [1]II. Physikalisches Institut, Universität zu Köln — [2]Institut für Physikalische Chemie, Georg-August Universität Göttingen — [3]FB Material- und Geowissenschaften, Technische Universität Darmstadt

The phase diagram of perovskite cobaltites is closely related to those of the CMR-manganites as they both show ferromagnetism and metallic behaviour at intermediate doping. We have studied the crystal structure of the series with Ca and Ba doping by combining different neutron and x-ray diffraction techniques and will discuss the corresponding phase diagrams. Furthermore magnetic excitations were studied by inelastic neutron scattering on a thermal triple-axis spectrometer for $La_{0.75}Sr_{0.25}CoO_3$ which exhibits ferromagnetic order below $T_C = 220$ K.The magnon excitations could be followed up to energies of 13 THz yielding an isotropic dispersion. We find a spin-wave stiffness constant of $D = 400 \pm 35\text{meV}\cdot\text{Å}^2$.

MA 15.122 Tue 15:00 Poster A

Static Characterization of the Antiferromagnetic-To-Ferromagnetic Phase Transition of FeRh Thin Films — •Paul Ramm[1], Ilie Radu[1], Alexander Weber[1], Christian Back[1], Christian Stamm[2], Torsten Kachel[2], Niko Pontius[2], Hermann Dürr[2], Jörg Raabe[3], Christoph Quitmann[3], Luiic Joly[3], and Jan-Ulrich Thiele[4] — [1]Institut für Angewandte und Experimentelle Physik, Universität Regensburg, Germany — [2]BESSY GmbH, Berlin, Germany — [3]Paul Scherrer Institut, Villingen PSI, Switzerland — [4]Hitachi Global Storage Technologies, San Jose Research Center, USA

The antiferromagnetic-to-ferromagnetic phase transition present on the FeRh thin film alloy is studied by employing static magneto-optic Kerr effect (MOKE), X-ray magnetic circular dichroism (XMCD) and X-ray photoemission electron microscopy (XPEEM) techniques, which give information on the average magnetization, the element-specific magnetic moments as well as the domain structure, respectively.

The element-specific hysteresis provided by the XMCD measurements near the transition temperature reveal the growth of the Fe magnetic moment and development of the small but crucial induced Rh magnetic moment in the ferromagnetic phase.

Using temperature dependent XPEEM in the vicinity of the phase transition we observe the formation and the partial reproducibility of the magnetic domain structure. The temperature hysteresis of the magnetic contrast deduced from the XPEEM data is in good agreement with the temperature dependent MOKE measurements.

MA 15.123 Tue 15:00 Poster A

Structural properties of PrB_6 — •Matthias Bleckmann[1,2], Desmond McMorrow[2], Helen Walker[2], Danny Mannix[3], Je-Geun Park[4], Seongsu Lee[4], and Keith McEwen[2] — [1]Institut für Physik der Kondensierten Materie, TU Braunschweig, Braunschweig, Germany — [2]Department of Physics and Astronomy, University College London, London, UK — [3]XMaS UK-CRG, European Synchrotron Radiation Facility, Grenoble, France — [4]SungKyumKwan University, Suwon, Korea

Multiferroic materials represent a topic of current interest in solid state physics. In order to understand the multitude of phenomena occurring in these materials the issue of quadrupolar ordering has attracted a lot of interest. Here, a model system to study and understand quadrupolar ordering phenomena is required. PrB_6, with its simple crystal structure and well known magnetic structure, is a suitable material to act as such a model system. In this contribution, we present a detailed study of the low-temperature structural properties of PrB_6. By means of high-resolution x-ray diffraction we find the first direct experimental proof of a structural lattice distortion in PrB_6, and which seems to be driven by its magnetic phase transition.

MA 15.124 Tue 15:00 Poster A

Frustrated Ising- and Heisenberg-type Spin Systems on a Hexagonal Lattice — Carsten Olbrich[1,2], •Tim Kunze[1], Sibylle Gemming[1,3], Klaus Morawetz[1,4], and Michael Schreiber[1] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]School of Engineering and Science, Jacobs University Bremen, 28725 Bremen, Germany — [3]Forschungszentrum Dresden-Rossendorf, PF 51 01 19, 01314 Dresden, Germany — [4]Max Planck Institute for the Physics of Complex Systems, Noethnitzer Str. 38, 01187 Dresden, Germany

The low-temperature behaviour of Ising- and Heisenberg-type spin systems on a periodically repeated hexagonal lattice is investigated by Metropolis-Monte-Carlo simulations. The correlation between various

realisations of the local coupling and the order-disorder phase transitions is studied as a function of the external magnetic field. Entropy effects are estimated by thermodynamic integration. Due to frustration effects complex spin patterns are obtained and analysed in specific parameter regimes.

MA 15.125 Tue 15:00 Poster A

Magnetic phases in Y_xCa_1-xMnO_3 — •Uwe Amann[1,2,3], Clemens Ritter[2], Dietmar Hohlwein[1,3], Andreas Pfrommer[1], and Jörg Ihringer[1] — [1]Institut für Angewandte Physik, Universität Tübingen, 72076 Tübingen, Germany — [2]Institut Laue-Langevine, 38100 Grenoble, France — [3]SF2/Magnetism, Hahn-Meitner Institut, 14109 Berlin, Germany

We report on studies on the CMR-compounds Y_xCa_1-xR_yMn_1-yO_3 which exhibit changing magnetic properties depending on concentration x and temperature. From the G-type AF CaMnO3, a new magnetic (C-type AF) phase occurs when exchanging Calcium by Yttrium in the region of x>=0.1. Phase transition temperature, phase fraction and strength of the magnetic moment of these phases depends strongly on the dopant R and amount y. Temperature dependent data collected with neutron and x-ray (powder) diffractometers has been analyzed simultaneously to determine the fractions of the different possible and realized magnetic and nuclear phases (nuclear structures P2_1/m, Pnma, magnetic structure type G,C,F,A).

For the substitution of Manganese by Gallium pronounced shifts in phase transition temperature are recorded, while the substitution by Iron leads to much weaker magnetic intensities with less effects on the nuclear structure.

