MA 20 Poster: Films(1-36) Transp(37-56) Ex.Bias(57-67) Spindyn(68-80) Micromag(81-95) Particle(96-109) Imag.+Surface(110-113) Spinelectr(114-122) Theory+Micromag(123-131) Spinstr+Aniso(132-142) MagMat(143-156) Meas(157,158) MolMag+Kondo(159-162) Postdead(163-)

Time: Tuesday 15:15–19:15 Room: P1

MA 20.1 Tue 15:15 P1

Preparation and Properties of thin Manganite-Titanate Composite-Films — •Kai Gehrke[1], Alexandr Belenchuk[2], Oleg Shapoval[2], Vasily Moshnyaga[1], and Konrad Samwer[1] — [1]1. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen — [2]Institute of Applied Physics, Academieis 5, MD-2028 Chisinau, Moldova

Multiferroic materials with coexistence of ferromagnetism and ferroelectricity are in the focus of modern fundamental and applied research. The coupling of these properties is believed to be very strong in nanocomposite films, containing epitaxial co-grown and elastically coupled Manganite and Titanate phases. The strain induced by the piezo effect of the Titanate phase should alter the magnetization of the CMR-Manganite phase. Thin Manganite-Titanate films were grown on MgO and STO substrates by Metalorganic Aerosol Deposition (MAD) technique. Manganites like La-Mn-O, La-Ca-Mn-O, La-Ce-Mn-O and La-Ba-Mn-O where combined with ferroelectric Barium Titanate. XRD, SEM (EDX) and TEM (EELS) where used to study the microstructure of the samples. Measurements of the temperature-dependence of both conductivity and the magnetic moment unveil a MI- and ferro-paramagnetic phase transition of the Manganite-phase. Dielectric spectroscopy in a wide range of frequencies and temperatures is used to determine the ferroelectric properties also in applied magnetic fields.

MA 20.2 Tue 15:15 P1

Investigation of manganite/strontium titanate interfaces by surface photovoltage spectroscopy — •Elke Beyreuther[1], Stefan Grafström[1], Christian Thiele[2], Kathrin Dörr[2], and Lukas M. Eng[1] — [1]Institut für Angewandte Photophysik, Technische Universität Dresden, D-01062 Dresden — [2]Institut für Metallische Werkstoffe, IFW Dresden, Postfach 270116, D-01171 Dresden

In the present study, we investigate the distribution of electronic interface states of three different perovskite oxide interfaces, formed by epitaxial thin films of $La_{0.7}Sr_{0.3}MnO_3$(LSMO), $La_{0.7}Ca_{0.3}MnO_3$(LCMO), and $La_{0.7}Ce_{0.3}MnO_3$(LCeMO) on $SrTiO_3$(100) substrates in the as-prepared state, as well as after an annealing procedure. We find that the annealing significantly reduced the number and density of interface trap states. Two different experimental techniques to comparatively inspect the surface photovoltage (SPV) spectra were employed: an approach based on X-ray photoelectron spectroscopy (XPS) and a capacitive approach. Advantages and limitations of both methods and their applicability to perovskite oxide interfaces are discussed critically.

MA 20.3 Tue 15:15 P1

Critical exponents of the ferromagnetic-paramagnetic phase transition of $La_{1-x}Sr_xCoO_3$ thin films — •Thorsten Schwarz[1,2], Dirk Fuchs[1], and Rudolf Schneider[1] — [1]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe — [2]Universität Karlsruhe, Fakultät für Physik, D-76128 Karlsruhe

The critical exponents of the second-order ferromagnetic-paramagnetic phase transition of $La_{1-x}Sr_xCoO_3$ thin films ($0.1 \leq x \leq 0.6$) and bulk materials are determined by magnetization measurements around the Curie temperature T_C ($-0.05 \leq \epsilon = (T-T_C)/T_C < 0.05$) applying fields from 0 T to 5 T. The $La_{1-x}Sr_xCoO_3$ thin films were grown on (001) $(LaAlO_3)_{0.3}(Sr_2AlTaO_6)_{0.7}$ (LSAT) single crystal substrates by pulsed laser deposition (PLD) and the bulk materials were made by standard solid state synthesis. T_C was determined by the derivative of the magnetization versus temperature, i.e., M vs. T, and $M_S \cdot (dM/dT)^{-1}$ vs. T. In order to determine the critical exponents β, γ and δ the following three different techniques have been applied for the evaluation: i) Scaling-Plots, ii) Kouvel-Fisher and iii) the modified Arrott-Plots technique. Best results for the critical exponents β, γ and δ were obtained by the modified Arrott-Plots which are presented for thin films and bulk-materials.

MA 20.4 Tue 15:15 P1

Resonant magnetic soft x-ray scattering from thin EuTe layers — •Enrico Schierle[1], Eugen Weschke[1], Alexander Gottberg[1], Günter Kaindl[1], Walter Söllinger[2], and Gunther Springholz[2] — [1]Institut für Experimentalphysik, Freie Universität Berlin, D-14195 Berlin, Germany — [2]Institut für Halbleiterphysik, Johannes Kepler University, A-4040 Linz, Austria

Magnetic structures and short-range correlations in thin EuTe(111) films [1] were studied by magnetic soft x-ray scattering at the Eu M_5 resonance. The prototypical Heisenberg antiferromagnet EuTe is ideally suited for a magnetic scattering study: (i) The high magnetic sensitivity at the lanthanide M_5 resonance [2] can be exploited and (ii) for the x-ray wavelength of the resonance, the magnetic signal appears exactly at the Brewster angle, which results in magnetic scattering virtually free of charge-scattering background. Magnetic diffraction provides well-resolved Laue profiles that permit a detailed reconstruction of the real-space magnetization profiles across the films, i.e. the temperature-dependent magnetization of the individual layers. The reduced values of the magnetization in the outer layers and the different temperature dependences compared to the inner layers are in good agreement with theoretical considerations. The high sensitivity of the method further permits even critical scattering studies above the ordering temperature in films with thicknesses down to 2 EuTe layers, revealing a transition to two-dimensional magnetic behavior around 3 EuTe layers.

[1] H. Kepa et al., Phys. Rev. B 68, 24419 (2003).
[2] E. Weschke et al., Phys. Rev. Lett. 93 (157204), 2004.

MA 20.5 Tue 15:15 P1

Magnetotransport in Sr_2CrWO_6 thin films — •Petra Majewski, Stephan Geprägs, Andrea Boger, Matthias Opel, and Rudolf Gross — Walther-Meissner-Institut, Bavarian Academy of Sciences, Walther-Meissner-Str. 8, 85748 Garching, Germany

We report on the fabrication and characterization of thin film samples of Sr_2CrWO_6 by PLD (Pulsed Laser Deposition). The growth process was monitored by RHEED (reflection high energy electron diffraction) and the high crystalline quality of the thin films was checked by X-ray diffraction. The Curie temperature T_C was found to exceed 400K from SQUID magnetization measurements. The magnetotransport properties of the samples were investigated in the temperature range from 5K to 300K and magnetic fields up to 14T. Hereby the magnetic field was applied in several directions with respect to the thin films. Preliminary results indicate that the transport properties are close to a metal-insulator transition. We also discuss an interesting fine structure in the MR at low fields, which is highly sensitive on the direction of the applied magnetic field.

This work is supported by the DFG (project GR 1132/13)

MA 20.6 Tue 15:15 P1

Multiferroic (La,A)MnO_3 / $PbZr_{0.52}Ti_{0.48}O_3$ bilayers: field effect vs. strain effect — •C. Thiele[1], K. Dörr[1], E. Beyreuther[2], A. A. Levin[3], W.-M. Lin[4], O. Bilani[1], and L. Schultz[1] — [1]IFW Dresden, PF 270116, 01171 Dresden — [2]IAPP, TU Dresden — [3]ISP, TU Dresden — [4]IFE, TU Dresden, 01062 Dresden

Magnetic transition metal oxides can be combined with ferroelectric titanates in epitaxially grown film structures [1]. This approach might offer effective access to the electric control of magnetic properties via electric field effect and induced elastic strain to the magnetic layers. Field effect transistor (FET) structures of epitaxial $PbZr_{0.52}Ti_{0.48}O_3$ / (La,A)MnO_3 / $SrTiO_3$(100) (A = Sr; Ca) have been prepared using off-axis PLD with a shadow mask technique. FETs with a $La_{0.8}Ca_{0.2}MnO_3$ channel show electrical modulation of the channel resistance proportional to the PZT electric polarization loop [2], which can be attributed to charge density modulation in the interface-near region of the manganite. Recording complete resistance (R) hysteresis loops in dependence on an applied gate voltage in FETs with $La_{0.7}Sr_{0.3}MnO_3$ channel has given evidence for butterfly-like hysteresis being typical for in-plane strain modulation in the manganite layer [3]. R modulation depending on channel

thickness is discussed. Results are compared with the effects of dynamically induced in-plane strain in epitaxial LSMO films on piezoelectric $Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$ (100) substrates. This work is supported by DFG, FOR 520.

[1] H. Tabata et al., IEICE Tran. El. E80-C (1997) 918. [2] S. Mathews et al., Science 276 (1997) 238. [3] C. Thiele et al., APL 87 (2005) 162512.

MA 20.7 Tue 15:15 P1

In-situ RHEED-Characterization of $La_{2/3}Ca_{1/3}MnO_3$ thin films — •Alexander Hirsch, Ralf Koppert, Frank Ludwig, and Meinhard Schilling — TU-Braunschweig, Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik,Hans-Sommer-Straße 66, D-38106 Braunschweig, Germany

The growth of doped perovskite manganites is interesting for both basic research and potential applications. These materials show a huge change in electric resistivity caused by an external magnetic field, the colossal magnetoresistance (CMR) effect. The strain induced by lattice mismatch between the substrate and the thin films influences the electric and magnetic properties of the manganite films.

$La_{2/3}Ca_{1/3}MnO_3$ thin films are grown on $SrTiO_3$ (001) substrates using pulsed laser deposition (PLD). The epitaxial growth of the films is investigated by in-situ reflection high energy electron diffraction (RHEED) supplemented by x-ray diffraction and atomic force microscopy. In particular the change of the lattice constant during the first monolayers is monitored by in-situ RHEED. Besides the dependence of the PLD parameters on the intervall deposition is analyzed. To obtain maximum information on the growth conditions the experiments are planned by means of statistical design of experiments (DOE).

MA 20.8 Tue 15:15 P1

LOW TEMPERATURE BEHAVIOR OF (Eu,La)1-xSrxMnO3 — •Yakov Mukovskii — Leninskii 4

Magnetic and transport properties of (Eu1-yLay)1-xSrxMnO3 poly- and single crystals were studied. Increasing as La as Sr leads to change from antiferromagnetic (AFM) to ferromagnetic (FM) ordering in the compounds. For some compositions application of an external magnetic field induces the transition into the FM state with changing temperature dependence of resistivity at low temperature from nonmetallic ($dR/dT < 0$) to metallic ($dR/dT > 0$) one. Magnetic susceptibility and magnetization data evidence on inhomogeneous magnetic structure in the material. The work was supported by the ISTC grant #1859

MA 20.9 Tue 15:15 P1

Electronic structure and transport properties of $Ce_2Rh_2XAl_9$ (X=Co,Ir,Pd) — •Jerzy Goraus and Andrzej Slebarski — Institute of Physics, University of Silesia

We have investigated transport properties and electronic structure of $Ce_2Rh_2XAl_9$ (X=Co,Pd,Ir) compounds which are formed by substitution of one Rh atomic site in $Ce_2Rh_3Al_9$. Specific heat measurements showed moderate γ value of $0.4\frac{J}{molK^2}$ for X=(Co,Rh) and a higher one for X=(Ir,Pd) of about $1.1\frac{J}{molK^2}$. XPS Ce-3d and Ce-4d spectra showed a clear mixed valence behaviour, confirmed also by the TB-LMTO-ASA and FP-LAPW band structure calculations. For X=Ir,Co and Rh we obtained a nonmagnetic semiconducting ground state from TB-LMTO calculations, whereas FP-LAPW gave us magnetic ground state for all compounds with pseudogap on Fermi level for one spin direction. Our susceptibility measurements show that no long range magnetic ordering is present for these compounds down to 2K, however for X=Pd,Ir we suspect spinglass transition with freezing temperature $\sim$ 5K. Electrical resistivity exhibits Kondo lattice behaviour for X=Co,Pd whereas for X=Ir we have metallic-like shape. Lack of activated behaviour in electrical resistivity we explain by an atomic disorder, however for temperatures similar to calculated gap there is present an anomaly in $\rho(T)$. Calculations for reduced and increased lattice constants doesn't lead to vanishing of gap in LMTO calculations.

