

MA 20 Poster: Schichten(1-29), Spintrsp(30-45), Ex-Bias(46-63), Spindyn(64-75), Mikromat.(76-80), Cluster(81-94), Abbv.(95-99), Obflm(100-02), SpElek.(103-09), E-Theo(110-14), Mikromag.(115-16), Spin+PÜ(117-26), Mag.Mat.(127-51), Meth.(152-55), Mol.Mag(156-59), Kondo(160-65)

Zeit: Montag 14:00–18:00

Raum: Poster TU C

MA 20.1 Mo 14:00 Poster TU C

Pulsed laser deposition of electron-doped $\text{La}_{1-x}\text{Ce}_x\text{CoO}_3$ thin films — ●DIRK FUCHS¹, PETER ADELMANN¹, PETER SCHWEISS¹, THORSTEN SCHWARZ^{1,2}, and RUDOLF SCHNEIDER¹ — ¹Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe, Germany — ²Universität Karlsruhe, Fakultät für Physik, D-76128 Karlsruhe, Germany

The electron doping of LaCoO_3 perovskites with the substitution of trivalent La^{3+} by tetravalent Ce^{4+} ions is usually strongly limited by the small solubility of Ce under standard conditions. With thin film preparation we succeeded in the growth of highly cerium-doped thin films. $\text{La}_{1-x}\text{Ce}_x\text{CoO}_3$ (LCCO) thin films, with $0.1 \leq x \leq 0.5$, were deposited by laser ablation using a KrF excimer laser. The deposition was carried out from polycrystalline LCCO targets prepared by the sol-gel route and standard solid state reaction. The film growth was studied as a function of the substrate temperature and material, laser energy and oxygen partial pressure. The films were optimised with respect to crystalline quality. The magnetic and electric properties of the samples were characterized by magnetization and resistivity measurements.

MA 20.2 Mo 14:00 Poster TU C

Unusual finite-size scaling behavior of $\text{La}_{0.7}\text{Sr}_{0.3}\text{CoO}_3$ thin films — ●THORSTEN SCHWARZ^{1,2}, DIRK FUCHS¹, PETER SCHWEISS¹, and RUDOLF SCHNEIDER¹ — ¹Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe — ²Universität Karlsruhe, Fakultät für Physik, D-76128 Karlsruhe

$\text{La}_{0.7}\text{Sr}_{0.3}\text{CoO}_3$ thin films were prepared by pulsed laser deposition on (001) oriented $(\text{LaAlO}_3)_{0.3}(\text{Sr}_2\text{AlTaO}_8)_{0.7}$ substrates with different film thickness, $400 \text{ nm} > d \geq 2.6 \text{ nm}$, and optimized with respect to their structural and magnetic properties. We carried out X-ray diffraction, transmission electron microscopy, Rutherford-backscattering spectrometry and energy dispersive X-ray absorption analysis in order to check the structural quality and chemical composition of the samples. The magnetic and electric properties were characterized by dc-SQUID and transport measurements, respectively. The microstructure and film magnetization seem to be homogeneous over the whole film thickness. Impurities or precipitations could not be observed. The decrease of the magnetic ordering temperature, T_C , with decreasing d , reflects finite-size effects with a critical scaling exponent of $\lambda \approx 1$, which is usually only expected for the 2 dimensional Ising model. Nearly the same scaling behavior was obtained for $\text{La}_{0.7}\text{Ca}_{0.3}\text{CoO}_3$ and $\text{La}_{0.7}\text{Ba}_{0.3}\text{CoO}_3$ thin films.

MA 20.3 Mo 14:00 Poster TU C

La-doping in epitaxial thin films of $\text{La}_x\text{Sr}_{2-x}\text{CrWO}_6$ — ●ROBERT GEISSLER, PETRA MAJEWSKI, STEPHAN GEPRÄGS, ANDREA BOGER, ANDREAS ERB, MATTHIAS OPEL, LAMBERT ALFF, and RUDOLF GROSS — Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Walther-Meißner-Str. 8, 85748 Garching

Ferromagnetic double perovskites show high Curie temperatures T_C up to 600 K. For the system $\text{Sr}_2\text{FeMoO}_6$ ($T_C \approx 420 \text{ K}$), it was shown that electron doping via the substitution of Sr^{2+} by La^{3+} increases T_C by about 80 K in polycrystalline samples [1]. For Sr_2CrWO_6 , the synthesis of bulk samples of electron doped $\text{La}_x\text{Sr}_{2-x}\text{CrWO}_6$ is difficult because of the preferential formation of LaCrO_3 . However, due to the non-equilibrium growth conditions in pulsed laser deposition (PLD), $\text{La}_x\text{Sr}_{2-x}\text{CrWO}_6$ with $x = 0.5$ could be grown epitaxially on SrTiO_3 substrates with good crystalline quality [2]. Here we report on the properties of $\text{La}_x\text{Sr}_{2-x}\text{CrWO}_6$ films with various doping concentrations x . Using in-situ RHEED, the layer-by-layer growth mode is confirmed. The epitaxial thin films are analyzed by HRXRD to examine the crystalline quality and to exclude parasitic phases. A systematic increase of the c -axis with increasing doping has been found. The magnetic properties have been measured up to 800 K using a SQUID magnetometer to determine the doping dependence of the Curie temperature $T_C(x)$.

This work is supported by the BMBF via grant no. 13N8279.

[1] C. Frontera *et al.*, Phys. Rev. B **68**, 012412 (2003).

[2] P. Majewski *et al.*, J. Magn. Magn. Mater., in print (2004).

MA 20.4 Mo 14:00 Poster TU C

Anisotropic Current-Voltage Characteristics of Strained Sr_2CrWO_6 Thin Films — ●ANDREA BOGER, PETRA MAJEWSKI, STEPHAN GEPRÄGS, ANDREAS ERB, MATTHIAS OPEL, LAMBERT ALFF, and RUDOLF GROSS — Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Walther-Meißner-Str. 8, 85748 Garching

It was predicted that the electrical conductivity of the ferromagnetic double perovskite $\text{Sr}_2\text{FeMoO}_6$ (space group $4I/mmm$, $T_C \approx 420 \text{ K}$) is intrinsically two-dimensional due to the symmetry of the involved oxygen orbitals and can be varied by pressure [1]. The related material Sr_2CrWO_6 ($Fm\bar{3}m$, $T_C \approx 460 \text{ K}$) has similar electronic structure. We have prepared coherently strained thin films of Sr_2CrWO_6 in an UHV-system by pulsed laser deposition (PLD). Due to the small but finite lattice mismatch to the substrate (SrTiO_3) the films grow in $4I/mmm$ -symmetry. The electrical transport properties of Sr_2CrWO_6 can be studied by introducing a thin, insulating NdGaO_3 buffer layer between the substrate and the double perovskite. High-resolution four circle X-ray diffractometry shows a FWHM below 0.04° for the rocking curves of the (004)-film peaks. Electrical transport measurements were performed in and out of plane from 25 K to 300 K. We detect a strong *anisotropic* behavior in the current-voltage characteristics (IVC): while the in-plane IVCs are ohmic over the whole temperature range, the c -axis transport shows a pronounced non-linear behavior.

This work is supported by the BMBF via grant no. 13N8279.

[1] P. Petrone *et al.*, Phys. Rev. B **66**, 104418 (2002).

MA 20.5 Mo 14:00 Poster TU C

Influence of a forming gas atmosphere on the properties of laser deposited FePt thin films — ●ROBERT MAASS, MARTIN WEISHEIT, SEBASTIAN FÄHLER, and LUDWIG SCHULTZ — Institut für Metallische Werkstoffe, IFW Dresden, Helmholtzstr. 20, 01069 Dresden

The FePt L1_0 phase is one of the most promising candidates for future perpendicular high density magnetic recording media. However, high temperatures are required for a well ordered structure, around 800°C for laser deposited films [1]. Lowering the ordering temperature is therefore of great interest. Recent work on electrodeposited FePt thin films has shown that a hydrogen atmosphere during post annealing strongly enhances the ordering of the FePt L1_0 phase [2]. We report on the influence of forming gas (5% H_2 in Ar) on the ordering temperature of L1_0 FePt alloy films prepared by pulsed laser deposition onto single crystal MgO substrates. Pressure and temperature dependent changes in microstructure, crystallographic texture and resulting magnetic properties are discussed.

[1] M. Weisheit, L. Schultz, and S. Fähler, J. Appl. Phys. **95** (2004) 7489

[2] K. Leistner, H. Schlörb, M. Weisheit, L. Schultz, and S. Fähler, Appl. Phys. Lett. **85** (2004) 3498

MA 20.6 Mo 14:00 Poster TU C

Rapid Thermal Annealing of FePt thin films — ●JÖRG BUSCHBECK, MARTIN WEISHEIT, SEBASTIAN FÄHLER, and LUDWIG SCHULTZ — IFW Dresden, Institut für Metallische Werkstoffe, Helmholtzstr. 20, 01069 Dresden

The outstanding intrinsic magnetic properties of the FePt L1_0 phase make this material a promising candidate for thin film applications. However, the high temperature required to form the L1_0 phase is a major disadvantage. One overcomes this problem by using thin films, as they allow for rapid heating and cooling without significantly heating the substrate. Such a rapid temperature change can be realized by the application of a pulsed excimer laser (KrF, 248 nm, 25 ns) post-annealing process on films deposited at room temperature. Because of the extremely short heat pulse in the range of μs and the small absorption length of less than 50 nm in the film, the substrate temperature can be kept at ambient temperature during the annealing process. Electrodeposited and pulse-laser deposited FePt films of 700 nm and 40 nm in thickness, respectively,

were pulse-heated by the excimer laser. Phase formation and magnetization behavior were studied as a function of laser energy, pulse number, and substrate base temperature.

MA 20.7 Mo 14:00 Poster TU C

Micromagnetic properties of MnAs films on GaAs (001) studied by variable temperature and field MFM — ●JYOTI MOHANTY, THORSTEN HESJEDAL, LUTZ DÄWERITZ, and KLAUS H. PLOOG — Paul Drude Institute, Hausvogteiplatz 5-7, 10117 Berlin, Germany

MnAs on GaAs(001) is a hybrid ferromagnet-semiconductor system that shows a first order magneto-structural phase transition that proceeds via a continuous variation of the phase ratio over a temperature range of 10-40°C. The coexisting phases, namely hexagonal, ferromagnetic α -MnAs and orthorhombic, paramagnetic β -MnAs form a periodic stripe structure, oriented along the MnAs[0001] direction. The system exhibits a strong in-plane uniaxial anisotropy. Magnetic force microscopy (MFM) images show a variety of domain configurations in the demagnetized state of the film. The domain structures and their dependence on the ferromagnetic stripe width (temperature dependence), stripe period (film thickness), and inter-stripe coupling distance were studied. Employing an external field, further insight into the coupling between the stripes and the magnetization reversal process was gained.

MA 20.8 Mo 14:00 Poster TU C

Temperature dependence of the magnetization in ultrathin epitaxial FeCo layers with vanishing crystal anisotropy — ●MATTHIAS SPERL, WOLFGANG KIPFERL, MARTIN DUMM and GÜNTHER BAYREUTHER — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, 93040 Regensburg

Epitaxial ultrathin Fe_xCo_{1-x} (001) layers were grown with molecular beam epitaxy on Au(001) surfaces. The alloy composition was chosen in the range of the composition dependent in-plane reorientation transition at about 30% Co [1]. Epitaxial growth was achieved by using an Fe seed layer and Au buffer layer on GaAs(001). Epitaxial quality and surface structure were verified in-situ by RHEED. The magnetic properties were investigated by MOKE and SQUID magnetometry between 10 and 400 K. All films show a reduced four-fold anisotropy compared to Fe layers on Au(001) at room temperature and a negligible uniaxial in-plane anisotropy. The samples were studied with respect to the critical behavior at the phase transition and thermal excitations due to spinwaves. This allows the determination of the influence of a reduced in-plane anisotropy on the temperature dependence of the spontaneous magnetization M_S which is discussed in connection with the increased exchange interaction of the used FeCo alloy compared to Fe.

[1] G. Bayreuther et. al., J. Appl. Phys. 93, 8230 (2003)

MA 20.9 Mo 14:00 Poster TU C

Magnetic saturation and anisotropy in FeCo alloy films grown on Pd(001) — ●A. WINKELMANN, M. PRZYBYLSKI, Y. SHI, J. BARTHEL, and J. KIRSCHNER — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle

Theoretical first-principles calculations for tetragonally distorted Fe_xCo_{1-x} alloys predict a high saturation magnetization and a high uniaxial magnetic anisotropy energy at specific values of the lattice distortion c/a and alloy composition x [1]. An unusually large magnetic anisotropy energy is expected for the $Fe_{40}Co_{60}$ alloy at a c/a ratio of about 1.2. Comparable tetragonal distortions in Fe and Co films have been observed on Pd(001). This suggests the deposition of Fe_xCo_{1-x} alloy films on Pd(001) by molecular beam epitaxy.

For $Fe_{40}Co_{60}$ at a film thickness of 3 monolayers (ML), scanning tunneling microscopy shows rough film surfaces. This is due to a structural transition caused by the large lattice misfit between the Pd substrate and the alloy film. Intensity oscillations in reflection high energy electron diffraction indicate a change in the growth mode after 2 ML of $Fe_{40}Co_{60}$. Low energy electron diffraction (LEED) patterns confirm a pseudomorphic growth of the $Fe_{40}Co_{60}$ film. Measurements of energy resolved LEED intensities point to the existence of a tetragonal distortion perpendicular to the film plane. Hysteresis loops were taken using the magneto-optical Kerr effect (MOKE). The results of the MOKE analysis are discussed in comparison to the results obtained for the Fe/Pd(001) and Co/Pd(001) systems.

[1] T. Burkert et al., Phys. Rev. Lett. 93, 027203 (2004)

MA 20.10 Mo 14:00 Poster TU C

On origin of perpendicular anisotropy in Co/Pd(111) system — ●J. ZUKROWSKI, M. PRZYBYLSKI, M. WASNIOWSKA, W. WULFHEKEL, J. BARTHEL, and J. KIRSCHNER — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle

Ultrathin Co films were grown on clean and atomically flat surfaces of Pd(111). Scanning tunneling microscopy (STM) measurements show that at room temperature (RT) the growth starts by a formation of double-layer patches. This is very different in comparison to the initial monolayer formation during the growth at 420 K. The films deposited at RT exhibit perpendicular magnetic anisotropy after exposure to a residual atmosphere for a long time at low temperatures (70 K). Our detailed magneto-optical Kerr effect (MOKE) analysis documents step by step an appearance of the perpendicular anisotropy and indicates a rotation of the magnetization vector from the sample plane. With increasing temperature the magnetization rotates back to the sample plane abruptly when the temperature approaches 200 K. For the growth at 420 K the STM images show that the film morphology is drastically changed. This is associated with changes of the magnetic properties detected by MOKE. In particular, the Kerr rotation loops measured in polar configuration change sign at a critical thickness of the Co film.

MA 20.11 Mo 14:00 Poster TU C

On the origin of perpendicular anisotropy in Co/Pd(111) — ●J. ZUKROWSKI, M. PRZYBYLSKI, M. WASNIOWSKA, W. WULFHEKEL, J. BARTHEL, and J. KIRSCHNER — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle

Ultrathin Co films were grown on clean and atomically flat surfaces of Pd(111). Scanning tunneling microscopy (STM) shows that at 300 K the growth starts by the formation of double-layer patches. This is very different in comparison to the initial monolayer formation during the growth at 420 K. The films deposited at 300 K exhibit perpendicular magnetic anisotropy after exposure to the residual atmosphere at low temperatures (70 K). Our detailed magneto-optical Kerr effect (MOKE) analysis documents step by step the appearance of the perpendicular anisotropy and indicates a rotation of the magnetization vector out of the sample plane. With increasing temperature the magnetization rotates back to the plane abruptly when the temperature approaches 200 K. For the growth at 420 K the STM images show that the film morphology is drastically changed. This is associated with changes of the magnetic properties detected by MOKE. In particular, the Kerr rotation loops measured in polar configuration change sign at a critical thickness of the Co film.

MA 20.12 Mo 14:00 Poster TU C

Strukturelle und magnetische Charakterisierung von Fe-Strukturen auf InAs(001) und GaAs(110)-Spaltflächen — ●MATTHIAS HAAK¹, D. YOU², C. URBAN¹, M. KNEPPE¹, I. RAUSCHENBACH¹, H. STEIN¹, U. KÖHLER¹, D. SPODDIG², R. MECKENSTOCK² und J. PELZL² — ¹Experimentalphysik IV/Oberflächenphysik — ²Experimentalphysik III/Festkörperspektroskopie

Zur Untersuchung des Raumtemperaturwachstums dünner Fe-Schichten auf InAs(001)-, bzw. GaAs(110)-Spaltflächen unter UHV-Bedingungen wurden in-situ STM- und ex-situ MOKE-, SQUID- und FMR-Experimente eingesetzt. Spaltflächen wurden verwendet, um eine Oberfläche mit möglichst hoher Reinheit und geringer Stufung zu erreichen. Diese Spaltflächen wurden innerhalb der UHV-Kammer hergestellt. Epitaktisches Fe-Wachstum ist sowohl auf InAs- als auch auf GaAs-Substraten bei Raumtemperatur mittels STM zu erkennen. Das initiale Wachstum und die Nukleation der Fe-Schichten konnte im Submonolagenbereich untersucht werden. Zur ex-situ magnetischen Charakterisierung wurden die Fe-Filme mit einer Ag/Au Schicht als Oxidationsschutz abgedeckt. Durch MOKE-Messungen konnte die schichtdickenabhängige Remanenz bestimmt werden. Mittels SQUID und FMR wurden die Sättigungsmagnetisierungen und die Anisotropiebeiträge exakt ermittelt. Der Einfluß des Wachstums auf das magnetische Verhalten wird diskutiert. Weiterhin waren die Einflüsse von Tunnelbarrieren (z.B. MgO) Gegenstand unserer Untersuchung. Erste Ergebnisse werden vorgestellt. Unterstützt durch SFB 491.

MA 20.13 Mo 14:00 Poster TU C

Digital Lock-In XMCD-experiments with a quarter wave plate — ●MAX HARLANDER, JOCHEN GEISLER, EBERHARD GOERING, UWE GRÜNER, SEBASTIAN MACKE und GISELA SCHÜTZ — Max-Planck-Institut für Metallforschung, 70569 Stuttgart

We have developed an ultra low noise digital lock in technique, utilizing a diamond single crystal quarter wave plate. At the ANKA MPG diffraction beamline we have achieved a degree of circular polarisation above 85%. The diamond quarter wave plate is controlled and flipped with a square wave shaped modulation, with a ground frequency up to 80Hz, by a positionally controlled piezo element. The related right and left polarised light absorption of the magnetized sample has been measured and recorded by an a/d-signal converting PC card. The sampled signals are numerically evaluated and analysed to obtain a digital lock-in-XMCD signal. FePt alloy measurements are in perfect agreement with conventional XMCD measurements. To demonstrate the capability of this method, XMCD and XAS spectra of an effective very small PtCo single crystal are shown. This improved method achieves a signal to noise ratio at the level of the pure photon statistics. Our system is portable and allows measurement at virtually any synchrotron radiation source.

MA 20.14 Mo 14:00 Poster TU C

Advanced fitting algorithm for resonant magnetic and non magnetic soft and hard X-ray reflectometry simulations — ●MAX HARLANDER, JOCHEN GEISLER, EBERHARD GOERING, UWE GRÜNER, SEBASTIAN MACKE, and GISELA SCHÜTZ — Max-Planck-Institut für Metallforschung, 70569 Stuttgart

We developed a new fit program to simulate and fit the reflectivity of multilayer systems, based upon a modified Parratt-formalism. Conventional Parratt programs allow simulations and fits of the reflectivity of magnetic and non magnetic multilayers, where the reflection curves depend on the thickness, roughness and non resonant and resonant optical constants (δ and β) of the layered system. With the advanced algorithm, even for single buried layers the resulting resonant and element specific asymmetry ratios for reversed magnetization directions could be fitted and optimized. The resonant magnetic scattering has been introduced by superposed magneto optical profiles, which are approximated by Gaussian lines and/or splines at each individual interface. Some additional aspects have been introduced to improve the fit quality beyond the small angle scattering limit, even for large scattering angles as observed in the soft X-ray region. The π - and σ components and the degree of circular polarization of the incident X-Ray beam could be taken into account and independently chosen. The major improvement is related to the fitting speed. After a careful optimization, the magnetic fitting is roughly 300 times faster than the previous implementation. In addition, a simulated annealing algorithm has been integrated to avoid local minima convergence.

MA 20.15 Mo 14:00 Poster TU C

Spectroscopy of unoccupied states and spin-depolarization dynamics of materials with a high spin-polarization — ●M. CINCHETTI, O. ANDREYEV, M. SÁNCHEZ-ALBANEDA, P. WÜSTENBERG, M. BAUER, and M. AESCHLIMANN — Universität Kaiserslautern

Half-metallic ferromagnetic Heusler alloys have been studied with two-photon photoemission (2PPE) spectroscopy. First spin-resolved measurements have been performed in order to investigate the behaviour of the surface spin polarization and its dependence on the surface preparation procedure. They show that significant changes occur in the spin polarization depending on the surface preparation. Moreover, the spin-dependent energy relaxation of excited electrons is under study using a pump-probe technique (time-resolved 2PPE). The obtained results give insight into the fundamental mechanisms of spin depolarization at the surface of half-metallic ferromagnets.

Funded by DFG: FOR 559/1

MA 20.16 Mo 14:00 Poster TU C

Core-valence interactions in 2p photoemission of 3d metals - a study of magnetic dichroism in spinresolved photoelectron spectroscopy — ●C. BETHKE¹, E. KISKER¹, N.B. WEBER², and F.U. HILLEBRECHT³ — ¹Institut für Angewandte Physik, Heinrich-Heine-Universität, Universitätsstraße 1, D-40225 Düsseldorf, Germany — ²Focus GmbH, Am Birkhecker Berg 20, D-65510 Hünstetten, Germany — ³Institut für Festkörperforschung, Forschungszentrum Jülich, D-52425 Jülich, Germany

The magnetic linear and circular dichroism (MLDAD and MCD) in the 2p photoemission spectra of ultrathin 3d metal films have been determined. Although the 3d electrons in transition metals like Fe and Co are itinerant, we can describe the spectra in terms of an atomic model in jj and jK coupling. The results of the model compare reasonably well

with the experimental data, especially for iron[1]. Because of the low energy difference between the different pd^n configurations in the final state the intensity of the satellite structures is transferred to the two dominant main structures with $j = 1/2, 3/2$. So for Fe mainly the hybridization between the configurations in the final state main lines is vital to describe the 2p photoemission spectrum. We will show that the fine structure of the measured spectra and the correlation between magnetic dichroism and spin-orbit and exchange induced spinpolarization can be explained in the final state model presuming a pure coupling approximation like jj coupling. Supported by the BMBF under grant no. 05 KS1 PFA 3.

[1] C. Bethke, E. Kisker, N.B. Weber, and F.U. Hillebrecht, Phys. Rev. B, accepted.

MA 20.17 Mo 14:00 Poster TU C

Der Einfluss von Spinwellen-Wechselwirkungen auf die Interlagen-Austauschkopplung — ●STEPHAN SCHWIEGER, JOCHEN KIENERT und WOLFGANG NOLTING — Humboldt Universität zu Berlin, Institut für Physik, Lehrstuhl Festkörperteorie, Newtonstr. 15, 12489 Berlin

Die Interlagen-Austauschkopplung, also die Kopplung zwischen magnetischen Schichten, die durch eine paramagnetische Zwischenschicht getrennt sind, zeigt eine deutliche Temperaturabhängigkeit. Es ist noch nicht geklärt, welcher physikalische Mechanismus das Absinken der Kopplungsstärke bei steigender Temperatur verursacht. Es gibt zwei Kandidaten: zum einen könnte das Aufweichen der Fermi-Oberfläche der Zwischenschicht die Kopplungsenergie absenken (Spacer-Effekt), zum anderen könnten Wechselwirkungen zwischen in den Magneten angeregten Spinwellen eine wichtige Rolle spielen (magnetischer Effekt). Wir stellen eine Methode vor, mit der temperaturabhängige FMR Experimente in einer Weise ausgewertet werden können, die eine Trennung dieser beiden Effekte ermöglicht. Dazu wird theoretisch direkt die FMR Observable, die Frequenz der Spinwelle mit unendlich langer Wellenlänge, mittels eines erweiterten Heisenbergmodells berechnet. Das Modell berücksichtigt äussere Felder, Gitteranisotropien, die Dipol-Dipol-Wechselwirkung zwischen den magnetischen Momenten einer Schicht, sowie die Interlagenkopplung zwischen den magnetischen Schichten. Dieses Verfahren erlaubt nun sowohl die separate Messung des Spacer Effekts als auch eine Untersuchung des Einflusses des Spinwelleneffektes auf das FMR Signal

MA 20.18 Mo 14:00 Poster TU C

Theory of field induced spin reorientation transition in thin Heisenberg films — ●JOCHEN KIENERT, STEPHAN SCHWIEGER, and WOLFGANG NOLTING — Humboldt University Berlin, Institute of Physics, Solid State Theory, Newtonstrasse 15, 12489 Berlin

We consider the spin reorientation transition in a ferromagnetic Heisenberg monolayer with a second order single ion anisotropy as a function of temperature and external field. Up to now analytical methods give satisfying results only for the special case that the external field is aligned parallel to the easy axis of the crystal. We propose a theory based on a generalization of the Callen decoupling, which can be used for arbitrary direction of the external field. Excellent agreement between our results and Quantum Monte Carlo data is found for the field induced reorientation at finite temperatures. Additionally, we discuss the temperature dependence of the transition in detail.

MA 20.19 Mo 14:00 Poster TU C

Observation of the Fe Spin Spiral Structure in Fe/Sm-Co Exchange Spring Bilayers by ⁵⁷Fe-Probe Layer Mössbauer Spectroscopy — ●A. KHRENOV¹, W. KEUNE¹, V.E. KUNCSEK², J.S. JIANG³ und S.D. BADER³ — ¹Angewandte Physik, Universität Duisburg-Essen, 47048 Duisburg — ²NIPM, RO-76900 Bucharest Magurele, Romania — ³Materials Science Div., Argonne National Laboratory, Argonne, IL 60439, USA

The layer resolved Fe spin spiral structure for Fe/Sm-Co(1100) exchange spring magnetic bilayers was investigated by ⁵⁷Fe conversion electron Mössbauer spectroscopy (CEMS) during the magnetization reversal process, and correlated with the hysteresis loops measured via the magneto-optic Kerr effect. 2 nm thick isotopically enriched ⁵⁷Fe-probe layers were sputter-deposited in the 20 nm thick natural Fe layer at different distances from the Fe/Sm-Co interface. A direct experimental proof for a relaxed spiral angular spin distribution in the Fe layer is presented. Contrary to expectation, weak out-of-plane Fe spin components were observed in a certain applied field range. Sponsored through Deutsche Forschungsgemeinschaft (SFB491) and DOE Contract No. W.31-109-ENG-38.

MA 20.20 Mo 14:00 Poster TU C

Magnetism of atomic chains, islands and surface alloys of Fe on Pt substrates — ●A. ENDERS¹, T.Y. LEE¹, J. HONOLKA¹, K. KUHNKE¹, D. REPETTO¹, K. FAUTH², M. HESSLER², G. SCHÜTZ², and K. KERN¹ — ¹MPI für Festkörperforschung, Stuttgart, Germany — ²MPI für Metallforschung, Stuttgart, Germany

The structure and magnetic properties of submonolayer coverages of Fe on Pt substrates have been investigated. By adjusting the preparation conditions and substrate orientation the Fe could be stabilized as atomic chains, flat monolayers, islands or as Fe-Pt surface alloy. Growth mode and structure of the Fe have been investigated under ultrahigh vacuum condition by thermal He-atom scattering (TEAS), low energy electron diffraction (LEED), and scanning tunneling microscopy (STM). The magnetism has been explored in-situ by X-ray magnetic circular dichroism (XMCD). The experiments clearly show a very sensitive dependence of the magnetic properties on the local atomic environment and dimensionality. For the Fe chains we find an oscillating magnetic anisotropy between perpendicular and in-plane direction with increasing chain width. Significantly enhanced magnetic moments and coercive fields are found for the Fe-Pt surface alloy, which is formed on stepped Pt(997) substrates at growth temperatures above 550 K. Element specific XMCD measurements on the alloys revealed an induced magnetic moment in the Pt which is a result of indirect exchange interaction. The comparison of the results underline the potential of stepped substrates for nanostructure fabrication due to their influence on growth mode, structure and magnetism in the thin film limit.

MA 20.21 Mo 14:00 Poster TU C

Magnetic structures in dipolar coupled multilayers — ●OLEG PETRACIC, SUBHANKAR BEDANTA, and WOLFGANG KLEEMANN — Angewandte Physik, Universität Duisburg-Essen, 47048 Duisburg, Germany

Metal-insulator multilayers can show various kinds of magnetization structures due to the competition of the usual magnetostatic and the so-called Néel inter-layer coupling. The second one becomes significant, when the roughness of the ferromagnetic films is large. We performed micromagnetic simulations motivated by recent experimental studies on the multilayers $[\text{Co}_{80}\text{Fe}_{20}/\text{Al}_2\text{O}_3]_n$. Varying different parameters, like roughness and interlayer distance various regimes of layer ordering can be observed.