MA 15.126 Tue 15:00 Poster A

***Ab Initio* Calculations of Exchange Interactions in Transition Metal Oxides** — •Guntram Fischer[1], Arthur Ernst[2], Markus Däne[1], Wolfram Hergert[1], Martin Lüders[3], Zdzislawa Szotek[3], and Walter Temmerman[3] — [1]Naturwissenschaftliche Fakultät II, Institut für Physik, Martin-Luther-Universität Halle-Wittenberg — [2]Max Planck Intitut für Mikrostrukturphysik, Halle — [3]Daresbury Laboratory, Daresbury, Warrington WA4 4AD

For the development of new materials in semi-conductor technology and spintronics it is essential to understand the magnetic effects and interactions in these systems. One method to describe the magnetic effects is to map the interactions onto an effective Heisenberg-Hamiltonian. To do so one needs to obtain the Heisenberg exchange parameters, which carry the relevant physical information about other quantities such as critical temperatures, magnetic susceptibilities, specific heat and others.

We present the results obtained by applying *ab initio*-methods to calculate the exchange parameters of transition metal oxides (TMO). With these results the Néel temperatures of the TMO are calculated via Mean Field Approximation, Random Phase Approximation and classical Monte Carlo simulations. The different results are compared with each other and possible future applications of the methods are shown.

MA 15.127 Tue 15:00 Poster A

Colossal magnetostriction and spin-driven phonon splitting in bond-frustrated Cr-spinels — •Joachim Hemberger, Torsten Rudolf, Christian Kant, Hans-Albrecht Krug von Nidda, Andrei Pimenov, Vladimir Tsurkan, and Alois Loidl — Center for Electronic Correlation and Magnetism, University of Augsburg, D-86135 Augsburg, Germany

The Cr-based cubic spinel compounds $ZnCr_2X_4$ (X=S,Se) exhibit complex magnetic ground states which are determined by the competing ferromagnetic (FM) and antiferromagnetic (AFM) exchange interactions yielding strong bond frustration: While in ZnCr2Se4 a spiral AFM structure is established below $T_N = 21$ K, in $ZnCr_2S_4$ the AFM spiral sets in below $T_{N1} = 15$ K and is changed into a collinear magnetic phase below $T_{N2} = 8$ K. Even though ESR measurements reveal a negligible spin-orbit coupling excluding orbitally induced Jahn-Teller distortions, the observed magnetic transitions are accompanied by significant magnetoelastic anomalies: In both compounds a splitting of individual phonon modes, pronounced thermal expansion anomalies, and large magnetostriction are denoting the spin-driven origin of a structural instability which can be fully suppressed in external magnetic fields. These effects are investigated by means of magnetization, specific heat, thermal expansion, dielectric and IR spectroscopy in external magnetic fields and the results are interpreted in terms of exchange-striction along the competing magnetic bonds.

[1] J. Hemberger et al., Phys. Rev. Lett. **97**, 087204 (2006) [2] J. Hemberger et al., cond-mat/0607811

MA 15.128 Tue 15:00 Poster A

The multiferroic phases of (Eu:Y)MnO_3 — •Florian Schrettle[1], Joachim Hemberger[1], Andrei Pimenov[1], Peter Lunkenheimer[1], Vseva Ivanov[2], Alexander Mukhin[2], Anatoli Balbashov[3], and Alois Loidl[1] — [1]Experimentalphysik V, Center for Electronic Correlations and Magnetism, Institut für Physik, Universität Augsburg, D-86135 Augsburg, Germany — [2]General Physics Institute of the Russian Academy of Sciences, 38 Vavilov Street, 119991 Moscow, Russia — [3]Moscow Power Engineering Institute, 14 Krasnokasarmennaja Street, 111250 Moscow, Russia

In recent years multiferroic magnetoelectrics attracted an increasing scientific and technological interest. In this rare class of compounds ferroelectricity (or at least a weak ferroelectric component) and (ferro-)magnetism coexist and both order-parameters are strongly coupled. Prominent examples for such type of materials are the heavy rare earth manganites like $TbMnO_3$, where the partial frustration in the spin-sector leads to spiral magnetic structures inducing finite ferroelectric polarization. The system (Eu:Y)MnO_3 offers the possibility to continuously control the orthorhombic distortion of the orbitally ordered perovskite structure and thus to tune the corresponding multiferroic phases without the additional influence of a magnetic rare earth moment. In the concentration range near x=0.2 for these class of materials the unique case of spontaneously coexisting ferroelectric and ferromagnetic components is realized.

[1] J. Hemberger et al., Phys. Rev. B, in press, cond-mat/0603258

MA 15.129 Tue 15:00 Poster A

Electronic and magnetic structure of cuprous oxide (Cu_2O) doped with Mn, Fe, Co, and Ni: A DFT study — Martin Sieberer, Josef Redinger, and •Peter Mohn — Center for Computational Materials Science, Technical University of Vienna, Austria

We investigate the effect of transition metal (TM) substitution in cuprous oxide Cu_2O on the basis of ab-initio calculations employing density functional theory (GGA+U). By using the supercell approach we study the effect of substituting Cu by Mn, Fe, Co, and Ni, assuming both, low TM concentrations (3.2 %) in a cubic geometry and higher TM concentrations (9.1 %) in a trigonal set-up. For the elements Mn and Co magnetic exchange constants up to the fifth nearest neighbor are calculated, assuming both cases, perfect Mn/Co:Cu_2O as well as defects in the host like single copper and oxygen vacancies. Our results clearly show the importance of defects in these materials and thus offer an explanation for various, seemingly opposed experimental results.

MA 15.130 Tue 15:00 Poster A

Electronic structure and magnetic properties of the $Th_xY_{1-x}Co_4B$ intermetallic compounds — •Diana Benea[1], Viorel Pop[1], and Olivier Isnard[2] — [1]Babes Bolyai University, Faculty of Physics, Cluj-Napoca, Romania — [2]Laboratoire de Cristallographie du CNRS, Joseph Fourier University, 38042 Grenoble, France

Detailed theoretical and experimental investigations on the electronic and magnetic properties of the $Th_xY_{1-x}Co_4B$ compounds have been performed. All investigations of the electronic, magnetic and structural properties have been done using the fully relativistic spin polarized Korringa-Kohn-Rostoker (SPR-KKR) band structure method in ferromagnetic state. The disorder in the system has been accounted for by means of the Coherent Potential Approximation (CPA). The $ThCo_4B$ compound orders ferromagnetically at 303 K, whilst the isotypic YCo_4B compound has a higher Curie temperature (380 K). The SPR-KKR calculated total magnetic moment decrease with Th concentration from 2.49 μ_B/f.u. for YCo_4B to 1.64 μ_B/f.u. for $ThCo_4B$. The magnetization measurements show a similar decrease of the magnetic moment with Th content from 2.90 μ_B/f.u. for YCo_4B to 1.49 μ_B/f.u. for $ThCo_4B$. The values of the Co magnetic moments depend strongly on the local environment. The preferential occupation of the Th/Y atoms evidenced by X-ray and neutron scattering experiments is investigated by theoretical calculations. In addition, the influence of the preferential occupation on the magnetic properties of the system is discussed.