MA 20.10 Tue 15:15 P1

Epitaxial growth and properties of multiferroic BiMO3 (M = Fe, Cr) thin films — •S. Geprägs, M. Opel, S.T.B. Goennenwein, and R. Gross — Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, Walther-Meissner-Str. 8, 85748 Garching

The coexistence of ferroelectricity and ferromagnetism makes multiferroic materials very attractive. Due to its strong ferroelectric (T_C = 1103K) and magnetic behavior (T_N = 643K) the compound $BiFeO_3$ has been extensively studied. Recently, it was reported that $BiFeO_3$ thin films show enhanced ferroelectric and ferromagnetic properties due to epitaxial strain, but this observation is still controversial [1,2]. Moreover, in the compound $BiCrO_3$ theoretical predictions suggest a G-type antiferromagnetic ground state accompanied by an antiferroelectric structural distortion. While $BiCrO_3$ therefore is also an interesting multiferroic material, no investigations of the ferroelectric properties, and also no successful thin film growth has been reported so far.
We have fabricated a series of high-quality epitaxial thin films of the compounds BiMO$_3$ (M = Fe, Cr) using pulsed laser deposition. The samples were characterized by high resolution x-ray diffraction, magnetization, transport, and dielectric measurements. In spite of their high structural quality, we have found no evidence for ferromagnetism in our $BiFeO_3$ films. We critical discuss these findings in context of the literature and compare them to the situation in $BiCrO_3$.

[1] J. Wang *et al.*, Science **299**, 1719 (2003).
[2] W. Eerenstein *et al.*, Science **307**, 1203b (2005).

MA 20.11 Tue 15:15 P1

Temperature dependence of magnetization in GaMnAs — •Matthias Sperl, Janusz Sadowski, Rashid Gareev, Werner Wegscheider, Dieter Weiss, and Guenther Bayreuther — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, 93040 Regensburg, Germany

Diluted magnetic semiconductors (DMS) based on III-V semiconductors doped with Mn have attracted a lot of interest recently. There is general agreement that ferromagnetism in these materials is caused by exchange interaction between Mn local moments mediated by holes.

In conventional ferromagnets thermally excited spin waves determine the temperature dependence of magnetization, M(T), well below the Curie temperature. This is to be contrasted with DMS materials where at low temperature spin-flip-like excitations are predicted [1] which lead to a steep decrease of the magnetization. M(T) should strongly depend on the homogeneity of the distribution of Mn ions in the lattice [1]. The aim of the present work is to experimentally study the influence of the Mn distribution on the appearance of spin wave-like excitations.

GaMnAs films with various Mn concentrations where grown on GaAs(100) and annealed under different conditions. M(T) was measured with a SQUID magnetometer. Experimental results on spin wave excitations will be discussed in comparison to theoretical predictions.

[1] M. Berciu, and R. N. Bhatt, Phys. Rev. B 66, 085207 (2002).

MA 20.12 Tue 15:15 P1

A FMR-investigation of 111 oriented NiMnSb grown by MBE — •A. Riegler, F. Lochner, P. Bach, G. Schmidt, and L. W. Molenkamp — Physikalisches Institut (EP3), Universität Würzburg, Am Hubland, 97074 Würzburg,Germany

We present the results of frequency domain ferromagnetic resonance measurements performed on NiMnSb layers on InP-b sustrate grown on (111) surfaces. Epitaxial NiMnSb layers are interesting for spin injection into semiconductors. Especially for layers grown on InP (111)-b surfaces a fully spin polarized interface is predicted [1]. While many FMR results on layers grown on (001) surfaces have been reported in the past years [2] nothing is known so far on the properties of thin (111) layers. We have performed frequency domain studies of NiMnSb (111) layers with thicknesses of 10, 40 and $\approx$ 200 nm grown on (In,Ga)As buffer layers. Surprisingly we observe a uniaxial anisotropy for all layers which becomes weaker with increasing layer thickness. We attribute this anisotropy to the asymmetry induced by a miscut of the substrates which is used to improve the epitaxial growth in molecular beam epitaxy.

We acknowledge financial support by BMBF (grant 13N8284) and we thank D. Grundler and colleagues for helpful discussions.

[1] R. A. de Groot et al., Physical Review Letters **50**, 2024 (1983)
[2] B. Heinrich et al., JOURNAL OF APPLIED PHYSICS **95**, 7462 (2004)

MA 20.13 Tue 15:15 P1

Ferromagnetism and magnetotransport in Co-doped ZnO — •Sebastian Bauer, Maike Luebbe, Karl-Wilhelm Nielsen, Matthias Opel, Sebastian T. B. Goennenwein, and Rudolf Gross — Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching

The interest in diluted magnetic semiconductors (DMS) has grown, since they would allow to combine spintronic devices with traditional

semiconductors. ZnO:Co is such a DMS, for which a Curie temperature above room temperature has been predicted [1].

We have grown homoepitaxial Co-doped ZnO films on ZnO substrates using pulsed laser deposition at different temperatures (300-600°C) and gas atmospheres (Ar, O_2). This allows to control the concentration of impurities, in particular oxygen vacancies. The magnetic properties of the thin films have been analyzed by dc magnetometry and electrical transport measurements.

Our results show that the films are electron doped and exhibit a ferromagnetic coupling that depends on the impurity concentration. The magnetoresistance shows a complex dependence on the orientation of the magnetic field with respect to the crystal axes and the current direction. Moreover, the magnetoresistance strongly depends on the temperature and even changes sign.

This work is supported by the DFG via SPP 1157.

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

MA 20.14 Tue 15:15 P1

Investigation of the magnetic anisotropy of $Ga_{1-x}Mn_xP$ via ferromagnetic resonance spectroscopy — •Michael Kraus[1], Christoph Bihler[1], Martin S. Brandt[1], Mike A. Scarpulla[2], Rouin Farshchi[2], and Oscar D. Dubon[2] — [1]Walter Schottky Institut, Technische Universität München, 85748 Garching, Germany — [2]Department of Materials Science and Engineering, University of California at Berkeley and Lawrence Berkeley National Laboratory, Berkeley, California 94720, USA

Recently, Scarpulla and coworkers [1] have shown that $Ga_{1-x}Mn_xP$ can be ferromagnetic with a Curie temperature of up to 65 K ($x = 0.06$). In $Ga_{1-x}Mn_xP$, the ferromagnetic exchange interaction is presumed to be mediated by localized holes in a Mn-impurity band, which is separated from the GaP holes band by ∼26 meV. In this contribution, we present an analysis of the magnetic anisotropy of this novel diluted magnetic semiconductor by means of ferromagnetic resonance (FMR) spectroscopy. We attribute the angular dependence of the FMR fields to the presence of a cubic magnetic anisotropy along the main crystalline ⟨100⟩ axes and two additional uniaxial magnetic anisotropies along the [100] growth direction and the in-plane [001] axis. Possible origins of these anisotropies will be discussed. Upon post-growth incorporation of hydrogen, the ferromagnetism in $Ga_{1-x}Mn_xP$ disappears, caused by a reduction of the hole concentration, as previously observed for hydrogenated $Ga_{1-x}Mn_xAs$.

[1] M. A. Scarpulla, B. L. Cardozo, R. Farshchi, W. M. Hlaing Oo, M. D. McCluskey, K. M. Yu, and O. D. Dubon, Phys. Rev. Lett. **95**, 207204 (2005)

MA 20.15 Tue 15:15 P1

Characterization of Co doped ZnO films on r-plane sapphire — •Milan Gacic, Gerhard Jakob, and Hermann Adrian — Institut für Physik, Universität Mainz, Staudinger Weg 7, 55128 Mainz

Diluted magnetic semiconductors (DMS) have recently attracted much interest because of there potential application in spintronics. Thereby ferromagnetism above room temperature is essential for practical applications, as found in Co doped ZnO. Though it is still very controversial if ferromagnetism in (Zn,Co)O is intrinsic and if yes by what kind of mechanism the exchange between the magnetic ions is mediated.

We report our results concerning growth and characterization of 5% Co doped ZnO films fabricated by pulsed laser deposition on r-plane sapphire. Our samples showed ferromagnetic and paramagnetic behaviour with weak in-plane anisotropy with ferromagnetism strongly depending on preparation conditions. Therefore we analysed the magnetic properties as a function of preparation parameters like laser energy, temperature an ambient pressure. The samples were characterized using x-ray diffraction, SQUID and VSM magnetometry.

MA 20.16 Tue 15:15 P1

Electronic Properties of Room-Temperature Ferromagnetic $Zn_{1-x}Co_xO$ — •Erwin Biegger[1], Mikhail Fonin[1], Yuriy S. Dedkov[2], and Ulrich Rüdiger[1] — [1]Fachbereich Physik, Universität Konstanz, 78457 Konstanz, Germany — [2]Institut für Festkörperphysik, Technische Universität Dresden, 01062 Dresden, Germany

Diluted magnetic semiconductors (DMS) have become recently the subject of intensive research due to the possibility to utilize both charge and spin degrees of freedom in the same material. The main research in this field is focused on the preparation of ferromagnetic DMS materials with high Curie temperatures which is crucial for possible spintronic applications. Recent theoretical calculations by Dietl *et al.*[1] predicted high temperature ferromagnetism (FM) in some 3*d* transition metal doped semiconductors, among them Co-doped ZnO. However, up to date experimental reports on the magnetic properties of $Zn_{1-x}Co_xO$ are very scattering[2] and the origin of FM is far from being understood.

In the present study $Zn_{1-x}Co_xO$ films have been prepared by means of magnetron sputtering. Magnetic properties of the $Zn_{1-x}Co_xO$ films were investigated by SQUID magnetometery indicating FM behavior above room temperature. X-ray absorption spectroscopy measurements show that Co atoms in $Zn_{1-x}Co_xO$ are present in the divalent Co^{2+} state under a tetrahedral symmetry confirming the proper substitution into the ZnO lattice. The Co 2*p*-3*d* resonant photoemission spectroscopy data shows that Co 3*d* states are present near the top of the valence band.

[1] T. Dietl *et al.*, Science **287**, 1019 (2000).
[2] J. M. D. Coey *et al.*, Nature Mat. **4**, 173 (2005).

MA 20.17 Tue 15:15 P1

Epitaxial thin films of $Co_2Cr_{0.6}Fe_{0.4}Al$ — •Andres Conca, Martin Jourdan, Anna Gerken, Christian Herbort, and Hermann Adrian — Institut für Physik, Johannes Gutenberg Universität, Staudinger Weg 7, 55128 Mainz, Germany

The full Heusler compound $Co_2Cr_{0.6}Fe_{0.4}Al$ (CCFA) is expected to show half-metallicity, i.e. 100 % spin polarization at E_F. We were able to deposite high quality CCFA thin films. The films were deposited by magnetron dc sputtering in a chamber with a base pressure $\approx 10^{-8}$mbar. A comparison of films deposited on different buffer layers at different temperatures is shown. The crystalline order was studied by X-ray diffraction. We observed that the films grow in the B2 structure. The preference of CCFA films to grow in the B2 structure instead of the fully ordered structure $L2_1$ is well known. This implies a complete mixing of Cr, Fe and Al atoms. The magnetic properties were determined with a VSM magnetometer, the relation between volume magnetization and crystalline quality of the samples is discussed. In order to implement CCFA films in spintronic devices such as MTJ's, the surface quality of the films is of critical importance. Therefore, the surface order was characterized by RHEED and the topology by STM/AFM. The dependence of surface roughness and ordering on the deposition temperature for the different buffer layers is discussed.