MA 20.22 Mo 14:00 Poster TU C

Electric control of exchange bias — ●PAVEL BORISOV, ANDREAS HOCHSTRAT, XI CHEN, and WOLFGANG KLEEMANN — Universität Duisburg-Essen, Angew. Physik, 47048 Duisburg

Gaining electric control on the Exchange Bias (EB) is one of the most challenging tasks in modern thin film magnetism. Apart from direct control of the EB by an applied electric field at a given temperature $T < T_N$, also the complete switching of the EB from positive to negative values and vice versa by a variation of the applied electric freezing field is possible. We realized the demonstration of this huge effect in Molecular Beam Epitaxy grown magnetic Co-Pt-heterostructures based on antiferromagnetic Cr_2O_3 , the prototypical system for investigations of the magneto-electric (ME) effect. The magnetic characterization was done by means of polar Magneto-Optical Kerr Effect as well as by SQUID-magnetometry. ME controlled perpendicular EB opens access to a broad variety of new applications in data storage technology, as there are e.g. a new design for a thermally assisted writing mechanism for perpendicular recording systems or a way to manage voltage induced writing in MRAM technique. Another spintronic application based on ME EB has been presented recently [1].

[1] Ch. Binek *et al.*, J. Appl. Phys (2005) *accepted*

MA 20.23 Mo 14:00 Poster TU C

X-ray and Neutron Scattering studies of NiMn-CoFe exchange bias systems — ●DANICA SOLINA¹, DIETER LOTT¹, R. KALTOFEN², J. SCHUMANN², JÜRGEN FASSBENDER³, URSULA TIETZE¹, and ANDREAS SCHREYER¹ — ¹Institute for Materials Research, Dept. WFN (Neutron-/Synchrotron Scattering), GKSS-Research Center, PO Box 1160, D-21494 Geesthacht, Germany — ²Leibniz Institute of Solid State and Materials Research Dresden, Germany, Helmholtzstr. 20, D-01069 Dresden — ³Institut fuer Ionenstrahlphysik und Materialforschung, Forschungszentrum Rossendorf, Postfach 51 01 19, 01314 Dresden Germany

Preliminary results are presented on the structural and magnetic properties of epitaxial antiferromagnetic NiMn and their correlation to the Exchange Bias Effect. Included are x-ray diffraction, reflection and rocking curves of pertinent diffraction peaks. The rocking curves have a FWHM of less than 3° indicating good epitaxial growth of the film. Polarized neutron reflectivity and high angle scattering measurements have been made in order to assess the magnetic properties of the system.

MA 20.24 Mo 14:00 Poster TU C

Magnetische und chemische Grenzflächeneigenschaften von Tunnelementen mit FeO_x Elektroden — ●MARC SACHER, JAN SCHMALHORST und GÜNTER REISS — Universität Bielefeld, Dünne Schichten und Nanostrukturen, Universitätsstr.25, 33615 Bielefeld

Magnetische Tunnelemente (MTJ) werden seit kurzem erfolgreich als Speicherbaustein in nichtflüchtigen Schreib-Lese-Bausteinen verwendet. Für die weitere Entwicklung sind dabei halbmolekulare Elektrodenmaterialien mit theoretischen Spinpolarisationen von 100% für die Steigerung des TMR-Effektes von entscheidender Bedeutung. Auch für Magnetit (Fe_3O_4) wird eine Spinpolarisation von 100% vorhergesagt, allerdings konnte diese in magnetischen Tunnelementen bisher nicht verifiziert werden. In dieser Arbeit wurden mittels verschiedener kombinierter Sputter- und Oxidationsverfahren hergestellter Eisenoxidschichten als Elektrodenmaterial in MTJ untersucht. Dabei wurde besonderes Augenmerk auf sowohl die magnetischen und strukturellen Eigenschaften des Volumenmaterials als auch die chemischen und magnetischen Eigenschaften an der FeO_x / Barrierengrenzfläche gelegt. Dazu wurde zum einen Magnetometrie (AGM und MOKE) durchgeführt und zum anderen die Beugung (XRD) und Absorption von polarisierter Röntgenstrahlung (XAS und XMCD) gemessen. Ein besonderer Fokus wurde auf die Präparation von Al_2O_3 Barrieren auf den Eisenoxidschichten gesetzt, um mögliche ungewollte Veränderungen in der Fe_3O_4 Stöchiometrie zu minimieren.

MA 20.25 Mo 14:00 Poster TU C

Magnetic domain structures in Fe_3O_4 thin films studied by magnetic force microscopy (MFM) — ●JIANDONG WEI¹, MICHAEL KOBLISCHKA¹, UWE HARTMANN¹, YANG ZHOU², SHANE MUPHY², and I.V. SHVETS² — ¹Experimental Physics Department, University of Saarbrücken, Saarbrücken, Germany — ²SFI Nanoscience Laboratory, Trinity College Dublin, Dublin 2, Ireland

Epitaxial Fe_3O_4 thin films of various thicknesses and thermo-chemical treatments have been studied by MFM. The subtle magnetic domain structures and their changes with varying preparation processes were clearly revealed, which is a basis for the understanding of the anomalous magnetic behavior caused by antiphase boundaries in the films. The film thickness and the temperature, atmosphere and duration of the annealing procedure are important factors to determine the final magnetic properties of the films. Particularly, the annealing time for epitaxial thin films has a significant influence on the formation of micromagnetic structures. The influence of external magnetic fields up to 50mT on the magnetic domain structures was also investigated by MFM. This work is supported by EU project of ASPRINT.

MA 20.26 Mo 14:00 Poster TU C

Structure and Electronic Properties of the $\text{Fe}_3\text{O}_4(100)$ Surface: Evidence of a Half-Metal to Metal Transition — ●M. FONIN^{1,2}, YU. DEDKOV^{3,2}, R. PENTCHEVA⁴, M. SPERLICH², M. SCHEFFLER⁵, U. RÜDIGER¹, and G. GÜNTHERODT² — ¹Fachbereich Physik, Universität Konstanz, 78467 Konstanz, Germany — ²II. Physikalisches Institut, Rheinisch-Westfälische Technische Hochschule Aachen, 52056 Aachen, Germany — ³Institut für Festkörperphysik, Technische Universität Dresden, 01062 Dresden, Germany — ⁴Dept. of Earth and Environmental Sciences, University of Munich, Theresienstr. 41, 80333 Munich, Germany — ⁵Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, 14195 Berlin, Germany

Highly spin-polarized transition metal oxide films, among them magnetite (Fe_3O_4), are a subject of intensive research due to the possible future applications in spin-electronic devices.

In situ prepared $\text{Fe}_3\text{O}_4(100)$ thin films were studied by means of scanning tunneling microscopy (STM) and spin-polarized photoelectron spectroscopy (SP-PES). The $(\sqrt{2} \times \sqrt{2})R45^\circ$ "wave-like" surface atomic structure observed by STM is in good agreement with the new structural model predicted by density functional theory (DFT) in the framework of *ab initio* thermodynamics. For the bulk oxide a spin polarization (SP) value of -100% was predicted by LSDA calculations [1]. On the

Fe₃O₄(100) surface both SP-PES and DFT results indicate a strong reduction of SP to about -55 % and a transition from half-metallic to metallic behavior.

[1] Z. Zhang and S. Satpathy, Phys. Rev. B **44**, 13319 (1991).

MA 20.27 Mo 14:00 Poster TU C

Growth of thin Ni₂MnIn Heusler alloy films on in-situ cleaved InAs (110)-surfaces — ●MAHDI MAHAJERI, JAN M. SCHOLTYSSEK, MALTE A. KURFISS, MALTE LIESKE, RAINER ANTON, and GUIDO MEIER — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg

Heusler alloys are interesting candidates as spin-injectors in prospective spintronic devices. A spinpolarisation of 100% is predicted for the Ni₂MnIn/InAs interface. In particular, this was calculated for the (100) and (110)-planes [1]. We fabricate thin Ni₂MnIn films by coevaporating Ni and a MnIn alloy from two independent sources. The usage of only two crucibles is possible due to the similar vapour pressures of Mn and In. The layers are deposited on the (110)-surface of in situ cleaved InAs and on amorphous carbon films. The latter are used for stoichiometric, morphological, and structural investigations in a transmission-electron microscope. We measure the resistivity $\rho(T)$ of the samples grown on InAs. The same samples are used for determination of the spinpolarisation by point contact Andreev-reflection spectroscopy (PCAR) [2]. Investigations concerning the magnetic properties of the layers are performed using a SQUID-magnetometer [3].

[1] K. A. Kilian and R. H. Victora. J. Appl. Phys. **87**, 7064 (2000)

[2] S. von Oehsen, et. al. JMMM, accepted (09/2004)

[3] M. Kurfiß, et. al. JMMM, accepted (10/2004)

MA 20.28 Mo 14:00 Poster TU C

Properties of thin LaMnO₃ layers and its characterization as a tunneling barrier — ●ANDREAS KLEINE, YUANSU LUO, MARKUS ESSELING, and KONRAD SAMWER — I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

The effort of preparing a full-oxid all-manganite TMR system motivates the characterization of thin LaMnO₃ (LMO) layers as a tunneling barrier. Good magnetic and electronic properties are expected due to the conservation of symmetry at the interface. Below the Neel temperature of 140K stoichiometric LaMnO_{3+ δ} is a canted antiferromagnetic insulator with a small magnetic moment. The excess oxygen δ in LaMnO_{3+ δ} mainly changes the electronic and magnetic properties, which are to be optimized. Structural, magnetic and electronic properties of DC-magnetron sputtered LMO layers are presented in dependency of the oxygen excess. Moreover the results of tunneling contacts with LMO barrier and its dependency on the preparation parameters and barrier thickness, as well as the property changes due to annealing, will be shown and discussed.

This work was supported by the DFG Sa 337/9-1.

MA 20.29 Mo 14:00 Poster TU C

Piezo-controlled cantilever magnetometer for de Haas-van Alphen effect studies on MnAs — ●O. RÖSLER¹, A. KROHN¹, M. WILDE¹, J.I. SPRINGBORN¹, D. GRUNDLER¹, CH. HEYN¹, D. HEITMANN¹, L. DÄWERITZ², K.J. FRIEDLAND², and K.H. PLOOG² — ¹Institut für Angewandte Physik, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg — ²Paul Drude Institut für Festkörperelektronik, Hausvogteiplatz 5 - 7, 10117 Berlin

Measuring the de Haas-van Alphen (dHvA) effect in a ferromagnetic thin film by means of a torque magnetometer is a challenging task. The spontaneous spin magnetization might induce such a large torque that the inherent high sensitivity of the magnetometer degrades significantly at high magnetic field B. We have realized a micromechanical cantilever magnetometer (MCM) with a piezo-controlled capacitance readout which circumvents the problem. Using the MCM, we first measured the hysteretic ferromagnetic behavior of an epitaxial MnAs layer at B < 3 T. Second, the large MCM deflection was compensated at B = 3 T using a piezoceramics-based walker. With the optimized configuration, we then measured the dHvA effect up to 15 T and down to 270 mK. Temperature-dependent data obtained at different tilt angles revealed an anisotropic Fermi surface and an anisotropic effective mass of the electrons. The absolute value was near the free-electron mass. We acknowledge financial support by the BMBF via 13N8283 "Spintronik" and by the DFG via SFB508 and Gr1640/1-2.

MA 20.30 Mo 14:00 Poster TU C

Magnetische sub-mikrometer Tunnelstrukturen in Logikgattern — ●DIRK MEYNER¹, HUBERT BRÜCKL¹, GÜNTER REISS¹, NILS WIESE^{1,2} und JOACHIM WECKER² — ¹Universität Bielefeld, Fakultät für Physik, Universitätsstr. 25, D-33615 Bielefeld — ²Siemens AG Corporate Technology, CT MM 1, Paul-Gossen-Str. 100, 91052 Erlangen Siemens

Der Einsatz magnetischer Tunnelstrukturen in logischen Bauteilen erscheint aufgrund der Nichtflüchtigkeit gespeicherter Information, hoher Integrationsdichte und schneller Programmierbarkeit vielversprechend. Dazu notwendig sind Tunnelstrukturen mit reproduzierbarem Schaltverhalten sowie geringer Fluktuation in Widerstand und TMR-Amplitude. Die mittels EBL elliptisch strukturierten Elemente mit einer lateralen Ausdehnung kleiner 0.04 μ m² sind daher auf Zellpaarigkeit untersucht worden, um Aufschluß über Ursprung und Stärke jener Fluktuation zu erhalten. Die untersuchten Schichtsysteme bestehen neben elektrischen Zuleitungen aus der Schichtfolge MnIr 10.8/ CoFe 2.3/ Al 1 plasmaoxidiert/ NiFe 5 (in nm) bzw. PtMn 25/ CoFe 3/ Ru 9/ CoFe 2.8/ Al 1.2 plasmaoxidiert/ CoFeB 4. Die Funktion bereits realisierter Logikgatter mit einer Gesamtausdehnung von 10x10 μ m² wird gezeigt.

MA 20.31 Mo 14:00 Poster TU C

Aspects of spin-dependent scattering in magnetic nanoconstrictions — ●JAMAL BERAKDAR¹, V.K. DUGAEV¹, J. BARNAS², M. VIEIRA³, W. DOBROWOLSKI⁴, and V.F. MITIN⁵ — ¹MPI für Mikrostrukturphysik, Halle, Germany — ²A. Mickiewicz University, Poznan, Poland — ³ISEL, Lisbon, Portugal — ⁴Institute of Physics, PAN, Warsaw, Poland — ⁵Institute of Semiconductor Physics, Kiev, Ukraine

Magnetoresistance of nanowires and nanoconstrictions based on GaMnAs magnetic semiconductors can be as large as 2000% [1]. We analyze theoretically this effect in terms of a thin domain wall model [2] and under the depletion conditions. The model is valid for long wavelengths of charge carriers as compared to the domain wall width (realizable for magnetic semiconductors). Largest magnetoresistance occurs when the splitting of electron bands is large enough to ensure full spin polarization of holes in p-type materials. Such a situation is realizable in heavily Mn-doped and strongly compensated GaMnAs semiconductors. We calculated the resistance of the domain wall as a function of the polarization and the hole density. Spin-orbit interaction is shown to play an important role in the magnetoresistance. We also discuss the role of localization corrections related to disorder. At low temperatures the magnetoresistance is strongly influenced by localization effects. Magnetoresistance can be electrically controlled by a gate in the nanoconstriction region.

[1] C. Ruester, T. Borzenko, et al. Phys. Rev. Lett. **91**, 216602 (2003).

[2] V.K. Dugaev, J. Berakdar, J. Barnas, Phys. Rev. B **68**, 104434 (2003).

MA 20.32 Mo 14:00 Poster TU C

Aluminum oxide tunnel junctions and all-metal mesoscopic spin-valve devices — ●ALEXANDER VAN STAA, CHRISTINE M. S. JOHNS, ULRICH MERKT, and GUIDO MEIER — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Jungiusstraße 11, 20355 Hamburg

In tunnel magnetoresistance devices aluminum oxide is a well established material for tunnel barriers. The oxidation of aluminum in pure oxygen has been investigated by varying the contact sizes on the μ m-scale and the oxidation time in all-metal systems. We will apply aluminum oxide tunnel barriers to improve the spin-injection efficiency in lateral Py/Al/Py spin-valve devices, which we have successfully characterized without tunnel barriers. On these devices simultaneous measurements of the spin-valve effect and the anisotropic magnetoresistance of the Py-electrodes have been performed at temperatures of liquid helium. Their micromagnetic behaviour has been imaged with a magnetic-force microscope at room temperature in external magnetic fields.

MA 20.33 Mo 14:00 Poster TU C

Die level uniformity of magnetic tunnel junctions under lithographic aspects — ●KARSTEN ROTT and HUBERT BRÜCKL — Universität Bielefeld, Nano Device Group, Universitätsstr. 25, 33615 Bielefeld

The uniform behaviour of magnetic tunnel junctions on a memory or logic chip is an absolutely necessary requirement for product fabrication. The junctions should show an equal and reproducible magnetic switching, the same area resistance and magnetoresistance amplitude. The first issue guarantees a reliable bit setting, the latter two the operation within certain voltage levels predefined by the according CMOS environment.

Since the tunnel resistance depends exponentially on the barrier thickness, the deviation from the mean thickness of 0.9 to 1.2 nm should be less than 0.01 nm. Electrical pinholes or defect states have to be avoided. The same arguments hold for the TMR amplitude where a standard deviation of 2% is tolerable. Besides the intrinsic film properties, the additional lithographic procedure is another source of errors and deviations. The impact of lithographic features on the die level uniformity will be discussed in dependence on the cell size. The lateral dimensions of the investigated junctions range from 100 nm up to a few microns.

MA 20.34 Mo 14:00 Poster TU C

Fabrication and characterization of magnetic tunnel junctions with ultrathin barriers — ●A. PARGE, G. EILERS, and M. MÜNZENBERG — IV. Phys. Inst., Universität Göttingen

The fundamental properties of ultrathin barriers in magnetic tunnel junctions (MTJs) have recently become an interesting aspect in the field of spindynamics, since ultrathin barriers can provide extremely high tunnel current densities, which are required for spin current induced switching experiments.

We have prepared AlO_x tunnel barriers by means of e-beam evaporation in UHV followed by either plasma or natural oxidation, thus changing the concentration of defects in the barriers. Besides, the barrier thickness and its lateral size (structured by shadow masks or lithography) were varied.

After the optimization of the growth parameters we are planning to characterize the exact transport properties (IV characteristics, TMR at different temperatures). Finally, the MTJs are supposed to be integrated into a strip line with a photoconductive switch in order to study the spin current induced switching effect.

MA 20.35 Mo 14:00 Poster TU C

Fe on GaAs(110) cleaved edges - magnetic, electrical and optical investigations — ●P. KOTISSEK¹, M. BAILLEUL^{1,2}, M. SPERL¹, W. KIPFERL¹, P. CHEN¹, W. WEGSCHEIDER¹ und G. BAYREUTHER¹ — ¹Universität Regensburg, 93040 Regensburg — ²CNRS Strasbourg

The aim of our work is to successfully inject spinpolarized carriers from a ferromagnetic metal into GaAs and to vary spin injection by optical methods. The crucial spin dependent resistance is given by the Schottky barrier system (Fe/(n+)GaAs) that is grown epitaxially on the (110) cleaved edge of an n-GaAs substrate. The magnetic properties of the Fe films were investigated by Kerr microscopy and SQUID magnetometry. We also measured the I-V characteristics of Fe/(n+)GaAs Schottky contacts with respect to the temperature to get information about the different transport mechanisms across the Schottky barrier. To gain information about the optical properties of our samples we also measured photoluminescence spectra at low temperatures.

Two different methods are used to detect the spin polarization of the injected electrons: i) via the polar optical Kerr effect and ii) via the circular polarization of the recombination light of the injected electrons with unpolarized holes.

MA 20.36 Mo 14:00 Poster TU C

Magnetotransport measurements and simulations of permalloy microstructures — ●J. KRUSE, R. EISELT, M. BOLTE, M. STEINER, U. MERKT, and G. MEIER — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstrasse 11, 20355 Hamburg, Germany

Spatially resolved measurements and simulations of magnetoresistance effects are required for a detailed understanding of magneto-transport in magnetic micro- and nanostructures at the fundamental level [1]. The anisotropic magnetoresistance of permalloy microstructures of various geometries are measured in the temperature range between 2 K and 300 K. We investigate rectangles of 20 nm, 40 nm, and 70 nm thickness with different aspect ratios and in addition rounded structures we address as eggs, beans, and lemons. By transport measurements, micromagnetic simulations, and magnetic-force microscopy we can clearly identify magnetic configurations and their electrical resistances. For the rectangular geometry we plan to study barber pole structures to linearize the magnetoresistance effect [2].

[1] R. Meckenstock, M.V. Rastei, and J.P. Bucher, *J. Appl. Phys.* **95**, 6753 (2004).

[2] Philips Semiconductors, Data Sheet SC17 (2000).

MA 20.37 Mo 14:00 Poster TU C

Large room temperature TMR effect in Fe₃O₄ based magnetic tunnel junctions — ●EDWIN MENZEL, SULEMAN QURESHI, DANIEL REISINGER, ANDREAS ERB, MATTHIAS OPEL, and RUDOLF GROSS — Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Walther-Meißner-Str. 8, 85748 Garching

Magnetite (Fe₃O₄) is an interesting candidate for applications in spin electronics. It shows a Curie temperature of 860 K and has been predicted to be half-metallic at room temperature [1]. We have fabricated Fe₃O₄/oxide/FM (FM = Ni, Co, Fe₃O₄) trilayer structures using pulsed laser deposition and electron beam evaporation. The thin film stacks have been studied by in-situ RHEED, SQUID magnetometry, and high-resolution X-ray diffraction. Magnetic tunnel junctions have been fabricated using optical lithography and Ar ion beam milling. The junctions have been characterized by magnetotransport measurements between 150 K and 350 K. They show a reproducible tunneling magnetoresistance (TMR) effect with almost ideal switching behavior. We obtain TMR values of up to 20% for Fe₃O₄/AlO_x/Co and Fe₃O₄/AlO_x/Ni at room temperature. We also found a geometry enhanced TMR effect due to an inhomogeneous current distribution in the junction electrodes. This effect has been modeled by finite element methods. We find that the geometry enhanced TMR effect can be optimized by adjusting the junction geometry and the electrode resistivity. In our experiments, reproducible TMR effects exceeding 1000% at room temperature have been found.

This work is supported by the BMBF with grant no. 13N8279.

[1] Z. Zhang, and S. Satpathy, *Phys. Rev. B*, **44**, 13319 (1991).

MA 20.38 Mo 14:00 Poster TU C

Magnetoresistance in bicrystal Fe₃O₄ thin films — ●A. BOLLERO¹, M. ZIESE¹, P. ESQUINAZI¹, K. DÖRR², and I. MÖNCH² — ¹University of Leipzig, Division of Magnetism and Superconductivity, Linnéstrasse 5, 04103 Leipzig — ²Institute for Metallic Materials, IFW Dresden, Helmholtzstr. 20, 01069 Dresden

Epitaxial and polycrystalline Fe₃O₄ films can have a large high-field magnetoresistance (absent in bulk material) attributed to electron transfer across the antiphase boundaries (APBs) [1]. In the present work an epitaxial magnetite (Fe₃O₄) film has been deposited by the pulsed laser deposition (PLD) technique on a bicrystal substrate. Magnetoresistance measurements on patterned stripes (width = 20 μm) across the bicrystal grain boundary have not revealed a distinguishable grain boundary contribution, by comparison with similar experiments performed on manganese perovskites [2]. Post-annealing of the film leads to a significantly enlarged high-field magnetoresistance with decreasing temperature for $T < T_V$ (T_V : Verwey transition temperature). Decreased resistivity and coercivity values are obtained after annealing of the film which is attributed to a reduction in the density of APBs.

[1] M. Ziese and H. J. Blythe, *J. Phys. Cond. Matt.*: **12** (2000) 13.

[2] K. Steenbeck, T. Eick, K. Kirsch, H.-G. Schmidt and E. Steinbeiß, *Appl. Phys. Lett.* **73** (1998) 2506.

MA 20.39 Mo 14:00 Poster TU C

Heusler alloy based MTJs with afm coupled reference layer system — ●J. SCHUMANN, H. VINZELBERG, R. KALTOFEN, D. ELEFANT, I. MÖNCH, J. THOMAS, and M. HECKER — IFW Dresden, POB 270116, 01171 Dresden

For advanced TMR switching elements applied e.g. in MRAMs, magnetic thin films with high spin polarization are indispensable. Half-metallic Heusler alloys are expected to be promising candidates for the magnetic components in prospective spin-electronic devices. Band structure studies for the compound Co₂CrAl [1] have proved the half-metallic state to be preserved in the immediate surface region. This is important for the spin transport through MTJs. A partial substitution of Fe for Cr enhances the Curie temperature ensuring thus stable working parameters at 300 K. Co₂Cr_{1-x}Fe_xAl based MTJs with an Al_xO_y barrier and an IrMn pinned CoFe top electrode present the typical switching behavior and a TMR ratio of ca. 28 % at 4.2K. The influence of the sputter conditions (growth rate, Ar-pressure, substrate temperature) on the structural and magnetic properties of the Heusler films is studied and the consequences on the TMR process are discussed.

[1] I. Galanakis, *J. Phys. C*, **14**, 6329 (2002).

MA 20.40 Mo 14:00 Poster TU C

Präparation und Eigenschaften dünner Manganat-Titanat Kompositsschichten — ●KAI GEHRKE¹, ALEXANDR BELENCHUK², OLEG SHAPOVAL², VASILY MOSHNYAGA¹ und KONRAD SAMWER¹ — ¹Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen — ²Institute of Applied Physics, Academiei 5, MD-2028 Chişinău, Moldova

Multiferroische Materialien zeigen zugleich die Eigenschaften von Ferromagnetika und Ferroelektrika. Nanocomposite, bestehend aus einer Manganat- (M) und einer Titanatphase (T), können multiferroisch sein und die Eigenschaften treten aufgrund von elastischer Kopplung zwischen M- und T-Phase in Wechselwirkung. Ausgangspunkt sind dünne LCMO-Schichten, die mit metallorganischer Aerosoldeposition (MAD) hergestellt wurden. Temperaturabhängige Messungen des elektrischen Widerstandes zeigen den für viele Manganate typischen Metall-Isolator-Übergang. Die Übergangstemperatur von $T=275\text{K}$ und der extrem große Temperaturkoeffizient des Widerstandes $\text{TCR}=31\%/K$ sind dabei ein Maß für die hohe Qualität der Schichten. Dünne Manganat-Titanat Kompositsschichten, mit nomineller Zusammensetzung $(\text{LCMO})_x : (\text{BaTiO}_3)_{1-x}$, wurden mit der MAD-Technik hergestellt. Röntgendiffraktometrie-messungen zeigen, daß die Schichten auf MgO(100) Substraten epitaktisch gewachsen sind. Magnetische Eigenschaften wurden mit Hilfe eines SQUID-Magnetometers untersucht. Die multiferroischen Eigenschaften sollen mit magneto-optischen Methoden untersucht werden.

MA 20.41 Mo 14:00 Poster TU C

Spin-dependent tunneling in the nearly-free-electron model — ●PETER BOSE¹, INGRID MERTIG¹, and JÜRGEN HENK² — ¹FG Theoretische Physik, FB Physik, Martin-Luther-Universität Halle-Wittenberg, D-06099 Halle an der Saale — ²Max-Planck-Institut für Mikrostrukturphysik, D-06120 Halle an der Saale

Spin-dependent ballistic transport through a tunnel barrier is treated within the one-dimensional nearly-free-electron model. The comparison with free electrons reveals significant effects of band gaps, in particular in the bias dependence. The results can be qualitatively explained by the number of incident and transmitted states in the leads. With an extension to ferromagnetic leads the bias dependence of tunnel magneto-resistance is discussed.

MA 20.42 Mo 14:00 Poster TU C

Scanning Tunneling Spectroscopy on $\text{La}_{0.7}\text{Ca}_{0.3}\text{MnO}_3$ — ●SIGRUN A. KÖSTER, LAKSHAMANA SUDHEENDRA, VASILY MOSHNYAGA, BERND DAMASCHKE, and KONRAD SAMWER — I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Manganites show the colossal magnetoresistance effect (CMR), which already has been very well investigated. 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. In our work we can show by scanning tunneling spectroscopy, that low resistivity and high resistivity regions do exist in the samples. These depend on several parameters like the microstructure of the samples, temperature of magnetic fields. Our investigations concentrate on achieving a more detailed picture of these phases and their origin.

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

MA 20.43 Mo 14:00 Poster TU C

Magnetotransport in Sr_2CrWO_6 thin films — ●PETRA MAJEWSKI, ANDREA BOGER, STEPHAN GEPRÄGS, ROBERT GEISSLER, ANDREAS ERB, MATTHIAS OPEL, LAMBERT ALFF, and RUDOLF GROSS — Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Walther-Meißner-Str. 8, 85748 Garching

High Curie temperatures T_C and large magnetoresistive effects in polycrystalline double perovskite samples raised renewed interest in these materials, due to possible applications in magnetoelectronics. Here we report on the structural, magnetic, and electrical properties of thin epitaxial Sr_2CrWO_6 films. The samples were grown in an UHV pulsed laser deposition (PLD) system. In-situ RHEED and AFM were used to monitor the growth process and surface quality. The epitaxial thin films show no parasitic phases in HRXRD measurements. Rocking curves of the (004)-film peaks have a FWHM as narrow as 0.016° . From SQUID magnetometry measurements between 4 and 380 K, T_C is estimated to be well above 380 K. Since the surface of the SrTiO_3 substrate becomes

conducting under the deposition conditions of Sr_2CrWO_6 , an insulating heteroepitaxial NdGaO_3 buffer layer was introduced in order to obtain reliable electrical transport data. The magnetotransport properties and the Hall effect have been measured in a wide temperature range (5 to 300 K) and in magnetic fields up to 15 T. The resistivity vs. temperature curves could be well described by a variable range hopping transport mechanism. In addition, grain-boundary junctions have been prepared to investigate spin-dependent tunneling effects.