MA 15.131 Tue 15:00 Poster A

Investigation of high-k materials $RScO_3$ (R=Sm,Gd,Dy) by XPS and band structure calculations — •M. Raekers[1], S. Bartkowski[1], K. Kuepper[2], S. Zhou[2], K. Potzger[2], A. Postnikov[3], R. Uecker[4], and M. Neumann[1] — [1]Universität Os-

nabrück, Fachbereich Physik, Osnabrück, Germany — [2]FZ Dresden-Rossendorf, Dresden, Germany — [3]Université Paul Verlaine, Metz, France — [4]IKZ, Berlin, Germany

There has been considerable interest in high-k-dielectrics rare earth oxides as replacement for SiO_2 in advanced field-effect transistors (FETs). Promising candidates are the perovskites $SmScO_3$, $GdScO_3$ and $DyScO_3$. A tendency towards antiferromagnetic ordering at low temperatures is observed for the high magnetic moments at rare earth atoms. We analyse the electronic structure of the single crystalline samlpes by means of X-ray photoelectron spectroscopy and first-principles theory. The electronic structure calculations are performed with the augmented plane waves method (WIEN2k code) of the density functional theory, taking into account the spin-orbit interaction and orbital-dependent potential (LDA+U). The calculated positions of the main features in the valence band agree with the XPS data, the underlying chemical bonding can be analysed in detail. Small differences in the electronic structure, resulting in different stability of ferro- and antiferromagnetic configurations, are discussed.

MA 15.132 Tue 15:00 Poster A

Heat conduction in spin-gap antiferromagnets — Igor Smiljanić[1], •Ante Bilušić[1,2], Ana Smontara[1], Helmuth Berger[3], and László Forró[3] — [1]Institute of Physics, Zagreb, Croatia — [2]Faculty of Science, Univ. of Split, Croatia — [3]Ecole Polytechnique Fédérale de Lausanne, Switzerland

Spin-gap antiferomagnets (SG AFMs) have a discrete spin-energy spectrum due to the existence of short-range spin correlations only. The thermal conductivity of SG AFMs is a tool that probes their spin excitations and spins-phonons interaction. A variety of phenomena are observed: for example, in various strontium-cuprates thermal conductivity strongly enhances due to the opening of the heat channel carried by either magnons or spinons. In spin-Peierls compounds the thermal conductivity exhibits rather unusual double peak features at low temperatures, explained as a fingerprint of the spin-phonon resonance scattering. The thermal conductivity of strongly frustrated systems also shows the existence of spin-phonon resonance at low temperatures. We present the study of the thermal transport of several SG AFMs: (i) of copper-tellurides, quasi-0D geomatrically frustrated compounds with S=1/2, (b) of a "zig-zag"frustrated spin ladder system $LiCu_2O_2$ (S=1/2), and (c) quasi-2D S=1 system nickel-telluride. We find that the thermal conductivity of these systems exhibit features typical for spin-phonon resonance coupling, gradually decreasing as the dimensionality of the systems increase. This work was done within the SNF SCOPES project No. IB7320-111044.

MA 15.133 Tue 15:00 Poster A

Calculation of interface properties for Heusler compounds — •Andrey Beznogov and Peter Entel — Theoretische Tieftemperaturphysik, Universität Duisburg-Essen, Lotharstr. 1, 47048 Duisburg, Germany

Heusler compounds, such as Co_2MnGe, are one of the most attractive half-metallic systems. Their bulk and surface properties are well understood. However, their implementation in devices based on giant and tunnel magnetoresistance effects means introduction of interfaces with other materials, which usually has a strong impact on their electronic and magnetic properties. The most important problem here is preservation of half-metallicity, which has a direct influence on unique transport properties of such systems, and is typically severely reduced by such structural changes.

Using *ab initio* density functional methods, we calculate the magnetic properties and the dependence of the half-metallicity from the interface structure for a layered system with Heusler contacts. Our main interest is the full Heusler compound Co_2MnGe in combination with MgO. Choosing the (001) orientation for MgO, several configurations with different termination and site disorder have been investigated by using the Vienna Ab-initio Simulation Package (VASP), employing the projector augmented wave method (PAW) and the generalized gradient approximation (GGA) for the exchange correlation potential.

This work is supported by the *Deutsche Forschungsgemeinschaft* through SFB 491.

MA 15.134 Tue 15:00 Poster A

Thermodynamic properties of intermetallic ternary rare-earth compounds — •J. Rohrkamp[1], O. Heyer[1], H. Hartmann[1], T. Lorenz[1], J. Mydosh[1], R. Pöttgen[2], and T. Fickenscher[2] — [1]II. Physikalisches Institut, Universität zu Köln, 50937 Köln, Germany — [2]Institut für Anorganische und Analytische Chemie, Universität Münster, 48149 Münster, Germany

Ternary rare-earth intermetallics of the composition *RET*Mg with RE = La, Eu, Gd, Yb and T = Ag, Au and GdAuIn show a rich variety of magnetic phases. Depending on the composition these compounds are paramagnetic (RE = La, Yb) or they order either ferro- or antiferromagnetically with transition temperatures ranging from about 13 to 81 K. We measured the susceptibility χ, the resistivity ρ, the specific heat C_p and the thermal expansion coefficient α and found well pronounced anomalies in each quantity at T_N or T_C. From the measurements of χ and C_p we calculate the magnetocaloric effect, which is sizeable for both the ferro- and the antiferromagnetic compounds. Furthermore we determine the hydrostatic pressure dependencies of the various transition temperatures from the specific heat and thermal expansion data using Ehrenfest's relation. We find rather large pressure dependencies of the transition temperatures. This indicates that the magnetic ordering is driven by the RKKY interaction between the 4f moments of the rare-earth ions via the conduction electrons.
This work was supported by the DPG through SPP 1166.