MA 20.18 Tue 15:15 P1

Spin-resolved photoemission studies of $Co_2Cr_{1-x}Fe_xAl$ and Co_2FeSi Heusler alloy films — •Jan-Peter Wüstenberg, Marina Sánchez Albaneda, Mirko Cinchetti, Oleksiy Andreyev, Michael Bauer, and Martin Aeschlimann — University of Kaiserslautern, Physics Department, Erwin Schroedinger-Str. 46, 67663 Kaiserslautern, Germany

Heusler alloys represent nowadays a class of materials with a high potential for application in the growing field of spintronics. This is due to the fact that theoretical calculations have predicted for many of such alloys the property of possessing 100% spin polarization at the Fermi level. However, for spintronics applications, the spin polarization must be high not only in the bulk, but also at the surface region. This is not straightforward, since extrinsic as well as intrinsic mechanisms can reduce the surface spin polarization. We have studied thin films of the Heusler compounds $Co_2Cr_{1-x}Fe_xAl$ and Co_2FeSi with spin-resolved photoemission spectroscopy, using as excitation source the second and fourth harmonic of a femtosecond Ti:sapphire laser, with photon energies of 3.1 eV and 6 eV. We compare the dependence of the measured surface spin polarization on the preparation procedure, the sample temperature and the photoemission mechanism, and discuss the observed differences.

MA 20.19 Tue 15:15 P1

Magneto-Optical Ellipsometry on Ni_2MnIn and NiMnIn Heusler Alloys — •Gerd Neuber, Jan Scholtyssek, Ulrich Merkt, Michael Rübhausen, and Guido Meier — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstraße 11, 20355 Hamburg

We use generalized magneto-optical ellipsometry [1,2] for measurements of the complete dielectric tensor of Ni_2MnIn [3] and NiMnIn Heusler alloys in the energy range from 1.6 eV to 5.5 eV and in the temperature range from 50 K to 450 K. Generalized magneto-optical ellipsometry allows the investigation of spin-polarized states and to understand the coupling between spin and charge degrees of freedom. We show differences in the metallic behavior of the semi-Heusler alloy NiMnIn and the full-Heusler alloy Ni_2MnIn related to the half-metallic ferromagnetism of the latter one. The polycrystalline Ni_2MnIn and NiMnIn films

were co-evaporated from two independent sources of Ni and MnIn on a Si(100) substrate under UHV conditions. The Ni_2MnIn alloy exhibits the ordered $L2_1$ crystalline structure and the NiMnIn alloy has a $C1_b$ structure.

[1] A. Berger and M. Pufall, Appl. Phys. Lett. **71**, 965 (1997)
[2] R. Rauer, G. Neuber, J. Kunze, J. Bäckström, and M. Rübhausen, Rev. Sci. Instr. **76**, 023910 (2005)
[3] S. von Oehsen, J.M. Scholtyssek, C. Pels, G. Neuber, R. Rauer, M. Rübhausen, and G. Meier et al., JMMM **290**, 1371 (2005)

MA 20.20 Tue 15:15 P1

Magnetotransport in CrO_2 single ferromagnetic domains — •S.W. Schink[1], S.T.B. Goennenwein[1], M. Opel[1], R. Gross[1], R.S. Keizer[2], T.M. Klapwijk[2], G. Miao[3,4], G. Xiao[4], and A. Gupta[3] — [1]Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Kavli Institute of NanoScience, Faculty of Applied Sciences, Delft University of Technology, Delft, The Netherlands — [3]MINT Center, University of Alabama, Tuscaloosa, AL, USA — [4]Physics Department, Brown University, Providence, RI, USA

Ferromagnetic materials with high spin polarisation (P) are very attractive for spin electronics. Chromium dioxide (CrO_2) is a well established half-metallic ferromagnet with a Curie temperature $T_C \approx 390$ K and $P \approx 0.98$. We have investigated the magnetic anisotropy of 150 nm thick CrO_2 single crystal films using magnetotransport measurements. The films were patterned into Hall-bar mesa structures with optical lithography and etching. The anisotropic magnetoresistance (AMR) was then measured with the external magnetic field applied in the film plane. We observe clear steps in both the longitudinal (sheet) and the transverse (planar Hall) magnetoresistance. This shows that the AMR is determined by one single, macroscopic magnetic domain, which abruptly switches from one easy axis to another. Our experiments thus are clear evidence that the CrO_2 thin films exhibit a biaxial magnetic anisotropy in the film plane. We discuss the influence of temperature, crystalline strain and specimen shape on the in-plane magnetic anisotropy.

MA 20.21 Tue 15:15 P1

Magnetic and structural properties of Cr_2O_3 thin film systems — •Tiberius Turi, Subhankar Bedanta, Pavel Borisov, Xi Chen, Andreas Hochstrat, Vladimir Shvartsman, and Wolfgang Kleemann — Angewandte Physik, Universität Duisburg-Essen, D-47048 Duisburg, Germany

Recently we demostrated magnetoelectric (ME) switching of exchange bias in magnetic heterosystems based on single crystalline antiferromagnetic Cr_2O_3 [1], which could be applied to develop a new kind of magnetoelectronic devices. For a closer approach to technical application, thin films of Cr_2 O_3 are prepared by Pulsed Laser Deposition (PLD) and Molecular Beam Epitaxy (MBE), respectively. X-ray diffraction shows epitaxial Cr_2O_3 (111) in both cases. Atomic Force Microscopy (AFM) is used to characterize the topography of the samples. Various magnetic heterostructures comprising CoFe, CrO_2 and Co/Pt layers, respectively, on top of Cr_2O_3 thin films are investigated.

[1] P. Borisov, A. Hochstrat, X. Chen, W. Kleemann, and Ch. Binek, Phys. Rev. Lett. **94**, 117203 (2005).

MA 20.22 Tue 15:15 P1

Circular magnetic dichroism in X-ray absorption of epitaxial $Co_2Cr_{1-x}Fe_xAl$ andCo_2FeSi Heusler alloy films — •M. Kallmayer[1], A. Gloskovskii[2], K. Kroth[2], U. Stumm[2], A. Conca[1], H. Schneider[1], G. Jakob[1], M. Jourdan[1], and H.J. Elmers[1] — [1]Johannes Gutenberg-Universität Mainz, Institut für Physik, Staudingerweg 7, D-55099 Mainz — [2]Johannes Gutenberg-Universität Mainz, Institut für Anorganische Chemie und Analytische Chemie, Staudingerweg 9, D-55099 Mainz

$Co_2Cr_{1-x}Fe_xAl$ and Co_2FeSi are potential candidates for providing a high spin-polarization at the Fermi surface. Element-specific magnetic properties as determined by X-ray magnetic circular dichroism (XMCD) provide a key test for band structure calculations. XMCD spectra were determined by measuring the total electron and fluorescence yield. Epitaxial $Co_2Cr_{1-x}Fe_xAl(100)$ films grown on MgO(100) by sputter deposition provide a high degree of local atomic order (B2 structure) that coincides with the occurrence of a magnetic dichroism at the Cr 2p edge which could not be observed for less ordered polycrystalline films. Epitaxial $Co_2FeSi(100)$ and $Co_2FeSi(110)$ films grown on MgO(100) and $Al_2O_3(11\bar{2}0)$, respectively, reveal a comparatively high magnetic moment of 2.6 μ_B (Fe) and 1.2 μ_B (Co) per formula unit at room temperature in agreement with the mean magnetization measured by magnetometry. The fluorescence yield spectra at the Co 2p edge significantly depends on the crystallographic orientation of the epitaxial films. We discuss the dependence of the orbital to spin moment ratio on the magnetization direction with respect to the film normal.

MA 20.23 Tue 15:15 P1

Onset of spin-density-wave magnetism in Cr/V superlattices — •E. Kravtsov[1], B. Hjörvarsson[2], A. Hoser[3], G. McIntyre[4], L. Paolasini[5], A. Nefedov[1], A. Remhof[1], F. Radu[1], and H. Zabel[1] — [1]Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universist Bochum, Bochum, Germany — [2]Department of Physics, Uppsala University, Uppsala, Sweden — [3]Institut für Kristallographie, RWTH-Aachen, Aachen, Germany — [4]Institut Laue-Langevin, Grenoble, France — [5]ESRF, Grenoble, France

Spin-density wave (SDW) state in thin Cr films is known to be under influence of dimensionality (film thickness) and proximity effects from neighboring layers. Here we report on a combined neutron and X-ray scattering study of these effects in a series of Cr/V superlattices with different Cr layer thicknesses. The neutron measurements have been performed at UNIDAS (Forschungszentrum Jülich) and D10 (ILL) instruments, the synchrotron measurements at the ID20 beamline in ESRF. From the above experiments we provide a systematical description of the onset of the SDW state in the system. It was found that Cr/V superlattices are non-magnetic for Cr layers thinner than 120 A. At this thickness a commensurate SDW originates and as Cr thickness increases further a fraction of incommensurate SDW appears and expands. Finally the SDW becomes completely incommensurate. The Neel temperature of the incommensurate SDW scales with Cr thickness as well. The research was supported by SFB 491.

MA 20.24 Tue 15:15 P1

Magnetic and structural properties of thin iron layers on (110)-cleavage faces of InAs and GaAs — •Christian Urban[1], Ulrich Köhler[1], Fang-Yuh Lo[2], Dirk Reuter[2], Andreas D. Wieck[2], Detlef Spoddig[3], and Ralf Meckenstock[3] — [1]Experimentalphysik / Oberflächenphysik, Ruhr-Universität Bochum, Germany — [2]Angewandte Festkörperphysik, Ruhr-Universität Bochum, Germany — [3]Experimentalphysik / Festkörperspektroskopie, Ruhr-Universität Bochum, Germany

The construction of a UHV-MOKE system which is integrated into an existing STM-setup is described. The geometrical arrangement allows to measure hysteresis loops directly while a film is deposited. Iron layers on the (110) side walls of UHV-cleaved InAs- and GaAs-wafers were investigated up to a coverage of 100 ML. STM shows for room temperature growth a granular structure where step edges of the substrate do not influence the nucleation. MOKE data show in agreement with FMR a strong uniaxial magnetic anisotropy on both substrates. The dependence of the magnetic behavior on the coverage was studied with MOKE and correlated with structural data obtained by STM. Iron cleaved-edge-overgrowth was used to obtain an ohmic contact to a 2D-Electron gas in the In-rich channel of a GaAs-HEMT-structure with no indication of the formation of a Schottky barrier.

MA 20.25 Tue 15:15 P1

Growth and characterisation of Fe thin films on GaN(0001) — •Stephen Krzyk[1], Mikhail Fonin[1], Reza Ghadimi[2], Ralph Meijers[3], Gernot Güntherodt[2], and Ulrich Rüdiger[1] — [1]Fachbereich Physik, Universität Konstanz, 78457 — [2]II. Physikalisches Institut, RWTH Aachen, 52056 Aachen, Germany — [3]Institute of Thin Films and Interfaces (ISG1), cni - Center of Nanoelectronic Systems for Information Technology, Research Centre Jülich, 52425 Jülich, Germany

We report growth studies of Fe on wurtzite GaN(0001) with respect to structural and magnetic properties. The growth of Fe has been carried out by molecular beam epitaxy (MBE) in ultra high vacuum (UHV). The Fe films were studied by a number of characterization techniques such as low-energy electron diffraction (LEED), reflection high energy electron diffraction (RHEED), X-ray diffraction (XRD), scanning tunneling microscopy (STM) and superconducting quantum interference device SQUID magnetometry. Despite the large lattice mismatch between Fe and wurtzite GaN epitaxial growth of Fe(110) was achieved. A strong dependence of the crystalline structure of the Fe films on the annealing parameters of the GaN substrates and the thickness of the grown films was observed. SQUID measurements showed ferromagnetic behaviour of the Fe films up to room temperature.