This work is supported by the BMBF via grant no. 13N8279.

MA 20.44 Mo 14:00 Poster TU C

Tunneling magnetoresistance of C_nH_m ($n=1,2,6$, $m=2,4,6$) molecules sitting between Co clusters — ●H. ZARE KOLSARAKI and H. MICKLITZ — II. Physikalisches Institut, Universität zu Köln, Zùlpicher Str. 77, D-50937, Köln, Germany

Spin-dependent transport in artificially nano-structured materials composed of magnetic clusters separated by insulating molecules is an actual field of research. Films composed of in-beam prepared Co clusters (mean diameter ≈ 4.5 nm) and various hydrocarbon molecules C_nH_m ($n=1,2,6$, $m=2,4,6$) have been prepared by co-deposition onto a cold ($T \approx 35$ K) substrate. The temperature dependence of the resistivity ρ for all films shows the expected $\ln \rho \propto T^{-1/2}$ behavior, typical for variable range tunneling. The tunneling magnetoresistance (TMR) is independent of the cluster volume fraction v_{cl} in Co/CH_4 , $\text{Co}/\text{C}_2\text{H}_2$ and $\text{Co}/\text{C}_6\text{H}_6$, while TMR in $\text{Co}/\text{C}_2\text{H}_4$ strongly depends on v_{cl} . $\text{TMR}(T=0)$ in Co/CH_4 and $\text{Co}/\text{C}_2\text{H}_4$ (for largest v_{cl}) is similar to that observed in non-interacting $\text{Co}/\text{Kr}(\text{Xe})$ -systems [$\text{TMR}(0) \approx 15\%$], while $\text{TMR}(0)$ in $\text{Co}/\text{C}_2\text{H}_2$, $\text{Co}/\text{C}_6\text{H}_6$ and $\text{Co}/\text{C}_2\text{H}_4$ (for smallest v_{cl}) is increased by a factor of about 2 [$\text{TMR}(0) \approx 30\%$]. We propose that the direct contact between Co-cluster surface-atoms and C-atoms is responsible for the enhanced TMR. The change of the TMR in C_2H_4 with changing v_{cl} reflects the change in the orientation of the C_nH_m molecules sitting between two Co clusters: for large v_{cl} one molecule sits with its C-C axis perpendicular to the cluster surface [small $\text{TMR}(0)$], while for small v_{cl} two molecules are positioned with the C-C axis parallel to the cluster surface [large $\text{TMR}(0)$].

MA 20.45 Mo 14:00 Poster TU C

Magnetowiderstandsmessungen an granularen Strukturen synthetisiert aus magnetischen Nanopartikeln — ●INGA ENNEN¹, DANIELA SUDFELD¹, ANDREAS HÜTTEN¹, KLAUS WOJCZYKOWSKI², PETER JUTZI² und GÜNTER REISS¹ — ¹Universität Bielefeld, Fakultät für Physik, Universitätsstr.25, 33615 Bielefeld — ²Universität Bielefeld, Fakultät für Chemie, Universitätsstr.25, 33615 Bielefeld

Eine physikalisch interessante Anwendung von magnetischen Nanopartikeln liegt in der bottom-up Herstellung granularer Strukturen. Diese lässt sich für ligandenstabilisierte Nanopartikel in folgende Schritte einteilen: 1. Aufbringung einer Partikelmonolage auf ein Substrat, 2. Entfernung der isolierenden, organischen Hülle durch Auslagerung in einem reduzierenden Gasgemisch, 3. Einbettung der metallischen Partikelkerne in eine nichtmagnetische Matrix. An so präparierten granularen Systemen, bestehend aus Co-Partikeln in einer Cu-Matrix, sind bislang GMR-Effekte von 4,5% bei Raumtemperatur gemessen worden. Die Messungen lassen sich darüber hinaus mit der aus elektronenmikroskopischen Aufnahmen gewonnenen Teilchengrößenverteilung und den magnetischen Eigenschaften, die mittels AGM-Messungen bei Raumtemperatur bestimmt worden sind, im Rahmen eines Modells korrelieren.

MA 20.46 Mo 14:00 Poster TU C

X-ray absorption and magnetic circular dichroism studies of ion bombarded ferromagnet-antiferromagnet bilayers — ●J. SCHMALHORST¹, M. SACHER¹, V. HÖINK¹, G. REISS¹, D. ENGEL², and A. EHRESMANN² — ¹University of Bielefeld, Department of Physics, Nano Device Group, P.O. Box 100131, 33501 Bielefeld, Germany — ²Department of Physics, Kaiserslautern University of Technology, D-67663 Kaiserslautern, Germany

The influence of He ion bombardment on the structural and magnetic interface properties of a polycrystalline $\text{Mn}_{83}\text{Ir}_{17}$ / Co antiferromagnet-ferromagnet bilayer system is investigated¹. For annealed as well as for not annealed samples an exchange bias field of up to 200 Oe is induced by the ion bombardment for doses up to 5×10^{14} ions/cm². The X-ray absorption and the X-ray magnetic circular dichroism of Co and Mn is not significantly altered by this ion dose. For higher doses the exchange bias field is strongly reduced and accompanied by an increase of the ratio of the Mn to Co X-ray absorption intensities and a reduction of the

Co X-ray magnetic circular dichroism signal. A model with a gaussian like intermixing zone at the AF / FM interface is developed to account for the observed changes of the X-ray absorption spectra. The authors gratefully acknowledge the opportunity to perform soft X-ray absorption spectroscopy at the Advanced Light Source, Berkeley, USA.

[1] J. Schmalhorst, M. Sacher, V. Höink, G. Reiss, D. Engel, A. Ehresmann, Phys. Rev. B, in press

MA 20.47 Mo 14:00 Poster TU C

Initialization of unidirectional anisotropy in a ferromagnet - antiferromagnet bilayer by keV-He ion bombardment — ●D. ENGEL¹, A. EHRESMANN¹, J. SCHMALHORST², M. SACHER², V. HÖINK², and G. REISS² — ¹Fachbereich Physik, Technische Universität Kaiserslautern, D-67663 Kaiserslautern, Germany — ²Fakultät für Physik, Universität Bielefeld, D-33501 Bielefeld, Germany

A polycrystalline Cu/Ni₈₀Fe₂₀/Mn₈₃Ir₁₇/Co/AlO_x ferromagnet-antiferromagnet layer system was grown without applying an external magnetic field showing no unidirectional anisotropy in the as prepared state. After 10-keV He-ion bombardment in an external in-plane magnetic field a clear unidirectional anisotropy collinear to the magnetic field direction during bombardment is observed, indicating that ion bombardment can be used for this system to initialize the unidirectional exchange anisotropy. The magnetization reversal processes for various ion doses are discussed, based on longitudinal Magneto-optical Kerr-Effect measurements.

MA 20.48 Mo 14:00 Poster TU C

Thermische Stabilität magnetischer Nanostrukturen in ionenstrahlmodifizierten Exchange Bias Systemen — V. HÖINK¹, M. SACHER¹, ●J. SCHMALHORST¹, G. REISS¹, D. ENGEL² und A. EHRESMANN² — ¹Universität Bielefeld, Fakultät für Physik, Dünne Schichten und Nanostrukturen, 33501 Bielefeld — ²Fakultät für Physik, Technische Universität Kaiserslautern, 67663 Kaiserslautern

Der Exchange Bias Effekt in Ferromagnet / Antiferromagnet Schichtsystemen kann durch He-Ionenbeschuss im Magnetfeld sowohl in seiner Stärke als auch in seiner Richtung gezielt eingestellt werden. Wird durch Verwendung von Resistmasken der Ionenbeschuss lokal eingeschränkt, so können magnetische Nanostrukturen in den Ferromagneten geschrieben werden, welche einer lateralen Variation der Orientierung der Magnetisierung im remanenten Zustand entsprechen. Diese magnetische Nanostrukturierung wird für neuartige Anwendungen im Bereich Magneto Elektronik nutzbar sein. In der hier vorgestellten Arbeit wurden in Co / Mn-Ir und Co-Fe / Mn-Ir Doppelschichtsystemen magnetische Nanostrukturen mit Strukturgrößen unter 1µm erzeugt. Durch die ortsaufgelöste Messung der Absorption elliptisch polarisierter weicher Röntgenstrahlung in einem Photoelektronenemissionsmikroskop (PEEM) wurden die magnetischen Nanostrukturen in Remanenz direkt abgebildet und die Entwicklung ihrer Domänenkonfiguration als Funktion der Proben temperatur zwischen Raumtemperatur und 370°C verfolgt. Die PEEM-Messungen wurden an der PEEM2-Beamline 7.3.1.1 der Advanced Light Source, Berkeley, USA durchgeführt und durch die Deutsche Forschungsgemeinschaft (DFG) gefördert.

MA 20.49 Mo 14:00 Poster TU C

AF thickness dependence of the 10keV He-ion bombardment induced exchange-bias modification in multilayers containing MnIr as antiferromagnet — ●T. WEIS, D. JUNK, D. ENGEL, A. EHRESMANN, V. HÖINK, J. SCHMALHORST, and G. REISS — tanja.jacob@web.de

It is known that the exchange bias field H_{eb} of antiferromagnet/ferromagnet (AF/F) bilayers can be modified by keV He-ion bombardment in an external magnetic field. The modification of the magnitude and the direction of H_{eb} is dependent on the He-ion dose and the direction of the external magnetic field applied during the ion bombardment.

In this contribution the AF layer thickness dependence of keV He-ion bombardment induced modifications of H_{eb} in magnetic multilayers with MnIr as AF and CoFe or Co as F was investigated. It was found that the ion dose dependence of H_{eb} is strongly influenced by the IrMn layer thickness. First experimental results for varying AF thicknesses will be presented.

MA 20.50 Mo 14:00 Poster TU C

Azimuthal dependence of exchange bias and coercive field of Fe(110)/CoO(111) exchange bias bilayer — ●GREGOR NOWAK, FLORIN RADU, KURT WESTERHOLT, and HARTMUT ZABEL — Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, 44780 Bochum

We have prepared epitaxial Fe(110)/CoO(111) bilayers and characterized their structure by x-ray diffraction. Structurally, the bilayer shows a single domain growth for the CoO layer with six-fold in-plane symmetry. The Fe layer, however, shows a Nishiyama-Wassermann growth of three equivalent domains. The exchange bias (EB) properties were investigated by SQUID magnetometry. First, we measured the EB field as a function of the field cooling direction. The EB field exhibits a twofold symmetry which defines the uniaxial anisotropy orientation of the AF layer. Then we cooled down the system for different orientations of the applied field with respect to the uniaxial axis of the AF layer. For each field-cooling orientation we recorded hysteresis loops as a function of the azimuth angle of the sample with respect to the applied field. The maximum EB field is not found along the field cooling direction instead we observed this maximum to be parallel to the easy axis of the AF layer. This is in very good agreement with the theoretical predictions of Nowak and Usadel¹. Also, the unidirectional behaviour of the EB field shows modulations created by the uniaxial nature of the AF layer anisotropy.

¹B. Beckmann, U. Nowak, and K. D. Usadel, Phys. Rev. Lett. 91, 187201 (2003).

This work was supported by SFB 491.

MA 20.51 Mo 14:00 Poster TU C

Coercivity and exchange bias of ferromagnetic/antiferromagnetic multilayers — ●ULRICH NOWAK, GREGOR SCHOLTEN, and KLAUS D. USADEL — Fachbereich Physik, Universität Duisburg-Essen, 47058 Duisburg, Germany

For a model system consisting of a ferromagnetic layer exchange coupled to an antiferromagnetic layer with a compensated interface detailed mean field type calculations are performed. For the coercive field a rather broad enhancement around the Néel temperature T_N of the antiferromagnetic layer is found irrespectively of whether the antiferromagnetic layer is structurally disordered or not, while exchange bias is only found for systems with defects. The results for the exchange bias field are in qualitative agreement with those obtained previously with Monte Carlo simulations [1,2].

With some simplifying assumptions, we can obtain from this approach analytic results for the coercive field and the exchange bias field. We show that the observed enhancement of the coercivity around T_N and the occurrence of exchange bias are of different origin.

Work supported by the *Deutsche Forschungsgemeinschaft* through SFB 491.

[1] P. Miltenyi, M. Gierlings, J. Keller, B. Beschoten, G. Güntherodt, U. Nowak, and K. D. Usadel, Phys. Rev. Lett. **84**, 4224 (2000).

[2] U. Nowak, K. D. Usadel, P. Miltényi, J. Keller, B. Beschoten, and G. Güntherodt, Phys. Rev. B **66**, 14430 (2002).

MA 20.52 Mo 14:00 Poster TU C

Nano-structured exchange bias systems — ●BJÖRN BECKMANN, ULRICH NOWAK, and KLAUS D. USADEL — Fachbereich Physik, Universität Duisburg-Essen, 47048 Duisburg, Germany

Recently, attention has been drawn to exchange bias (EB) systems where the size of either the ferromagnetic (FM) or antiferromagnetic (AFM) layer or even both was modified on a nanoscale. Using Monte Carlo simulations of the domain state model [1,2] we study exchange bias of an array of squared ferromagnetic dots on a continuous antiferromagnetic substrate.

For sufficiently large dot sizes the results agree with those obtained earlier for continuous systems [2]. With decreasing FM dot size the average (over many dots) EB field decreases before it eventually vanishes when reaching a certain critical size. To explain this effect we note that during field cooling domains in the AFM layer are formed which then influence the FM. Thus, once the lateral size of the FM is below the average size of the AFM domains EB has to vanish. It is noteworthy, however, that for the single dots strong fluctuations of the bias field occur where both, negative or even positive bias may be observed.

Work supported by the *Deutsche Forschungsgemeinschaft* through SFB 491.

[1] P. Miltenyi, M. Gierlings, J. Keller, B. Beschoten, G. Güntherodt, U. Nowak, and K. D. Usadel, Phys. Rev. Lett. **84**, 4224 (2000).

[2] U. Nowak, K. D. Usadel, P. Miltényi, J. Keller, B. Beschoten, and G. Güntherodt, Phys. Rev. B **66**, 14430 (2002).

MA 20.53 Mo 14:00 Poster TU C

Magnetic domain structure of micro-patterned PtMn/NiFe exchange bias bilayers — ●K. POTZGER¹, L. BISCHOFF¹, M. O. LIECKE^{1,2}, B. HILLEBRANDS², M. RICKART³, P. FREITAS³, J. MCCORD⁴, and J. FASSBENDER¹ — ¹FZ Rossendorf, Institut für Ionenstrahlphysik und Materialforschung, 01314 Dresden — ²Fachbereich Physik, TU Kaiserslautern, 67663 Kaiserslautern — ³INESC MN, 1000 Lisabon, Portugal — ⁴IFW Dresden, Institut für Metallische Werkstoffe, 01069 Dresden

A bottom pinned exchange bias bilayer system consisting of 20 nm PtMn and 6 nm NiFe (produced using ion beam deposition (IBD) and physical vapour deposition (PVD, magnetron sputtering)) was laterally magnetic patterned by means of focused ion beam irradiation (FIB) on a micrometer scale. 25 keV ion irradiation with a fluence of $2 \times 10^{14} \text{Ga}^+ \cdot \text{cm}^{-2}$ leads to a disordering of the as prepared chemically ordered PtMn-phase with only minor changes in sample topography. Thus the exchange bias field as well as the coercive field was reduced to a large extent on a local scale. The magnetic properties of FIB written $1 \mu\text{m}$ wide stripes and their interaction with the non-irradiated spacing were analyzed by means of magneto-optic Kerr effect, magnetic force microscopy, and Kerr microscopy. The application of a magnetic field between -12 Oe and -80 Oe with respect to the exchange bias field direction leads to an antiparallel alignment of irradiated and non-irradiated stripes forming pronounced domain walls. A parallel alignment was found below -100 Oe and in the positive field region.

MA 20.54 Mo 14:00 Poster TU C

All-optical probe of magnetization dynamics in exchange bias systems — ●M. C. WEBER¹, H. NEMBACH¹, H. SCHULTHEISS¹, C. BAYER¹, S. BLOMEIER¹, R. KALTOFEN², J. SCHUMANN², M. J. CAREY³, B. HILLEBRANDS¹, and J. FASSBENDER⁴ — ¹Fachbereich Physik, Technische Universität Kaiserslautern, 67663 Kaiserslautern, Germany — ²Institut für Dünnschichtsysteme der Mikroelektronik, IFW Dresden, 01171 Dresden, Germany — ³Hitachi Global Storage Technologies, San Jose Research Center, San Jose CA 95120, USA — ⁴Institut für Ionenstrahlphysik und Materialforschung, FZ Rossendorf, 01314 Dresden, Germany

The picosecond optical control of the exchange bias anisotropy was investigated in real time for different exchange bias bilayers (NiFe/FeMn, CoFe/NiMn, CoFe/IrMn) using time-resolved magneto-optics. Upon photoexcitation the spin temperature is increased leading to a collapse of the interfacial exchange coupling. Both the shift fields and the easy axis coercivities are reduced within the first 10 ps. The unpinning is followed by a slower spin-lattice relaxation process. The deduced relaxation times turn out to be quite comparable (< 205 ps) for all bilayers. The thermal decoupling of the bilayers can lead to a high frequency precession of the magnetization of the ferromagnetic layers. The precessional response of the CoFe/IrMn system reveals a Kittel type field dependence of the precession frequency. Brillouin light scattering measurements of the field dependence of the FMR frequency are in good agreement with the real time measurements, further supporting the homogeneous mode character of the optically excited precession.

MA 20.55 Mo 14:00 Poster TU C

Bi-domain state in the exchange bias system FeF₂/FM with FM=Fe, Co or Ni — ●OLEG PETRACIC^{1,2}, IGOR V. ROSHCHIN¹, ZHI-PAN LI¹, RAFAEL MORALES¹, XAVIER BATLLE¹, and IVAN K. SCHULLER¹ — ¹Physics Department, University of California, San Diego, La Jolla, California 92093, USA — ²Angewandte Physik, Universität Duisburg-Essen, 47048 Duisburg, Germany

Independently exchange biased subsystems can coexist in FeF₂/FM bilayers (FM=Fe, Co or Ni) after various field-cooling protocols. This is evidenced from double hysteresis loops found in magnetization and spatially resolved magneto-optic Kerr-data. Surprisingly the double loops are not only found after zero-field cooling, but also using intermediate cooling fields. In both cases the ferromagnet does not experience an average bias from the antiferromagnet but rather two independent subsystems ('bi-domain' state). This idea is confirmed by micromagnetic simulations including the effect of the antiferromagnet. We also present experiments, where thermally activated motion of these antiferromagnetic 'domain' boundaries can be achieved.

MA 20.56 Mo 14:00 Poster TU C

"Gigantic" Magnetolectric Effect in Multiferroic Manganites — ●M. FIEBIG¹, TH. LOTTERMOSER¹ und T. LONKAI^{1,2,3} — ¹Max-Born-Institut, Max-Born-Straße 2a, 12489 Berlin — ²Institut für Angewandte Physik, Universität Tübingen, Auf der Morgenstelle 10, 72076 Tübingen — ³Hahn-Meitner-Institut, Glienicker Straße 100, 14109 Berlin

The crosslink between magnetic and electric properties expressed by the magnetolectric (ME) effect opens new degrees of freedom for device construction. Recently, an enormous interest in ME phenomena is observed because composite materials and multiferroics, i.e. materials with multiple magnetic, electric and/or elastic ordering, exhibit structural and gigantic ME effects which exceed previous effects by many orders of magnitude and control phase transitions. We will discuss three types of "gigantic" ME coupling that were observed in ferroelectric (FEL) antiferromagnetic (AFM) RMnO₃ (R = Sc, Y, In, Ho-Lu). (i) An external magnetic or electric field induces ferromagnetic R³⁺ ordering which is reversibly switched on or off. The process is monitored by magneto-optical techniques (second harmonic generation, Faraday rotation). Its microscopic origin is disclosed by neutron and x-ray powder diffraction. (ii) An interaction of FEL and AFM domain walls which clamps the AFM to the FEL domain structure. It roots in piezomagnetic interaction between magnetization of the AFM walls and strain in the FEL walls which lowers the free energy. (iii) A massive formation of *spin-rotation domains* which supplement *spin-reversal domains* in the course of a reorientation of Mn³⁺ spins. This leads to a local ME effect which is only allowed because of the low symmetry of the domain walls.

MA 20.57 Mo 14:00 Poster TU C

Magnetization Reversal in Exchange Biased Multilayers with Field Direction — ●AMITESH PAUL, EMMANUEL KENTZINGER, ULRICH RÜCKER, DANIEL BÜGLER, and THOMAS BRÜCKEL — Institut für Festkörperforschung, Forschungszentrum Jülich GmbH, D-52425 Jülich, Germany

The magnetization reversal in exchange-biased multilayers is studied by specular reflection and off-specular scattering of polarized neutrons for polycrystalline [Ir₂₀Mn₈₀(6.0 nm)/Co₈₀Fe₂₀(3.0 nm)]₁₀ multilayers. For increasing and decreasing applied fields, we have observed earlier symmetric and sequential reversal only via domain formation [1], when the applied field direction was along the exchange bias direction. In the present study, the CoFe layer remagnetizes symmetrically for both field branches in a uniform (via coherent rotation) as well as non-uniform mode (via domain formation) for different directions (90 and 45 deg.) of the applied fields w.r.t. the unidirectional anisotropy direction. We observe the enhanced spin-flip specular intensity at the HADAS reflectometer [1] indicating coherent rotation of the in-plane component of magnetization perpendicular to the field due to the variation of the field direction, which is in agreement with the theoretical model of Beckmann *et al* [2]. However, we show that such uniform mode of reversal can take place irrespective of the underlying domain wall motion. The small scale magnetization fluctuations as revealed by off-specular spin-flip scattering at reversal points clearly demonstrates this for different field directions.

[1] A. Paul *et al*, Phys. Rev. B (in press) 2004.

[2] B. Beckmann *et al*, Phys. Rev. Lett. 91, 187201, 2004.

MA 20.58 Mo 14:00 Poster TU C

Reversal of interlayer coupling with temperature — ●M. WIETSTRUK, K.M. DÖBRICH, J.E. PRIETO, O. KRUPIN, F. HEIGL, G. KAINDL, and K. STARKE — Freie Universität Berlin, Fachbereich Physik

The oscillatory nature of interlayer coupling has been analyzed for the case of Gd/Y/Tb trilayers. This epitaxial all-rare-earth system differs from the well known transition metal systems as both the interlayer and the intralayer coupling are of the indirect RKKY type, and hence of similar strength. We used x-ray magneto-optical Kerr effect (XMOKE) at the 3d-4f excitation thresholds to record element specific hysteresis loops of Gd and Tb for different Y spacer thicknesses up to 2 nm. For a constant spacer thickness, the interlayer coupling is found to change with temperature between antiferromagnetic and ferromagnetic. This up to now unobserved effect shows a systematic behavior with spacer thickness; it will be discussed in light of a simple model for interlayer exchange coupling.

MA 20.59 Mo 14:00 Poster TU C

Asymmetric fixed and rotatable magnetic anisotropy at the onset of exchange bias — ●JEFFREY MCCORD¹ and ROLAND MATTHEIS² — ¹Leibniz Institute for Solid State and Materials Research Dresden - Institute for Metallic Materials - 01169 Dresden — ²Institut für physikalische Hochtechnologie IPHT Jena - 07745 Jena

The strength of exchange bias and rotatable anisotropy in polycrystalline NiFe/IrMn ferromagnet/antiferromagnet systems is quantified from dc down to the ps time-scale by regular quasi-static and microwave magnetometry, as well as magnetic domain observation. A transition from superparamagnetic to antiferromagnetic behavior with increasing IrMn thickness is derived from the magnetic resonance frequency and the effective magnetic damping parameter. A discrepancy between magnetic loop shift and dynamically obtained exchange bias strength is explained by asymmetric rotatable anisotropy contributions with different relaxation times in the antiferromagnetic layer. The time dependent relaxation is directly confirmed by magnetic domain observations. Partially switching in the IrMn layer even with strong exchange bias is concluded. The increase of coercivity rises solely from the rotatable anisotropy contribution.

MA 20.60 Mo 14:00 Poster TU C

Tuning the Exchange Bias in FeMn/Ni₈₁Fe₁₉ by nonmagnetic Cu defects in the FeMn layer — ●J.O. HAUCH, C. PAPUSOI, M. FECIORU, and G. GÜNTHERODT — II. Physikalisches Institut, RWTH Aachen, 52056 Aachen

Previous theoretical [1] and experimental [2] work on CoO/Co antiferromagnetic/ferromagnetic (AFM/FM) bilayer systems revealed that increasing the nonmagnetic defect concentration at the Co site in the AFM layer leads to an enhancement of the exchange bias. In this study we present the dependence of the exchange bias in FeMn/Ni₈₁Fe₁₉ on nonmagnetic Cu dilution in the AFM layer. Experiments have been performed on Au(5nm)/(Fe₅₀Mn₅₀)_{1-x}Cu_x(10nm)/Ni₈₁Fe₁₉(10nm)/Cu/SiO₂ layer systems. The exchange bias shows a maximum at around 10% Cu defect concentration. These results can be explained as a consequence of a competition between two effects: The increase of the defect concentration leads to an increase of the number of uncompensated moments in the AFM enhancing the exchange bias. On the other hand, the distance of the nonmagnetic pinning sites is decreased by increasing Cu concentration inducing domain walls in the AFM layer. Thereby the thermal instability of the uncompensated moments is increased, thus decreasing the exchange bias. Monte Carlo simulations have been performed to prove the above statement. [1] U. Nowak, K.D. Usadel, J. Keller, P. Miltenyi, B. Beschoten, and G. Güntherodt, Phys. Rev. B **66**, 014430 (2002). [2] J. Keller, B. Beschoten, G. Güntherodt, U. Nowak, and K.D. Usadel, Phys. Rev. B **66**, 014431 (2002).

MA 20.61 Mo 14:00 Poster TU C

Orbital polarons versus itinerant e_g electrons in doped manganites — ●MARIA DAGHOFER¹, ANDRZEJ OLES², and WOLFGANG VON DER LINDEN¹ — ¹Institute for Theoretical and Computational Physics, TU Graz, Austria — ²Marian Smoluchowski Institute of Physics, Jagellonian University, Kraków, Poland

We study an effective one-dimensional (1D) orbital t - J model derived for strongly correlated e_g electrons in doped manganites. At half doping, an FM chain with alternating orbital order competes with an orbitally polarized AFM chain. Alternating orbitals are supported by an alternating Jahn-Teller potential, while spin AFM is favored by the t_{2g} superexchange. Because the FM and AFM states have very similar energy, small changes in the concerning parameters can have a large impact and can switch the system from one scenario to the other.

At finite doping, the kinetic energy favors both ferromagnetism and orbital polarization. The transition from the undoped chain with alternating spin or orbital order to the polarized chain at high doping is investigated by examining a variety of observables. Upon doping, orbital polarons enter the FM chain with alternating orbital order, and spin polarons are found for the AFM chain. Phase separation into regions of high and low carrier density is only observed for FM chains *without* Jahn-Teller distortions.

The Jahn-Teller potential is found to hinder the transition to the orbitally polarized state, but at least for small potentials, it does not substantially decrease the kinetic energy once this transition has occurred.

MA 20.62 Mo 14:00 Poster TU C

Magnetization Reversal in Exchange Biased Multilayers with Field Direction — ●AMITESH PAUL, EMMANUEL KENTZINGER, ULRICH RÜCKER, DANIEL BÜRGLER, and THOMAS BRÜCKEL — Institut für Festkörperforschung, Forschungszentrum Jülich GmbH, D-52425 Jülich, Germany

The magnetization reversal in exchange-biased multilayers is studied by specular reflection and off-specular scattering of polarized neutrons for polycrystalline [Ir₂₀Mn₈₀(6.0 nm)/Co₈₀Fe₂₀(3.0 nm)]₁₀ multilayers. For increasing and decreasing applied fields, we have observed earlier symmetric and sequential reversal only via domain formation [1], when the applied field direction was along the exchange bias direction. In the present study, the CoFe layer remagnetizes symmetrically for both field branches in a uniform (via coherent rotation) as well as non-uniform mode (via domain formation) for different directions (90 and 45 deg.) of the applied fields w.r.t. the unidirectional anisotropy direction. We observe the enhanced spin-flip specular intensity at the HADAS reflectometer [1] indicating coherent rotation of the in-plane component of magnetization perpendicular to the field due to the variation of the field direction, which is in agreement with the theoretical model of Beckmann *et al* [2]. However, we show that such uniform mode of reversal can take place irrespective of the underlying domain wall motion. The small scale magnetization fluctuations as revealed by off-specular spin-flip scattering at reversal points clearly demonstrates this for different field directions. [1] A. Paul *et al*, Phys. Rev. B (in press) 2004.

[2] B. Beckmann *et al*, Phys. Rev. Lett. 91, 187201, 2004.