MA 15.135 Tue 15:00 Poster A

Crystal structure and physical properties of $Eu_4Pd_{29}B_8$ and $YbNi_7B_3$ borides — Igor Veremchuk, •Roman Gumeniuk, Andreas Leithe-Jasper, Walter Schnelle, Yuri Prots, and Yuri Grin — Max-Planck-Institut für Chemische Physik

Crystal structures of the ternary borides $Eu_4Pd_{29}B_8$ ($I41/amd$ (no. 141), a = 8.5686(4) Å, c = 16.596(1) Å, Z = 2,) and $YbNi_7B_3$ (structure type $ErNi_7B_3$ [1], s.g. $I41/amd$ (no. 141), a = 7.6419(4) Å, c = 15.568(1) Å, Z = 8) were refined by means of X-ray single-crystal method. A X-ray absorption spectroscopic study at the Yb-L_{III} and Eu-L_{III} edges as well as measurements of magnetic susceptibility show Eu atoms to be in mixed (+2–+3) valence state while a stable +3 valence state is observed for the Yb-containing boride. Magnetic susceptibility data of the $Eu_4Pd_{29}B_8$ compound indicate a thermally induced valence change from nonmagnetic $4f^7$ to magnetic $4f^6$ state.

[1] Kuz'ma Yu. B., Babizhetskyj V., Veremchuk I. and Chaban N. J. Solid State Chemistry, **177** 425-430 (2004).

MA 15.136 Tue 15:00 Poster A

Investigation of the valence states of $Fe_{1-x}Cu_xCr_2S_4$ by X-ray absorption spectroscopy — •C. Taubitz[1], M. Raekers[1], V. Tsurkan[2], and M. Neumann[1] — [1]Universität Osnabrück, Fachbereich Physik, Barbarastraße 7, D-49069 Osnabrück, Germany — [2]Institute of Applied Physics, Academy of Sciences of Moldova, Kishinev MD 2028, Republic of Moldova

Spinel compounds of $Fe_{1-x}Cu_xCr_2S_4$ have attracted much attention since the discovery of a very large negative magnetoresistance (MR) effect. A long-standing issue in the attempt to understand the magnetic and electric properties of these compounds has been the Fe valency. We have investigated the valency of Fe by XAS and XPS. In the region 0<x<0.5 the Lotgering model predicts Fe to be in a mixed valence state between Fe^{2+} and Fe^{3+}. For x=0.5 all Fe-ions are assumed to be trivalent. While Mössbauer measurements confirm this model our investigations with XAS and XPS show Fe in a divalent state. We suppose that this is due to charge transfer effects between Fe and the S ligand, that originate from the excitation of electrons during the measurement. XPS and XAS measurements of the region 0.5<x<1 show a mixed Fe valence state. We discuss the valence states in comparison with the models of Lotgering and Goodenough.

MA 15.137 Tue 15:00 Poster A

Dielectric and thermodynamic properties of — •Norman Leps[1], Janet Leschner[1], Andrei Sotnikov[1], Dmitri Souptel[1], Sang-Wook Cheong[2], Rüdiger Klingeler[1], Christian Hess[1], Natalia Tristan[1], and Bernd Büchner[1] — [1]Leibniz-Institute for Solid State and Materials — [2]Department of Physics & Astronomy Rutgers

In so-called multiferroics the magnetic and the ferroelectric order parameter might be controlled by the application of the respective complementary field provided that significant magneto-electric coupling exists. Recently, the materials RMn_2O_5 and $RMnO_3$ (R: small rare earth) have attached attention in this regard. Here we present experimental results for thermodynamic and dielectric properties of several compounds of this family with Eu, Bi and Y on the R sites. We compare our results with data for other multiferroic systems and discuss possibilities for specificly altering the materials properties by doping.

MA 15.138 Tue 15:00 Poster A

Magnetic properties of the tetragonal $Mn_{3-x}Ga$ ($0 \leq x \leq 1$) system — •Jürgen Winterlik, Benjamin Balke, Gerhard H. Fecher, and Claudia Felser — Johannes Gutenberg-Universität Mainz

Recently the cubic DO_3 phase of the compound Mn_3Ga was predicted to be a half-metallic completely compensated ferrimagnet. A tetragonal distortion of the cubic lattice to the DO_{22} structure leads to a change in magnetic properties of the compound.

A series of samples of tetragonal $Mn_{3-x}Ga$ was prepared in the range of ($0 \leq x \leq 1$) by arcmelting under argon atmosphere and annealing the resulting samples in evacuated quartz tubes at 350°C for one week. XRD measurements prove that the DO_{22} structure could be realised in the whole concentration range.

Magnetic measurements were carried out by SQUID magnetometry. All samples show hardmagnetic behaviour. The Curie temperature of the materials cannot be specified due to a phase transition to the hexagonal DO_{19} phase at about 700-800K. The results are evaluated and discussed regarding the Mn-concentration.

MA 15.139 Tue 15:00 Poster A

Single crystal growth and physical properties of $ErPd_2Si_2$ intermetallic compound — •Chongde Cao[1], Günter Behr[1], Wolfgang Löser[1], Irina Mazilu[1], E.V. Sampathkumaran[2], and Bernd Büchner[1] — [1]Leibniz Institute for Solid State and Materials Research Dresden, 01171 Dresden, Germany — [2]Tata Institute of Fundamental Research, Homi Bhabha Road, Colaba, Mumbai - 400005, India

The various classes of multicomponent intermetallic rare earth-transition metal-compounds offer a great potential of outstanding properties. A bulk single crystal (d=6mm, l=50mm) of $ErPd_2Si_2$ compound has been successfully grown at a velocity of 10 mm/h by using floating zone method with optical heating. X-ray Laue back-scattering analysis indicates the crystal growth direction is close to [110] orientation with an inclination angle of 14.9° against the rod axis. Morphological observation and concentration measurement show element segregation occurs along the rod axis and the radius directions. The magnetic susceptibility of $ErPd_2Si_2$ single crystal reveals an antiferromagnetic ordering at about 4 K. The crystal structures, electrical resistivity, magnetic susceptibility, heat-capacity and magnetoresistance of different orientations are investigated in comparison with polycrystals. References:

W. Bazela, J. Leciejewicz, A. Szytula, et al., J. Mag. Mag. Mater., 1991, 96, 114.

K. Tomala, J.P. Sanchez, B. Malaman, et al., J. Mag. Mag. Mater., 1994, 131, 345.

MA 15.140 Tue 15:00 Poster A

Temperature driven spin reorientation transition in thin films — •Fritz Körmann[1], Stefan Schwieger[2], Jochen Kienert[1], and Wolfgang Nolting[1] — [1]Lehrstuhl Festkörpertheorie, Institut für Physik, Humboldt Universität zu Berlin, Newtonstr. 15, 12489 Berlin, Germany — [2]Technische Universität Ilmenau, Theoretische Physik I, Postfach 10 05 65, 98684 Ilmenau, Germany