MA 20.26 Tue 15:15 P1

Weak ferromagnetism in epitaxial metastable c-FeSi thin films on MgO(100) — •M. Walterfang[1], K. Trounov[1], W. Keune[1], U. Rücker[2], and K. Westerholt[3] — [1]Angewandte Physik, Universität Duisburg-Essen, 47048 Duisburg — [2]Forschungszentrum Jülich, Institut für Festkörperforschung, 52425 Jülich — [3]Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, 44780 Bochum

The metastable c-FeSi phase (B2 structure) is an interesting spacer material providing large interlayer exchange coupling [1]. Thin films of nominal composition c-$FeSi_{0.85}$ were grown by codeposition of ^{57}Fe and Si onto MgO(100) carrying a thin Fe or Cr buffer layer. The metastable B2 structure was observed by XRD and Mössbauer spectroscopy (CEMS). Based on EDX results, CEM spectra have been analyzed in terms of a quadrupole doublet representing stoichiometric c-FeSi, and a magnetic component with a hyperfine field distribution, $P(B_{hf})$, representing non-stoichiometric c-$FeSi_x$. CEMS and SQUID magnetometry demonstrate magnetic ordering effects upon cooling to 4.2 K. Stoichiometric c-FeSi is observed to be paramagnetic at 300 K and ferromagnetic below $\sim$ 30 K, while non-stoichiometric c-$FeSi_x$ is ferromagnetic at and below 300 K. The Fe atomic magnetic moments μ_{Fe} in the ground state (T $\rightarrow$ 0 K) are found to be $\sim$ 0.1 μ_B for both phases. These small Fe moments are reflected in the observed small values of $\langle B_{hf} \rangle \approx$ 2 - 4 T at low temperature.

Sponsored by DFG (GRK 277 und Ke 273/18-1).

[1] B. Croonenborghs *et al.*, Phys. Rev. B 71, 024410 (2005).

MA 20.27 Tue 15:15 P1

Structural properties of Fe_3Si thin films — •K. Trounov[1,2], W. Keune[1], M. Walterfang[1], N. Utochkina[1], and A. Trounova[3] — [1]Angewandte Physik, Universität Duisburg-Essen, 47048 Duisburg — [2]new address: Angewandte Festkörperphysik, Ruhr-Universität Bochum, 44780 Bochum — [3]Experimentalphysik, Universität Duisburg-Essen, 47048 Duisburg

Fe_3Si alloy thin films with the $D0_3$ structure are candidates for soft ferromagnetic contacts with high spin polarization in spin injection devices.

Fe_3Si thin films were prepared under MBE conditions by codeposition of Fe and Si onto various substrates (Si(100), MgO(100), NaCl(100) and KCl(100)) held at 130 K. The structural properties were determined by x-ray diffraction (XRD), transmission electron microscopy (TEM) and Mössbauer spectroscopy (^{57}Fe-CEMS). Our results demonstrate that Fe_3Si films prepared on substrates with a lattice parameter similar to that of Fe_3Si (e.g. Si(100) and NaCl(100)) grow in the crystalline B2 structure, while Fe_3Si films on MgO(100) and KCl(100) substrates (with a lattice parameter deviating from that of Fe_3Si) grow in the amorphous structure.

Sponsored by DFG (GRK 277 und Ke 273/18-1).

MA 20.28 Tue 15:15 P1

Magnetic anisotropy of magnetite thin films — •Andreas Brandlmaier, Andrea Boger, Matthias Opel, Sebastian T. B. Goennenwein, and Rudolf Gross — Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, Walther-Meissner-Str. 8, 85748 Garching

Magnetite (Fe_3O_4) is very promising for spintronic devices, since it is predicted to be a half-metallic ferrimagnet with a Curie-temperature T_C = 860 K. A detailed understanding of the magnetic properties, in particular magnetic anisotropy, therefore is of significant importance.

We have investigated epitaxial Fe_3O_4 thin films deposited by pulsed laser deposition in Ar atmosphere at a substrate temperature of 320°C. The crystalline quality of the films was checked with x-ray diffraction, and the magnetic anisotropy was studied by means of ferromagnetic resonance (FMR) at a microwave frequency of 9.3 GHz.

In (001) oriented films, we observe a cubic magnetic anisotropy in the film plane, and a strong uniaxial magnetic anisotropy perpendicular to it. At room temperature, the cubic anisotropy field K_{c1}/M = 0.6 mT is much smaller than the effective uniaxial anisotropy field K_{eff}/M = 430.0 mT, where the latter can be quantitatively understood in terms of demagnetization. In contrast, (111) oriented films exhibit uniaxial magnetic anisotropy both in and out of plane. We discuss possible origins of this unusual in-plane anisotropy. We furthermore address the influence of specimen shape and temperature on the magnetic properties.

MA 20.29 Tue 15:15 P1

Magnetic Domain Structures of Microstructured Fe_3O_4(100) Thin Films — •Christine Hartung[1], Mikhail Fonin[1], Markus Laufenberg[1], Wolfgang Bührer[1], Dirk Backes[2], L. J. Heyderman[2], Fritjof Nolting[2], Mathias Kläui[1], and Ulrich Rüdiger[1] — [1]Fachbereich Physik, Universität Konstanz, 78457 — [2]Paul Scherrer Institut, 5232 Villigen

Recently the switching of magnetic structures by current induced domain wall (DW) propagation (CIDP) has been intensively investigated as an alternative to conventional switching by external magnetic fields [1]. However the current densities needed for the DW displacement in NiFe microstructures [1] are too high for use in spintronic devices. This obstacle might be overcome by using materials with high spin polarization (P) and low saturation magnetization (M_s), since the strength of the spin torque effect, which is the origin of the DW motion, was predicted to be directly proportional to P/M_s [2]. Magnetite, Fe_3O_4(100), combining high values of P at E_F with relatively low M_s, is a promising material for CIDP experiments. Before carrying out CIDP experiments, a thorough investigation of the magnetic domain configuration in Fe_3O_4 microstructures is mandatory. For this purpose, thin Fe_3O_4(100) films were prepared by molecular beam epitaxy and patterned by electron beam lithography. Subsequently the magnetic domain structure was investigated by means of x-ray circular dichroism photoemission electron microscopy and magnetic force microscopy.

[1] M. Kläui et al., Phys. Rev. Lett. **94**, 106601 (2005).
[2] Z. Li and S. Zhang, Phys. Rev. B **70**, 24417 (2004).

MA 20.30 Tue 15:15 P1

Magnetization dynamics of an unbiased permalloy thin-film microstructure and the free layer of a synthetic spin valve — •F. Wegelin[1], A. Krasyuk[1], D. Valdaitsev[1], S. Nepijko[1], H.J. Elmers[1], G. Schönhense[1], I. Krug[2], and C.M. Schneider[2] — [1]Johannes Gutenberg-Universität Mainz, Institut für Physik, D-55128 Mainz, Germany — [2]Institut für Festkörperforschung IFF-6, Forschungszentrum Jülich GmbH, D-52425 Jülich, Germany

Applying a biasing magnetic field on a thin micron-sized permalloy (Py) layer leads to suppression of domain wall creation and of Landau-Liftschitz flux-closure pattern formation. The magnetization dynamics of such a pinned and almost uniformly magnetized platelet differs from that of an unbiased particle because the pinning field defines the magnetic ground state of the system. We compare the dynamic properties of a single unbiased Py layer and the topmost Py layer in a GMR (Giant MagnetoResistive [1]) spin valve stack. Whereas the oscillatory behavior at 0.5 GHz of the single Py platelet exhibits considerable contribution of higher harmonics resulting in a shift of the 180° Neél wall [2], the magnetization within the free layer of the spin valve rotates coherently performing a critically damped oscillation. Our investigations have been performed using TR-XMCD-PEEM (Time Resolved Photoemission Electron Microscopy exploiting the X-ray Magnetic Circular Dichroism) [3] with a time resolution of 15 ps.

[1] B. Dieny et al., Phys. Rev. B 43 (1991) 1297
[2] A. Krasyuk et al. Phys. Rev. Lett. 95 (2005) 207201
[3] A. Krasyuk et al. Appl. Phys. A 76 (2003) 863

MA 20.31 Tue 15:15 P1

Structural and Local Magnetic Characterization of Fe/MgO and MgO/Fe Interfaces — •Ellen Schuster and Werner Keune — Angewandte Physik, Uni Duisburg-Essen, Duisburg

An epitaxial sandwich system of Fe/MgO/Fe is a simple realization of a tunnel junction with high tunneling magnetoresistance. The structure of the tunnelbarrier and specially the magnetism at the interfaces of MgO/Fe and Fe/MgO are of great importance to achieve spin conservation during spin dependent tunneling. We report on the structural and magnetic properties of the two different interfaces. The samples have been epitaxially grown in an MBE chamber and the structural characterization was carried out using RHEED and XRD. For the magnetic properties two monolayers of 57Fe have been deposited directly at either interface. This 57Fe tracer layer was investigated by conversion electron Mössbauer spectroscopy (CEMS) to determine the magnetic properties at the interfaces. We observe an enhancement of the interfacial hyperfine magnetic field, which is different for both types of interfaces.(Supported by DFG (SFB491))

MA 20.32 Tue 15:15 P1

Magnetism and interlayer exchange coupling in Kondo-lattice films — •Jochen Kienert and Wolfgang Nolting — Humboldt-Universität zu Berlin*Institut für Physik*Theoretische Festkörperphysik*Newtonstraße 15*D-12489 Berlin

We propose a theory for layered structures consisting of localized moments interacting with free charge carriers (Kondo-lattice model). By using an extension of the well-known RKKY-interaction we can evaluate magnetic properties as well as the charge excitation spectrum self-consistently. Typical features of the double exchange, i.e. strong Hund coupling, are recovered by our theory. The role of anisotropy and charge transfer, which have to be taken into account in dimensionally reduced systems, have also been investigated. We present results on the temperature dependence of the interlayer exchange coupling between Kondo lattice layers separated by a non-magnetic spacer.

MA 20.33 Tue 15:15 P1

Temperature dependence of interlayer exchange coupling — •Stephan Schwieger, Jochen Kienert, and Wolfgang Nolting — Humboldt-Universit{\"a}t zu Berlin*Institut für Physik*Theoretische Festk{\"o}rperphysik*Newtonstra{\ss}e 15*D-12489 Berlin

Temperature dependent FMR-measurements of exchange coupled Ni-Co films are analysed using a microscopic theory for ultrathin metallic systems. The mechanism governing the temperature dependence of the anisotropy coefficients and the interlayer exchange coupling is identified and discussed. Both quantities are reduced with increasing temperature. This behavior is found to be caused by magnon excitations.

MA 20.34 Tue 15:15 P1

Magnetic reorientation and breakdown of Landau-Lifshitz theory — •Stephan Schwieger, Jochen Kienert, and Wolfgang Nolting — Humboldt-Universität zu Berlin*Institut für Physik*Theoretische Festkörperphysik*Newtonstraße 15*D-12489 Berlin

A theory is proposed which yields excellent results for the magnetic reorientation transition in ultrathin metallic films. Thermodynamic properties as well as spin wave excitation spectra are presented and compared to classical Landau-Lifshitz theory onto which our microscopic approach can be mapped and which is widely used in the evaluation of experiments on metallic films and interlayer exchange coupled systems. It is found that, in two dimensions, the classical theory breaks down at the reorientation transition.

MA 20.35 Tue 15:15 P1

Domain structure of thin magnetic films with high perpendicular anisotropy — •Jens Brandenburg, Volker Neu, and Ludwig Schulz — IFW Dresden, Institut für Metallische Werkstoffe, PF 270116, D-01171 Dresden

To examine the influence of magnetic anisotropy and strayfield energy onto domain formation, the domain structure of thin Co based films with high perpendicular anisotropy and varying thickness was investigated using magnetic force microscopy (MFM). These films were prepared in a thickness range from 10 to 100 nm by physical vapour deposition (PVD). They were deposited either directly onto Al_2O_3 single crystal substrates or with an intermediate Ruthenium (Ru) buffer layer. The influence of the growth conditions (temperature, substrate orientation, buffer layer) onto the texture and as a consequence onto the magnetic properties of the sample was studied by x-ray diffractometry (XRD), pole-figure measurements and vibrating sample magnetometry (VSM). The dependence of the observed domain width from the thickness of the film is compared with the existing models for the domain structure for extended films.

MA 20.36 Tue 15:15 P1

Characteristics of magnetic thin films on PS nano spheres — •Edward Amaladass[1], Thomas Eimüller[1,2], Bernd Ludescher[1], Theresa Dragon[1], and Giesela Schütz[1] — [1]MPI for Metals Research — [2]Ruhr - Universität Bochum

The need for high density storage devices at low costs has initiated the search for new technologies such as patterned media. Magnetic thin films on self assembled polystyrene or silica nano-spheres are a very promising candidate [1]. Multilayered Fe/Gd and Co/Pt films were deposited on polystyrene spheres of different diameters. Polar MOKE measurements showed that the curved substrate has a substantial influence on the hysteresis loop. The fact that the film is separated in isolated islands of equal size leads to a very pronounced squareness of the magnetization loop with a coercive field in the order of a few millitesla. The micromagnetic behavior was probed with a high lateral resolution by scanning transmission x-ray microscopy (STXM) and photoemission electron microscopy (PEEM).