MA 20.63 Mo 14:00 Poster TU C

Exchange bias effects in [Pt/Co] - IrMn multilayers with perpendicular anisotropy — ●S. BRÜCK¹, J. SORT^{1,2}, V. BALTZ², B. RODMACQ², B. DIENY², S. SURIÑACH¹, J. S. MUÑOZ¹, M. D. BARÓ¹, and J. NOGUÉS³ — ¹Dept. de Física, Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain — ²SPINTEC, CEA/Grenoble, 17 Rue des Martyrs, 38054 Grenoble Cedex 9, France — ³Institució Catalana de Recerca i Estudis Avançats (ICREA) and Dept. de Física, Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain

Exchange coupled [Pt/Co]-IrMn multilayers (ML), where IrMn is antiferromagnetic at room temperature, exhibit simultaneously a perpendicular to film magnetic effective anisotropy and a shift of the hysteresis loop along the magnetic field axis (i.e., perpendicular exchange bias). By varying the thickness of the Co layers in the ML or by inserting a Pt spacer between the ML and the AFM the magnitudes of both, the exchange bias field H_E and the coercivity H_C , can be accurately tailored. The perpendicular magnetic anisotropy is found to play a significant role on the shape of the hysteresis loops and the exchange bias effects. Some outstanding properties of the [Pt/Co]-IrMn ML compared to the commonly studied ferromagnetic-antiferromagnetic bilayers with in-plane anisotropy will be discussed. Our results are particularly appealing for the design of novel types of magnetic reading heads consisting of spin valves or magnetic tunnel junctions with perpendicular anisotropy.

MA 20.64 Mo 14:00 Poster TU C

Dynamic quasi-particle behaviour of geometrically confined domain walls — ●DANIEL BEDAU¹, MATHIAS KLÄUI¹, ULRICH RÜDIGER¹, DIRK BACKES², L. J. HEYDERMAN², GIANCARLO FAINI³, C.A.F. VAZ⁴ und J.A.C. BLAND⁴ — ¹FB Physik, Universität Konstanz, Konstanz, Germany — ²LMN, Paul Scherrer Institut, Villigen, Switzerland — ³LPN-CNRS, Marcoussis, France — ⁴CavendishLaboratory, University of Cambridge, UK

Geometrically confined domain walls in which the spin structure of a wall can be controlled via the lateral dimensions and film thickness have recently become the focus of intense research. Ferromagnetic rings are of particular interest, since in these structures simple magnetic states with head-to-head domain walls are found that make this geometry suitable for probing domain wall properties, e.g. the pinning at or the repulsion from notches depending on the domain wall type [1]. Transverse domain walls are attracted by constrictions and due to their small lateral dimensions they act as quasi-particles in an attractive potential well. Using magnetoresistance measurements, the depth and the width of the potential well can be determined [2]. To completely characterize the potential 'landscape', the curvature of the potential well needs to be ascertained by studying dynamic oscillation of the domain wall (resonance frequencies). Apart from the fundamental oscillation, higher-order resonances are found with frequencies in the GHz range.

[1] M. Kläui et al., Phys. Rev. B 68, 134426 (2003), Physica B 343, 343 (2004) [2] M. Kläui et al., Phys. Rev. Lett. 90, 97202 (2003)

MA 20.65 Mo 14:00 Poster TU C

Superparamagnetic behaviour of vortex cores. — ●ROBERT WIESE, NATALIA KAZANTSEVA, ULRICH NOWAK und K. D. USADEL — Fachbereich für Physik, Universität Duisburg-Essen

Magnetic vortices have been studied for a long time. The reviewed interest is triggered by the possibility of a direct observation of vortices in permalloy and Co magnetic nanodots. Such vortex structures are discussed in connection with high density data-storage and miniature sensors.

Earlier theoretical investigations in this regime have been done mostly at zero temperature. In this contribution we report on the thermodynamical behaviour of such vortex structures.

Our simulation based on Langevin dynamics show that the vortex core becomes superparamagnetic with increasing temperature. The energy barrier is estimated as difference between the energy of the in-plane vortex (all spins in plane) and the energy of the out-of-plane vortex (with central polarization). The barrier decreases with increasing core radius, which is given by the relation between dipol-dipol and exchange interaction.

Additional we found that with increasing temperature the magnetization inside the vortex core decreases faster than the magnetization outside the central region.

ACKNOWLEDGMENTS: Work supported by the Deutsche Forschungsgemeinschaft (SFB 491).

MA 20.66 Mo 14:00 Poster TU C

Ultrafast photo-conductive switches — ●M. PIETZ¹, S. BRETSCHNEIDER¹, A. PARGE¹, T. SALDITT², A. FÖRSTER³, and M. MÜNZENBERG¹ — ¹4. Phys. Institut Universität Göttingen — ²Institut für Röntgenphysik Universität Göttingen — ³Institut für Schichten und Grenzflächen (ISG1) Forschungszentrum Jülich

Ultrafast photoconductive switches, based on metal-semiconductor-metal contact pads using low temperature grown GaAs as a semiconductor, deliver the fastest current pulses on a chip so far. Using fs-laser pulses from a TiSa-laser system for the excitation of the carriers, current pulses of a few picoseconds (2-3 ps) in length are generated. The pulses are characterised with autocorrelation and photoconductive sampling techniques. The field pulse in the order of 10 Oe can be used to trigger the magnetization dynamics in a magnetic nanostructure. Therefore, magnetic structures on a strip line are prepared with the help of optical and e-beam lithography, with the aim to explore magnetic Eigen mode oscillations and extrinsic as well as intrinsic damping parameters in a pump-probe experiment with ps time resolution.

MA 20.67 Mo 14:00 Poster TU C

Spin-lattice relaxation phenomena in manganite $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$ thin films — ●MARKUS C. WEBER¹, VASILY MOSHNYAGA², KONRAD SAMWER², and BURKARD HILLEBRANDS¹ — ¹Fachbereich Physik und Forschungsschwerpunkt MINAS, Technische Universität Kaiserslautern, Erwin-Schrödinger-Str. 56, 67663 Kaiserslautern, Germany — ²I. Physikalisches Institut, Universität Göttingen, Bunsenstr. 9, 37073 Göttingen, Germany

All-optical pump-probe experiments employing magneto-optics as a probe were performed to study spin and lattice relaxation dynamics in thin epitaxial $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$ films. The perovskite manganites were grown by a metalorganic aerosol deposition technique [1] onto MgO substrates. The films reveal a ferromagnetic-paramagnetic phase transition at a Curie temperature of about $T_C = 360$ K. Upon photoexcitation the spin temperature is elevated close to or even above T_C . By properly choosing the pump pulse energy it is possible to demagnetize the sample completely within the pump pulse width ($\tau = 8.3$ ps), associated with a collapse of the remanence. Two distinct recovery regimes of the ferromagnetic order can be resolved upon arrival of the pump pulse, which manifest themselves by two different relaxation times. A pump pulse energy independent spin-lattice relaxation time of about 200 ps can be deduced from the real time evolution of the remanence. One dimensional heat flow out of the manganite film into the substrate with a time constant of about 0.5 ns up to 1 ns depending on the pump pulse energy sets the ultimate speed of recovery of the ferromagnetic order.

[1] V. Moshnyaga et al., Appl. Phys. Lett. 74, 2842 (1999).

MA 20.68 Mo 14:00 Poster TU C

New 3D coplanar wave guide design using organic isolation layers for ultrafast magnetic switching investigations — ●P. MARTIN PIMENTEL¹, H.T. NEMBACH¹, B. LEVEN¹, B. HILLEBRANDS¹, S. TRELLENKAMP², and S. WOLFF² — ¹FB Physik und FSP MINAS, TU Kaiserslautern, — ²Nano+Bio-Center, TU Kaiserslautern, Paul-Ehrlich-Str. 13, 67663

In order to push magnetic random access memory (MRAM) into the GHz operation regime, coplanar wave guides must be used for applying the magnetic field pulses. We have developed a complex 3D sample structure consisting of a base stack of three different microstructured field pulse lines isolated against each other which form the carrier of the magnetic element. In contrast to using inorganic isolation layers we improved the sample processing using the organic photoresist benzocyclobutene BCB (Dow Chemical, cyclothene™ 4026), which provides fast usage, high planarization, good isolation and flexibility to adjust the isolation layers to the sample design.

This work is supported by the EU-RTN ULTRASWITCH (HPRN-CT-2002-00318).

MA 20.69 Mo 14:00 Poster TU C

Ferromagnetic resonance in mesoscopic rectangular permalloy structures — ●P. REUTER, F. GIESEN, and D. GRUNDLER — Institut für Angewandte Physik und Mikrostrukturforschungszentrum, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg, Germany

The magnetization dynamics of miniaturized ferromagnets is increasingly interesting for applications in magnetic storage devices. We have studied the dynamics of 20 nm thin ferromagnetic permalloy films shaped to squares ($1 \times 1 \mu\text{m}^2$) and rectangles (1×2 and $1 \times 4 \mu\text{m}^2$) using network-analyzer ferromagnetic resonance (FMR) measurements in the range of 45 MHz to 20 GHz at room temperature. By electron beam lithography and lift-off processing of thermally evaporated $\text{Ni}_{80}\text{Fe}_{20}$ the permalloy structures were deposited in arrays on broadband coplanar wave guides. In our devices we find several FMR modes which shift systematically with the applied in-plane magnetic field H_b and which reflect the different domain configurations. We attribute these modes to localized spin waves. FMR frequencies up to 13 GHz are observed at 90 mT, higher than the uniform precession mode of 10 GHz in an unpatterned permalloy film. Through aligning H_b in hard- or easy-axis direction we have addressed the dynamics originating from the bulk area and from the edge area, respectively. We thank D. Heitmann and J. Podbielski. Financial support by the BMBF via 13N8283 is gratefully acknowledged.

MA 20.70 Mo 14:00 Poster TU C

Localized spin waves in nanostructured permalloy rings — ●JAN PODBIELSKI, FABIAN GIESEN, and DIRK GRUNDLER — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstraße 11, 20355 Hamburg.

Due to the increased data transfer rates in magnetoelectronic devices the dynamic properties of ferromagnetic nanostructures have become increasingly important. Using a broadband microwave spectrometer (45 MHz - 20 GHz) we have studied the ferromagnetic resonance (FMR) in periodic arrays of $\text{Ni}_{80}\text{Fe}_{20}$ rings. The outer diameter of the rings was $2 \mu\text{m}$ and the ringwidth w was varied in the different arrays down to 300 nm. The devices were deposited on broadband coplanar wave guides. For all rings we observe a series of FMR modes which shift characteristically as a function of w and external magnetic field. These modes are attributed to localized spin waves.[1] We developed an extended macrospin model subdividing the ring into characteristic segments which explains the observed features. Further intriguing observations are made on rings with a small width: hysteretic behavior and irreversible jumps of FMR modes as well as microwave assisted switching. We explain these features by the magnetic-field dependent spin configurations, namely the onion and vortex states in the rings. We thank D. Heitmann, T. Korn and M. Steiner. Financial support by the BMBF via 13N8283 and by the DFG is gratefully acknowledged.

[1] F. Giesen, J. Podbielski, T. Korn, and D. Grundler, J. Appl. Phys. (in press).

MA 20.71 Mo 14:00 Poster TU C

Magnetic excitations in finite rectangular elements — ●C. BAYER¹, J. JORZICK¹, H. SCHULTHEISS¹, B. HILLEBRANDS¹, S.O. DEMOKRITOV², A.N. SLAVIN³, K. GUSLIENKO⁴, and M.P. KOSTYLEV⁵ — ¹Fachbereich Physik and Forschungsschwerpunkt MINAS, Technische Universität Kaiserslautern, Germany — ²Institut für Angewandte Physik, Westfälische Wilhelms-Universität Münster, Germany — ³Department of Physics, Oakland University, Rochester, Michigan 48309, USA — ⁴Materials Science Division, Argonne National Laboratory, Argonne, USA — ⁵St. Petersburg Electrotechnical University, 197376 St. Petersburg, Russia

We report on progress in the understanding of spin-wave modes in arrays of micron-size magnetic Ni₈₀Fe₂₀ stripes and rectangular elements. Several effects caused by the lateral confinement in the stripes are investigated using Brillouin light scattering: (i) lateral quantization of dipole-dominated Damon-Eshbach spin-wave modes in a longitudinally magnetized stripe due to its finite width, (ii) localization of exchange-dominated spin wave modes near the edges and dipole-dominated spin wave modes near the center of a transversely magnetized long magnetic stripe due to the inhomogeneity of its internal magnetic field, (iii) combination of quantization and localization effects for the spin wave modes in rectangular elements. The observed effects are analyzed theoretically using an analytical approach as well as numerical simulations. From the comparison of the latest experimental findings with the results of new calculations the mode spectrum of rectangular elements can now be described quantitatively with very good accuracy.

MA 20.72 Mo 14:00 Poster TU C

Ferromagnetische Resonanz an Fe/ZnSe detektiert mit nicht-zeitaufgelöstem Magnetooptischen Kerr-Effekt — ●MARC MÖLLER, DETLEF SPODDIG und RALF MECKENSTOCK — AG Festkörperspektroskopie, Institut für Experimentalphysik, Ruhr-Universität Bochum, D-44780 Bochum

In der Ferromagnetischen Resonanz (FMR) wird die Magnetisierung einer magnetischen Schicht zur Präzession um ihre Gleichgewichtslage angeregt. Die Präzession kann mit Hilfe des magnetooptischen Kerr-Effektes (MOKE) in einem konventionellen Aufbau ohne die Notwendigkeit der zeitaufgelösten Messung detektiert werden. Durch geeignete Wahl der Einfallsebene des Lichts können verschiedene Magnetisierungskomponenten selektiert werden. Für die Messung wird ein konventionelles FMR-Spektrometer mit offenem Zylinderresonator verwendet, so dass das anregende Mikrowellenfeld am Probenort wohldefiniert und homogen ist. Durch Verwendung eines fokussierten Laserstrahls wird eine Ortsauflösung im Mikrometerbereich erreicht. Es wurden (001)-Fe Schichten auf ZnSe mit ZnSe-Deckschicht untersucht und die Ergebnisse mit numerischen Simulationen verglichen.

Diese Arbeit wurde unterstützt vom Sonderforschungsbereich 491.

MA 20.73 Mo 14:00 Poster TU C

Ab initio Calculation of Excitation Spectra in Magnetic Materials — ●MANFRED NIESERT, CHRISTOPH FRIEDRICH, ARNO SCHINDLMAYR, and STEFAN BLÜGEL — Institut für Festkörperforschung, Forschungszentrum Jülich, 52425 Jülich

Although spin-wave excitations play an important role in the thermodynamics of magnetic materials, theoretical studies are still mostly based on simple lattice systems with empirical parameters, such as the Heisenberg model. Constrained density-functional theory does not suffer from this disadvantage, but the frozen-magnon approximation restricts practical calculations to the adiabatic regime. Dynamical properties like excited-state lifetimes can only be obtained from a true many-body approach. The key quantity in this respect is the dynamical spin susceptibility. As a first step towards a full ab initio treatment, we investigate time-dependent density-functional theory at the level of the Kohn-Sham response function. This approach is inherently dynamical and can be made formally exact with the inclusion of an exchange-correlation kernel. In addition, quasiparticle excitations are studied using the *GW* approximation for the electronic self-energy. We assess the performance of these approaches for different classes of magnetic materials. The implementations are based on the full-potential linearized augmented plane-wave (FLAPW) method.

MA 20.74 Mo 14:00 Poster TU C

Near-field imaging of magnetic nanostructures with high lateral and temporal resolution — ●GEREON MEYER, ANDREAS BAUER, ANDREAS GORIS, and GÜNTER KAINDL — Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin-Dahlem

Magnetic-domain patterns can be imaged with high magnetic contrast, sub-wavelength lateral resolution and in the presence of external magnetic fields by utilizing a scanning near-field optical microscope in combination with a Sagnac interferometer (Sagnac-SNOM), which measures the magneto-optical Kerr effect [1,2]. One major advantage of magneto-optics is the ability to study magnetization dynamics on ultrashort time scales. We report on first test measurements of time-resolved magneto-optical SNOM based on Sagnac interferometry: In a stroboscopic measurement, a femtosecond pulse of a frequency-doubled Ti:sapphire laser is split into two counter-propagating pulses of different intensity. One of them is used as pump pulse that optically excites the sample, the other, delayed one, probes the sample with a variable time delay. The non-reciprocal phase shift between the two pulses is a measure of the transient magnetization [2]. In this way, we intend to monitor spin-precessions in ultrathin films with a lateral resolution of < 150 nm.

[1] G. Meyer et al., Appl. Phys. Lett. **83**, 1394 (2003).

[2] G. Meyer, A. Bauer, and G. Kaindl, *Near-Field Imaging of Magnetic Domains*, in: *Progress in Nano-Electro Optics IV*, M. Ohtsu (ed.) (Springer, Berlin, 2005).

MA 20.75 Mo 14:00 Poster TU C

Dynamic properties of geometrically confined domain walls — ●FREDERIK WEGELIN¹, ALEXANDER KRASYUK¹, MATHIAS KLÄUI², HANS-JOACHIM ELMERS¹ und GERHARD SCHÖNHENSE¹ — ¹Johannes Gutenberg-Universität Mainz — ²FB Physik, Universität Konstanz

The critical property for the use of any ferromagnetic nanostructure in applications such as memory or sensor devices is the magnetodynamic switching. While switching by coherent rotation has been widely studied [1], recently switching by domain wall motion has become the focus of intense investigations, since large wall velocities have been observed by Kerr microscopy [2]. To gain a deeper understanding of the domain wall dynamics, we have probed the nanoscale domain wall spin structure in real time using time resolved photoemission electron microscopy (XMCD-PEEM). Micron-sized permalloy structures with square, round and ring geometries have been excited by field pulses down to 100ps length and the magnetization dynamics has been probed with 3ps long x-ray pulses. The propagation and the modification of the domain wall spin structure have been measured during the pulse injection. In particular we observe oscillatory behaviour of transverse head-to-head domain walls [3] in rings, when subjected to 300 ps field pulses.

[1] H. W. Schumacher et al., Phys. Rev. Lett. **90**, 17201 (2003) [2] D. Atkinson et al., Nature Mat. **2**, 85 (2003) [3] M. Kläui et al., J. Phys.: Condens. Matter **15**, R985 (2003)

MA 20.76 Mo 14:00 Poster TU C

Ground state and constrained domain walls in Gd/Fe multilayers — ●BAS B. VAN AKEN^{1,2}, JOSÉ L. PRIETO¹, and NEIL D. MATHUR¹ — ¹Department of Materials Science, University of Cambridge, Cambridge U.K. — ²present address: Max-Born-Institut, Berlin

The study of spin-polarised transport is key for the understanding of processes involved in spin-electronics. A particular interesting point is the effect of domain walls (DWs) on the transport properties of ferromagnetic materials. The magnetic ground state of antiferromagnetically coupled Gd/Fe multilayers and the evolution of in-plane domain walls is modelled with micromagnetics. The twisted state is characterised by a rapid decrease of the interface angle with increasing magnetic field. We found that for certain ratios of the Gd and Fe layer thicknesses, the twisted state is already present at low fields. However, the magnetic ground state is not only determined by the layer thickness ratio, or magnetic moment ratio. It is also effected by the thicknesses of the layers, that is the total moment of each layer. The dependence of the magnetic ground state is explained by the amount of overlap of the domain walls at the interface. Thicker layers suppress the Fe aligned state and the Gd aligned state in favour of the twisted state. On the contrary, ultrathin layers exclude the twisted state, since wider domain walls can not form in these ultrathin layers.

MA 20.77 Mo 14:00 Poster TU C

Magnetisch Wechselwirkende Permalloy Inseln auf Si(100) — ●CENGIZ BIRCAN, ANDREAS WESTPHALEN, ARNDT REMHOF und HARTMUT ZABEL — Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, 44780 Bochum

Wir haben das Ummagnetisierungsverhalten von periodisch angeordnete Permalloy ($\text{Ni}_{80}\text{Fe}_{20}$) Inseln in Abhängigkeit des lateralen Abstand untersucht. Die künstlich strukturierten magnetischen Inseln wurden mittels Elektronenstrahlolithographie und Ionensputtern hergestellt. Drei verschiedene Strukturen wurden realisiert: (i) $0.3 \mu\text{m} \times 3 \mu\text{m} \times 30 \text{ nm}$ große Inseln, (ii) geschlossene und (iii) offene Rahmen von $0.3 \mu\text{m}$ Breite, $3 \mu\text{m}$ Länge und 30 nm Dicke. Die magnetische Charakterisierung erfolgte durch SQUID-Magnetometrie, Magneto-optischen Kerr Effekt (MOKE) und durch resonante magnetische Röntgenbeugung im Bereich der magnetisch sensitiven Absorptionskanten (L-Kanten). Sowohl bei der Röntgenbeugung als auch bei MOKE wurde insbesondere die spekulären Beugungsmaxima (Bragg-MOKE) untersucht. In Abhängigkeit von der Probengeometrie und der gewählten Abständen ändern sich sowohl das Koerzitivfeld als auch die magnetische Ausrichtung der einzelnen Py-Inseln. Bei den Rahmenstrukturen konnten je nach vorhergehender Aufmagnetisierung verschiedene remanente Anordnungen, wie z. B. der Vortex state, aber auch der sogenannte Onion state und der Horseshoe state realisiert werden.

Gefördert durch die DFG im Rahmen des SFB 491.

MA 20.78 Mo 14:00 Poster TU C

Magnetic domain structure of micro-patterned PtMn/CoFe exchange bias bilayers — ●M.O. LIEDKE^{1,2}, K. POTZGER¹, B. HILLEBRANDS², M. RICKART³, P. FREITAS³, and J. FASSBENDER¹ — ¹FZ Rossendorf, Institut für Ionenstrahlphysik und Materialforschung, 01314 Dresden — ²Fachbereich Physik, TU Kaiserslautern, 67663 Kaiserslautern — ³INESC MN, 1000 Lisabon, Portugal

Using magnetron sputtering deposition a number of high exchange bias field samples were prepared for magnetic patterning investigations. The system prepared is as follow: glass/Ta 70 Å/PtMn 200 Å / $t_{\text{CoFe}} = 20 - 60 \text{ Å}$ /Ta 40 Å. One of such bottom pinned samples with 40 Å of CoFe was used for optical lithography. Several patterns have been etched physically with decreasing lateral sizes of either the edges or the spacing between the elements. The largest square is $50 \times 50 \mu\text{m}$ and the smallest only $1 \mu\text{m}^2$. The separating lines are ranging from $10 \mu\text{m}$ to $2 \mu\text{m}$ width. The magnetic characterization of the samples have been done by VSM and MOKE. All samples exhibit well defined exchange bias field. A series of MFM images were taken from the structures. All images show a monodomain magnetization state in zero magnetic field. The shape of the structure itself dose not influence stray field direction. The shape anisotropy contribution is thus smaller than the unidirectional anisotropy given by the exchange bias. MFM investigation in an applied magnetic field have been done to get a deeper understanding of the domain pattern.

MA 20.79 Mo 14:00 Poster TU C

Untersuchungen an elektrolytisch abgeschiedenen Permalloy nano Strukturen mittels lokaler thermischer Ferromagnetischer Resonanz — ●D. SPODDIG¹, M. V. RASTEI², M. BAIFFEUL², E. BEAUREPAIRE², R. MECKENSTOCK¹, J.-P. BUCHER² und J. PELZL¹ — ¹AG Festkörperspektroskopie, Ruhr-Universität Bochum, D-44780 Bochum, Deutschland — ²IPCMS, Université Louis Pasteur, F-67037 Strasbourg Cedex, Frankreich

Magnetische Untersuchungen von nano-strukturierten Probensystemen werden von immer größerer Bedeutung. In diesem Beitrag werden lateral strukturierte Permalloy(Py)-Schichten auf Si-Substraten untersucht. Die Strukturierung erfolgt durch Elektronenstrahlolithographie. Als Strukturen wurden Streifen mit $80 \mu\text{m}$ Länge und Breiten zwischen 200 und 500 nm gewählt. Der Abstand wurde zwischen 200 und 1000 nm variiert. Durch einen elektrolytischen Prozess wurde die Py-Schicht abgeschieden. Da der Fotolack nicht entfernt wird, sind die Kanten der Strukturen wohl definiert. Die lokale Detektion der Ferromagnetischen Resonanz (FMR) erfolgt durch ein scannendes thermisches Mikroskop (SthM), welches durch einen Temperatursensor (100 nm Auflagefläche) an der Spitze des eingesetzten Cantilevers eine Temperaturänderung im mK-Bereich feststellen kann. Eine solche Erwärmung wird in der Probe durch die FMR Absorption erzeugt. Durch die lokale Detektion ist es möglich das Signal der FMR in der Mitte, am Rand und den Enden der Streifen zu untersuchen. Einflüsse durch die Formanisotropie können dabei diskutiert werden. Unterstützung von SFB 491.

MA 20.80 Mo 14:00 Poster TU C

Nanoscale Mechanosynthesized Magnesium Ferrite with Enhanced Magnetization — ●VLADIMIR ŠEPELÁK¹, INGO BERGMANN², FRANK KRUMEICH³, DIRK MENZEL⁴, and KLAUS DIETER BECKER² — ¹Center for Solid State Chemistry and New Materials, University of Hannover, 30167 Hannover, Germany; on leave from Slovak Academy of Sciences, Košice, Slovakia — ²Institute of Physical and Theoretical Chemistry, TU Braunschweig, 38106 Braunschweig, Germany — ³Laboratory of Inorganic Chemistry, Swiss Federal Institute of Technology Zurich, 8093 Zurich, Switzerland — ⁴Institute of Semiconductor Physics and Optics, TU Braunschweig, 38106 Braunschweig, Germany

Nanosized spinel-type ferrites are currently key materials for advancements in electronics, magnetic storage, ferrofluid technology, optoelectronics, and in many bioinspired applications (for example, as drugs carriers for magnetically guided drug delivery and as contrast agents in magnetic resonance imaging). In this contribution, nanocrystalline magnesium ferrite (MgFe_2O_4) with crystallite size of 8 nm has been synthesized by high-energy milling method from a mixture of $\alpha\text{-Fe}_2\text{O}_3$ and MgO. High-field Mössbauer spectroscopy, X-ray powder diffraction, transmission electron microscopy, and magnetization (SQUID) measurements have been used to investigate the structural and magnetic states of the nanoscale mechanosynthesized spinel ferrite. Several interesting features are involved in the work, e.g., superparamagnetism and an irreversible magnetic behavior. The observed enhancement of the magnetization in nanosized mechanosynthesized MgFe_2O_4 is discussed with respect to the non-equilibrium cation distribution and spin canting.

MA 20.81 Mo 14:00 Poster TU C

Investigation of $(\text{Fe}_{(1-x)}\text{Co}_x)_{(1-y)}\text{Pt}_y$ nanoparticles by different electron microscopic methods — ●DANIELA SUDFELD¹, INGA ENNEN¹, ANDREAS HÜTTEN¹, GÜNTHER REISS¹, DANIEL MEISSNER², KLAUS WOJCZYKOWSKI², and PETER JUTZI² — ¹Thin Films and Nanostructures, Department of Physics, University of Bielefeld, Universitätsstr. 25, D-33615 Bielefeld, Germany — ²Inorganic Chemistry III, Department of Chemistry, University of Bielefeld, Universitätsstr. 25, D-33615 Bielefeld, Germany

Today iron oxide particles are used for diverse biological or medical applications as magnetic carriers, for example. For the next generation of magnetic markers ligand stabilized $(\text{Fe}_{(1-x)}\text{Co}_x)_{(1-y)}\text{Pt}_y$ nanoparticles are interesting to substitute the usually used beads. Especially analytical and high-resolution transmission electron microscopy is a primary tool to investigate the ternary alloyed nanocrystals. Additionally the particles have been investigated by other methods like transmission in scanning electron microscopy, x-ray analyses and magnetization measurements. The combination of all techniques give closer insights in the formation and composition of the $(\text{Fe}_{(1-x)}\text{Co}_x)_{(1-y)}\text{Pt}_y$ cluster, the particle size distributions, self-assembling and magnetization behavior.

MA 20.82 Mo 14:00 Poster TU C

Growth Kinetics and Magnetic Properties of Alloyed Fe/Co Nanoparticles — ●KLAUS WOJCZYKOWSKI¹, DANIELA SUDFELD², INGA ENNEN², ANDREAS HÜTTEN², and PETER JUTZI¹ — ¹Inorganic Chemistry III, Department of Chemistry, University of Bielefeld, Universitätsstr. 25, D-33615 Bielefeld, Germany — ²Thin Films and Nanostructures, Department of Physics, University of Bielefeld, Universitätsstr. 25, D-33615 Bielefeld, Germany

Future applications of magnetic nanoparticles will require well-defined magnetic properties of these systems. Monodisperse Nanoparticles of the high-moment iron-cobalt-alloy were synthesized by the co-decomposition of metalorganic cobalt and iron precursors in solution. We found a strong dependence between particle composition and precursor decomposition kinetics. The use of $\text{Co}_2(\text{CO})_8$ as cobalt precursor and $\text{Fe}(\text{CO})_5$ as iron precursor can lead to a core shell structure with iron enriched at the particle surface. Faster decomposing iron precursors of the type $\text{Fe}(\text{CO})_4\text{L}$, where L means donor-ligand, can reverse the situation. Microstructural and magnetic methods are used to elucidate the true structure of the alloyed Fe/Co system.