The temperature dependent orientation of the magnetization vectors in thin ferromagnetic films is directly connected to the giant magneto resistance. Starting from an extended Heisenberg model we calculate the equilibrium angles of the magnetization and the magnetization norm of thin magnetic films quantenmechanically and self consistently. The model includes interlayer exchange (IEC) coupling, single ion anisotropies and dipolar coupling. We present a new type of temperature driven spin reorientation transition (SRT) in thin films. It can occur when the lattice and the shape anisotropy favor different easy directions of the magnetization. Due to different temperature dependencies of the two contributions the effective anisotropy may change its sign and thus the direction of the magnetization as a function of temperature may change. Contrary to the well-known reorientation transition caused by competing surface and bulk anisotropy contributions the presented SRT is also found in film systems with a uniform lattice anisotropy. We show the temperature and external field dependent reorientation of the magnetization vectors of IEC coupled films. The theory is also able to describe experimental ferromagnetic resonance results as accurately as the (classical) Landau Lifshitz equation.

MA 15.141 Tue 15:00 Poster A

Magnetic anisotropy of $Fe_{1-x}Co_x(110)$ on GaAs(110) — •Björn Muermann, Matthias Sperl, Alexander Spitzer, and Günther Bayreuther — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Regensburg, Germany

In this contribution we investigate the magnetic anisotropy of epitaxial $Fe_{1-x}Co_x(110)$ films (x = 0...0,64) grown by molecular beam epitaxy (MBE) on GaAs(110). The samples were grown on clean wafer as well as on surfaces prepared by cleaving in ultra high vacuum and studied by means of alternating gradient magnetometry (AGM) and ferromagnetic resonance (FMR) spectroscopy. The angular dependent energy density observed can be explained by two main contributions to the magnetic anisotropy: an effective magnetocrystalline anisotropy $K^{eff}_{cryst}(t)$ caused by the symmetry of the $Fe_{1-x}Co_x(110)$ lattice, and an effective uniaxial anisotropy, $K^{eff}_U(t)$. The strength of these anisotropies is thickness dependent due to a volume and a surface contribution, $K^{eff}_i(t) = K^{Vol}_i + K^{Surf}_i/t$. Néel's pair energy model is used to derive the relation between the surface and volume term of the crystalline anisotropy. The strain induced uniaxial anisotropy is altered by different compositions of iron and cobalt. The effects of interface roughness and structural defects to the anisotropy are discussed.

MA 15.142 Tue 15:00 Poster A

Magnetfeldsteuerbarer magnetischer Widerstand — •Robert Jäger und Marc Jäger — Resogap, 75053 Gondelsheim

Der Ferromagnetismus und damit der magnetische Widerstand eines Ferromagneten hängen von der Temperatur aber auch von einem steuernden externen Magnetfeld ab. Neben der materialspezifischen kritischen Temperatur T_C (Curie Temperatur) existiert auch eine materialspezifische kritische äußere Feldstärke B_k, ab welcher der Ferromagnetismus vollständig zerstört wird. Mit steigendem äußerem Magnetfeld B_a erfolgt kontinuierlich eine Reduzierung der stoffabhängigen Permeabilität. Dieses Magnetfeld muss groß genug sein, um eine sichtbare Wirkung zu erzielen. Das Magnetfeld der Erregung reicht hierfür normalerweise nicht aus. Wegen der Robustheit eines Magnetfeldes, dem preiswerten Material, dem kleinen Raumbedarf, dem geringen Gewicht und der masselosen Steuerung eines magnetischen Widerstandes werden durch den Effekt viele technische Anforderungen erfüllt. Technische Anwendungen sind immer dann möglich, wenn ein ausreichend starkes Magnetfeld eingesetzt werden kann. Alle Größen, die ein Magnetfeld ändern können, wie z.B. Umdrehungen, Drehmoment, Winkel, Neigungen, Beschleunigungen, Abstände, Dehnungen sowie Materialeigenschaften (über Dämpfungen der Magnetfelder) lassen sich mit diesem Effekt robust in Größen wie Spannungen, Zeiten oder Frequenzen umsetzen. Der Aufbau des Experimentes zur Messung der Magnetisierung in Abhängigkeit von einem äußeren Magnetfeld und das Ergebnis werden beschrieben.

MA 15.143 Tue 15:00 Poster A

Using a highly sensitive TMR sensor array for the detection of moving biomolecules — •Camelia Albon, Sascha Walkenhorst, Simone Herth, Michael Schilling, and Günter Reiss — Thin Films and Nanostructures, Department of Physics, Bielefeld University, Bielefeld, Germany

The use of magnetoresistive biosensors for the detection of biomolecules attached to magnetic nanoparticles is already a well-known technique. For the detection of magnetic nanoparticles attached only by one biomolecule the improvement of the magnetoresistive sensors sensitivity is mandatory. In this way the application of new detection schemes in order to measure the biochemical processes that take place at single biomolecular level can be done more accurately. TMR sensors with MgO as barrier material represent promising candidates to achieve highly improved sensitivity. In order to acquire a spatial resolution for the detection of magnetic nanoparticles a highly integrated sensor array is created. In our approach a sensor array is patterned by e-beam lithography with 20 elliptical sensors having the dimensions of 100×400 nm on an area of $18.2\mu m^2$. This TMR array will be used for detection of single molecule processes with the help of magnetic nanoparticles.

MA 15.144 Tue 15:00 Poster A

Das Swiss-cross-Helmholtz-Design für großvolumige Permanent-Magnet-Anordnungen: vielfältige Zugangsmöglichkeiten und gute Homogenität — •Holger Stork[1], Manuel Ross[1], Achim Gädke[1] und Nikolaus Nestle[1,2] — [1]TU Darmstadt, Institut für Festkörperphysik — [2]BASF AG Ludwigshafen

Hochkoerzitive Permanentmagneten aus FeNdB-Materialien sind heute in einer Reihe von Standardgeometrien zu günstigen Preisen verfügbar. Wegen technischer Probleme bei der Aufmagnetisierung und

Sicherheitsauflagen für den Transport ist die Größe dieser Magneten auf ca. 10 x 10 cm begrenzt. Außerdem sind FeNdB-Materialien relativ temperaturempfindlich. Für Messungen bei tiefen oder hohen Temperaturen können aus solchen Magneten aufgebaute Magnetsysteme nur dann eingesetzt werden, wenn die Probenumgebung mit guter Isolierung in den Magneten eingebaut werden kann. Im Beitrag wird ein Konzept für ein großvolumiges Magnetsystem vorgestellt, das für Magnetfelder im Bereich von ca. 0.2 T diesen Anforderungen genügt und außerdem zahlreiche Zugangsmöglichkeiten parallel und senkrecht zur Magnetfeldrichtung ermöglicht. Erfahrungen beim Aufbau eines solchen Magnetsystems werden ebenso präsentiert wie weitere Optimierungen und mögliche Anwendungsgebiete in Halbleiterphysik und TD-NMR.