[1] M.Albrecht,Nature Materials 4, (2005) 203-206

MA 20.37 Tue 15:15 P1

Exploring lattice effects on transport properties in manganite/alumina superlattices — •Yuansu Luo and Konrad Samwer — I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Superlattice properties of out-of-plane lattice spacing d modulation and interfacial dilatation were used to explore lattice effects, i.e. changes in Mn-O-Mn bond length of MnO_6 octahedra, on transport behaviors in manganite/alumina multilayers. Epitaxial growth and high quality of stacking as well structural coherency (length $\xi >$ bilayer period Λ) were confirmed by x-ray measurements. As the measure of lattice distortion, the average d, coherency length ξ, Curie temperature T_C, magnetization M, coercive field H_c as well as resistance R are found to be a function of the interface fraction $1/\Lambda$. Accordingly, we divided each manganite layer into two parts, i.e. weakly distorted "innermost" atomic layers and strongly dilated interfacial atomic layers, as is well clarified by observation of two component magnetization loops and huge variation in R values of current in- and perpendicular to- plane (CIP & CPP). At low T, the CPP value provides a magnetotunneling effect, but near T_C of the interfacial atomic layers, the low-bias tunneling current is oscillated with applied magnetic field, which may be associated with field-induced changes in density of e_g electron state near the Fermi level.

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MA 20.38 Tue 15:15 P1

Current-assisted Domain Wall Depinning at Variable Temperatures — •M. Laufenberg[1], D. Backes[1,2], W. Bührer[1], D. Bedau[1], P.-E. Melchy[1], M. Kläui[1], U. Rüdiger[1], C. A. F. Vaz[3], J. A. C. Bland[3], L. J. Heyderman[2], F. Nolting[2], S. Cherifi[4], A. Locatelli[4], S. Heun[4], G. Faini[5], and E. Cambril[5] — [1]Fachbereich Physik, Universität Konstanz, Germany — [2]Paul Scherrer Institut, 5232 Villigen PSI, Switzerland — [3]Cavendish Laboratory, University of Cambridge, UK — [4]Sincrotrone Trieste, 34012 Basovizza, Trieste, Italy — [5]Laboratoire de Photonique et de Nanostructures - CNRS, 91460 Marcoussis, France

The temperature dependence of domain wall spin structures and of current- and field-induced domain wall depinning has been studied in ferromagnetic nanostructures using magnetoresistance measurements and photoemission electron microscopy. Thermally activated transitions from transverse to vortex walls were observed [1]. The critical fields and currents for domain wall depinning were found to be dependent on temperature. The influence of Joule heating by the current [2] was studied quantitatively.

[1] M. Laufenberg, D. Backes, W. Bührer, D. Bedau, M. Kläui, U. Rüdiger, et al., submitted

[2] A. Yamaguchi et al., Appl. Phys. Lett. **86**, 012511 (2005)

MA 20.39 Tue 15:15 P1

Spin-flip scattering cross sections of point defects in 3d metals — •Peter Zahn, Dmitry Fedorov, and Ingrid Mertig — Fachbereich Physik, Martin Luther University Halle, D-06099 Halle

An important ingredient for the microscopic understanding of spin diffusion processes in magnetic nanostructures is the spin diffusion length. It is strongly influenced by the spin-flip scattering length. We restrict our considerations to T=0 and focus on the spin-flip scattering at point defects only. The electronic structure of the host material and the defects is calculated self-consistently in the framework of scalar-relativistic density-functional theory by a KKR Green's function method. The transition probability of the electronic states is evaluated using the microscopic scattering matrix. The non-spin-conserving part of the scattering matrix is obtained in first order perturbation theory by the spin-orbit-coupling matrix elements. So, the momentum and spin scattering lengths are obtained without adjustable parameters.

The qualitative behaviour of the obtained spin-flip scattering cross sections for 3d bulk materials and ultrathin layers will be discussed. The impact on the spin-mixing resistivity and the influence of the reduced dimensionality will be elucidated.

MA 20.40 Tue 15:15 P1

Noncollinear magnetic order in transition metal nanowires — •Michael Czerner, Bogdan Yu. Yavorsky, and Ingrid Mertig — Martin Luther University, FB Physik, FG Theorie, D-06099 Halle, Germany

Metal nanowires are very attractive systems to study the role of low dimensonality in the magnetic properties. The results of recent experiments indicate the existence of noncollinear magnetic order in metallic nanowires [1,2]. However, for the systems with a large number of the magnetic degrees of freedom direct unambiguous measurements of the magnetic configuration without preliminary model assumptions are impossible. In this respect the predictive role of the first-principle calculations is of great importance. We have developed a modification of the (screened) KKR method to noncollinear magnetic systems. We calculate both diagonal and off-diagonal elements of the spin density matrix to get information about the direction of the local moment.

We present *ab initio* calculations of magnetic nanowires suspended between two semi-infinite leads and discuss the possibility of the formation of noncollinear magnetic structures in the Ni,Co, and Fe nanowires. In addition, we calculate the electronic transport through the nanowire using the Landauer approach in the formulation of Baranger-Stone [3].

[1] M.R. Sullivan et al., Phys.Rev.B **71**, 024412 (2005)
[2] V. Rodrigues et al., Phys.Rev.Lett. **91**, 096801 (2003)
[3] H.U. Baranger and A.D. Stone, Phys.Rev.B **40**, 8169 (1989)

MA 20.41 Tue 15:15 P1

Influence of stress on film growth mode and GMR in Cu/Co multilayers — •Senthilnathan Mohanan, Andreas Grob, and Ulrich Herr — Materials Division, Albert-Einstein-Allee 47, Universität Ulm, 89081 Ulm, Germany

Co/Cu multilayers exhibiting the giant magnetoresistance (GMR) effect are used as sensors in various fields of application. The transport properties of the multilayer can be modified by changing the number of Co/Cu bilayers. The stress which is induced in the multilayers during deposition may influence the film growth mode and hence the magnetotransport properties. The main aim of this study is to investigate the influence of stress on the film growth mode of Co/Cu multilayer with Ta buffer layer and on its magnetotransport properties. An increase in the giant magnetoresistance has been observed with increasing number of Co/Cu bilayers. However, beyond a certain number of bilayers we observed a drop in GMR. This change is well accompanied by a corresponding change in magnetic characteristics. In order to investigate the origin of the changes in the magnetotransport properties, the surface roughness of the samples was studied using atomic force microscopy, which revealed the existence of a sharp increase in the roughness beyond a certain number of bilayers. Stress measurements showed that there exists a sharp increase in stress beyond the same number of bilayers. The increase in roughness indicates a change in the film growth mode due to the change in the intrinsic stress of the multilayers. This change in the film growth mode leads to the observed modification of the magnetic and magnetotransport properties.

MA 20.42 Tue 15:15 P1

Growth, Structure, and Electronic Properties of Epitaxial Fe/MgO/Fe(110) Trilayers — •Mikhail Fonin[1], Yuriy S. Dedkov[2], Jan Hauch[3], Ulrich Rüdiger[1], and Gernot Güntherodt[3] — [1]Fachbereich Physik, Universität Konstanz, 78457 Konstanz, Germany — [2]Institut für Festkörperphysik, Technische Universität Dresden, 01062 Dresden, Germany — [3]II. Physikalisches Institut, Rheinisch-Westfälische Technische Hochschule Aachen, 52056 Aachen, Germany

Recently high tunneling magnetoresistance (TMR) values in fully epitaxial Fe/MgO/Fe(100) magnetic tunnel junctions (MTJs) have been reported with magnetoresistance ratio of about 180 % measured at room temperature (RT) [1]. However, (110)-oriented Fe films can be even more attractive as electrode material for MTJs due to the high spin polarization value of about -80% observed for Fe(110)[2].

In this study the surface morphology of ultra thin MgO films grown on Fe(110) was investigated by low energy electron diffraction (LEED) and scanning tunneling microscopy (STM) at RT as well as at 250° C. The structural studies reveal a three dimensional growth mode of MgO on the Fe(110) surface giving dense MgO(111) films. As observed by STM, the initial deposition of MgO leads to the partial oxidation of the Fe(110) surface. Auger-electron spectroscopy as well as spin-polarized photoelectron spectroscopy measurements on the MgO/Fe(110) system confirm the FeO layer formation at the MgO/Fe(110) interface. TMR values of about 28 % at RT were measured in the Fe/MgO/Fe(110) MTJs.

[1] S. Yuasa *etal.*, Nature Materials **3**, (2004) 868.
[2] Yu. S. Dedkov *et al.*, Phys. Rev. B **65**, 064417 (2002).

MA 20.43 Tue 15:15 P1

How does the interface structure influence the thickness dependence of tunneling magnetoresistance? — •Christian Heiliger, Peter Zahn, Bogdan Yu. Yavorsky, and Ingrid Mertig — Martin Luther University, FB Physik, FG Theorie, D-06099 Halle, Germany

New experiments [1-3] based on epitaxially grown Fe/MgO/Fe samples obtained TMR ratios which exceed the predictions by Julliere's model. In addition an oscillating behaviour of the tunneling magnetoresistance (TMR) depending on the barrier thickness was found [1].

The aim of our work is to demonstrate the influence of different interface geometries on the thickness dependence of the TMR ratio. Three different interface configurations deduced from experiments have been considered [4]. A screened Korringa-Kohn-Rostoker (KKR) method based on density functional theory was applied to calculate the electronic and magnetic structure of the different junctions self-consistently. The Landauer conductance of planar junctions was calculated using the Baranger-Stone scheme by means of Green's functions in the limit of coherent tunneling.

Positive and negative TMR ratios are obtained as a function of interface structure and bias voltage. The results demonstrate that the IV-characteristic is determined by the interface structure independent on the barrier thickness.

[1] S. Yuasa et al., Nature Materials **3**, 868 (2004)
[2] J. Faure-Vincent et al., Appl. Phys. Lett. **82**, 4507 (2003)
[3] S.S.P. Parkin et al., Nature Materials **3**, 862 (2004)
[4] C. Heiliger et al., Phys. Rev. B accepted

MA 20.44 Tue 15:15 P1

Amorphous leads and tunneling magnetoresistance — •Martin Gradhand, Christian Heiliger, and Ingrid Mertig — Martin Luther University, FB Physik, FG Theorie, D-06099 Halle, Germany

High tunnelling magnetoresistance ratios up to 230 % have been obtained recently [1] for magnetic tunnel junctions consisting of amorphous CoFeB leads separated by a crystalline MgO barrier. The idea of this contribution is to understand the spin-polarization of the tunnelling current and the TMR for a system composed of a crystalline MgO barrier sandwiched between two amorphous Fe leads. The role of a crystalline Fe spacer between the leads and the barrier is investigated. The amorphous Fe leads were simulated by fitting the pair-correlation function of a super cell by a reverse Monte-Carlo algorithm. The performance of the algorithm was tested for different initial configurations (bcc, fcc, sc, and random) and a varying number of atoms in the super cell. The electronic structure of the system was calculated self-consistently using a linear muffin-tin orbital (LMTO) method [2]. The spin-polarized tunnelling current is obtained by means of the Kubo formula using the scheme of Baranger and Stone [3].

[1] D. D. Djayaprawira et al., Appl. Phys. Lett. **86**, 092502 (2005)
[2] http://www.fkf.mpg.de/andersen/
[3] H. U. Baranger and A. D. Stone, Phys. Rev. B **40**, 8169 (1989)

MA 20.45 Tue 15:15 P1

Ballistic magnetoresistance in Ni single-atom contacts — •Steven Walczak, Michael Czerner, and Ingrid Mertig — Martin Luther University, FB Physik, FG Theoretische Physik, D-06090 Halle

Extraordinary large ballistic magnetoresistance has been measured in Ni single-atom contacts [1,2]. The experimental results are still in contradiction to other experimental [3] and to theoretical results in the coherent limit of transport [4].