MA 20.83 Mo 14:00 Poster TU C

Interface Magnetism in Co/CoO core-shell nanoparticles — ●U. WIEDWALD¹, H.-G. BOYEN¹, J. EISENMENGER¹, F. WEIGL¹, K. ZÜRN¹, P. ZIEMANN¹, K. FAUTH², J. LINDNER³, M. SPASOVA³ und M. FARLE³ — ¹Abteilung Festkörperphysik, Universität Ulm, D-89069 Ulm — ²Experimentelle Physik IV, Universität Würzburg, Am Hubland, D-97074 Würzburg — ³Institut für Physik, Universität Duisburg-Essen, D-47048 Duisburg

Colloidal Co particles (9-13 nm) were prepared by organometallic synthesis. The magnetism of these particles is heavily influenced by unavoidable surface modifications due to the attachment of hydro-carbonic ligands and the formation of a 2-3 nm thick antiferromagnetic CoO layer. To study the magnetic response of both Co/CoO core-shell particles and ligand-free metallic particles we employed a combination of hydrogen and oxygen plasma treatments. The degree of surface oxidation/reduction was tracked by x-ray absorption spectroscopy. By combining para/ferromagnetic resonance techniques with x-ray magnetic circular dichroism we quantitatively address the interface magnetism of the particles. Core-shell Co/CoO particles show a rigorous increase in the ratio of orbital-to-spin magnetic moment while metallic Co particles reveal the expected fcc bulk-like behaviour for particles with a low ratio of surface-to-volume atoms ($d > 8$ nm). The separation of the magnetic dichroism of Co atoms in metallic and oxidic environments suggests that the exchange coupling at the interface favours parallel alignment. All results are compared with detailed structural analysis by high-resolution transmission electron microscopy.

MA 20.84 Mo 14:00 Poster TU C

Monte Carlo simulations for Hollow Invar Nanoparticles — ●SANJEEV K. NAYAK, MARKUS E. GRUNER, and PETER ENTEL — Institute of Physics, University of Duisburg-Essen, Duisburg Campus, 47048 Duisburg, Germany

Monte Carlo simulations for Fe₆₅Ni₃₅ hollow spherical Invar nanoparticles have been performed with an effective spin-1 Ising model with coupled magnetic and spatial degrees of freedom taking into account the occurrence of high and low magnetic moments in Fe rich γ -FeNi alloys. Heating the system up above the Curie point starting from the ferromagnetic ground state and subsequent cooling breaks the system into domains. This effect depends on the size of the particle and the thickness of the shell. The energy difference between the domain state and the ferromagnetic phase is very low due to the fact that the low spin atoms form the domain boundary. To compare these results similar calculations were performed on pure hollow Ni nanoparticles.

MA 20.85 Mo 14:00 Poster TU C

Magnetoelastic properties and stability of hollow nanocomposites — ●MARKUS E. GRUNER, SANJEEV K. NAYAK, and PETER ENTEL — Institute of Physics, Universität Duisburg-Essen, Campus Duisburg, D-47048 Duisburg

We investigate the magnetic and elastic properties of hollow spherical nanocomposite systems using the Hybrid Monte Carlo method. The nanocomposites consist of ferromagnetic nanoparticles with a diameter of 14 nm, which are arranged densely packed on the surface of a sphere. The magnetic coupling is described by dipolar interactions, whereas the elastic properties are given by pair potentials. We consider especially the stability and deformation of the systems under the influence of a magnetic field and external pressure.

MA 20.86 Mo 14:00 Poster TU C

Kettenbildung bei dipolaren magnetischen Nanopartikeln — ●STEPHAN BUSCHMANN, ALFRED HUHT und PETER ENTEL — Theoretische Physik, Universität Duisburg-Essen und SFB 445, 47048 Duisburg

Neue Untersuchungen an Fe- und Ni-Nanopartikeln aus der Gasphase zeigen, dass diese sich unter bestimmten Bedingungen in Form langer Ketten anordnen [1]. Es wird angenommen, dass die Dipolwechselwirkung zwischen den magnetischen Nanopartikeln Ursache für die Kettenbildung ist.

Dieser Kettenbildungsübergang wird theoretisch mit Hilfe von Molekulardynamik-Simulationen untersucht. Hierbei kann auch eine Rückwirkung der Partikelkonfiguration auf den inneren Zustand (magnetisches Moment) der Partikel berücksichtigt werden. Es werden Phasendiagramme in den Variablen Partikelgröße, Temperatur und Magnetfeld präsentiert.

[1] J. Knipping *et al.*, Nanotechnology 15, 1665 (2004).

MA 20.87 Mo 14:00 Poster TU C

Jahn-Teller Effect in CuFe₂O₄ Nanoparticles — ●BALAJI GOPALAN¹, JÖRG WEISSMÜLLER^{1,2}, and NAMDEO GAJBHIYE³ — ¹Institute for Nanotechnology, Forschungszentrum Karlsruhe, P. O. Box 3640, D-76021, Germany — ²Universität des Saarlandes, Fachrichtung Technische Physik, Saarbrücken, P.O. Box 151150, D-66041, Germany — ³Department of Chemistry, Indian Institute of Technology, Kanpur, 208016 India

Nanosize CuFe₂O₄ particles are prepared by coprecipitation method. The particles of various sizes are obtained by heat treatment at temperatures between 573–1273 K and are characterized by X-ray diffraction, Mössbauer spectroscopy and magnetization measurements. X-ray diffraction pattern indicates that the crystal structure of nanosize CuFe₂O₄ particles obtained above 973 K is tetragonal while that prepared below 973 K is cubic. The room temperature Mössbauer spectrum indicates that the isomer shift, quadrupole splitting and hyperfine field values are found to change with heat treatment temperature. These changes in Mössbauer parameters may also be due to the Jahn-Teller effect that essentially arises due to the migration of Cu²⁺ ions from tetrahedral sites to octahedral sites resulting in crystal structure change from cubic to tetragonal system. The maximum coercivity obtained has been 700 Oe at heating temperature of 823 K. The enhanced coercive force can be mainly attributed to uniaxial magnetic anisotropy produced by crystal distortion.

MA 20.88 Mo 14:00 Poster TU C

FMR an Fe_xPt_{1-x} Nanopartikeln: Messung der temperaturabhängigen Anisotropieenergie — F. WIEKHORST^{1,2}, ●D. GÖRLITZ¹ und J. KÖTZLER¹ — ¹Institut f. Angewandte Physik, Univ. Hamburg, 20355 Hamburg — ²Physikalisch-Technische Bundesanstalt, 10587 Berlin

Es werden zwischen 10 K und 500 K bei 9 GHz gemessene FMR-Spektren von 4-6 nm großen Pt-reichen nanokristallinen FePt-Partikeln untersucht. Die zu tiefen Temperaturen zunehmend breiter werdenden Resonanzen lassen sich sehr gut mit der Gilbert-Shape beschreiben, die das Resonanzfeld und den Gilbert-Parameter definiert. Aus Magnetisierungs- und AC-Suszeptibilitätsmessungen [1] ist eine starke Anisotropie bekannt, woraus $H_A(0) > \omega/\gamma$ resultiert. Für diesen Fall gibt es kein analytisches Modell zur Analyse der FMR-Spektren. Wir beschreiben daher ein Mittelungsverfahren für die Resonanzfeldstärke, dessen Ergebnisse recht gut mit vorliegenden temperaturabhängigen Anisotropieenergien aus aufwendigen Analysen von Magnetisierungsisothermen [2] übereinstimmen.

[1] F. Wiekhorst et al., Phys. Rev. B 67, 224416 (2003)

[2] F. Wiekhorst et al., J.Magn.Magn. Mat.272-276 ,1559 (2004)

MA 20.89 Mo 14:00 Poster TU C

Magnetization of blocked magnetic nanoparticles — ●H. BREMERS, O. MICHELE, and J. HESSE — Institut für Metallphysik und Nukleare Festkörperphysik, Technische Universität, Mendelssohnstrasse 3, D-38106 Braunschweig, Germany

The basic properties of magnetic nanoparticle systems can be understood in the highly idealized well known Stoner-Wohlfart (SW) model. The simplicity of this model sometimes becomes more complex when considering the energy minima of the particles magnetic moments and very special the equilibrium angles corresponding with respect to the direction of the applied external magnetic field [1]. We show that in a rather simple vector model representing the effective behaviour of the nanoparticle system the estimation of the mean equilibrium angles can be simplified. The description of the magnetization of a blocked nanoparticle system versus magnetic field becomes easy and applicable to measurements performed on real magnetic particle systems. [1] H. Pfeiffer, phys. stat. sol. (a) 118(1990)295-306.

MA 20.90 Mo 14:00 Poster TU C

Magnetization measurements on frozen ferrofluids - an attempt to separate interaction and anisotropy influences — ●H. BREMERS, O. MICHELE, and J. HESSE — Institut für Metallphysik und Nukleare Festkörperphysik, Technische Universität, Mendelssohnstrasse 3, D-38106 Braunschweig, Germany

In this contribution we focus on a novel way to perform magnetization experiments on frozen ferrofluids or magnetic nanoparticles fixed in space. The basic idea is to project the behaviour of a real particle system onto a Stoner-Wohlfart (SW) particle ensemble behaviour. Therefore first an ideal SW particle system with unique size and orientation of easy axis was

studied numerically by introducing a particle - particle interaction via an demagnetizing field. We have shown that for non-interacting SW particles the universal mean value rule holds that the magnetization measured after ZFC (zero field cooling) can be expressed as a mean value of the magnetization measured after PHFC and NHFC (positive and negative high field) [1] cooling processes. Any deviation from this mean value rule is due to interactions only and can be derived from the magnetization measurements and assigned to equivalent behaviour of a SW particles system. By this new method it is possible to determine the mean value of the particles anisotropy and the mean interaction which is expressed as magnetic field. [1] O. Michele, J. Hesse, H. Bremers, E.K. Polychroniadis, K.G. Efthimiadis, H. Ahlers; J. Phys.: Cond. Matter 16 (2004) 427-443

MA 20.91 Mo 14:00 Poster TU C

Magnetic property of a weakly interacting nanoparticle system — ●XI CHEN¹, SUBANKAR BEDANTA¹, WOLFGANG KLEEMANN¹, S. CARDOSO², and P. P. FREITAS² — ¹Angewandte Physik, Universität Duisburg-Essen, D-47048 Duisburg, Germany — ²INESC, Rua Alves Redol 9-1, 1000, Lisbon, Portugal

The magnetic property of a weakly interacting nanoparticle system [CoFe(0.7 nm)/Al₂O₃(3 nm)]₁₀ is investigated by a Superconducting Quantum Interference Device (SQUID) magnetometer. The temperature T dependence of the field cooled magnetization shows a clear increase at low temperature following a simple Curie law, which can be due to the "lost" spins undetectable in Transmission Electron Microscopy (TEM) images. The relaxation curves of the thermoremanent magnetic moment at different temperatures collapse onto one master curve under $T \ln(t/\tau_0)$ scaling. Aging and memory effects are also observed, which evidence a collective spin glass-like behavior in this nanoparticle system.

MA 20.92 Mo 14:00 Poster TU C

Segregation properties of Fe-Ni clusters — ●SANJUBALA SAHOO, GEORG ROLLMANN und PETER ENTEL — Theoretical Low-Temperature physics, University of Duisburg-Essen, Lotharstr. 1, D-47048 Duisburg

Structure optimisation of Fe_nNi_{N-n} clusters has been performed using density functional theory and the generalised gradient approximation allowing for noncollinear magnetisation density. The calculations are carried out without imposing any symmetry constraints. Evaluation of the mixing energy of the clusters shows that mixed clusters are energetically more favourable than pure Fe and Ni clusters. Furthermore, the mixing energy not only depends on the size and composition of the clusters but also on their geometrical structures. Significant difference in energy is found for different arrangement of Fe and Ni atoms in the mixed cluster.

MA 20.93 Mo 14:00 Poster TU C

Entwicklung von Leiterbahnstrukturen zum Transport von magnetischen Teilchen — ●A. SHOSHI, M. PANHORST und H. BRÜCKL — Universität Bielefeld, Fakultät für Physik, Universitätsstr. 25, 33615 Bielefeld

Paramagnetische Teilchen, wie beispielsweise Fe₃O₄ Beads, die in vielen unterschiedlichen Konfigurationen für biotechnologische Anwendungen kommerziell erhältlich sind, lassen sich durch externe Magnetfelder manipulieren.

Bei dem hier vorgestellten on-chip Manipulationssystem erzeugen Ströme durch Leiterbahnen radiale Magnetfelder, die den Transport von magnetischen Markern und eine genaue Positionierung auf der Chipoberfläche ermöglichen. Diese Magnetfelder können durch zusätzliche ferromagnetische Schichten, die als Flusskonzentratoren wirken, verstärkt werden. Direkt auf die Gold-Leiterbahnen wird dazu eine ferromagnetische Schicht variabler Dicke gesputtert. Die Leiterbahnstrukturen bestehend aus Gold und Permalloy (NiFe) werden auf einem Si-Wafer mit optischer Lithographie strukturiert. Der Transport paramagnetischer Teilchen in Flüssigkeiten ist in einem optischen Mikroskop beobachtbar und die wirkenden Kräfte auswertbar.

MA 20.94 Mo 14:00 Poster TU C

Ferromagnetic filled carbon nanotubes: Synthesis, magnetic properties and delivery into human tumor cells — ●I. MÖNCH¹, A. MEYE², D. ELEFANT¹, S. NING², R. KOZHUHAROVA¹, M. RITSCHHEL¹, T. GEMMING¹, J. ACKER¹, and A. LEONHARDT¹ — ¹Leibniz Institute for Solid State and Materials Research (IFW) Dresden, Helmholtzstr. 20, D 01069 Dresden, Germany — ²Department of Urology, Technical University of Dresden, Fetscherstrasse 74, D 01307

We describe the synthesis and the properties of Fe-filled multi-walled carbon nanotubes (MWNTs) produced by chemical vapor deposition (CVD) for biomedical applications. The magnetic properties and the interaction of the material with human cancer cells were determined. The preincubation of the nanotube suspension with cationic lipid caused an efficient delivery of the lipid-nanostructure complexes into the cytoplasm within two hours after adding to the culture medium $1/\mu$. The Fe-concentration in the cells was determined by chemical analyses. These results are in good agreement with the magnetic measurements (AGM, SQUID).

$1/\mu$ I. Mönch, A. Meye, A. Leonhardt, K. Krämer, R. Kozhuharova, T. Gemming, M.P. Wirth, and B. Büchner; JMMM (in press)

MA 20.95 Mo 14:00 Poster TU C

Quantitative imaging of magnetization distributions of nanostructured ferromagnetic films — ●SEBASTIAN DREYER¹, CHRISTIAN JOOSS¹, SIBYLLE SIEVERS², MARTIN ALBRECHT² und UWE SIEGNER² — ¹Institut für Materialphysik, Universität Göttingen, D-37077 Göttingen — ²Physikalisch-Technische Bundesanstalt, D-38116 Braunschweig

An important issue of nanomagnetism is a full quantitative mapping of magnetization distributions also with a great importance for high-density magnetic recording applications. We report on the development of a quantitative spatially resolved measurement technique with a spatial resolution of ~ 500 nm and its application to the mapping of magnetization distributions of patterned ferromagnetic films. This quantitative magnetic imaging is based on magneto-optics, using the Faraday effect in advanced sensor films, for nanostructures with a size down to ~ 700 nm and smaller sizes in combination with MFM measurements. The stray field imaging was performed on Permalloy, Co and CoPt nanostructures in the thickness range of 2μ m down to 10nm.

Co as example for inplane magnetized structures and CoPt nanostructures with a perpendicular anisotropy serve as test systems for the two limits of pure in- and pure out-of-plane magnetization. Results of an advanced inversion method, based on the Fourier transform ansatz, for the determination of magnetization distributions from the measured stray field are presented for these systems.

MA 20.96 Mo 14:00 Poster TU C

Herstellung von speziellen MFM-Cantilevern für HF-MFM — ●MICHAEL R. KOBLISCHKA¹, MICHAEL KIRSCH¹, UWE HARTMANN¹ und THOMAS SULZBACH² — ¹FR Experimentalphysik, Universität des Saarlandes, Postfach 151150, D-66041 Saarbrücken — ²Nanoworld Services GmbH, Schottkystrasse 10, D-91058 Erlangen

Für die magnetische Abbildung werden bei der Hochfrequenz-MFM (HF-MFM)-Technik MFM-Cantilever benötigt, die auch bei hohen Frequenzen (derzeit bis zu 650 MHz, geplant bis 2 GHz) noch eine magnetische Hysterese aufweisen. Aus diesem Grund besputtern wir kommerzielle, mikrostrukturierte Si-Cantilever mit verschiedenen Ferrit- und Granat-Schichten. Die Herstellungsparameter der Schichten auf (100)-Si Substraten und Cantilevern und die resultierenden Eigenschaften werden im Detail diskutiert.

Diese Arbeit ist Teil des EU-Projektes 'ASPRINT'.

MA 20.97 Mo 14:00 Poster TU C

Study of the micromagnetic structure of a La_{0.7}Sr_{0.3}MnO₃ film — ●MICHAEL ZIESE — University of Leipzig, Division of Magnetism and Superconductivity, Linnéstrasse 5, 04103 Leipzig

The magnetic domain-structure of easy-plane La_{0.7}Sr_{0.3}MnO₃ films has been studied by various groups and a "feather-like" pattern has been typically observed, see e.g. [1]. This pattern was recently interpreted as arising from magnetic ripples, a substructure of magnetic domains [2]. In this work the micromagnetic structure of a La_{0.7}Sr_{0.3}MnO₃ film was studied using magnetic force microscopy and micromagnetic simulations. For a 150 nm thick epitaxial, strain relaxed film grown on SrTiO₃ evidence is shown from experiment and simulation that magnetic domains

have a typical size of 1 μm at room temperature and well explain the "feather-like" pattern.

[1] J. Dho, Y. N. Kim, Y. S. Hwang, J. C. Kim and N. H. Hur, Appl. Phys. Lett. **82**, 1434 (2003).

[2] Y.-A. Soh, G. Aeppli, C.-Y. Kim, N. D. Mathur and M. G. Blamire, J. Appl. Phys. **93**, 8322 (2003).

MA 20.98 Mo 14:00 Poster TU C

Simulation of magnetic force microscopy of MnAs/GaAs(001) — ●ROMAN ENGEL-HERBERT, JYOTI MOHANTY, and THORSTEN HESJEDAL — Paul-Drude-Institut, Hausvogteiplatz 5-7, 10117 Berlin, Germany

Magnetic force microscopy (MFM) is a commonly employed tool for the micromagnetic investigation of a sample, however, the quantitative interpretation and analysis of MFM experiments is difficult. We performed a more realistic simulation based on the extended tip model. This allows a more accurate description of the tip-sample interaction in the near-field, as compared to the commonly applied point-dipole model. Following this approach one is able to predict optimal scan parameters (working distance, oscillation amplitude of the cantilever) and tip properties for a given experimental problem. The simulation was applied to MnAs thin films that exhibit a self-organized array of ferromagnetic stripes in the phase-coexistence regime. The magnetic domain structure is governed by the strong uniaxial anisotropy and shape anisotropy of the film that lead to simple domain configurations, where the magnetic moments are all aligned in-plane along the easy axis direction of the film. Therefore the individual domains can be approximated by bar magnets, for which we derived an analytical solution for the magnetic stray field.

MA 20.99 Mo 14:00 Poster TU C

Lokale thermische Detektion der Ferromagnetischen Resonanz an Permalloy-Streifen Gittern — ●IGOR BARSUKOV¹, DETLEF SPÖDDIG¹, RALF MECKENSTOCK¹, CENGİZ BIRCAN², ARNDT REMHOF² und HARTMUT ZABEL² — ¹AG Festkörperspektroskopie, Institut für Experimentalphysik III, Ruhr-Universität Bochum, D-44780 Bochum — ²Institut für Experimentalphysik IV, Ruhr-Universität Bochum, D-44780 Bochum

Die lokale Detektion der Ferromagnetischen Resonanz (FMR) an nanostrukturierten magnetischen Systemen ist von immer größerem Interesse. Dabei ist insbesondere die Untersuchung einzelner Strukturen von Bedeutung. In diesem Beitrag zeigen wir erstmals den Nachweis der FMR mittels Detektion der Temperaturänderung in einer Nano-Struktur durch die absorbierte Mikrowellenleistung. Dazu wurde ein scannendes thermisches Mikroskop (SthM) eingesetzt. Der Temperatursensor an der Spitze ist in der Lage, Temperaturänderungen im mK-Bereich nachzuweisen bei einer Auflagefläche von ca. 100 nm Durchmesser. Die untersuchten Proben waren Permalloy-Streifen mit 1000 nm Länge und 300 nm Breite, die zwei senkrecht aufeinander stehende Untergitter bilden. Es werden die konventionellen und die ortsaufgelösten FMR Ergebnisse miteinander verglichen. Die beobachteten zwei Resonanzen in der konv. FMR konnten eindeutig den beiden Untergittern zugeordnet werden. Bei der ortsaufgelösten SthM-FMR wurden sowohl einzelne Spektren an festen Positionen auf den Nano-Strukturen als auch Image-Scans der thermischen Response an den Positionen der beiden Hauptresonanzfeldern aufgenommen. Unterstützt vom SFB 491.

MA 20.100 Mo 14:00 Poster TU C

Photoelektronenbeugung (PED) und magnetischer Dichroismus in Rumpfniveau-Photoemission von Fe und Co — ●C. BETHKE¹, N.B. WEBER², F.U. HILLEBRECHT³ und A. CHASSÉ⁴ — ¹Inst. f. Angewandte Physik, Uni Düsseldorf, 40225 Düsseldorf. — ²Focus GmbH, 65510 Hünstetten — ³IFF, FZ Jülich, 52425 Jülich — ⁴FB Physik, MLU Halle, 6099 Halle

Photoemissionsspektren von Rumpfniveaus magnetischer Festkörper zeigen i.A. magnetischen Dichroismus. Bei kristallinen Proben wird die Größe des magnetischen Dichroismus durch Photoelektronenbeugung beeinflusst. Außerdem ist eine Beeinflussung der Spektren durch spinabhängige Streuung der Photoelektronen möglich. Für PE aus dem 3s-Niveau variiert das Intensitätsverhältnis I/I_0 von Hauptlinie zur Gesamtintensität um den Mittelwert von 0,7, wobei gilt $\Delta(I/I_0)(\Theta) = -\Delta(I/I_0)(-\Theta)$. Ähnliches Verhalten wurde im magnetischen Dichroismus für die 3p und die 2p Niveaus beobachtet. Die entgegengesetzte Abweichung vom mittleren Intensitätsverhältnis bzw. Dichroismus beiderseits der senkrechten Emissionsrichtung identifiziert den Bahndrehimpulscharakter der auslaufenden Photoelektronenwelle als bestimmende

Eigenschaft. Die Daten sind in Übereinstimmung mit Rechnungen zur Photoelektronenbeugung, die auf Mehrfach-Streuung in einem Cluster-Modell basieren, und die Austauschwechselwirkung der Spin-Bahn-aufgespaltenen Rumpfniveau-Zustände mit dem spinpolarisierten Valenz-Zuständen enthalten.

MA 20.101 Mo 14:00 Poster TU C

Variation of the Magnetic Moment of Nickel by Electrochemical Charging — ●CHRISTIAN LEMER¹, SADHAN GHOSH¹, JÖRG WEISSMÜLLER^{1,2}, and RAGHAVAN N. VISWANATH¹ — ¹Institut für Nanotechnologie, Forschungszentrum Karlsruhe GmbH — ²Fachrichtung Tech. Physik, Universität des Saarlandes

It has been proposed that changes in the electronic structure in superficial space-charge regions may substantially affect the properties of metals near the surface [1]. In nanostructured materials, due to the high surface to volume ratio, even changes in a thin surface layer involve considerable amounts of the volume fraction. Therefore, these materials can be used to study the effect of charging on the surface properties. An implementation of this principle is to use a nanoporous material immersed in an electrolyte. Application of an electric field gives rise to an electric double layer region at the metal-electrolyte interface and allows to store a considerable amount of charge. Recently, changes in the lattice parameter of nanoporous Pt [2] and macroscopically bending of nanoporous Au cantilevers [3] have been observed. Here, we examine the possibility of tuning of the magnetic moment of Ni, deposited with a few monolayer thickness on nanoporous Au, and on high surface area Carbon. Changes in the magnetic moment of up to 10% have been observed by in-situ charging experiments. Special focus has been on the discrimination of the relative influence of band-filling versus that of hydride formation, OH adsorption and oxidation. [1] H. Gleiter, et al., Acta Mater. 49 (2001), 737. [2] J. Weissmüller, et al., Science 300 (2003), 312. [3] D. Kramer, et al., Nano Lett. 4 (2004), 793.

MA 20.102 Mo 14:00 Poster TU C

Reduced Magnetic Ordering Temperatures in Polycrystalline Ho Films — ●E. SCHIERLE, E. WESCHKE, and G. KAINDL — Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, D-14195 Berlin, Germany

The magnetic structure and ordering temperatures of polycrystalline Ho metal films were studied by magnetic x-ray scattering at the Ho- M_5 resonance. Ho metal is characterized by a long-period helical magnetic structure with a period of 10 layers at 40 K. As recently demonstrated, the helical magnetic ordering temperature drops substantially in single-crystalline films with thicknesses comparable to the length of the magnetic period [1]. In the polycrystalline films, we observe a substantial reduction of the ordering temperature even in films as thick as 100 layers, where finite-size effects are expected to be absent. This shows that the magnetic coherence does not extend across the whole film, i.e. exchange coupling across the grain boundaries is negligible and the helical domains are limited to the individual grains. The work was supported by the BMBF, project 05 KS1KEE/8.

[1] E. Weschke *et al.*, Phys. Rev. Lett. **93**, 157204 (2004).

MA 20.103 Mo 14:00 Poster TU C

Charakterisierung von Fe/GaAs(110) Grenzflächen mittels Ballistischer Elektronen Emissions Mikroskopie — ●SANDRA SCHMAUNZ, JOHANN VANCEA und CHRISTIAN H. BACK — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Universitätsstrasse 31, 93040 Regensburg, Germany

Die Spininjektion aus einem ferromagnetischen Metall über die Schottky - Barriere in einen Halbleiter ist für zukünftige Bauelemente der Spintronik von entscheidender Bedeutung. Die lokale Beschaffenheit der Metall / Halbleiter Grenzfläche hat dabei einen entscheidenden Einfluss. Als Untersuchungsmethode bietet sich dafür die Ballistische Elektronen Emissions Mikroskopie (BEEM) an. Dazu wurden epitaktische Fe - Schichten auf GaAs(110) Spaltkanten hergestellt und mit Au abgedeckt. Mittels BEEM im UHV konnten lokale IU - Kennlinien mit einer lateralen Auflösung von ca. 1nm gemessen werden. Die Auswertung dieser Kennlinien führten folglich zur Bestimmung der lokalen Schottky - Barrierenhöhen.

MA 20.104 Mo 14:00 Poster TU C

Atomic structure and magnetic properties of MnSi thin films — ●M. HORTAMANI, P. KRATZER, and M. SCHEFFLER — Fritz Haber Institut der Max-Planck Gesellschaft, Faradayweg 4-6, 14195 Berlin, Germany

Epitaxial manganese silicide compounds are promising candidates as materials for magneto-electronic and spintronic devices. We compare the structural and magnetic properties of Mn-silicide films on Si(111) and Si(001) surfaces using density functional theory calculations performed with the full-potential augmented plane wave plus local orbital method (FP-LAPW+lo). Experimental studies find initial epitaxial growth of Mn or Mn_xSi_y clusters in the Volmer-Weber growth mode on both Si(001) and Si(111) substrates, which later grow together to form a rough thin film in case of Si(111). Our calculations show that ferromagnetic manganese-silicon multilayers are the most stable epitaxial films on both surfaces. These films have a CsCl-like atomic structure with a lattice mismatch of less than 2% to the substrate. Their formation is exothermic in thermodynamic equilibrium with bulk Mn, and endothermic in equilibrium with bulk MnSi. Moreover, MnSi films with CsCl-like structure on Si(111) are found to be more stable than films of other epitaxial silicides, such as Mn_3Si or Mn_5Si_3 . The Mn magnetic moments are as high as $1.8 \mu_B$ at the surfaces and interfaces, and saturate at $0.3 \mu_B$ in the interior of the film. The calculated spin polarization at the Fermi level for CsCl-like MnSi on Si is higher than 30% and for the (001) interface, and 35% for the (111) interface, which opens up the possibility for a highly spin-polarized current to be injected into the Si substrate.