MA 15.145 Tue 15:00 Poster A

Detection of superparamagnetic nanoparticles with AlOx magnetic tunnel junctions and development of hysteresis free MgO via shape anisotropy — •Sascha Walkenhorst, Michael Schilling, Simone Herth, Andreas Hütten, and Günter Reiss — Bielefeld University, Department of physics, Thin Films & Nanostructures, P.O. Box 100 131, 33501 Bielefeld, Germany

Signal enhancement was so far necessary for detection of single magnetic markers using magnetoresistive sensors. Detection without signal enhancement on basis of a magnetic tunnel junction (MTJ) would be an important feature for miniaturization and for applications as biosensors. Attempts based on conventional MTJs with AlOx and out-of-plane saturation of superparamagnetic beads were done. TMR measurements with and without beads on top of a sensor, alternatively saturated or not were compared. With Helmholtz-coils a shifted and narrow hysteresis is possible, whereas permanent magnets seem to be not applicable due to a very inhomogeneous field in this setup.

Elements are expected to have a hysteresis-free switching due to a perpendicular pinning. For MgO based sensors perpendicular pinning has been established via shape anisotropy. Arrays containing thousands of (sub-)micron elements were structured by electron beam lithography and ion beam etching. Measurements using the magneto optical Kerr-effect show a hysteresis free signal for low magnetic fields.

MA 15.146 Tue 15:00 Poster A

Spin-wave theory for magnetic molecules — •Roman Schnalle[1] and Jürgen Schnack[2] — [1]Universität Osnabrück, Fachbereich Physik, D-49069 Osnabrück — [2]Universität Bielefeld, Fakultät für Physik, PF 100131, D-33501 Bielefeld

Unfortunately exact diagonalization of the Heisenberg Hamiltonian of some molecular systems like the famous $\{Mo_{72}Fe_{30}\}$ is limited by the huge size of the related Hilbert space that quickly grows with system size. Following Takahashi [1] finite-size spin-wave theory seems to be appropriate to access low-temperature properties of huge magnetic molecules. By comparing results calculated by spin-wave theory with results obtained from exact diagonalization it is investigated whether spin-wave theory is able to give reliable information about magnetic and thermodynamic properties of molecular systems. Within this theory rotational invariance of the participating spins is restored by the introduction of a set of Lagrange-multipliers. Then the modified Hamiltonian is diagonalized numerically. The energy spectra and the low-temperature thermodynamics are calculated and compared with results from exact diagonalization for quasi-onedimensional Neél-like systems, namely spin rings, and a frustrated system, where twelve spins occupy the vertices of a cuboctahedron.

[1] M. Takahashi, Phys. Rev. B 40, 2494 (1989)

MA 15.147 Tue 15:00 Poster A

Magnetic properties of homo- $[Ni(II)_4]$ and heterotetranuclear $[Fe(III)_2Cu(II)_2]$ high-spin molecular complexes — •Christian Golze[1], Rüdiger Klingeler[1,2], Bernd Büchner[1], Vladislav Kataev[1], Michel Goiran[2], Jean M. Broto[2], Harison Rakoto[2], Berthold Kersting[3], and Phalguni Chaudhuri[4] — [1]IFW Dresden, Germany — [2]LNCMP Toulouse, France — [3]Institute for Anorganic Chemistry, University of Leipzig, Germany — [4]MPI for Bioinorganic Chemistry Mülheim, Germany

HF ESR and magnetization data of new multicenter complexes are presented. In compound **(1)** two Ni ions are coupled to a dimer via a diaminthio-bridge, and a pair of dimers is coupled in a single molecule via a $\mu_{1,3}$ azide bridge. Thus a single molecule spin cluster of a quadrangular shape comprising four Ni(II) (each $S = 1$) is formed. The magnetically active fragments Fe_2Cu_2 of **(2)** form the so-called *butterfly*-motive. The intramolecular exchange paths between Fe(III) and Cu(II) are provided by OH-, ON-, and O-bridges and yield competing FM and AFM exchange interactions. Both complexes exhibit magnetic ground states which have been characterized by magnetization measurements in fields < 52 T. ESR has been measured on the polycrystalline samples of **(1)** and **(2)** to determine the zero field splittings of the spin-levels and the g-factors. While the crystallites of **(1)** could be oriented in high fields yielding the possibility to compare experimental quasi single-crystal and powder-averaged ESR data with the theoretical model, the appearence of the low temperature spectra of **(2)** is of unexpected symmetric step-like shape.

MA 15.148 Tue 15:00 Poster A

Inelastic neutron scattering studies of two Mn(III)-based Single Molecule Magnets — •Oliver Pieper[1,2], Joris van Slageren[3], Tatiana Guidi[1], Bella Lake[1,2], Hannu Mutka[4], Margarita Russina[1], Alexander Schnegg[1], Alexandra Buchsteiner[1], Constantinos J. Milios[5], Euan K. Brechin[5], and Anna Julia[6] — [1]Hahn-Meitner Institut, Glienicker Straße 100, 14109 Berlin — [2]Technische Universität Berlin, Institut für Festkörperphysik, Hardenbergstraße 36, 10623 Berlin — [3]Universität Stuttgart, Pfaffenwaldring 57, 70550 Stuttgart — [4]Institut Laue-Langevin, 6, rue Jules Horowitz, BP 156 - 38042 Grenoble Cedex 9 - France — [5]School of Chemistry, The University of Edinburgh, West Mains Road, UK — [6]UBX Laboratory, Universitat de Barcelona, Spain

Recently, two new SMMs has been synthesised, with similar magnetic structures consisting of six Mn(III)-ions. While one of them contains two antiferromagnetically coupled triangles leading to a S=4 ground state and giving rise to frustration effects, the other consists of six ferromagnetically coupled ions leading to a S=12 ground state and a high anisotropy barrier.