This contribution aims to explain the strong changes of resistance under the influence of an external magnetic field by means of a rotating magnetic Ni particle in the constriction.

The electronic structure of the Ni particle in the constriction is calculated selfconsistently using the Korringa-Kohn-Rostoker method. Different orientations of the Ni particle in the constriction caused by an external magnetic field are considered. Transport through the Ni particle is described by means of the Landauer approach in the formulation of Baranger and Stone [5]. It will be shown that small rearrangements of a Ni particle under the influence of an external magnetic field can change the conductance by a few G_o and can cause BMR ratios of several hundred percent.

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MA 20.46 Tue 15:15 P1

Local magnetic-switching-behaviour of Magnetic Tunnel Transistors studied by Ballistic Electron Magnetic Microscopy (BEMM) — •Emanuel Heindl, Johann Vancea, and Christian Back —
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We used Ballistic Electron Magnetic Microscopy to study the local magnetic properties of spin-valve-structures. Local switching behaviour has been measured for Py/Cu/Co- and FeCo/Au/FeCo-spin-valves with magnetoresistance-effects of several hundred percent. Close to the switching field μm-scale-magnetic-domains have been imaged.

MA 20.47 Tue 15:15 P1

Magnetoresistive effects in LSMO:MgO TMR-systems — •Markus Esseling[1], Stephanie Raabe[1], Vasily Moshnyagy[1], Achim Marx[2], Rudolf Gross[2], and Konrad Samwer[1] — [1]I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, D-37077 Göttingen — [2]Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, Walther-Meissner-Str. 8, D-85748 Garching

The TMR effect is known to be very sensitive to the quality of the interface ferromagnet/insulator. The influence of the interfacial properties on the spin-dependent transport can be studied by using different ways to prepare the tunnel junction, namely i) a nanocomposite film consisting of ferromagnetic metallic grains separated by an insulator ii) a well defined grain-boundary of the ferromagnet doped with the insulator due to a chemical phase separation using a bicrystal-substrate and iii) an artificial multilayer structure. Using the highly spin-polarized manganite $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) and the insulating MgO, which is an ideal candidate to achieve high TMR-values, it is possible to prepare these different systems mentioned above. We present results of the structural and electronic characterization of the bicrystal samples, which were prepared on symmetric 24° [001] tilted $SrTiO_3$- and MgO-substrates to trigger an epitaxial growth of the LSMO on both sides of the grain-boundary of the bicrystal. The results are compared with the nanocomposite, which was characterized using low-frequency 1/f-noise measurements [1].

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

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MA 20.48 Tue 15:15 P1

Scanning probe microscopy on manganite thin films — •S. A. Köster, L. Sudheendra, V. Moshnyaga, B. Damaschke, and K. Samwer — I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Doped manganites show the colossal magnetoresistance effect (CMR). The main effect is observed in high magnetic fields in the vicinity of the metal insulator transition temperature. According to the percolation model of Dagotto et al.[1] two different phases, an insulating and conducting one, exist in parallel. We prepared our thin films on MgO substrates by Metallorganic aerosol deposition (MAD) , while the films turned out to be perfectly epitaxial. In our work we can show by scanning tunneling spectroscopy, that low resistivity and high resistivity regions do exist in the samples and that these are changed with applied magnetic fields. Our investigations concentrate on achieving a more detailed picture of these phases and their origin on a microscopic scale. The dependency on several parameters like the microstructure of the samples, temperature or magnetic fields can be observed.

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

Acknowledgement: This work was supported by DFG within SFB602, TP A2.

MA 20.49 Tue 15:15 P1

Distribution of spin-polarized current in magnetic nanoconstrictions with noncollinear Magnetization — •O. Vedmedenko[1], E.Y. Vedmedenko[2], and D. Pfannkuche[1] — [1]ITP, Universität Hamburg, Jungiusstr. 9, 20355 Hamburg — [2]IAP, Universität Hamburg, Jungiusstr. 11c, 20355 Hamburg

The magnetoresistivity of a nanomagnet depends on both the shape of the sample and the configuration of magnetic moments. Especially important for transport properties is the magnetic ordering in the area of a domain wall. Depending on the energy of electrons and the width of a wall the polarized charge transfer can be either adiabatic or non-adiabatic. In adiabatic process the spin of a conducting electron changes its orientation accordinly to the magnetization profile of a domain wall. In the non-adiabatic case spins of the charge carriers are not able to follow the wall magnetization and the total magnetization of conducting electrons reverses. This can lead to the displacement of the domain wall. Knowledge of spin-polarized current distribution is often needed as initial configuration for further investigations on the magnetoresistance and current-assisted domain-wall propagation. We calculate numerically spin-polarized current distributions in nanoconstrictions of different shape for different material parameters in the adiabatic and the non-adiabatic approximation. Stable low-temperature magnetic configurations for the computations are taken from the Monte-Carlo simulations.

MA 20.50 Tue 15:15 P1

Transport properties of epitaxially grown thin $Pr_{0,68}Ca_{0,32}MnO_3$ film on vicinal $SrTiO_3$ substrates — •Peter Moschkau, Sebastian Schramm, and Christian Jooss — Institut für Materialphysik, Universität Göttingen

In order to investigate mechanisms and length scales for the insulator metal transition and a possible formation of phase separation in PCMO films, defect structures are tailord via growth on vicinal $SrTiO_3$ substrates. The films are epitaxially grown by pulsed laser deposition and are c-axis oriented. The characteristic structural properties are analysed by x-ray diffraction, scanning electron microscopy and atomic force microscopy. We find a transition from island growth mode to step-flow growth mode for vicinal substrate with tilt angles between 3 and 10 degree. The lattice strain is strongly increased with increasing tilt angle of the substrates. Transport measurements in applied external field show an Insulator-Metal (IM) transition with huge resistivity changes of several orders of magnitudes. A significant change of the IM transition is observed on vicinal substrates with tilt angles larger than 3 degree. An important observation is the change of the electronic-history dependence of the IM transition in films on vicinal substrates. We discuss the relation between structure and electronic properties for the films as a function of tilt angle.

MA 20.51 Tue 15:15 P1

Characterization and optimization of magnetic tunnel junctions with ultrathin barriers — •G. Eilers, A. Parge, and M. Münzenberg — IV. Phys. Inst., Universität Göttingen

Ultrathin barriers can provide extremely high tunnel current densities, which are required for spin current induced switching experiments. For future MRAMs with high read and write performance a high room-temperature tunnelling magnetoresistance (TMR) is also necessary.

We have prepared magnetic tunnel junctions (MTJs) with either plasma oxidized AlOx tunnel barriers or MgO tunnel barriers by means of e-beam evaporation of stoichiometric MgO. Besides, the barrier thickness and its lateral size (structured by shadow masks) were varied. Aim is to correlate structurel defects, especially important for ultrathin barriers, with the transport properties.

After the optimization of the growth parameters and characterizing the transport properties (I/V characteristics, TMR at different temperatures) we are planning to integrate the MTJs into a strip line with a photoconductive switch in order to study the spin current induced switching effect.

MA 20.52 Tue 15:15 P1

Magnetic switching behavior of LSMO-Alq_3-Co layered structures — •J. Schumann, D. Elefant, H. Vinzelberg, J. Thomas, K. Dörr, R. G. Gangineni, and B. Büchner — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

Giant magnetoresistance effects found in $La_{0.7}Sr_{0.3}MnO_3$-Alq_3-Co layer stacks [1] show the Alq_3-Co interface to be the crucial preparation problem. We produced a diversity of such layered structures on $SrTiO_3$ substrates, systematically changing the preparation methods and parameters and subsequently monitoring the switching behavior of the magnetic components of the different layer stacks via alternating gradient magnetometry and SQUID magnetometry down to T=1.8K. As supplementary electrodes NiFe and CoFe were tested. Including TEM cross section investigations, an optimized preparation procedure for the layer stacks was searched to realize defined magnetic switching (especially without any exchange biasing) - the prerequisite for magnetoresistance measurements.

[1] Z. H. Xiong, Di Wu, Z. Valy Vardeny, and Jing Shi, Nature 427,

821(2004)

MA 20.53 Tue 15:15 P1

Magnetoresistance behavior of Co nanowires with constrictions — •P. Krzysteczko, M. Brands, and G. Dumpich — Experimentalphysik, Universität Duisburg-Essen (Campus Duisburg), Lotharstraße 1, 47048 Duisburg

We investigate spin transport through a domain wall confined in a nanoconstriction and ballistic spin transport in ferromagnetic crossbar configurations. For this, resistance measurments are performed on polycrystalline cobalt nanowires which are prepared by means of high resolution electron beam lithography (HR-EBL). Constrictions with critical dimensions of the order of 10 nm are prepared at the junction of T-shaped Co nanowires. In order to prevent oxidation some of the Co nanowires are covered *in situ* with a 2 nm Pt layer or a 10 nm carbon layer. By annealing, the mean grain size of the nanowires has been varied in the range of approximately 7 to 35 nm. The magnetic properties are investigated by magnetic force microscopy (MFM). Due to the shape anisotropy the two sides of the nanocontact respond in different ways to an applied magnetic field. Magnetoresistance measurements were carried out via a four-terminal ac resistance bridge in a ^{4}He bath cryostat at a temperature of $T = 4.2$ K. Magnetic fields up to $B = 5$ T were applied along different in-plane directions. Furthermore, the ballistic transport is investigated by nonlocal resistance measurements.

MA 20.54 Tue 15:15 P1

Heusler alloy based magnetic tunnel junctions with MgO barrier — •R. Kaltofen, H. Vinzelberg, J. Schumann, D. Elefant, I. Mönch, and J. Thomas — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

Half-metallic Heusler alloys are expected to be promising candidates for ferromagnetic electrode materials in magnetic tunnel junctions. In this work MTJs with the stack structure $Ta/Co_2Cr_{0.6}Fe_{0.4}Al/MgO_x/CoFe/$ IrMn/Ta/Cu/Au were magnetron sputtered on thermally oxidized Si. The MgO_x tunnel barrier was prepared by oxidizing a Mg film using a rf wave resonance plasma beam source as well as by rf sputtering from a MgO target in an Ar/O_2-mixture. The obtained junction properties (junction resistance, magnetorestistance ratio, switching characteristics) are discussed in dependence on the preparation conditions of the Heusler electrode and the tunnel barrier, on the barrier thickness and on the annealing temperature.

MA 20.55 Tue 15:15 P1

Interface properties of the half-metallic Co_2MnSi — •Marc D Sacher[1], Daniel Ebke[1], Ning-Ning Liu[1], Andreas Hütten[2], Jan Schmalhorst[1], and Günter Reiss[1] — [1]Fakultät für Physik, Universität Bielefeld, D-33615 Bielefeld, Germany — [2]Institut für Nanotechnologie, Forschungszentrum Karlsruhe GmbH, Germany

Halfmetallic ferromagnets are promising candidates as electrode material in magnetic tunnel junctions (MTJ). Because of their predicted spinpolarization of 100% one expects high tunnel magneto resistance (TMR) effects. With the Heusler alloy Co_2MnSi a TMR of currently 108% at 20K has been reached. This leads to a spinpolarization of 70%. The high TMR value strongly depends on the oxidation parameters of the adjacent alumina layer and the annealing temperature of the Co_2MnSi. Two mechanisms can explain this behavior. On the one hand there is found a Mn and Si diffusion to the electrode/ barrier interface and on the other hand a formation of MnO at the interface. We have investigated the stoichiometry and the element specific magnetization at the Co_2MnSi/ barrier interface with X-Ray absorption spectroscopy (XAS) and the magnetic circular dichroism (XMCD). We introduced thin interlayer (Co, Mn or Si) with varying thickness between the Heusler alloy and the tunnel barrier. Thus we can investigate in detail the influence of the three materials on the TMR as well as on the magnetic moment and the stoichiometry.