MA 20.105 Mo 14:00 Poster TU C

Co-doped zinc oxide — ●M. LÜBBE¹, K.-W. NIELSEN¹, A. ERB¹, J. SIMON², W. MADER², L. ALFF¹, M. OPEL¹, and R. GROSS¹ — ¹Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, D-85748 Garching — ²Institut für Anorganische Chemie, Rheinische Friedrich-Wilhelm Universität, D-53117 Bonn

Due to their potential application in spintronics diluted magnetic semiconductors have attracted much interest. In particular, thin films of ZnO with a few atomic percent of a transition element substituted for zinc are studied intensively. Recently, a model based on a narrow impurity band [1] has been proposed for explaining the ferromagnetic exchange in ZnO. According to this model, $Zn_{1-x}Co_xO$ is expected to show ferromagnetism at room temperature and hence has attracted broad interest.

We have prepared quasi-homoepitaxial $Zn_{0.95}Co_{0.05}O$ and $Mn_{0.95}Co_{0.05}O$ films on ZnO substrates by UHV pulsed laser deposition with substrate temperatures ranging between room temperature and 600°C and different background atmospheres (Ar or Ar + 1% O₂). During growth the thin films are characterized by in-situ RHEED. Furthermore X-ray diffraction and reflectometry as well as transmission electron microscopy have been applied for structural characterization. The magnetic properties have been analyzed by SQUID magnetometry and magnetotransport experiments. The Co substituted samples show ferromagnetic hysteresis at room temperature and a saturation magnetization of up to $1\mu_B/Co$.

This work is supported by the DFG via SPP 1157.

[1] M. Venkatesan *et al.*, Phys. Rev. Lett. **93**, 177206 (2004)

MA 20.106 Mo 14:00 Poster TU C

Heterostructures based on ZnO and Magnetic Materials – a Possible Way to Artificial Magnetic Semiconductors?

— ●KARL-WILHELM NIELSEN¹, MAIKE LÜBBE¹, ANDREAS ERB¹, JÜRGEN SIMON², WERNER MADER², MATTHIAS OPEL¹, LAMBERT ALFF¹, and RUDOLF GROSS¹ — ¹Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Walther-Meißner Straße 8, 85748 Garching — ²Institut für Anorganische Chemie, Rheinische Friedrich-Wilhelm Universität, Römerstraße 164, 53117 Bonn

Diluted Magnetic Semiconductors (DMS) are interesting materials for spintronics due to the combination of semiconducting and magnetic properties. A promising candidate in this field is transition metal doped ZnO, since this material systems allows for ferromagnetism at room temperature. Very recently, the observed room temperature ferromagnetism in ZnO-based DMS was explained by Venkatesan *et al.* [1] in term of a model based on a narrow impurity band.

Whereas in usual DMS the magnetic ions are distributed statistically within the semiconducting matrix, in our work we want to artificially synthesize a new class of DMS by growing epitaxial heterostructures consisting of semiconducting and magnetic materials. We present our first steps in this direction based on heterostructures consisting of ZnO and

magnetic materials. The samples are prepared by UHV pulsed laser deposition and are characterized by SQUID-magnetometry, transport measurements and transmission electron microscopy.

This work is supported by the DFG via SPP 1157.

[1] M. Venkatesan *et al.* Phys. Rev. Lett. **93** 177206 (2004).

MA 20.107 Mo 14:00 Poster TU C

Inelastic electron tunneling spectroscopy and bias voltage dependence of magnetic tunnel junctions with polycrystalline Co₂MnSi electrode — ●JAN SCHMALHORST, S. KÄMMERER, G. REISS, and A. HÜTTEN — University of Bielefeld, Department of Physics, Nano Device Group, P.O. Box 100131, 33501 Bielefeld, Germany

Spintronics needs half-metallic materials implemented in technologically relevant devices. We prepare Co₂MnSi / AlO_x / Co₇Fe₃ junctions showing a tunneling magnetoresistance of 95% at 1mV and 20K. Their inelastic electron tunneling spectra at 20K show typical magnon and phonon excitations in the electrode and the barrier and an additional shoulder around -22mV not observed in Co₇Fe₃ / AlO_x / Ni₈₁Fe₁₉ reference junctions. Furthermore, the bias voltage and temperature dependence of the tunneling magnetoresistance is considerably larger than for the reference junctions. The transport properties are discussed with respect to a variety of current contributions associated with the structural and magnetic properties of the Co₂MnSi / AlO_x interface.

MA 20.108 Mo 14:00 Poster TU C

Implementation of Co₂MnSi electrodes in magnetic tunnel junctions: magnetic and chemical bulk properties compared to the interface — ●JAN SCHMALHORST¹, M. SACHER¹, S. KÄMMERER¹, V. HÖINK¹, G. REISS¹, A. HÜTTEN¹, D. ENGEL², A. EHRESMANN², and E. ARENHOLZ³ — ¹University of Bielefeld, Department of Physics, Nano Device Group, P.O. Box 100131, 33501 Bielefeld, Germany — ²Department of Physics, Kaiserslautern University of Technology, D-67663 Kaiserslautern, Germany — ³Lawrence Berkeley National Laboratory, Advanced Light Source, Berkeley, CA 94720, USA

The 100% spin polarization predicted theoretically for some Heusler alloys make them attractive for spintronic applications, e.g., as electrode material in magnetic tunnel junctions. The formation of a high quality tunneling barrier without generating defects in the adjacent half-metallic electrode is the crucial preparation step. We have prepared Co₂MnSi / AlO_x / Co₇Fe₃ junctions showing a low temperature / low bias voltage tunneling magnetoresistance of 95% corresponding to an effective spin polarization of 66% instead of the predicted half-metallicity. By comparing soft X-ray absorption in total electron and total fluorescence detection we have determined differences of the chemical and the magnetic properties in bulk Co₂MnSi and at the Co₂MnSi / AlO_x interface. These results show up a way of how to improve the magnetoresistive transport in the future. The authors gratefully acknowledge the opportunity to perform soft X-ray absorption spectroscopy at the Advanced Light Source, Berkeley, USA and at the Berliner Elektronenspeicherring-Gesellschaft für Synchrotronstrahlung m.b.H., Berlin, Germany.

MA 20.109 Mo 14:00 Poster TU C

Thin epitaxial films of the Heusler compound Co₂Cr_{0.6}Fe_{0.4}Al — ●HORST SCHNEIDER¹, GERHARD JAKOB¹, FREDERICK CASPER^{1,2}, ANDRÉS CONCA¹, MARTIN JOURDAN¹, HANS-JOACHIM ELMERS¹, and CLAUDIA FELSER² for the DFG Forschergruppe 559 collaboration — ¹Institut für Physik, Universität Mainz, Staudinger Weg 7, 55128 Mainz — ²Institut für Anorganische und Analytische Chemie, Universität Mainz, Düsbergweg 10-14, 55128 Mainz

Co based Heusler alloys as Co₂Cr_{0.6}Fe_{0.4}Al possess a high Curie temperature and according to band structure calculations this material is half metallic, i.e. there exists only one spin direction for the charge carriers at the Fermi edge. We prepared thin epitaxial films of this compound in the B2 structure by sputtering and laser ablation and realized first tunnel magnetoresistive elements. Films grown at high temperatures (T=600°C) on *a*-plane (11 $\bar{2}$ 0) Al₂O₃ are fully epitaxial with the (110) and (1 $\bar{1}$ 0) planes of the film parallel to the (11 $\bar{2}$ 0) and (0001) planes of the substrate, respectively. The films show nearly rectangular hysteresis loops with coercitive fields of the order of 10 mT. On GaAs substrates film deposition at lower temperatures and subsequent annealing improved the magnetic moment to 3.5 μ_B per formula unit. Magneto-optical Kerr measurements show an in-plane anisotropy of the magnetization with the easy axis in {001} direction. Hall measurements show a strong anomalous Hall effect and a weak normal Hall voltage signalling the existence of a compensated Fermi surface.

MA 20.110 Mo 14:00 Poster TU C

Current-density-functional theory approach to persistent currents and orbital magnetism — ●MARC SIEGMUND and OLEG PANKRATOV — Lst. für Theoretische Festkörperphysik, Universität Erlangen-Nürnberg, Staudtstr. 7, 91058 Erlangen

A local approximation of current-density-functional theory [1] (LCDA) permits to derive a universal relation between current and density distributions in inhomogeneous systems [2]. We apply this relation to a homogeneous, non-interacting electron gas of a finite spatial extension. The magnetization of such a system is commonly calculated as a derivative of the free energy with respect to the magnetic field strength. Physically, however, it arises due to the diamagnetic persistent current at the edges of a system and one should be able to find it directly from the current density. We verify that LCDA indeed leads to a correct universal magnetization, despite the current density distribution is affected by the inaccuracy of the LCDA. Finally the applicability of the current-density relation to an inhomogeneous system in an ultra-strong magnetic field is studied for a non-interacting electron gas in a parabolic potential.

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 [2] G. Vignale and P. Skudlarski, Phys. Rev. B **46**, 10232 (1992)

MA 20.111 Mo 14:00 Poster TU C

Orbital Polarization in the Kohn-Sham-Dirac Theory — ●MAHDI SARGOLZAEI, HELMUT ESCHRIG, MANUEL RICHTER, KLAUS KOEPERNIK, and INGO OPAHLE — Leibniz Institute for Solid State and Materials Research, IFW-Dresden, P.O.Box 270016, D-01171 Dresden, Germany

The consequent relativistic form of density functional theory is the 4-current density functional theory (CDFT). With Gordon's decomposition of the 4-current, the spin density enters, and is used to obtain the spin density functional theory (SDFT). The orbital current and orbital polarization effects are usually neglected in SDFT. This orbital current density of unfilled inner shells can be used to define a kind of an orbital angular momentum density, which may be treated in a local density approximation of the correlation energy leading to orbital polarization correction terms to the ordinary Kohn-Sham or Kohn-Sham-Dirac equation. Results for transition metal and rare-earth atoms are presented.

MA 20.112 Mo 14:00 Poster TU C

XMCD studies of magnetic properties of ZrZn₂ — ●SERGEY MANKOVSKY¹, HUBERT EBERT¹, FABRICE WILHELM², and ANDREJ ROGALEV² — ¹Dept. Chemie und Biochemie, Universität München, Butenandtstr. 5-13, D-81377 München, Germany — ²ESRF, B.P.220, 38043 Grenoble, France

The ZrZn₂ weak ferromagnet attracts the attention for last few years due to coexistence in it of ferromagnetism and superconductivity on the one side and due to its very interesting magnetic properties on another. The magnetic properties of this compound have been studied using the X-ray magnetic circular dichroism (XMCD) method, which allows to probe locally the spin and orbital magnetic moments and therefore is a very efficient tool for studies of complex magnetic materials. The XMCD spectra of ZrZn₂ have been measured at the L_{2,3} edges of Zr. The experiments have been performed both without and in the presence of external magnetic field to study the field-dependent behaviors of spin and orbital magnetic moments. To interpret the experimental results, they are accompanied by SPR-KKR calculations of electronic structure and XMCD spectra of a compound under investigation. An analysis of the XMCD spectra of ZrZn₂ is done also in comparison with the spectra obtained for ZrFe₂.

MA 20.113 Mo 14:00 Poster TU C

Correlation effects in the valence bands of EuS — ●ANAND SHARMA and WOLFGANG NOLTING — Lehrstuhl Festkörpertheorie, Institut fuer Physik, Humboldt-Universität zu Berlin, Newtonstr.15, 12489, Berlin, Germany.

We present a many body analysis of the multiband Kondo lattice model. The study is then combined with the first principles TB-LMTO band structure calculations, in order to investigate the temperature dependent correlation effects in the 3*p* valence bands of the ferromagnetic semiconductor, EuS. Some of the physical properties of interest like the quasi-particle density of states (Q-DOS), spectral density (SD) and quasi-particle band structure (Q-BS) are calculated and discussed. Therewith, we propose a spin resolved ARPES of the valence bands of EuS to be performed.

MA 20.114 Mo 14:00 Poster TU C

Calculated Magnetic Susceptibility of Palladium metal — ●MAENG-SUK KIM, MANUEL RICHTER, MICHAEL D. KUZ'MIN, INGO OPAHLE, and KLAUS KOEPERNIK — Leibniz Institute for Solid and Materials Research, IFW, P.O. Box 270016, D-01171 Dresden

Magnetization curves of Pd have been calculated in the local spin density approximation (LSDA). The scalar-relativistic version of the full-potential local orbital code (FPLO-4) was used. The character of the calculated curves depends most strongly on the assumed lattice constant. A ferromagnetic ground state is obtained at the experimental lattice constant, $a = 3.89$ Å. At $a = 3.84$ Å (the LSDA equilibrium value) the $M(B)$ dependence is still noticeably curved upwards in small fields ($B < 8$ T) and downwards in higher fields, the initial susceptibility exceeding the experimental value by a factor of two. At a yet smaller lattice constant, $a = 3.79$ Å, the calculated initial susceptibility equals the experimental one, the upward curvature in small fields being hardly noticeable. The inflection point in the magnetization curve is associated with the presence of a saddle point in the 4d bands just below the Fermi level. The curvature of $M(B)$ changes sign as the related Van Hove singularity in the minority subband hits the Fermi level.

MA 20.115 Mo 14:00 Poster TU C

Breakdown of magnetization in nano-constricted domain walls. — ●NATALIA KAZANTSEVA, ROBERT WIESER, ULRICH NOWAK, and KLAUS D. USADEL — Fachbereich für Physik, Universität Duisburg-Essen, 47048 Duisburg, Germany

The understanding and control of domain wall properties is important for future magneto-electronic applications, but only few publications have considered the influence of finite temperatures on domain walls [1] which becomes increasingly important for decreasing sizes of the magnetic systems considered. We investigate static aspects of nano-constricted domain walls with analytical (micromagnetic) and numerical methods (mean field approximation, Monte Carlo simulation). We find that the magnetization within a domain wall has a stronger temperature dependence than in a region with uniform magnetization. Even a continuous disappearance of the magnetization at a temperature T_h below the Curie temperature T_c can be observed inside a domain wall. This effect is much bigger for nano-constricted domain walls. In this case the temperature T_h decreases with $\cos(\pi/L)$, where L is the length of the constriction.

ACKNOWLEDGMENTS: Work supported by the Deutsche Forschungsgemeinschaft (SFB 491).

- [1] J. Kötzler, D. A. Garanin, M. Hartl, and L. Jahn Phys. Rev. Lett. **71**, 177 (1993)

MA 20.116 Mo 14:00 Poster TU C

Analyse magnetischer Volumendomänen in FeSi (111)-Kristallen — ●RUDOLF SCHÄFER und SABINE SCHINNERLING — IFW Dresden, Helmholtzstr. 20, 01069 Dresden

Die magnetischen Domänen in eisenartigen Materialien mit stark fehl-orientierten Oberflächen sind charakterisiert durch aufgespaltene Strukturen, die sich in fraktaler Weise in mehreren Generationen auf die Oberfläche zu verfeinern. Zur Dickenabhängigkeit der Volumendomenweite gibt es bislang nur theoretische Modellbetrachtungen [1], welche bei kleinen Dicken eine Wurzelabhängigkeit und bei Dicken oberhalb beginnender Domänenaufspaltung eine lineare Dickenabhängigkeit der Volumendomenweite vorhersagen. In diesem Beitrag berichten wir von erstmaligen experimentellen Messungen der Volumendomenweite in keilförmigen Fe_{12.8at%Si} Kristallen mit (111)-Oberfläche. Zum einen wurde durch kernmikroskopische Oberflächenbeobachtungen indirekt auf die Volumenweite geschlossen, indem durch gezielte Entmagnetisierung eine geeignete Domänenüberstruktur erzeugt wurde. Dabei konnten die Vorhersagen bestätigt werden. Zum anderen wurden die Volumendomen direkt ausgewertet, nachdem die Domänen als Ausscheidungsmuster eingefroren wurden [2, 3]. Hier wurden andere Gesetzmäßigkeiten gefunden. [1] A. Hubert and R. Schäfer: Magnetic Domains. Springer Verlag (1998). [2] S. Libovicky, Phys. Status Solidi A 12 (1972) 539. [3] R. Schäfer and S. Schinnerling, J. Magn. Magn. Mat. 215-216, 140-146 (2000)

MA 20.117 Mo 14:00 Poster TU C

Spin structure of domain walls in ferromagnetic ring magnets — ●M. LAUFENBERG¹, M. KLÄUI¹, D. BEDAU¹, U. RÜDIGER¹, C.A.F. VAZ², J.A.C. BLAND², L.J. HEYDERMAN³, D. BACKES^{1,3}, F. NOLTING³, E. BAUER⁴, S. CHERIFT⁴, S. HEUN⁴ und A. LOCATELLI⁴ — ¹Fachbereich Physik, Universität Konstanz, Germany — ²Cavendish Laboratory, University of Cambridge, U.K. — ³Paul-Scherrer-Institut, 5232 Villigen, Switzerland — ⁴Sincrotrone Trieste, 34012 Basovizza, Italy

The spin structure of domain walls (DW) in ferromagnetic rings has been studied by high-resolution photoemission electron microscopy for various ring widths (110-1800 nm), thicknesses (2-38 nm), and materials (permalloy, Co).

Experimental phase diagrams show transitions between transverse and vortex walls [1]. Micromagnetic simulations reproduce the experimental results for Co rings very well while in permalloy rings an unexpected second phase boundary at ultralow thicknesses is observed.

By varying the edge-to-edge spacing, the influence of dipolar DW coupling on the DW spin structure is studied. Furthermore, a linear dependence of the DW width on the ring width is found.

[1] M. Kläui *et al.*, Appl. Phys. Lett., in press

MA 20.118 Mo 14:00 Poster TU C

Entanglement and the phase diagram of spin-1 chains — ●CLEMENS MÜLLER-GUGENBERGER, ANDREAS SCHADSCHNEIDER, and ACHIM ROSCH — Institut für Theoretische Physik, Universität zu Köln

Entanglement as a resource for quantum computing and communication is a central concept in quantum information science. Furthermore, it can be used to quantify nonclassical correlations in interacting systems.

Here, we investigate antiferromagnetic spin-1 chains. These systems are generically gapped and therefore robust against external disturbances. Already the case of isotropic interactions exhibits a rich phase diagram with several quantum phase transitions and the occurrence of topological order. While the model allows analytical treatment at special points of the phase diagram, for the general case a numerical treatment like the density matrix renormalisation group (DMRG) is necessary.

Using DMRG techniques, we investigate various entanglement properties in the ground state of the bilinear biquadratic spin-1 chain. We test the applicability of different entanglement measures to these models with special emphasis on the various phases, their phase transitions and the topological order.

MA 20.119 Mo 14:00 Poster TU C

Ferromagnetic Polarons in the 1D ferromagnetic Kondo Model with quantum mechanical $S = 3/2$ corespins — ●DANILO NEUBER¹, MARIA DAGHOFER¹, HANS GERD EVERTZ¹, REINHARD NOACK², and WOLFGANG VON DER LINDEN¹ — ¹Inst. f. Theo. Physics, TU Graz, Petersg. 16, 8010 Graz, Austria — ²FB Physik, Philipps-Universität Marburg, 35032 Marburg, Germany

We present the first exhaustive numerical study of the ferromagnetic (FM) Kondo lattice model with quantum mechanical $S = 3/2$ corespins. We treat non-degenerate orbitals in one dimension using the density matrix renormalization group (DMRG). We examine parameters relevant to manganites and the range of low to intermediate doping $0 \leq x < 0.5$ and we include on-site Coulomb repulsion between the electrons.

In particular, we examine whether quantum fluctuations favor phase separation over the ferromagnetic polarons observed in a model with classical corespins. We find that quantum spins instead enhance the polaronic behavior and we find no phase separation for small doping. Coexistence of larger FM and antiferromagnetic (AFM) regions is only occasionally observed at rather high doping $x \approx 0.3$ near the transition to the FM ordered state.

We present a phase diagram with respect to doping and the t_{2g} superexchange parameter J' with and without Coulomb repulsion.

MA 20.120 Mo 14:00 Poster TU C

Size-effects on the magnetic phase transition of Fe/GaAs(001) — ●ROLAND MEIER, FRANK BENSCH, WOLFGANG KIPFERL, and GUENTHER BAYREUTHER — Universitätsstraße 31, 93040 Regensburg

For ultrathin single crystalline Fe-films on GaAs(001) an extraordinary sharp magnetic phase transition at T_c was found in addition to a strong uniaxial anisotropy [1]. Furthermore, an effective $T^{3/2}$ -dependency of the spontaneous magnetization is valid at $T < 1/2 \cdot T_c$ for both, the extended layer and submicron disks [2]. In the present work we study the details of the phase transition in these confined magnetic systems.

Approaching T_c , the correlation length of order parameter diverges: in a real Fe/GaAs-system it can exceed one micron. Thus, the critical behavior of submicron-particles should be affected massively by finite size effects. By means of the longitudinal Kerr effect large area ensembles of uniform nanostructures produced with EBL were investigated. We systematically varied structure size (below 100 nm to 1 micron), shape and the distance between the elements. The influence on the phase transition and the Curie temperature is discussed. The determined critical exponents are compared to theoretical models. Ref. [1] F. Bensch, JAP 89, 7133 (2001) [2] W. Kipferl, JAP 95, 7417 (2004)

MA 20.121 Mo 14:00 Poster TU C

Oberflächenmagnetisierung an flüssigem $Co_{80}Pd_{20}$ in der Nähe der Curietemperatur — ●LUCIAN ISFAN und KARL MAIER — Helmholtz - Institut für Strahlen- und Kernphysik der rheinischen Friederich-Wilhelms Universität zu Bonn

Magnetisierungsverläufe an flüssigem $Co_{80}Pd_{20}$ wurden mit Hilfe des Magneto-Optischen Kerr-Effektes aufgenommen. Zu diesem Zweck wurden Proben mit 10-11mg Masse in einer reinen H_2 -Atmosphäre mittels einer Kurzwellenlevitationsanlage prozessiert. Diese Anlage erlaubt eine Unterkühlung der Proben von mehr als $\Delta T = 350K$ unter ihre Liquidustemperatur ($T = 1610K$). Eine computergesteuerte Probenstabilisierung ermöglicht ortsgenaue optische Messungen auch in der Nähe der Curietemperatur. Auf der Probe wird ein linear polarisierter Laserstrahl fokussiert und an der Reflektion die Drehung der Polarisationsachse untersucht. Die Signaldifferenz der an zwei Dioden erfasste Intensität des Lichts ist ein Maßstab für die erfahrene Drehung der Polarisationsachse (Kerr-Winkel) und für die lokale Magnetisierung. Es wurden temperaturabhängige Messungen des Kerr-Winkels bis zur Curietemperatur durchgeführt. Die aufgenommenen Magnetisierungskurven weisen einen typischen Curie-Weiss Verlauf auf. Die Genauigkeit der Messmethode gibt Hoffnung auf ortsaufgelöste Untersuchungen der Domänenstruktur einer ferromagnetische Substanz in der flüssigen Phase.

MA 20.122 Mo 14:00 Poster TU C

New model for conversion process in RCu_2 ($R = \text{rare earth}$) — ●SEBASTIAN RAASCH^{1,2}, MATHIAS DOERR¹, MARTIN ROTTER^{3,1}, ANDREAS KREYSSIG¹, JENS-UWE HOFFMANN², and MICHAEL LOEWENHAUPT¹ for the HMI Berlin - TUD collaboration — ¹TUD-IFP, D-01062 Dresden, Zellescher Weg 16 — ²HMI Berlin, D-14109 Berlin — ³Uni Wien-IPC, A-1090 Wien

Since the 1990s a magnetic field induced conversion effect in orthorhombic RCu_2 compounds (space group $Imma$) has been observed. To force the conversion a strong magnetic field (3 to 20 T) has to be applied in the a - c plane away from the magnetic easy axis. As the magnetization properties of the hard and easy axis exchange during the conversion, this effect has been misleadingly called *Ising axis conversion effect* based on a metamagnetic transition. Further a giant magnetostrictive effect of more than two percent due to the conversion has been found in 1996 by Takeuchi by macroscopic measurements. We present a new conversion model and its experimental proof: the twin-domain model. It explains the change of the easy axis by structural changes during the conversion. The atoms undergo a slight shift of either 0.29(1) Å or 0.50(1) Å in their atomic positions driven by the external field. Due to the *pseudo-hexagonal structure* the crystal decays into many small identical twin-domains of three different orientations. They are rotated along b direction by ± 60.52 deg. Thereby the GMS effect of more than two percent in a direction can be explained. The structural changes due to the conversion have been studied intensely by neutron scattering.

MA 20.123 Mo 14:00 Poster TU C

A nuclear magnetic resonance study of $RMn_6Ge_{6-x}Ga_x$ -compounds — ●JENS SCHNELZER und ELMAR DORMANN — Physikalisches Institut, Universität Karlsruhe (TH); D-76128 Karlsruhe

⁷³Ge-nuclear magnetic resonance spectra on the $RMn_6Ge_{6-x}Ga_x$ -series ($R = \text{rare earth metal}$) will be presented. All representatives of this series have the hexagonal $HfFe_6Ge_6$ -type structure in common. These compounds are characterized by ferromagnetic Mn Kagomé layers and by different interplane couplings giving rise to various magnetic ordering-phenomena such as antiferromagnetic, helical or ferrimagnetic structures, depending on the nature of the R element and the Ge/Ga-proportion. The main effect of this substitution is to enhance the relative strength of the ferromagnetic interaction with respect to the antiferromagnetic one and for critical Ga concentration ferromagnetic or ferrimagnetic structures are stabilized. The influence of these different magnetization configurati-

ons on the NMR spectra is analysed.

We thank G.Venturini, Nancy for providing the samples, and GK 284 (DPG) for financial support.

MA 20.124 Mo 14:00 Poster TU C

Magnetic structure of Tb_2PdSi_3 : Investigation of long- and short-range magnetic order in external magnetic fields — ●MATTHIAS FRONTZEK¹, ANDREAS KREYSSIG¹, MATHIAS DOERR¹, JENS-UWE HOFFMANN², and MICHAEL LOEWENHAUPT¹ — ¹TU Dresden, Institut für Festkörperphysik, D-01062 Dresden — ²Hahn-Meitner-Institut, BENSC, Glienicke Straße 100, D-14109 Berlin

Tb_2PdSi_3 , crystallizing in an AlB_2 derived hexagonal structure (space group $P6/mmm$) shows a very complex magnetic behavior due to low-dimensional magnetism as well as spin-glass like properties. The hexagonal structure allows the possibility of a 2-dimensional geometrical frustration which might be the cause of the observed spin-glass like behavior.

Tb_2PdSi_3 orders antiferromagnetically at $T_N = 23$ K and undergoes a spin-glass like transition at $T_2 = 9$ K. For the zero field long-range antiferromagnetic structure we determine a propagation vector $(1/2, 1/2, 1/16)$ at $T = 2$ K. Additionally we observe intensity due to antiferromagnetic short-range order (SRO) with a correlation length of about 30 Å. The observed antiferromagnetic SRO is probably linked to the spin-glass like transition. The magnetic behaviour of Tb_2PdSi_3 investigated with ac susceptibility and magnetisation delivered ambiguous results and left open several questions. Using neutron diffraction in external magnetic fields we studied the microscopic cause of the hysteretic behaviour and the co-existence of different long-range and short range ordered magnetic phases up to a field of $\mu_0 H = 6.5$ T. In our contribution we will present and discuss the results.

MA 20.125 Mo 14:00 Poster TU C

Thermodynamic and Transport Properties of the Antiferromagnetic Order in $EuZn_2Sb_2$ — ●F. WEBER^{1,2}, S. DROBNIK^{1,2}, K. GRUBE², C. PFLEIDERER^{1,2}, A. COSCEEV¹, M. UHLARZ¹, H. V. LÖHNEYSEN^{1,2} und A. NATEPROV³ — ¹Physikalisches Institut, Wolfgang-Gaede Str. 1, D-76128 Karlsruhe, Germany — ²Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe, Germany — ³Institute of Applied Physics, Academiei 5, MD-2028 Kishinev, Moldova

We report an experimental study of the specific heat, thermal expansion, magnetisation, Hall effect and resistivity of $EuZn_2Sb_2$. Single crystals have been synthesized by means of a solid state reaction using carbon glass crucibles. The crystal structure of $EuZn_2Sb_2$ is trigonal, space group $P\bar{3}m1$. A second order phase transition at $T_N = 13.27$ K bears all the Hall marks of 3D-XY antiferromagnetic order, where the high field magnetisation and evidence of a spin-flop transition at very low fields are consistent with a weak magnetic anisotropy. Microprobe analysis reveals, however, that the samples are Eu-deficient. Remarkably, the Eu-deficiency may be accounted for purely in terms of two metallurgically segregated phases, where one of the phases is stoichiometric $EuZn_2Sb_2$.