Here we present recently performed inelastic neutron scattering measurements that allowed us to observe magnetic excitations within the anisotropy split ground state multiplet. In addition a number of excitations to lower lying multiplets with different total S have been found. We will discuss the energy level diagram and its relevance to quantum tunnelling in these molecules.

MA 15.149 Tue 15:00 Poster A

Magnetism of the single molecule magnet system $[(Mn^{II}L_2)_3Mn^{II}](BF_4)_2$ — •Manuel Prinz[1], Sebastian Voget[1], Niklas Damnik[1], Michael Raekers[1], Karsten Kuepper[2], Phalguni Chaudhuri[3], Simon George[4], Marin Coldea[5], and Manfred Neumann[1] — [1]Universität Osnabrück, Fachbereich Physik, Barbarastr. 7, D-49069 Osnabrück — [2]Forschungszentrum Rossendorf, Nanofunktionsschichten, Postfach 510119, D-01314 Dresden — [3]MPI für Bioanorganische Chemie, PO Box 101365, D-45413 Mülheim an der Ruhr — [4]Lawrence Berkeley National Laboratory, Advanced Biological and Environmental X-ray Facility, Berkeley, CA 94720, USA — [5]Faculty of Physics, Babeş-Bolyai University, RO-400084, Cluj-Napoca

The single molecule magnet system $[(Mn^{II}L_2)_3Mn^{II}](BF_4)_2$ containing four Mn^{2+} ions has been studied using X-ray photoelectron spectroscopy (XPS), X-ray absorption spectroscopy, and X-ray magnetic circular dichroism (XMCD). The XPS Mn 2p and Mn 3s spectra confirm the manganese 2+ valency. From XMCD measurements at a temperature of $T = 2$ K and a magnetic field of $B = 5$ T we obtained a high magnetic moment of 12 μ_B/f.u. This spin moment agrees in an excellent way with magnetic measurements which show a magnetization saturation of 10 μ_B/f.u. at 7 T and 2 K. From XMCD a quenching of the Mn orbital moments was observed ($m_{\mathrm{orb}} = 0.4$ μ_B/f.u.).

MA 15.150 Tue 15:00 Poster A

Molecular magnetism of metallo-supramolecular hierarchically ordered materials consisting of mixtures from different transition metal ions — •M. Lommel[1], U. Pietsch[1], G. Schwarz[2], D. G. Kurth[2], Y. Bodenthin[3], W. Haase[4], and Z. Tomkowicz[5] — [1]Institute of Physics, University of Siegen, Walter-Flex-Str 3, 57078 Siegen, Germany — [2]Max Planck Institute of Colloids and Interfaces, 14424 Potsdam, Germany — [3]Swiss Light Source, Paul Scherrer Institute, CH-5232 Villigen PSI, Switzerland — [4]Institute of Physical Chemistry, Petersenstrasse 20, 64287 Darmstadt — [5]Institute of Physics, Jagellonian University, Reymonta 4, 30-059 Kraków, Poland

We use metallo-supramolecular mesophases consisting of periodic arrangements of transition metal ions tightly coupled through ditopic bis-terpyridine-ligands and embedded in an amphiphilic mesophase called polyelectrolyt-amphiphile-complex. The materials made by self-

assembly of transition metal ions, ligands and amphiphilic molecules. We used temperature induced structural changes of an amphiphilic phase to deliberately manipulate the magnetic properties of tightly coupled metal ion coordination centers. Consequently, the energetic separation of the metal centered orbitals (crystal field) can change giving rise to a spin crossover. In our systems the spin-crossover is driven by the induced structural change of surrounding nitrogen-atoms around the ions. We have investigated different types of metallo-supramolecular complexes with mixtures of transition metal ions. We found that several parameters being characteristic for the spincrossover are changing non-linear as a function of the concentration of metal ions.

MA 15.151 Tue 15:00 Poster A

Magnetic and electronic properties of the transition metal containing polyoxotungstate — •Niklas Damnik[1], Manuel Prinz[1], Albert Takács[4], Jürgen Schnack[1], Ulrich Kortz[2], Istvan Balasz[3], Emil Burzo[3], and Manfred Neumann[1] — [1]Department of Physics, University of Osnabrück, Barbarastraße 7, D-49069 Osnabrück — [2]International University Bremen, P.O. Box 750561, D-28725 Bremen — [3]Faculty of Physics, Babes-Bolyai University, RO-400084, Cluj-Napoca — [4]Physikalisches Institut, Universität Karlsruhe, Wolfgang-Gaede-Straße 1, D-76131 Karlsruhe

New materials based on polyoxometalates (metal-oxygen clusters) are promising stages of development in nano/micro electronic applications that can lead to the emergence of a new technology. Together with X-ray photoelectron spectroscopic (XPS) studies on dimeric Ni-substituted β-Keggin polyoxotungstates $K_{12}[\{\beta\text{-}GeNi_2W_{10}O_{36}(OH)_2(H_2O)\}_2]\cdot 20\ H_2O$ and $K_{12}[\{\beta\text{-}SiNi_2W_{10}O_{36}(OH)_2(H_2O)\}_2]\cdot 20\ H_2O$ magnetic and XPS measurements on the transition metal substituted, dimeric polyoxotungstate $[Fe_4(H_2O)_{10}(\beta\text{-}SbW_9O_{33})_2]^{6-}$ are reported. Magnetic measurements of the salt $Cs_6[Fe_4(H_2O)_{10}(\beta\text{-}SbW_9O_{33})_2]$, containing Fe^{3+} ions, show a magnetization of approximately 10 μ_B/f.u. at T = 4.2 K and B = 9 T without saturation and were analysed by using an isotropic Heisenberg Hamiltonian. The ground state of the frustrated molecule has a total spin of S = 2. The XPS Fe 2p spectra suggest a 2+ formal valence state indicating that charge-transfer effects are involved.