MA 20.56 Tue 15:15 P1

Magnetoresistance of tunnel junctions with electrodes of the Heusler compounds Co_2MnGe and Co_2MnSn — •Verduijn Erik and Kurt Westerholt — Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, 44780 Bochum, Germany

Heusler compounds with predicted 100% spin polarization at the Fermi level are materials of great potential in the field of spintronics. We have fabricated magnetic tunnel junction using the fully spin polarized Heusler compounds Co_2MnGe and Co_2MnSn as the bottom electrode and Co as the counter electrode. The films are patterned using shadow mask technique and the Al_2O_3 tunnel barrier is prepared by plasma oxidation of a thin Al layer. The tunnel magnetoresistance which we determine at low temperatures is 27% maximum, corresponding to a spin polarization much lower than the theoretically predicted 100%. We discuss the origin of the loss of full spin polarization, which could be caused by some oxidation of the Heusler surface at the Heusler/barrier interface, or the loss of half metallicity for a surface layer of the Heusler compound due to by site disorder or interdiffusion.

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MA 20.57 Tue 15:15 P1

Strong temperature dependence of antiferromagnetic coupling in CoFeB/Ru/CoFeB — •N. Wiese[1,2], T. Dimopoulos[1,3], M. Rührig[1], and G. Reiss[2] — [1]Siemens AG Corporate Technology, CT MM 1, Erlangen, Germany — [2]Universität Bielefeld, Nano Device Group, Bielefeld, Germany — [3]ARC Seibersdorf research GmbH, Vienna, Austria

Due to their high tunneling magnetoresistance (TMR) of up to 70%, magnetic tunnel junctions (MTJ) with electrodes consisting of amorphous $Co_{60}Fe_{20}B_{20}$ have gained considerable interest for the use in applications, e.g. sensor applications or magnetoresistive random access memories (MRAM).

Furthermore it has been shown, that artificial ferrimagnets (AFi), consisting of two antiferromagnetically coupled layers of amorphous CoFeB separated by a thin nonmagnetic Ru-spacer, exhibit a stable coupling and a significant lower coercivity than AFi systems of polycrystalline CoFe materials.[1] Due to their magnetic properties, they are promising candidates also for the use as soft magnetic electrode in MTJs.[2]

Here we present the temperature dependence of saturation field (coupling) in dependence of Ru spacer thickness and net moment of the AFi. In good accordance to the theory, the investigated samples show a strong temperature behavior $\sim \frac{T/T_0}{\sinh(T/T_0)}$, where $T_0 = \frac{\hbar v_F}{2\pi k_B t_{Ru}}$. The Fermi velocity, v_F, evaluated for the investigated samples within this model, turns out to be in the order of 10^7cm/s.

[1] N. Wiese et al., J. Magn. Magn. Mater. 290-291, 1427 (2005)
[2] N. Wiese et al., accepted for publication in J. Appl. Phys. (2005)

MA 20.58 Tue 15:15 P1

Angular dependence of Magnetization Reversal In Exchange Biased Multilayers — •Amitesh Paul, Thomas Brueckel, Emmanuel Kentzinger, and Ulrich Ruecker — IFF-Forschungszentrum Jülich

Recently we observed sequential and symmetric magnetization reversal of the ferromagnet (FM) layers by domain wall motion for exchange coupled FM and antiferromagnetic (AF) multilayer systems such as [IrMn/CoFe]_10 [1] and [Co/CoO]_20. This symmetric reversal on both branches of the hysteresis loop without the usually observed magnetization component perpendicular to the applied field - follows the theoretical speculation of an alignment of the field-cooling axis (H_{FC}) with the applied field axis (H_a) by Beckmann et al [2]. In the present case, we investigate the same polycrystalline IrMn/CoFe sample measuring along each full magnetization loop: increasing (H_a along H_{FC}) and decreasing (H_a opposite H_{FC}), by specular and off-specular Polarized Neutron scattering as we vary the directions (theta) of the H_a with respect to the unidirectional anisotropy direction or the H_{FC} direction. Depending upon theta, the remagnetization behavior of all FM layers takes place sequentially which is either by nonuniform mode (via domain formation) or uniform mode (via coherent rotation) and also simultaneously which is by uniform mode only. [1] A. Paul et al., Phys. Rev. B 70, 224410 (2004). [2] B. Beckmann et al., Phys. Rev. Lett. 91, 187201 (2003).

MA 20.59 Tue 15:15 P1

Thermal stability of three dimensional structured exchange bias systems with ion bombardment induced magnetic patterning — •V. Höink[1], M. D. Sacher[1], K. Rott[1], J. Schmalhorst[1], G. Reiss[1], D. Engel[2], T. Weis[2], and A. Ehresmann[2] — [1]Universität Bielefeld, Fakultät für Physik, Dünne Schichten und Nanostrukturen, PF 100131, D-33501 Bielefeld — [2]Universität Kassel, Institut für Physik, Heinrich-Plett-Str. 40, D-34132 Kassel

The magnitude as well as the direction of the exchange bias effect in ferromagnet/antiferromagnet layer systems can be manipulated by He-

ion bombardment in a magnetic field. By restricting the area exposed to ion bombardment by resist masks, magnetic nanostructures characterized by a lateral variation of the orientation of the magnetization in remanence can be produced. This magnetic nanostructuring can be used for new applications in magnetoelectronics. In the experiments presented here CoFe/IrMn double layers have been patterned magnetically as well as three dimensional with a varying shape and size. By spacially resolved measurements of the absorbtion of elliptically polarized soft x-rays with a photo electron emission microscope (PEEM), the magnetically patterned three dimensional structures have been investigated in remanence and the magnetic domain configuration has been measured for several temperatures. The PEEM measurements have been performed at the PEEM2 beamline 7.3.1.1 at the Advanced Light Source, Berkeley, USA.

MA 20.60 Tue 15:15 P1

α-MnS-based Exchange Bias Systems — •Andreas Hochstrat, Pavel Borisov, Xi Chen, and Wolfgang Kleemann — Angewandte Physik, Universität Duisburg-Essen, D-47048 Duisburg, Germany

With decreasing temperature the NaCl-structure-type antiferromagnetic α-MnS exhibits a phase transition from the paramagnetic to an antiferromagnetic state at T_{c1} ≈152 K, while a spin reorientation transition from single- to multiaxis antiferromagnetism occurs at T_{c2} ≈129 K [1]. (111)-oriented α-MnS crystals were grown by the vapor transport method. Exchange bias (EB) systems with thin ferromagnetic metal films epitaxially grown on top of these α-MnS crystals show a new type of EB temperature dependence. While the EB field, measured with a Superconducting Quantum Interference Device (SQUID), is normal in the temperature regime $T_{c2} < T < T_{c1}$, it seems to vanish below T_{c2}.

[1] W. Kleemann and F.J. Schäfer, Solid State Commun. **69**, 95 (1989).

MA 20.61 Tue 15:15 P1

X-PEEM investigation of a magnetoelectric exchange bias system — •Pavel Borisov[1], Andreas Hochstrat[1], Xi Chen[1], Wolfgang Kleemann[1], Thomas Eimüller[2], Arantxa Fraile-Rodríguez[3], and Christoph Quitmann[3] — [1]Angewandte Physik, Universität Duisburg-Essen, D-47048 Duisburg, Germany — [2]Nachwuchsgruppe Magnetische Mikroskopie, Ruhr-Universität Bochum, D-44780 Bochum, Germany — [3]Paul-Scherrer-Institute, SLS, CH-5232 Villigen, Switzerland

Due to the magnetoelectric properties of Cr_2O_3 its antiferromagnetic domain structure can be changed after cooling through the Néel-Temperature in simultaneously applied magnetic and electric fields. Based on this we could show [1] the complete switching of the perpendicular exchange bias field from positive to negative values and vice versa by variation of an applied electric freezing field for the system $Cr_2O_3/[Co/Pt]_n$. In order to image uncompensated spins at the ferromagnetic-antiferromagnetic interface X-ray photoelectron emission microscopy (X-PEEM) was performed on $Al_2O_3(0001)/Pt/Cr_2O_3/[Co/Pt]_n$ heterolayers after cooling in the same magnetic, but in opposite electric freezing fields. The orientation of the uncompensated spins and the magnetic structure at the interface, measured at the Cr and the Co $L_{3,2}$ absorption edges, are discussed.

[1] P. Borisov *et. al.*, Phys. Rev. Lett. **94**, 117203 (2005)

MA 20.62 Tue 15:15 P1

Magnetization reversal in NiFe/FeMn ion irradiated patterns — •P. Candeloro[1], S. Blomeier[1], A. Beck[1], H. Schultheiss[1], H. Nembach[1], B. Hillebrands[1], M.O. Liedke[1,2], J. Fassbender[2], and B. Reuscher[3] — [1]Fachbereich Physik, TU Kaiserslautern, Erwin-Schrödinger-Str. 56, 67663 Kaiserslautern, Germany — [2]FZ Rossendorf, Institut für Ionenstrahlphysik und Materialforschung, 01314 Dresden, Germany — [3]Institut für Oberflächen- und Schichtanalytik, Brüsseler Str. 3, 67657 Kaiserslautern, Germany

Recently ion irradiation has been proposed as a patterning tool for different magnetic systems. The increasing interest for this technique is due to the capability of tailoring the magnetic properties without affecting the sample topography. We present a study of the magnetic properties of patterns with different geometries produced by ion irradiation on a $Ni_{81}Fe_{19}/Fe_{50}Mn_{50}$ exchange bias bilayer by magneto-optic Kerr effect (MOKE) magnetometry and magnetic force microscopy (MFM). The hysteresis loops measured by MOKE present features evidently related to the irradiated geometries. Moreover they also reveal that the magnetization reversal is not proceeding independently in irradiated and non-irradiated areas. This magnetic coupling is confirmed by MFM images, which clearly show that magnetic domains in irradiated and non-irradiated elements are mutually influencing each other during the reversal process. Comparison with previous studies indicates that the above mentioned coupling dramatically affects the reversal process only when the lateral size of irradiated elements approaches a characteristic coupling length. This work was supported within the EC project NEXBIAS.

MA 20.63 Tue 15:15 P1

Domain structure during magnetization reversal of PtMn/CoFe exchange bias micro-patterned lines — •Maciej Oskar Liedke[1,2], Kay Potzger[1], Burkard Hillebrands[2], Marc Rickart[3], Paulo Freitas[3], and Jürgen Fassbender[1] — [1]FZ Rossendorf, P.O. box 510119, 01314 Dresden, Germany — [2]TU Kaiserslautern, Erwin-Schrödinger-Str. 56, 67663 Kaiserslautern, Germany — [3]INESC MN, Rua Alves Redol 9-1, 1000 Lisbon, Portugal

In order to investigate the relation between shape anisotropy and unidirectional anisotropy in exchange biased stripes, the magnetic domain configuration during magnetization reversal was studied as a function of the ratio between both anisotropy contributions. For that purpose a number of PtMn/CoFe samples were prepared by sputter deposition. By means of optical lithography several line pattern in micron length range have been prepared. In order to modify the ratio between both anisotropy contributions the exchange bias field strength was reduced by means of 5 keV He^+ ion irradiation. The domain structure during magnetization reversal was then investigated by means of magnetic force microscopy. For the as-prepared samples a mono-domain magnetization state with the magnetization direction aligned along the exchange bias field direction was found regardless of its shape. After irradiation the homogeneous magnetization state broke up into small domains with 360° domain walls in between. The appearance of these domain walls was only observed for the descending branch of the magnetization reversal. In addition it was found that the number of domain walls created depends strongly on the stripe width and orientation.

MA 20.64 Tue 15:15 P1

LLG-simulations of FM/AFM multilayers — •Björn Beckmann[1], Ulrich Nowak[2], and Klaus D. Usadel[1] — [1]Fachbereich Physik, Universität Duisburg-Essen, 47048 Duisburg, Germany — [2]Department of Physics, University of York, Heslington, York YO10 5DD, United Kingdom

Magnetization dynamics has become an object of intense studies in recent years. In particular, for achieving high speed magnetization switching, e. g. for magnetic random access memory devices, it is extremely important to know the Gilbert damping constant and, moreover, to know how to influence this constant. One approach is to use FM/AFM multilayers. Even though numerous works have dealt with such systems a fundamental knowledge of the underlying microscopic mechanism is still lacking.

Therefore, in our contribution we present results from numerical simulations of FM/AFM multilayers. The system investigated consists of an FM monolayer exchange coupled to several AFM layers. We included nearest neighbor exchange interaction, in-plain/out-of-plain anisotropies, the long range dipole-dipole interaction and the coupling to an external field. The dynamics is described by LLG equations at finite temperatures which are solved numerically.