MA 20.126 Mo 14:00 Poster TU C

Effective spin description of crystal field effects in $NdAl_2$ — ●ULRICH KÖBLER¹ and ANDREAS HOSER^{1,2} — ¹IFF, FZ-Jülich — ²Inst.f.Kristallographie, RWTH-Aachen

We propose a new analysis of the paramagnetic susceptibility and the spontaneous magnetization of the ferromagnet $NdAl_2$ (electronic configuration $4f_{9/2}$). As a consequence of a large crystal field splitting the observed saturation magnetic moment of $m=2.484\mu_B$ per Nd is considerably smaller than the free Nd^{3+} value of $3.273\mu_B$. On the other hand, the effective magnetic moment of the high temperature Curie-Weiss susceptibility conforms well to the theoretical value of the Nd^{3+} ion. We show that the number of relevant states, N , is the important quantity for the thermodynamics. This number is always an integer. The character of the states seems to be less important. Far above $T_c=78$ K all states of the Nd^{3+} are relevant, i. e. $N=2J+1=10$. For $T \rightarrow 0$ the effective spin is only $J_{eff}=3$, i. e. $N=7$. The decrease of N is in steps of unity. Each decrease of N is associated with a crossover phenomenon. This crossover can be in the paramagnetic phase as well as in the ordered state. The thermodynamics can therefore be considered as quantized. Depending on whether N is even or odd the temperature dependence of the spontaneous magnetization is according to different universality classes.

MA 20.127 Mo 14:00 Poster TU C

Spin correlations in disordered spin chain with itinerant electrons — ●ANDREAS ROTHE and ALEXANDER CHUDNOVSKIY — Universität Hamburg Jungiusstr. 9 20355 Hamburg

We investigate spin-spin correlations mediated by itinerant electrons. We calculate the localization length in a special model of a disordered Ising spin chain. We treat this model by means of real space renormalization group (RG). Further we analyse the frequency dependence of the spin-spin correlation function.

MA 20.128 Mo 14:00 Poster TU C

Electronic structure and magnetism of "Ferric Star" molecule — ●A. F. TAKÁCS¹, M. NEUMANN¹, M. PRINZ¹, A. POSTNIKOV², J. KORTUS³, A. SCHEURER⁴, S. SPERNER⁴, and R. W. SAALFRANK⁴ — ¹Universität Osnabrück, Fachbereich Physik, Barbarastr. 7, D-49069 Osnabrück, Germany — ²IFF F2 Jülich, D-52425 Jülich, Germany — ³IPCMS- GMI F -67037 Strasbourg -France — ⁴University of Erlangen-Nuernberg, 91054 Erlangen- Germany

The electronic structure of magnetic molecules of the type $[M(FeL_2)_3] \cdot 4CHCl_3$ where $M=Fe, Cr$ and $L=H_3CN(CH_2CH_2O)_2^{2-}$ has been studied using X-ray photoelectron spectroscopy, soft X-ray emission spectroscopy as well as theoretical density-functional-based methods. Three peaks have been found in the valence band region by XPS, which are excellently reproduced by the calculated tDOS, also the partial DOS agrees very well with the XES results. The top of the valence band is dominated by the hybridization between M 3d and O 2p bands. The Fe core level spectra indicate that Fe is in the Fe^{2+} state, which is in a good agreement with the calculated magnetic moment of $\approx 4\mu_B$. The neighbouring atoms primarily oxygen and nitrogen exhibit a magnetic polarisation yielding effective spin $S=5/2$ per iron atom. Due to antiparallel orientation of the magnetic moments of the central M ion relatively to three peripheral Fe, the total resulting spin per molecule in the ground state amounts to $S=5$ ($M=Fe$) or $S=6$ ($M=Cr$).

MA 20.129 Mo 14:00 Poster TU C

Synthese formanistropen magnetischer Partikel im Submikrometerbereich — ●FRANK DÖBRICH, ANDREAS TSCHÖPE und RAINER BIRINGER — 7.3 Technische Physik, Universität des Saarlandes, Geb. 43B, D-66123 Saarbrücken

Zur Modifikation der magnetoviskosen und viskoelastischen Eigenschaften von Ferrofluiden wird versucht, statt sphärischer Partikel solche mit starker Formanisotropie der Brownschen Teilchen in einer Trägerflüssigkeit zu dispergieren. Dieser Beitrag befasst sich mit Methoden zur Synthese solcher formanistropen Partikel. Dabei wird zum einen die Synthese auf dem Aeosolwege verfolgt und zum andern der Herstellung auf einer nasschemischen Route nachgegangen. Die hergestellten Partikel werden in erster Linie bezüglich ihrer Morphologie mittels Transmissionselektronenmikroskopie charakterisiert, wobei Unterschiede, bedingt durch die verschiedenen Syntheserouten oder durch Variation verschiedener Syntheseparameter, diskutiert werden.

MA 20.130 Mo 14:00 Poster TU C

Correlation between structural and magnetic characteristics of aligned Fe-filled carbon nanotubes grown on Si substrates — ●RADINKA KOZHUHAROVA¹, STEFKA GROUDEVA-ZOTOVA¹, DIETER ELEFANT¹, ANDREAS GRAFF², ALBRECHT LEONHARDT¹, INGOLF MÖNCH¹, THOMAS MÜHL¹, MANFRED RITSCHEL¹, and CLAUD SCHNEIDER³ — ¹IFW Dresden, Helmholtzstr. 20, D-01069 Dresden — ²now at: MPI of Microstructure Physics, Halle — ³now at: IFF-IEE, Jülich

Aligned Fe-filled multi-walled carbon nanotubes (MWNTs) were grown perpendicularly to oxidized Si substrates by pyrolysis of ferrocene. Recently, we have reported on encapsulated Fe nanowires having at room temperature the bcc and the fcc phase and possessing a pronounced uniaxial magnetic anisotropy with easy axis of magnetization perpendicular to the substrate surface.

Here we present a systematic comparison of the magnetic properties of Fe-filled MWNTs samples having different phase compositions and an establishment of possible correlations between structural and magnetic characteristics of the carbon nanotube filling. It was found that the specific saturation magnetization and the magnetic anisotropy strongly depends on the relative amount of the bcc Fe phase and the bcc Fe crystallite grain size.

MA 20.131 Mo 14:00 Poster TU C

Druckabhängigkeit der Suszeptibilität von $\text{Fe}_{1-x}\text{Co}_x\text{Si}$ — ●M. FINKE, D. MENZEL, D. ZUR und J. SCHOENES — Institut für Halbleiterphysik und Optik, TU Braunschweig, Mendelssohnstrasse 3, 38106 Braunschweig, Germany

Während FeSi ein paramagnetischer Halbleiter mit einer Bandlücke von ca. 60 meV und CoSi ein diamagnetisches Metall ist, ordnet $\text{Fe}_{1-x}\text{Co}_x\text{Si}$ ab einer Konzentration von 5% Co ferromagnetisch. Druckuntersuchungen an diesem Material können Hinweise geben, ob dieses System in einem Einteilchen- oder einem korrelierten Bild zu beschreiben ist. Es wurden die magnetischen Eigenschaften von $\text{Fe}_{1-x}\text{Co}_x\text{Si}$ -Einkristallen bei Drücken bis 0,7 GPa untersucht. Während der Curie-Anteil der Suszeptibilität als Funktion des Druckes konstant bleibt, nimmt bei Proben mit einem Co-Anteil von über 5% die Pauli-Suszeptibilität mit zunehmendem Druck ab. Dagegen zeigen Proben mit niedrigerer Co-Konzentration bei Feldern bis ca. 3 Tesla den umgekehrten Effekt. In höheren Magnetfeldern nimmt auch bei geringen Co-Konzentrationen die Suszeptibilität mit zunehmendem Druck ab. Dieses Verhalten wird mit Hilfe von Bandstrukturberechnungen nach der SPRKKR-Methode interpretiert.

MA 20.132 Mo 14:00 Poster TU C

Lokale Struktur fester Lösungen von Mn und Fe in Ge — ●I. KRUG, H. BRAAK, R. GAREEV, D. BÜRGLER, ST. CRAMM, F.U. HILLEBRECHT und C.M. SCHNEIDER — IFF, FZ Jülich, 52425 Jülich

Halbleiter mit ferromagnetischer Ordnung sind für Anwendungen in Bauelementen der Spinelektronik von Interesse, um spinpolarisierte Ladungsträger in Halbleiter zu injizieren. Durch Einbringen von magnetischen Spezies in konventionelle Halbleiter, z.B. Mn in GaAs, konnte eine ferromagnetische Ordnung in diesem Material induziert werden. Kürzlich wurde in Mn-Ge-Lösungen ebenfalls Ferromagnetismus beobachtet, dessen Ordnungstemperatur durch den Zusatz von Fe deutlich über Raumtemperatur gebracht werden kann. Um zu klären, ob es sich hierbei um echten Ferromagnetismus handelt, ist u.a. eine möglichst genaue Kenntnis der Struktur erforderlich. Deshalb haben wir EXAFS-Untersuchungen an diesen Materialien durchgeführt. Die Ergebnisse zeigen, dass Mn in die Ge-Struktur eingebaut wird. Allerdings sind in den EXAFS-Spektren die Maxima der zweiten und höheren Koordinationsschale nur sehr schwach, was auf einen hohen Grad von Unordnung in der Umgebung der Dotieratome hinweist.

MA 20.133 Mo 14:00 Poster TU C

Magnetic properties of the diluted semiconductor $\text{Ge}_{1-x}\text{Mn}_x$ ($\text{Ge}_{1-x}\text{Co}_x$) — ●ERWIN BIEGGER, LORENZ STÄHEL, MIKHAIL FONIN, und ULRICH RÜDIGER — FB Physik/LS Rüdiger/Universitätsstraße10/78457 Konstanz

Diluted magnetic semiconductors (DMS) attract extensive attention because of their possible applications to spintronics based on the semiconductor technology [1]. DMS are made by substitution of small amount of magnetic transition metal (TM) such as Cr, Mn, Fe, Co, and Ni into semiconductors. The coupling mechanism in these systems are still unclear. Recently, Mn substitution has yielded ferromagnetism in germanium with T_C at 285 K in bulk single crystals [2]. Magnetic properties have been investigated between 5 and 400 K. The magnetisation showed two distinct transitions at about 150 K and about 285 K which were identified as antiferromagnet-ferromagnet and ferromagnet-paramagnetic transition, respectively.

$\text{Ge}_{1-x}\text{Mn}_x$ ($\text{Ge}_{1-x}\text{Co}_x$) have been grown in vertical furnaces. Bulk crystals have been cut to analyse its crystal structure with X-ray diffraction techniques. SQUID measurements have been done to investigate the magnetic properties.

[1] R. Fiederling *et al.*, Nature (London) 402, 787 (1999); Y. Ohno, D. K. Young, B. Beschoten, F. Matsukura, H. Ohno, and D. D. Awschalom, *ibid.* 402, 790 (1999); T. Dietl, H. Ohno, F. Matsukura, J. Cibert, and D. Ferrand, Science 287, 1019 (2000). [2] S. Cho *et al.*, Phys. Rev. B 66, 033303 (2002).

MA 20.134 Mo 14:00 Poster TU C

Ultraviolette Photoelektronen-Spektroskopie von $\text{Mn}:\text{TiO}_2$ — ●IVAN JURŠIĆ, DIRK MENZEL und JOACHIM SCHOENES — Institut für Halbleiterphysik und Optik, Mendelssohnstr. 3, 38106 Braunschweig

$\text{Mn}:\text{TiO}_2$ ist ein verdünnter magnetischer Halbleiter, bei dem sogar oberhalb Raumtemperatur Ferromagnetismus beobachtet werden kann.

Das $\text{Mn}:\text{TiO}_2$ wurde mittels Ionenimplantation von Mn^+ -Ionen in TiO_2 hergestellt. Zum einen wurden kommerzielle, kristalline $\text{TiO}_2(001)$ Sub-

strate in der Rutil Phase implantiert und zum anderen amorphe Schichten, die mit einer thermischen Aufdampfanlage hergestellt wurden. Dies ermöglicht die Untersuchung des Einflusses der Kristallstruktur auf den Magnetismus. Es wurden Mn-Konzentrationen von 3%, 5% und 7% hergestellt, um die Konzentrations- bzw. Abstandsabhängigkeit der Mn-Atome zu untersuchen. Um die durch die Ionenimplantation hervorgerufenen Defekte auszuheilen, wurde bei verschiedenen Temperaturen in einer Sauerstoffatmosphäre mit einem Druck von $3 \cdot 10^{-3}$ mbar *getempert*.

SQUID-Messungen ergaben nach der Ionenimplantation ein maximales magnetisches Moment von $0,41 \mu_B$ pro Mn-Atom und eine Curie-Temperatur von 650K. Die elektronische Struktur wurde mittels Ultravioletter Photoelektronen-Spektroskopie mit der He-I-Linie untersucht.

Die beobachteten Veränderungen in der elektronischen Struktur und im magnetischen Verhalten nach dem *tempern* deuten auf zwei Ursachen für den Ferromagnetismus; zum einen einen Austausch über die Leitungselektronen und zum anderen eine Abstandsabhängigkeit der Mn-Atome.

MA 20.135 Mo 14:00 Poster TU C

Elektroresistiver Effekt im sauerstoffdefizitären Manganit $\text{Nd}_{0.7}\text{Sr}_{0.3}\text{MnO}_{3-d}$ — ●KLAUS BAERNER¹, CHANGPING YANG¹, VLADIMIR MORCHSHAKOV¹ und IGOR TROYANCHUK² — ¹FB Physik, 4 Physik, Uni-Goettingen — ²Institute of solid state and semiconductor physics, Minsk

Wir beobachten einen starken elektroresistiven Effekt (ER) in leicht sauerstoffdefizitärer $\text{Nd}_{0.7}\text{Sr}_{0.3}\text{MnO}_{3-d}$ Keramik ($0 < d < 0.2$) der sich ganz ähnlich verhält wie der bekannte magnetoresistive Effekt (MR) in diesen Verbindungen und der wie dort offenbar sowohl die besser isolierenden Korngrenzen wie auch Teile des Korn- oder Domänenvolumens involviert. Während beim MR das externe magnetische Feld direkt auf die magnetischen Dipole der Mn-Ionen einwirkt, ist die Natur der korrespondierenden elektrischen Dipolmomente zur Zeit noch unklar. Da sich der ER-Effekt jedoch dramatisch mit zunehmendem d steigert, sieht es so aus als ob die (induzierten) elektrischen Dipole etwas mit der lokalen Gitterkonstruktion zu tun hat, die sich aus dem Sauerstoffdefizit notwendig ergibt. Ein um eine elektrische Suszeptibilität erweitertes deGennes Modell ermöglicht eine eingehendere Analyse sowohl des ER-Effektes als auch der Verschiebung der Übergangstemperaturen im E-Feld.

MA 20.136 Mo 14:00 Poster TU C

Ferrimagnetism in the Brownmillerit compounds $\text{Sr}_2\text{M}_2\text{O}_5$ M = Fe, Co — ●FRANZISKA EMMERLING, GERHARD H. FECHER, VADIM KSENOFONTOV und CLAUDIA FELSER — Johannes Gutenberg - Universität, D-55099 Mainz, Germany

The oxides $\text{Sr}_2\text{M}_2\text{O}_5$ (M=Fe, Co) were prepared via ceramic and sol-gel methods. The samples were characterized by X-ray diffraction, SQUID magnetometry, XPS- and Mößbauer spectroscopy. The XRD diffraction patterns confirmed that, at least within the sensitivity of XRD, the samples are single phase with the expected lattice parameter (Ima2, $a=15.66/15.59 \text{ \AA}$, $b=5.56/5.66 \text{ \AA}$, $c=5.46/5.53 \text{ \AA}$ Co/Fe). SQUID measurements revealed a total magnetic moment of 0.34 (Co) and 0.46 (Fe) μ_B . The ⁵⁷Fe Mößbauer spectrum of $\text{Sr}_2\text{Fe}_2\text{O}_5$ indicates the two expected Fe positions and points on magnetic order at room temperature.

The electronic structures were calculated using the self-consistent, linearized muffin-tin orbital (LMTO) program of Anderson *et al.* The calculations revealed a ferrimagnetic ordering with magnetic moments of 1.30 (Co)/2.67 (Fe) for the octahedral coordinated A-site and 1.29 (Co)/2.90 (Fe) for the tetrahedral coordinated B-site and a resulting moment of 0.215(Co)/ 0.94 (Fe) μ_B .

The series $\text{Sr}_2\text{Co}_{2-x}\text{Fe}_x\text{O}_5$ with varying Co to Fe ratio x will be discussed on hand of experimental data and calculated results.

MA 20.137 Mo 14:00 Poster TU C

Substitutional effects in rare earth based half Heusler compounds — ●FRED CASPER, VADIM KSENOFONTOV, GERHARD H. FECHER, and CLAUDIA FELSER — Johannes Gutenberg - Universität, 55099 Mainz, Germany

Half Heusler compounds offer a variety of half-metallic ferromagnetic materials. This study focuses on Heusler compounds $\text{RE}_{1-x}\text{M}_x\text{XY}$ containing mixed rare earth - transition metal sublattices, because one expects an interplay of d- and f- electrons with respect to the magnetic properties. The families of compounds RENiBi and REAuSn are of particular interest. GdAuSn is known to be a semiconducting antiferromagnetic compound with $T_N \cong 60\text{K}$, whereas MnAuSn belongs to the ferromagnetic metals. A dramatic increase of the Neel temperature up to

approximately 200 K was found during the study of the doped compound $Gd_{0.9}Mn_{0.1}AuSn$ from the series $Gd_{1-x}Mn_xAuSn$. Gd, Au and Sn Mößbauer spectroscopy is applied to elucidate the magnetic state of the constituents of this compound. Band structure calculations using the FLAPW method provide an insight in the magnetic and electronic properties of doped, rare earth based half Heusler compounds.

(This work is funded by the DFG.)

MA 20.138 Mo 14:00 Poster TU C

Calculated electronic structure of semiconducting Gd compounds with Half-Heusler and LiGaGe-structure — ●HEM C. KANDPAL, GERHARD H. FECHER, and CLAUDIA FELSER — Johannes Gutenberg - Universität, 55099 Mainz, Germany

We present spin polarized LSDA calculations of different semiconducting Gd-compounds with cubic Half-Heusler ($C1_b$, $F\bar{4}3m$) or hexagonal LiGaGe ($P6_3mc$) structure. Half Heusler compounds may be described by a partial filling (4b or 4d site) of the Zinblende structure with a third element and LiGaGe as Wurtzite structure with the origin (2a site) filled by a third element. Most of the investigated compounds follow the Slater-Pauling rule with the magnetic moment per unit cell scaling with the number of valence electrons. The f-electrons at Gadolinium sites are localized. Nearly all compounds are semiconductors or semimetals because of the total number of 18 valence electrons, remaining. The potential of these semiconducting materials for spininjection devices will be discussed.

(This work is funded by the DFG.)

MA 20.139 Mo 14:00 Poster TU C

Calculated electronic structure of X_2YZ Heusler compounds — ●HEM C. KANDPAL, GERHARD H. FECHER, CLAUDIA FELSER, and GERD SCHÖNHENSE — Johannes Gutenberg - Universität, 55099 Mainz, Germany

We present calculations on a series of X_2YZ full Heusler compounds which show the phenomenon of half metallic ferromagnetism. The crystal structures have been obtained for some of the compounds through structural relaxation in the first principles framework determining the minimum total energy as function of the lattice parameter. We find that mostly Co based Heusler compounds are exhibiting half-metallic behavior. We also analyze the influence of the lattice parameter on the minority band gap. We find that smaller lattice parameter result in larger minority band gaps. The width of the gap is seemingly a linear function of the lattice constant. X=Co based Heusler compounds exhibit high Curie temperature with a linear dependence on the number of valence electrons. Our results show that Co based Heusler compounds obey the Slater-Pauling rule, while most of the others do not. There are slight changes in the magnetic moment of the Co atoms, while the magnetic moment of Y increases with the number of valence electrons. The peculiarities of the electronic structure suggest that the Co based Heusler compounds are the best candidates for potential spintronics applications.

(This work is funded by the DFG in FG 559.)

MA 20.140 Mo 14:00 Poster TU C

EXAFS-measurements on doped Heusler compounds — ●SABINE WURMEHL¹, GERHARD H. FECHER¹, JONDER MORAIS², MARIA C. M. ALVES², SERGIO R. TEIXEIRA², CLAUDIA FELSER¹, and GERD SCHÖNHENSE¹ — ¹Johannes Gutenberg - Universität, 55099 Mainz, Germany — ²Universidade Federal do Rio Grande do Sul, Porto Alegre, 91501-970 RS, Brazil

Doped Heusler compounds with composition $Co_2Cr_{1-x}Fe_xAl$ were prepared by arc melting and comprehensively characterized by means of SQUID magnetometry, Mößbauer spectroscopy, ESCA and AES depth profiling. X-ray diffraction pointed on structural disorder phenomena. Therefore, EXAFS measurements on polished discs and powders were performed. The XAS spectra were taken at the 3d-metal K-edges to compare each edge of the contributing d-metals in powder and bulk samples. The near edge region (NEXAFS) is similar for each edge and gives no hint for chemical alteration. The EXAFS signal of Cr and Co in the same composition differs significantly if the measurements were taken from powder or polished discs. This shows that the neighborhood of Fe is not changed when grinding a sample, whereas Cr and Co exhibit different surroundings in powder and bulk material. It indicates that determining structural properties from powder diffraction may lead to wrong conclusions.

(This work is funded by the DFG in FG 559.)

MA 20.141 Mo 14:00 Poster TU C

First-principles investigation of electronic structures and vibrational modes of various types of ternary Heusler alloys with $L2_1$ structure — ●WAHEED ADENIYI ADEAGBO¹, ALEXEI T. ZAYAK², and PETER ENTEL¹ — ¹Institute of Physics, MC 328, University of Duisburg-Essen, Duisburg Campus, Lotharstr.1, 47048, Duisburg, Germany — ²Department of Physics and Astronomy, Rutgers University, 136 Frelinghuysen Rd, Piscataway, NJ 08854-8019, USA

The first-principles method is used to show the trend of instabilities and stabilities exhibited by many Heusler alloys. We have calculated the phonon spectra of various types of ternary Heusler alloys (X_2YZ) with ferromagnetic order (where X and Y are mostly 3d-metals and Z non-magnetic metallic atoms). We correlate the results of the spectra with their corresponding electronic density of states at the Fermi level in order to address some of the trends of anomalous softening behaviour, which is mostly dictated by the TA_2 mode in the acoustic region of the phonon dispersion of some magnetic Heusler alloys. While most series of the non-magnetic Heusler alloys show non-softening in the acoustic mode, the magnetic counterparts are either non-softened or softened. Our phonon calculations are based on the direct method which yields good agreement with existing experimental data.

MA 20.142 Mo 14:00 Poster TU C

First-principles investigation of electronic structures and vibrational modes of various types of ternary Heusler alloys with $L2_1$ structure — ●WAHEED ADENIYI ADEAGBO¹, ALEXEI T. ZAYAK², and PETER ENTEL¹ — ¹Institute of Physics, University of Duisburg-Essen, Duisburg Campus, Lotharstr.1, 47048, Duisburg, Germany — ²Department of Physics and Astronomy, Rutgers University, 136 Frelinghuysen Rd, Piscataway, NJ 08854-8019, USA

The first-principles method is used to show the trend of instabilities and stabilities exhibited by many Heusler alloys. We have calculated the phonon spectra of various types of ternary Heusler alloys (X_2YZ) with ferromagnetic order (where X and Y are mostly 3d-metals and Z non-magnetic metallic atoms). We correlate the results of the spectra with their corresponding electronic density of states at the Fermi level in order to address some of the trends of anomalous softening behaviour, which is mostly dictated by the TA_2 mode in the acoustic region of the phonon dispersion of some magnetic Heusler alloys. While most series of the non-magnetic Heusler alloys show non-softening in the acoustic mode, the magnetic counterparts are either non-softened or softened. Our phonon calculations are based on the direct method which yields good agreement with existing experimental data.

MA 20.143 Mo 14:00 Poster TU C

Magnetic properties in chromium-chalcogenide systems — ●DIANA BENE¹, HUBERT EBERT¹, WOLFGANG BENSCH², and ZHONG-LE HUANG² — ¹Department of Chemistry and Biochemistry, LMU-Munich, Germany — ²Institute for Inorganic Chemistry, CAU-Kiel, Germany

A detailed theoretical and experimental investigation on the electronic and magnetic properties of several Cr-Te systems with the Te concentration between 60.6 and 62.2 % have been performed. Depending on the heat treatment and on the composition, these systems show different structures with a monoclinic, trigonal supercell and trigonal basic unit cell. The phase transitions between these crystallographic structures induced by a change in composition is discussed. The preferential occupation of the metal layers evidenced by X-ray and neutron scattering experiments is investigated by theoretical calculations. In addition, the influence of the substitution of Cr and Te by Ti and Se, respectively, on the magnetic properties of the system is discussed. All investigations of the electronic, magnetic and structural properties have been done using the Korringa-Kohn-Rostoker (KKR) band structure method. The disorder in the system has been accounted for by means of the Coherent Potential Approximation (CPA).

MA 20.144 Mo 14:00 Poster TU C

Canted antiferromagnetism in $U_{1-x}La_xCu_9Sn_4$ — ●E.-W. SCHEIDT¹, U. KILLER¹, H. MICHOR², H.-A. KRUG VON NIDDA³, and W. SCHERER¹ — ¹CPM, Institut für Physik, Universität Augsburg, 86135 Augsburg, Germany — ²Institut für Festkörperphysik, TU Wien, 1040 Wien, Austria — ³EKM, Institut für Physik, Universität Augsburg, 86135 Augsburg, Germany

UCu_9Sn_4 crystallizes in the tetragonal space group $I4/mcm$ with the lattice parameters $a = 0.86nm$ and $c = 1.236nm$. This compound is iso-

typ to the ferromagnetic systems RECu_9Sn_4 (RE = Ce, Pr, Nd) with Curie-Weiss temperatures of $\Theta_{CW} = 5.5\text{K}$, 10.5K and 15K , respectively. UCu_9Sn_4 exhibits an uncommon magnetic behaviour which is reflected in three different magnetic phase transitions: i) valence shift at 105K , ii) onset of helimagnetic order at 32K , and iii) transition into a commensurate antiferromagnetic structure at 22K with magnetic field induced canting [1]. Here we present specific heat, susceptibility and resistivity studies on La-substituted samples $\text{U}_{1-x}\text{La}_x\text{Cu}_9\text{Sn}_4$. [1] U. Killer, E.-W. Scheidt, H. Michor, J. Hemberger, H. A. Krug von Nidda and W. Scherer, *Physica B*, in print.

MA 20.145 Mo 14:00 Poster TU C

Magnetic and electrical properties of intermetallic ternary rare earth compounds — •H. HARTMANN¹, O. HEYER¹, S. JODLAUK¹, K. KORDONIS¹, T. LORENZ¹, A. FREIMUTH¹, T. FICKENSCHER², and R. PÖTTGEN² — ¹II. Physikalisches Institut, Universität zu Köln, 50937 Köln — ²Anorganisch-Chemisches Institut, Universität Münster, D-48149 Münster

We present measurements of the magnetization M , the specific heat c_p , and the resistance ρ of GdAuIn , GdAuMg , EuAuMg , EuAgMg , YbAuMg , YbAgMg , and LaAgMg . The measurements of the magnetization and the specific heat indicate a ferromagnetic ordering in EuAuMg ($T_c \simeq 36\text{K}$) and EuAgMg ($T_c \simeq 22\text{K}$). According to a very small hysteresis, EuAgMg and EuAuMg may be classified as soft ferromagnets. An antiferromagnetic ordering is present in GdAuIn ($T_N \simeq 12\text{K}$) and GdAuMg ($T_N \simeq 80.5\text{K}$). For LaAgMg and YbAgMg we find no indications for magnetic ordering, but in YbAuMg c_p and M show small anomalies around 2.5K , whose origin is yet to be clarified. In all samples with magnetic order we find a large negative magnetoresistance around the respective ordering temperature. Moreover, the magnetocaloric effect is very pronounced in some of the samples. For example, when GdAuIn is magnetized under adiabatic conditions it drastically lowers its temperature. *supported by the DFG through SPP 1166*

MA 20.146 Mo 14:00 Poster TU C

Investigation of $\text{Sr}_2\text{FeMoO}_6$ by means of magnetic circular dichroism in x-ray absorption and resonant x-ray emission at the Fe L-edge — •M. RAEKERS, K. KUEPPER, A. F. TAKÁCS, H. HESSE, and M. NEUMANN — Universität Osnabrück, Fachbereich Physik, Barbarastr. 7, D-49069 Osnabrück, Germany

Ordered double perovskites like $\text{Sr}_2\text{FeMoO}_6$ have attracted much attention since the discovery of colossal magnetoresistance at room temperature by Kobayashi *et al.* [1].

The electronic and magnetic properties of $\text{Sr}_2\text{FeMoO}_6$ have been already intensively studied, i. e., [2]. We present here magnetic circular dichroism (MCD) on the Fe L edge of $\text{Sr}_2\text{FeMoO}_6$ in x-ray absorption (XAS) and resonant inelastic x-ray scattering (RIXS). The results are discussed in the light of other XAS-XMCD spectra, Mössbauer data and available theoretical calculations.