MA 15.152 Tue 15:00 Poster A

EPR and magnetic susceptibility investigations on Cu(II)-bis(oxamato) complexes — •Björn Bräuer[1], Tobias Rüffer[1], Dietrich Zahn[1], Georgeta Salvan[1], Dante Gatteschi[2], Andrea Caneschi[2], Maria Fittipaldi[2], and Federico Totti[2] — [1]Chemnitz University of Technology, Faculty of Natural Sciences, Reichenhainer Straße 70, 09126 Chemnitz, Germany — [2]University of Florence, Department of Chemistry, Via della Lastruccia 3, 50019 Florence, Italy

Cu(II)-bis(oxamato) complexes are prominent representatives for basic research studies of magnetic exchange phenomena with square planar coordination geometry [1]. In order to study the influence of the deviations from square planar coordination geometry on the spin density determined by electron paramagnetic resonance (EPR), we have synthesized a ligand with a N2O2 donor set providing distortion from a square planar geometry due to steric reasons. The magnetic coupling constant J of tri-nuclear Cu(II)-bis(oxamato) complexes was determined from magnetic susceptibility measurements using superconducting quantum interference device (SQUID) magnetometer. The superexchange interactions between the Cu(II) ions were found to be antiferromagnetic and to vary significantly with the coordination geometry. The trends were reinforced by density functional theory (DFT) studies. [1] O. Kahn, Molecular Magnetism, VCH Weinheim, 1993.

MA 15.153 Tue 15:00 Poster A

Characterization of Magnetic Structure in NiMnGa Alloys by Means of Lorentz Electron Microscopy and Electron Holography — •Karin Vogel[1], Dorin Geiger[1], Hannes Lichte[1], Werner Skrotzki[1], Robert Chulist[1], Uwe Gaitzsch[2], Martin Pötschke[2], Stefan Roth[2], and Andrea Böhm[3] — [1]Institute for Structure Physics, TU Dresden, 01062 Dresden — [2]IFW Dresden, P.O. Box 270116, 01171 Dresden — [3]Fraunhofer IWU, 01187 Dresden

The magnetic field induced strain (MFIS) in NiMnGa alloys is based on easy motion of twin boundaries. Therefore, it is necessary to understand the influence of microstructural parameters on twin boundary motion. We investigate microstructure and magnetic structure of martensitic NiMnGa alloys by conventional transmission electron microscopy (TEM) and Lorentz TEM, as well as electron holography (EH). TEM offers characterization of nano-features like twin boundaries, grain boundaries, precipitates, etc.; Lorentz TEM allows analysing the coarse magnetic structure, e.g. magnetic domain boundaries; EH is used to determine the fine-scale distribution of magnetization, e.g. inside the domains. We use a Philips CM200 TEM equipped with a Lorentz lens and an electron biprism. The conventional in-focus TEM images show the twin-band structure of the martensitic material. From the Lorentz images, the correlation of magnetic domains with the twin band structure both in domain size and orientation follows. In the EH phase images, lines of equal phase display the 3D magnetization distribution projected into the recording plane. Financial support from DFG-SPP 1239 is gratefully acknowledged.

MA 15.154 Tue 15:00 Poster A

Phenomenological models for magnetic shape memory materials — •Ulrich K. Rössler[1], Nicloai S. Kiselev[2], Igor E. Dragunov[1,2], and Alexei N. Bogdanov[1,2] — [1]IFW Dresden — [2]Donetsk Institute for Physics and Technology

A phenomenological theory for magnetic shape-memory effects [1] for twinned ferromagnetic martensites with tetragonal lattice structure is described and extended. The theory couples micromagnetic continuum theory for magnetization distribution and linear elasticity in the twin variants. Magnetization processes under external stress and magnetic fields can be analysed based on phase diagrams from the phase-theory approximation that is applicable for volume systems. Generalizations allow (i) to introduce 180-degree magnetic domain structures within the twin variants and (ii) rotation of magnetic moments within magnetic domains in case of relatively weak magnetic anisotropies. Hysteretic processes can be described by an effective relaxation equation, which accounts for a thermally activated twin boundary motion. Geometrical domain models with 90-degree magnetization stripe structure allow to derive characteristic lengths of thermodynamically stable coupled multidomain structures applicable to twinned platelets or thin films with two homogeneously magnetized variants. The application of the theory for (textured) polycrystalline materials through an effective (mean-field) coupling in an assembly of variously oriented single-crystals is demonstrated.

[1] U. K. Rößler, A. N. Bogdanov, A. DeSimone, S. Müller, U. K. Rößler, J. Magn. Magn. Mater. (2002).

MA 15.155 Tue 15:00 Poster A

MBE-thin film growth of NiMn-based magnetic shape memory alloys — •Ralf Hassdorf[1,3], Jürgen Feydt[2], and Michael Moske[1] — [1]Thin adaptive films, Research center caesar, 53175 Bonn — [2]Electron microscopy, Research center caesar — [3]Institute of Condensed Matter Physics, TU Braunschweig, 38106 Braunschweig

In a previous study, we reported on (111) highly oriented Ni-Mn-Al grown films, deposited on amorphous thermal SiO_2. TEM images revealed the occurrence of modulated martensitic structures, more precisely a striped morphology of 2M and 14M within the single grains [1]. By varying the film composition the austenite/martensite transition boundary was experimentally obtained, in accordance with e/a-dependency predictions. In a theoretical approach, using *ab initio* calculations, we confirmed that in the system Ni-Mn-Al the cubic $L2_1$ Heusler structure is unstable against shear displacement along the [110] direction which promotes lattice modulation [2].

Here, we report on single-crystal films grown on several different single crystalline substrates with different orientations, *i.e.*, on MgO (001), α-Al_2O_3 (0001) and (11-20) as well as on GaAs (001). For the latter, specifically, Ga is incorporated into the film structure almost homogeneously arising from a solid state reaction at the film-substrate interface. This opens up the possibility for exploring compositions with an isoelectronic substitution, here, Al *vs* Ga. The compositional and microstructural aspects will be discussed.

[1] R. Hassdorf *et al.*, Mater. Res. Soc. Symp. Proc. 785, 57 (2004).

[2] T. Büsgen *et al.*, Phys. Rev. B 70, 014111 (2004).

MA 15.156 Tue 15:00 Poster A

Towards phase-field modelling of magnetically induced microstructure evolution Towards phase-field modelling of *magnetically induced microstructure evolution — •Britta Nestler — Institute for Computational Engineering, Karlsruhe University of Applied Sciences, Karlsruhe, Germany

The magnetomechanical responses of magnetic shape memory (MSM) alloys to external magnetic fields are correlated with the coupled magneto-elastic domain structure evolutions in these materials. Hence, the kinetic pathways of the domain evolutions play a key role in determining the materials properties. Mesoscopic simulations based on

phase-field modelling can provide valuable information to understand the dynamic processes and main quantities affecting the MSM effect. A phase-field model for polycrystals is presented and simulation results of three dimensional grain structures are shown. To consider effects of an external magnetic field the model formulation has to be modified by including elastic, magnetic and elastomagnetic free energy contributions and different martensitic crystal structures.