[1] K.-I. Kobayashi *et al.*, *Nature* 395 677 (1998)

[2] *phys. stat. sol. (a)*, in press, DOI 10.1002/pssa.200405432

MA 20.147 Mo 14:00 Poster TU C

Absorption spectroscopy and XMCD at the Verwey transition of Fe_3O_4 — •EBERHARD GOERING, MIRSINI LAFKIOTI, STEFAN GOLD, and GISELA SCHÜTZ — Max-Planck-Institut für Metallforschung, 70569 Stuttgart

Fe_3O_4 has been investigated since decades, because of its magnetic and unusual electronic transport properties, which exhibit significant changes at the so called Verwey transition. Nevertheless, recent investigations have shown that Fe_3O_4 has a remarkable high spin polarization at the Fermi energy [1], which transfers this system into a promising magnetic layer material for spin electronic devices. We will show detailed magnetic and nonmagnetic absorption spectroscopy results of an *in situ* cleaved high quality single crystal. We clearly observe a reproducible and very small energy shift (14meV) of the O K edge threshold across the Verwey transition. In addition, our observed orbital moments and the magnetic changes across the Verwey transition are much smaller and in strong contradiction to recently published data [2]. [1] Dedkov, Yu. S., Rüdiger, U., *et al.*; *Phys. Rev. B* 65 (2002) 64417 [2] D.J. Huang *et al.*, *Phys. Rev. Lett.* 93(2004) 77204

MA 20.148 Mo 14:00 Poster TU C

Doping and lattice effects in the half-metallic double perovskite A_2CrWO_6 — •OLIVER SANGANAS, STEPHAN GEPRÁGS, PETRA MAJEWSKI, ANDREAS ERB, MATTHIAS OPEL, LAMBERT ALFF, and RUDOLF GROSS — Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Walther-Meißner-Str. 8, 85748 Garching

Ferromagnetic double perovskites have attracted renewed interest due to the fact that they combine high Curie-temperature T_C and a half-metallicity [1]. Recently, in the compound $\text{Sr}_2\text{FeMoO}_6$ the substitution of Sr^{2+} by trivalent La^{3+} has been reported to lead to an even further increase of T_C [2]. With respect to the mechanism of ferromagnetism in the double perovskites it is important to clarify whether this behavior is general [3]. We have fabricated a series of polycrystalline samples of the two compounds with different La doping in order to compare carefully the different effects on T_C . All samples were characterized by x-ray powder diffraction, neutron scattering, magnetization and transport measurements. We find that the preferential formation of LaCrO_3 prevents the formation of La-doped Sr_2CrWO_6 . However, in the system Ca_2CrWO_6 La doping can be achieved. In agreement with the results for $\text{Sr}_2\text{FeMoO}_6$, T_C is increased as a function of La doping, paving the way for double perovskites with very high T_C as functional material for magnetoelectronics.

[1] K.-I. Kobayashi *et al.*, *Nature* 395, 677 (1998)

[2] J. Navarro *et al.*, *Phys. Rev. B* 64, 092411 (2001).

[3] J. B. Philipp *et al.*, *Phys. Rev. B* 68, 144431 (2003).

MA 20.149 Mo 14:00 Poster TU C

Investigation of Transition Metal Substituted Polyoxotungstates by X-ray Photoelectron Spectroscopy — •M. PRINZ¹, A. F. TAKÁCS¹, M. NEUMANN¹, U. KORTZ², I. BALASZ³, and E. BURZO³ — ¹Department of Physics, University of Osnabrück, 49069 Osnabrück, Germany — ²International University Bremen, P.O. Box 750561, 28725 Bremen, Germany — ³Faculty of Physics, Babes-Bolyai University, 3400, Cluj-Napoca, Romania

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. We have investigated the electronic and magnetic properties of the dimeric, transition metal substituted polyoxotungstates $\text{Cs}_n[\text{M}_4(\text{H}_2\text{O})_{10}(\beta\text{-XW}_9\text{O}_{33})_2]$ ($n = 6, \text{M} = \text{Fe}^{3+}, \text{Cr}^{3+}, \text{X} = \text{Sb}^{III}; n = 8, \text{M} = \text{Co}^{2+}, \text{Mn}^{2+}, \text{X} = \text{Se}^{IV}$) synthesized by Ulrich Kortz at the IUB [1]. X-ray photoelectron spectroscopy (XPS) and X-ray emission spectroscopy (XES) measurements have been performed. Hybridization of the O 2p, M 3d and W 5d states close to the Fermi level was found. Magnetic measurements of $\text{Cs}_6[\text{Fe}_4(\text{H}_2\text{O})_{10}(\beta\text{-SbW}_9\text{O}_{33})_2]$ show a magnetization of approximately $10 \mu_B/\text{f.u.}$ at $T = 4.2\text{K}$ and $B = 9\text{T}$ without saturation.

[1] Kortz *et al.*, *Inorg. Chem.* 2002, 41, 783-789

MA 20.150 Mo 14:00 Poster TU C

Corrosion of Nd-Fe-B magnets in aqueous environments — •MIHAELA RADA, ANNETT GEBERT, OLIVER GUTFLEISCH, and LUDWIG SCHULTZ — IFW Dresden, Postfach 27 0116, 01171

The corrosion properties of hot compacted $\text{Nd}_2\text{Fe}_{14}\text{B}/\text{Fe}$ (0 to 35 wt. %) nanocomposites (exhibiting remanence enhancement) produced from intensively milled powders and of polymer-bonded nanocrystalline magnets made from commercial rapidly quenched NdFeB-based powders with compositions varying from the Nd-rich to slightly Fe-rich range are evaluated in neutral and acidic aqueous media. The electrochemical properties of the magnets are discussed with respect to the behaviour of their single phases (Nd-rich phase, Fe, Fe_3B and $\text{Nd}_2\text{Fe}_{14}\text{B}$). Polymer-bonded magnets of different compositions have a significantly improved environmental resistance as compared to hot pressed magnets. Slight enrichment in Fe content and additions like Co and Nb improve their corrosion behaviour. For nanocomposites with increasing Fe content up to 35 wt. % decreasing corrosion rates as well as increasing passivation ability is detected. Effects of grain orientation on the corrosion rate are studied in detail for textured sintered magnets.

MA 20.151 Mo 14:00 Poster TU C

Oxidationsverhalten von Sm-Co-Permanentmagneten bis 500°C — •STEFAN KARDELKY, ANNETT GEBERT, OLIVER GUTFLEISCH and LUDWIG SCHULTZ — Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden, PF 270116, 01171 Dresden

Die Kenntnis des Oxidationsverhaltens von $\text{Sm}(\text{Co,Fe,Cu,Zr})_z$ Permanentmagneten des Typs $\text{Sm}_2\text{Co}_{17}$ ist notwendig für die Einschätzung ihrer Stabilität unter Einsatzbedingungen. Gesinterte Magnete mit variieren-

dem Fe, Cu, Zr-Gehalt wurden hinsichtlich Oxidsschichtbildung bei verschiedenen Auslagerungstemperaturen und -zeiten in Luft und in O₂/Ar-Gemischen untersucht. Die Kinetik der Oxidschichtwachstumsprozesse wurden mittels TGA verfolgt. Die oxidierten Magnetoerflächen wurden nachfolgend mit OM und REM sowie mittels GDOES charakterisiert. Anhand zeitabhängigen Massenänderungen wurden unter Anwendung bekannter Wachstumsgesetze parabolische Zunderkonstanten bestimmt, mit denen das Langzeitoxidationsverhalten vorhergesagt werden konnte. Durch Reduzierung des Fe- und Erhöhung des Cu, Zr-Gehaltes in der Zusammensetzung der Magnete werden sowohl magnetische Eigenschaften stabilisiert als auch Zunderkonstanten bei 500°C in Luft um bis zu 30 % gesenkt. Magnetische Kennwerte wurden nach Oxidationsversuchen in Luft bei 500°C bis 1000h bestimmt. Nach 600h Oxidation in Luft bei 500°C verminderte sich (BH)_{max} auf 50 %. Durch elektrolytisches Aufbringen von bis zu 15 μm starken Ni Schichten wurde die Oxidationsgeschwindigkeit bei 500°C in Luft um bis zu 96,5 % reduziert, d.h. die Stabilität gegenüber Oxidation wurde deutlich verbessert.

MA 20.152 Mo 14:00 Poster TU C

AMR Sensor Array for the Detection of Defects in Aluminum Laser Welds — ●KAI ALLWEINS and MARC VON KREUTZBRÜCK — Institut für Angewandte Physik, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 16, 35392 Giessen

Increasing demands in material testing have led to growing interest for advanced and reliable electro-magnetic testing methods. We present eddy current measurements with an AMR sensor array for the detection of imperfections in aluminum laser welds used in automotive industry. Usually material defects in laser welds are micro-cracks as well as porosities with diameters often as small as 100 μm. Measurements of laser welds with a width of 1-2 mm in an AlMg3 aluminum alloy with a thickness of more than 1 mm were performed. The welds contain reference defects or unknown defects. The separation of defect signals from noise caused by the weld's surface texture required additional efforts in signal processing and simulations. Due to the field sensitivity of about 100 pT/√Hz and high spatial resolution of the implemented AMR sensor array small porosities with a radius of 65 μm could be detected in a depth of up to 1 mm with a sufficiently high signal-to-noise ratio.

MA 20.153 Mo 14:00 Poster TU C

Magnetische Ortung und Klassifizierung von Luft- und Landfahrzeugen auf Flughäfen — ●THOMAS HEUER, HAIBIN GAO und UWE HARTMANN — FR 7.2 Experimentalphysik, Universität des Saarlandes, Im Stadtwald, 66123 Saarbrücken

Angeht die weltweit rapide steigende Zahl von Flugbewegungen wird ein System benötigt, das die Ortung und Klassifizierung von Objekten auf einem Flughafen auch unter ungünstigen Witterungsbedingungen gewährleistet und somit die Voraussetzung für eine zügige und sichere Verkehrsabwicklung schafft. Ein neuartiges, im Rahmen des EU-Projektes "ISMAEL" zu entwickelndes System erfasst die durch die Präsenz von Luft- und Landfahrzeugen erzeugten Änderungen im Erdmagnetfeld. Es kann damit andere, auf Radar basierende Ortungssysteme ergänzen oder, insbesondere auf kleineren Flughäfen, vollständig ersetzen. Besondere Herausforderungen bei der Entwicklung dieses Systems stellen dabei der geringe Anteil ferromagnetischer Werkstoffe in Luftfahrzeugen sowie die Vielzahl starker Störsignale auf einem Flughafen dar. Schwerpunkte der Forschungstätigkeit sind daher neben der numerischen Simulation der zu erwartenden Signale und dem Vergleich mit tatsächlich gemessenen Werten die Optimierung der Sensoren hinsichtlich Empfindlichkeit und Zuverlässigkeit.

MA 20.154 Mo 14:00 Poster TU C

Modelling the Procopiu Effect — ●J. VELLEUER, A. HACKL, and E. KISKER — Institut für Angewandte Physik, Heinrich-Heine Universität Düsseldorf, 40225 Düsseldorf

The Procopiu effect [1], used for very sensitive magnetic field sensing, manifests itself in the occurrence of an AC voltage on a solenoid wrapped around a softmagnetic wire, when an AC current is flowing through the wire and an external magnetic field (H_z) is applied. The magnitude of the voltage increases quasilinearly from very small values at H_z=0 until two maxima symmetrical to H_z=0 are observed at about the earth magnetic field strength. At the same time, the wire exhibits the giant magnetoimpedance (GMI) effect [2] which, at frequencies above about 500 kHz, also shows two maxima at some small magnetic field strength, also symmetrical to zero field. We are able to model the Procopiu effect quantitatively using only the magnetic material properties. Whereas

the maxima in the GMI effect are considered to arise from the coercive field of the softmagnetic wire, the maxima in the Procopiu voltage are shown to originate already from a non-hysteretic magnetization curve. This suggests that the Procopiu effect and the GMI effect arise from different shells of the wire, i.e. the former from the magnetic core and the latter from the outer shell as a consequence of the skin effect. [1] see, e.g.: J. J. Freijo, J. Appl. Phys. **85**, 5450 (1999) [2] see, e.g.: C. Bethke et al., Technisches Messen **70**, 12 (2003)

MA 20.155 Mo 14:00 Poster TU C

A Desktop NMR Cryogen free Magnet For 100 And 200Mhz — ●JEREMY GOOD — 30 Acton Park Industrial Estate, London W3 7QE, UK

Cryogenic have built a miniature helium and cryogen free magnet in a miniature cryostat with 5 ppm conformity at fields of 2.5 and 5 Tesla. The magnet is cooled by a small refrigerator to 4K without the use of liquid helium. The overall dimensions of the cryostat are 260mm high with a footprint 240 x 540mm. The workspace is a bore of 51mm but other sizes are practical in the same geometry. For the lower field the system is designed to run with a 1 Kilowatt air-cooled single-phase compressor making the magnet easy to use by non-specialists and to transport between locations. The magnet is intended for use in ESR as well as low field NMR experiments. It is thought to be the smallest High Field Superconductors NMR magnet yet built.

MA 20.156 Mo 14:00 Poster TU C

EPR Study of N@C₆₀ and P@C₆₀ in 1D Matrices — ●CH. SPUDAT¹, W. HARNEIT¹, B. NAYDENOV¹, M. SCHELOSKE¹, H.I. SÜSS², and J. HULLINGER² — ¹Institut für Experimentalphysik, Freie Universität Berlin, Arnimalle 14, 14159 Berlin, Germany — ²Dept. f. Chemie & Biochemie, Universität Bern, Freiestrasse 3, 3012 Bern, Switzerland

We will present our latest results towards the electron spin quantum computer (QC) based on the group V endohedral fullerenes N@C₆₀ and P@C₆₀ as qubits. These molecules are very suitable for QC purposes because of their very long relaxation times and the possibility of good scalability [1]. We show the dependence of the spin-spin relaxation of polycrystalline P@C₆₀ samples on the temperature and on spin concentration. At low temperatures and low concentrations, we found a value of T₂ = 150 μs, which is very long for molecular systems. We also managed to align our fullerenes in the perfectly one-dimensional channels of the organic crystal BrPOT (2,4,6-tris-(4-bromo-phenoxy)-1,3,5-triazine) as described in [2]. The inclusion lowers the symmetry of the fullerene cage and gives rise to a considerable zero-field splitting. This provides a way to selectively address the (±3/2; ±1/2) and (1/2;-1/2) transitions, giving access to all internal spin degrees of freedom. The relaxation times of the corresponding transitions are also presented.

[1] W. Harneit, Phys. Rev. A **65** (2003) 032322

[2] H.I. Süß, M. Lutz, J. Hulliger, Cryst. Eng. Comm. **4** (2002) 610

MA 20.157 Mo 14:00 Poster TU C

Electronic and magnetic properties of a hexanuclear ferric wheel — ●HARALD NIEBER, KLAUS DOLL, and GERTRUD ZWICKNAGL — Institut für Mathematische Physik, TU Braunschweig, Mendelssohnstr. 3, D-38106 Braunschweig

The electronic and magnetic properties of the hexanuclear ferric wheel [LiFe₆(OCH₃)₁₂-(dbm)₆]PF₆ have been studied with all-electron Hartree-Fock and full-potential density functional calculations. The best agreement for the magnetic exchange coupling is at the level of the B3LYP hybrid functional. The local density approximation and the gradient corrected functional PBE strongly overestimate the exchange coupling due to the too large delocalization of the d-orbitals. These findings are supported by results from the Mulliken population for the magnetic moments and the charge on the individual atoms.

MA 20.158 Mo 14:00 Poster TU C

Electronic and magnetic properties of multinuclear Ni(II) complexes — C. MENNERICH¹, ●C. GOLZE^{2,1}, M. BRÖCKELMANN^{1,2}, V. KATAEV², H.-H. KLAUSS¹, B. BÜCHNER², A. WOLTER¹, S. SÜLLOW¹, J. LITTERST¹, R. KLINGELER², S. DEMESHKO³, G. LEIBELING³, F. MEYER³, and D.-J. PRICE⁴ — ¹Institut für Metallphysik und Nukleare Festkörperphysik, TU Braunschweig — ²Leibniz-Institut für Festkörper- und Werkstofforschung, Dresden — ³Institut für Anorganische Chemie, U Göttingen — ⁴Department of Chemistry, Univ. of Glasgow, United Kingdom

We present thermodynamic and high field ESR studies of the magnetic behaviour of two newly synthesized Ni(II) S=1 molecular magnets. In $\text{Na}_2\text{Ni}_2(\text{C}_2\text{O}_4)_3(\text{H}_2\text{O})_2$ Ni dimers are weakly coupled along one direction forming a S=1 two-leg spin ladder. Magnetic susceptibility data and results of tunable ESR at frequencies up to 600 GHz in fields up to 15 T enable the accurate determination of the magnetic interactions J_{rung} and J_{leg} , the local anisotropy parameters D and E as well as the estimate of the relative energies of the Ni orbital states. The measurements prove that this system is close to the dimer limit. In the tetranuclear Ni(II) complexes $[\text{L}_2\text{Ni}_4(\text{N}_3)_{5-i}(\text{O}_2\text{CR})_i](\text{ClO}_4)$, $i=2,4$, three symmetric magnetic interaction paths are realized by azide groups. The magnetic susceptibility of these systems indicates an S=0 ground state. This is confirmed by a numerical analysis using a three- J approach and a uniaxial anisotropy D which reveals a combination of antiferromagnetic and ferromagnetic interactions between the individual metal ions. First ESR results on this system will be discussed as well.

MA 20.159 Mo 14:00 Poster TU C

Electronic and magnetic properties of Fe (II) based molecular magnets — ●F. GOUIDER¹, J. KREITLOW¹, D. BAABE¹, S. SÜLLOW¹, J. LITTERST¹, R. FEYERHERM², A. LOOSE², T. ISHIDA³, T. NOGAMI³, K. DOLL⁴, and H.-H. KLAUSS¹ — ¹Institut für Metallphysik und Nukleare Festkörperphysik, TU Braunschweig — ²Hahn-Meitner-Institut, 14109 Berlin — ³Dep. of Appl. Phys. and Chem., University Chofu, Tokyo 182-8585, Japan — ⁴Institut für Mathematische Physik, TU Braunschweig

We present Moessbauer spectroscopy studies on two Fe(II) S=2 based molecular magnets, FePM_2Cl_2 and FePMCl_2 ($\text{PM}=\text{N}_2\text{C}_4\text{H}_4$ = pyrimidine). In both compounds the pyrimidine molecule forms the magnetic exchange path. FePM_2Cl_2 crystallizes in a chiral lattice. Combined magnetization, Moessbauer spectroscopy, and powder neutron diffraction studies reveal that it is a canted antiferromagnet below $T_N=6.4$ K with an unusually large canting of the magnetic moments of 14° from their general antiferromagnetic alignment. This results in weak ferromagnetism with a ferromagnetic component of $\approx 1 \mu_B$ [1]. In FePMCl_2 anisotropic magnetic interactions are provided via the PM molecules and the Cl^- ions. This leads to a long range magnetic order below ≈ 11 K. Although neutron scattering results in an ordered moment of $3.2 \mu_B$ the Moessbauer experiments reveal a strongly reduced magnetic hyperfine field of ≈ 4 T. These results are discussed in terms of the interplay of orbital and spin magnetic moments on the local Fe complexes. [1] R. Feyerherm et al., PRB **69** (2004) 134427.

MA 20.160 Mo 14:00 Poster TU C

Neutron Diffraction Studies of the Long-Range Magnetic Ordering in the Antiferromagnetic Quantum Chain System CuBr_2 — ●REINHARD K KREMER¹, MICHAEL BANKS¹, ARNDT SIMON¹, and BACHIR OULADDIAF² — ¹MPI-FKF, 70569 Stuttgart — ²ILL Grenoble, CEDEX 9

Historically, the binary CuBr_2 and the structurally similar CuCl_2 are among the very first systems the magnetic properties of which were analyzed in terms of a linear spin chain arrangements. Low-dimensional magnetism with typical signatures, e.g. a broad short-range ordering maxima in the susceptibility have been found. The antiferromagnetic (afm) intra-chain exchange parameters are significant (e.g. $\approx 320\text{K}$ for CuBr_2), however, both systems are far from representing ideal one-dimensional magnets as must be concluded from the rather high transition temperatures to long-range ordering (e.g. 74 K for CuBr_2) indicating appreciable inter-chain coupling. To the best of our knowledge, the magnetic structures of CuBr_2 and CuCl_2 remained unsolved until now. We studied the afm ordering of CuBr_2 in detail by neutron powder diffraction using ILL's high flux powder diffractometer D20 in its high resolution option. Below T_N , two very weak additional reflections of magnetic origin were identified which can be indexed with a propagation vector (0,0.54,0) indicating an incommensurate antiferromagnetic structure. A first analysis assumes

a longitudinal amplitude modulation with moments ($\mu = 0.2 \mu_B$) oriented along (0,1,0). In the critical regime characteristic magnetoelastic anomalies are observed for the b lattice parameter and the monoclinic angle β .

MA 20.161 Mo 14:00 Poster TU C

EuGe: A system close to the transition from a ferro- to an antiferromagnetic state — ●JULIA FERSTL and CHRISTOPH GEIBEL — Max Planck Institut fuer Chemische Physik fester Stoffe, Noethnitzer Strasse: 40, 01187 Dresden

The Rare earth compound series RGe has attracted some attention because of the transition from a ferromagnetic state for light rare earth towards an antiferromagnetic state for heavy rare earth, the transition occurring in between Nd and Eu. However, for EuGe, beside structural data, only the susceptibility and a magnetization curve at low T have yet been reported [1]. From these data a divalent Eu state ordering antiferromagnetically below $T_N = 20$ K was inferred. In an attempt to synthesize EuFe_2Ge_2 , we obtained EuGe single crystals. We present here the investigation of these single crystals by means of susceptibility, specific heat and resistivity measurements. Our results confirm a divalent Eu state, but indicate a more complex magnetic ordering behavior. Very pronounced anomalies in the specific heat and in the resistivity show that magnetic ordering occurs at a much higher temperature $T_N = 38$ K, while a pronounced anomaly in the susceptibility in low fields at 25 K, which likely corresponds to the anomaly seen in [1], indicate a further transition associated with a change in the magnetic structure. This complex magnetic behavior is probably related to the proximity to a ferromagnetic state, which is also evidenced by a ferromagnetic Curie-Weiss temperature $\theta_{CW} = +34$ K. [1] K.H.J. Buschow et al. Journal of Less-Common Metals, 139 (1988) 221-231

MA 20.162 Mo 14:00 Poster TU C

New clathrate-like compounds EuPd_5P_2 and $\text{EuPd}_{12}\text{P}_5$ — ●ULRIKE KÖHLER, SERGIJ BUDNYK, SILKE PASCHEN, FRANK STEGLICH, and YURI GRIN — MPI für Chemische Physik fester Stoffe, Nöthnitzer Straße 40, 01187 Dresden

Many filled cage compounds are known to have low phonon thermal conductivities κ_{ph} . In Kondo insulators the hybridization between localized 4f states and a conduction band is held responsible for the formation of a narrow band gap at the Fermi level and hence for a semiconductor-like electrical resistivity ρ and a low electronic thermal conductivity κ_{el} . The strong energy dependence of the quasiparticle density of states near the Fermi level in these materials gives rise to high values of the thermopower S . Since a good thermoelectric material is characterized by a high thermoelectric figure of merit $ZT = TS^2/[\rho(\kappa_{ph} + \kappa_{el})]$, Kondo insulating filled cage compounds appear to be a promising class of new materials. In this contribution we present physical properties of the two newly discovered filled cage compounds EuPd_5P_2 and $\text{EuPd}_{12}\text{P}_5$ which crystallize in a novel clathrate-like structure. Both materials have a metallic $\rho(T)$ and are therefore expected to show neither high $S(T)$ nor low $\kappa_{el}(T)$. The high temperature magnetic susceptibility χ is well described by a Curie-Weiss law with a full Eu^{2+} effective moment. Below 10 K both compounds order magnetically. The large Eu-Eu distance indicates that not the direct exchange interaction between the localized 4f moments but the RKKY interaction is responsible for the magnetic ordering.

Modifications of the compounds investigated here will be necessary to make them good thermoelectrics.

MA 20.163 Mo 14:00 Poster TU C

$\text{YbFe}_4\text{Sb}_{12}$: Divalent Ytterbium State and Itinerant Magnetism of the Skutterudite Host Structure — ●W. SCHNELLE, A. LEITHE-JASPER, H. ROSNER, M. SCHMIDT, M. BAENITZ, J.A. MYDOSH, and Y. GRIN — Max-Planck-Institut für Chemische Physik fester Stoffe, Dresden, Germany

The filled skutterudite $\text{YbFe}_4\text{Sb}_{12}$ has been investigated by Maple et al. [1] and other groups [2] and its remarkable properties have been interpreted involving an intermediate valence state of Yb and heavy-fermion behaviour at low temperatures. The large linear term γ in the specific heat (≈ 140 mJ/mol K²) and the 'S'-shape of the metallic resistivity have been presented as evidence for a Kondo effect and heavy electrons. However, the filled skutterudites $M\text{Fe}_4\text{Sb}_{12}$ with $M = \text{Na}, \text{K}, \text{Ca}, \text{Ba}$ [3] and La all display γ terms of 100–200 mJ/mol K² and strongly curved resistivities $\rho(T)$, irrespective of their magnetic ground state. Also, their paramagnetic effective moments are quite similar and derive almost completely from the itinerant magnetism of the $\text{Fe}_4\text{Sb}_{12}$ host which is only

slightly modified by the various filler atoms. Conclusively, X-ray absorption spectra (XANES) at the Yb L_{III} threshold demonstrate that Yb is in a divalent $4f^{14}$ state and thus $YbFe_4Sb_{12}$ can neither exhibit a Kondo effect nor show conventional heavy fermion behaviour.

[1] N.R.Dilley et al. Phys. Rev. B 58, 6287 (1998). S.V.Dordevic et al. Phys. Rev. Lett. 86, 684 (2001).

[2] see e.g. E.Bauer et al. Acta Phys. Polon. B 34, 595 (2003).

[3] A. Leithe-Jasper et al. Phys. Rev. B, in print (1 Dec 2004).

MA 20.164 Mo 14:00 Poster TU C

Electronic structure of NiO monolayer on Ag(100) — •L. H. TJENG¹, C.-F. CHANG¹, S. ALTIERI², S. HEISE¹, M. W. HAVERKORT¹, Z. HU¹, S. V. STRELTSOV³, V. I. ANISIMOV³, H. H. HSIEH⁴, H.-J. LIN⁵, D.-J. HUANG⁵ und C.T. CHEN⁵ — ¹II. Physikalisches Institut, Universität zu Köln, Zùlpicher Str. 77, 50937 Köln, Germany — ²INFM, Modena, Italy — ³Institute of Metal Physics, Ekaterinburg, Russia — ⁴Chung Cheng Institute of Technology, Taiwan — ⁵NSRRC, Taiwan

We have investigated the electronic structure of a NiO monolayer deposited on top of a Ag(100) substrate. Using x-ray absorption spectroscopy we found that the Ni ions are in the $3d^8$ ($2+$) valence state, with one hole in a $3d_{3z^2-r^2}$ orbital and another in a $3d_{x^2-y^2}$, very similar to bulk NiO. From the polarization dependence we observed nevertheless that the $3d_{3z^2-r^2}$ orbital in the NiO monolayer is somewhat less unoccupied than in bulk NiO and that there is a large $3d_{3z^2-r^2}-3d_{x^2-y^2}$ crystal field splitting. Our LDA+U calculations show that the unoccupied $3d_{3z^2-r^2}$ orbital is not pushed up so strongly above the Fermi level because in the monolayer there are no oxygens above or below it to hybridize with. This $3d_{3z^2-r^2}$ forms a band via the Ag sp-states, with a low energy tail extending below the Fermi level. This is confirmed by our photoemission data, which show a clear Fermi cut-off in the Ni 3d. In other words, the monolayer is metallic. Moreover, except for a rigid energy shift, the photoemission spectra of the NiO monolayer and bulk NiO look rather similar. We have more spectroscopic data to suggest that the NiO monolayer on Ag is actually a Kondo lattice system.

MA 20.165 Mo 14:00 Poster TU C

Spin versus orbital Kondo effect in electrostatically coupled double quantum dots — •DANIEL BEZECNY and ALEXANDER L. CHUDNOVSKIY — I. Institut für theoretische Physik, Uni Hamburg, Jungiusstr. 9, 20355 Hamburg

We consider the Kondo effect in strongly electrostatically coupled double quantum dots. The orbital structure of the electron wave function of a double dot crucially influences the transport properties if there is no energy cost to transfer an electron from one dot to the other. In that case the two degenerate states with the "last" electron either in the right or in the left dot can be associated with a spin-like degree of freedom that we call pseudo-spin. Resonant transfer of an electron corresponds to a flip of the pseudospin analogously to a spin flip in the Kondo effect. The process of a resonant pseudospin flip can induce a so called orbital (or pseudospin) Kondo effect quite similar to - and to a large extent independent of - the well-known (spin) Kondo effect. Varying the strength of the tunnel coupling between the reservoirs and each of the two dots allows a controllable change of the coupling symmetry of the Orbital Kondo effect without affecting the spin Kondo effect. Furthermore, the orbital Kondo effect can be suppressed by lifting the degeneracy of the energy levels of the left and right dot.