A main result of our simulations is that the FM damping is greatly enhanced just by adding a single AFM layer, but a further increase of the AFM layer thickness has no considerable effect on the FM damping.

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

MA 20.65 Tue 15:15 P1

Magnetic properties of FePt based exchange coupled films — •Felix Kurth, Martin Weisheit, Sebastian Fähler, and Ludwig Schultz — Institute for Metallic Materials, IFW Dresden, Helmholtzstr. 20, D-01069 Dresden

FePt is a promising material for future high density magnetic recording, due to its high magnetocrystalline anisotropy and therefore higher thermal stability at smaller grain size compared to currently used materials. However, high anisotropy results in prohibitively high coercivity, which currently prevents the use of this material due to the limited switching field of write heads. One way to decrease coercivity while only moderately affecting the thermal stability is to couple the hard magnetic

FePt film to a soft phase, like Fe or FeCo. This has been shown theoretically [1]. Here we present first results on the properties of FePt/Fe and FePt/FeCo bilayers prepared by pulsed laser deposition. The influence of deposition parameters, e.g. substrate temperature, on the surface morphology and crystallographic structure and their effect on the magnetic properties is discussed.
[1] D. Suess, T. Schrefl, S. Fähler, M. Kirschner, G. Hrkac, F. Dorfbauer, and J. Fidler, Appl. Phys. Lett. **87** (2005) 012504

MA 20.66 Tue 15:15 P1

In-situ MFM study of the magnetization process in AF coupled CoPt/Ru multilayers — •Ulrike Wolff[1], Tetyana Shapoval[1], Ulrich Rössler[1], Ludwig Schultz[1], Olav Hellwig[2], and Volker Neu[1] — [1]IFW Dresden, Helmholtzstr. 20, D-01069 Dresden, Germany — [2]Hitachi GST, San Jose, CA

CoPt/Ru multilayers exhibit a broad range of fascinating magnetic structures due to the competing energy terms of antiferromagnetic exchange coupling through the Ru spacer, dipolar stray field interactions and magnetostatic Zeeman terms in an external magnetic field. In zero field, two distinctly different magnetic states are observed depending on temperature and magnetic history, but possess vanishing remanence and are therefore best studied by direct imaging of the domain structure. This paper presents a study of magnetization processes of a CoPt/Ru sample directly observed in a Low Temperature Magnetic Force Microscope at different temperatures and magnetic fields. After saturation at 300 K in a field of 0.5 T the zero field state resembles typical stripe domains observed for films with perpendicular magnetic anisotropy. This state is explained by an effectively ferromagnetic dipolar coupling through the Ru layer. Saturating in a field of 0.6 T at 10 K brings the sample into a completely compensated, which can be understood by the AF coupling through the Ru layer. The cross-over temperature T_x for these two different ZF states is found to be 270 K.

MA 20.67 Tue 15:15 P1

Co moment reduction in the NiCoO/Co exchange bias system — •Sebastian Brück[1], Uwe Grüner[1], Myrsini Lafkioti[1], YunJun Tang[2], Eberhard Goering[1], and Ami E. Berkowitz[2] — [1]Max-Planck-Institut für Metallforschung, Heisenbergstrasse 3, D-70569 Stuttgart — [2]University of California, San Diego, 9500 Gilman Dr, La Jolla, CA 92093-0401, USA

We have investigated a thin layered stack of NiCoO(50nm)/Co(1nm)/Ru using x-ray magnetic circular dichroism (XMCD) and resonant soft x-ray reflectivity (XRMS) at the Ni and Co L2,3 edges. A clear average magnetic Ni spin polarization of 0.037μB has been observed, while the orbital moment is 0.006μB. Assuming that the Ni magnetization is purely located at the first interface layer, it results in an average Ni moment of 0.36μB. The magnitude of the exchange bias effect in the system is strongly increasing for decreasing temperatures. While the Ni moment remains constant when cooling from RT to 80 K, the XMCD related Co moment strongly decreases by 10%, consistent to additional SQUID measurements. Since bulk Co magnetic moments increases for lower temperatures, the observed decrease is interpreted in terms of Co momentum freezing in the antiferromagnetic NiCoO layer. This freezing corresponds quantitatively to the increase of the exchange bias effect.

MA 20.68 Tue 15:15 P1

Dynamic quasi-particle behaviour of geometrically confined domain walls — •Daniel Bedau[1], Mathias Kläui[1], Ulrich Rüdiger[1], Dirk Backes[2], L. J. Heyderman[2], Giancarlo Faini[3], C.A.F. Vaz[4], and J.A.C. Bland[4] — [1]FB Physik, Universität Konstanz, Konstanz, Germany — [2]LMN, Paul Scherrer Institut, Villigen, Switzerland — [3]LPN-CNRS, Marcoussis, France — [4]Cavendish Laboratory, University of Cambridge, UK

Due to their small lateral dimensions domain walls behave like quasi-particles in an attractive potential well.

We have chosen ferromagnetic rings because in these structures simple magnetic states with head-to-head domain walls are found making this geometry suitable for probing domain wall properties, e.g. pinning at or repulsion from notches which depend on the specific domain wall type [1]. Different types of domain walls are either attracted or repelled by constrictions. The depth and the width of the potential well which correspond to the shape of the pinning potential have been determined using magnetoresistance measurements [2,3]. To completely characterize the potential landscape, the curvature of the potential well needs to be ascertained. This can be achieved by studying the behaviour of a domain wall under periodic excitation. For this purpose a new setup has been constructed allowing magnetoresistance measurements at low temperatures under high frequency excitation from 100 MHz to 20 GHz. [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) [3] M. Kläui et al., APL 87, 102509 (2005)

MA 20.69 Tue 15:15 P1

Laser induced precessional switching in exchange biased NiFe/FeMn bilayers — •Markus C. Weber[1], Steffen Blomeier[1], Burkard Hillebrands[1], and Juergen Fassbender[2] — [1]Fachbereich Physik and Forschungsschwerpunkt MINAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Institute of Ion Beam Physics and Materials Research, Forschungszentrum Rossendorf, 01314 Dresden, Germany

Laser pulse induced field assisted precessional switching in exchange coupled mesoscopic NiFe/FeMn striplines has all-optically been triggered and magneto-optically observed in real time with switching times down to 500 ps. A fast decoupling of the exchange bias bilayer launches coherent precession of the magnetization of the ferromagnetic layer of the exchange bias system. By properly choosing the initial equilibrium orientation the optical unpinning of the bilayer can induce complete magnetization switching. Stroboscopic time domain imaging of the switching event has been realized by a sophisticated synchronization scheme of a magnetic preset pulse and both the optical pump and probe pulses, respectively. The observed laser assisted switching can be well described by the Landau-Lifshitz-Klaasen-van Peppen equation combining precessional and thermally activated spin dynamics.

This work was supported by the EC-RTN NEXBIAS and ULTRASWITCH and by the DFG Graduiertenkolleg 792.

MA 20.70 Tue 15:15 P1

Internally tunable notch filters and attenuators for microwave devices using ferromagnetic resonance absorption — •Tobias Korn[1], Ursula Ebels[2], Philippe Ferrari[3], and Pascal Xavier[3] — [1]Institut für Angewandte und Experimentelle Physik, Universität Regensburg, 93040 Regensburg — [2]SPINTEC CEA/CNRS, 17 Rue des Martyrs, 38054 Grenoble, France — [3]IMEP, 23 Rue des Martyrs,38054 Grenoble, France

We present a new concept for internally tunable microwave attenuators and notch filters using microstructured ferromagnets as absorptive elements. The devices consist of a Permalloy (Py, $Fe_{20}Ni_{80}$)line which is inductively coupled to a coplanar waveguide structure. At its ferromagnetic resonance frequency, the Py line absorbs microwave power from the waveguide. The resonance frequency at zero external bias field may be tailored to device applications by using shape anisotropy. If a DC current is passed through the waveguide, it creates a local in-plane hard-axis magnetic field. This field changes the equilibrium angle of the magnetization of the Py line and thus reduces its resonance frequency. In fixed-frequency attenuation applications at a certain operating frequency f_0, the attenuation in the Py line may thus be tuned using a DC current to move its resonance frequency closer to or farther away from f_0. For higher applied DC currents, the ferromagnetic absorption may be suppressed completely. No externally created magnetic fields are necessary in these applications, enabling the attenuator and notch filter to be used in miniaturized or mobile devices.

MA 20.71 Tue 15:15 P1

Scattering of dipole dominated spin waves from 1D inhomogeneity in ferromagnetic film — •M. Kostylev[1], A. Serga[2], T. Schneider[2], B. Leven[2], B. Hillebrands[2], and R.L. Stamps[1] — [1]Department of Physics, University of Western Australia, Nedlands WA 6907, Australia — [2]Fachbereich Physik, TU Kaiserslautern, 67663 Kaiserslautern

The scattering of backward volume magnetostatic spin waves (BVMSW) from a region of highly inhomogeneous magnetic field in ferromagnetic film was studied. The inhomogeneity was created by applying a dc current flowing through a thin wire situated on the surface of the film. Depending on the current direction the Oersted field either enhanced or decreased locally the total static field, thus creating a field profile in a form of a barrier (B) or a well (W). The amplitude T and phase ϕ of the BVMSW transmitted through the inhomogeneity was measured as a function of the magnitude of the current I and the wavenumber of incident wave k. In W-regime $T(I)$ was found to be a monotonically decreasing function, whereas in B-regime the transmission is a minimum at about 0.6 A and maximum at about 1 A. The phase ϕ decreases linearly with I in B-regime, whereas in W-regime

it deviates from linear increase towards lower values. Theoretically it was shown that the maximum of transmission in B-regime is a transmission resonance. The transition from linear to nonlinear $\phi(I)$ in the W-regime is interpreted as a transition from scattering of spin waves from an inhomogeneity to tunnelling through a prohibited zone [1].
[1] S.O.Demokritov et al. PRL, v.93, 047201 (2004)

MA 20.72 Tue 15:15 P1

Laser induced magnetization dynamics: precession modes and damping parameter — •J. Walowski[1], M. Djordjevic[1], G. Eilers[1], A. Parge[1], M. Münzenberg[1], and J. S. Moodera[2] — [1]IV. Phys. Institute, University of Goettingen, Germany — [2]Francis Bitter Magnet Laboratory, MIT, Cambridge, USA

The development of spintronics requires coherent optical control of magnetization in thin ferromagnetic films on sub ns timescale. Time resolved magneto-optical Kerr effect is used to follow the magnetization dynamics upon ultrafast laser excitation with 50 fs resolution. We will present a detailed study of the dominant magnetic relaxation modes and the energy dissipation processes through both intrinsic and non-local Gilbert damping in thin Ni films. We were able to trigger the magnetization dynamics with a laser induced change in the anisotropy field and control the precession modes with the amplitude and the orientation of the external field, as well as with the pump laser fluence. The frequency spectrum are in the ranges from 1.5 GHz up to 13 GHz. They describe the characteristic homogeneous mode as well as the intrinsic standing spin wave modes. The corresponding intrinsic Gilbert damping parameter has been found to be dependent on the precession mode, taking values from $\alpha = 0.05$ up to $\alpha = 0.25$. The non-local Gilbert damping, due to emission of spin waves, is investigated at **Ni/NM** double layers (**NM** = **Cu**, **Al**, **Ti**, **Cr**, **Pd**, **Dy**). Enhancement in the Gilbert damping parameter of more than one order of magnitude is observed for materials with strong spin-orbit coupling and we present for the first time a coherent study.

MA 20.73 Tue 15:15 P1

Effect of Rare Earth Dopands in Permalloy Films and Multilayers — •Georg Woltersdorf[1], Jan-Ulrich Thiele[2], Manfred Schabes[2], Gereon Meyer [3], Matthias Kissling[1], Michael Binder[1], and Christian Back[1] — [1]Universität Regensburg, Institut für Experimentelle und Angewandte Physik — [2]Hitatchi Global Storage Technologies — [3]Stanford University, Department of Physics

We investigated the influence of rare earth dopands on the magnetic relaxation. In our experiments Permalloy ($Ni_{81}Fe_{19}$) films were doped with various concentrations of the rare earth ions Dy, Ho, and Tb. The magnetization dynamics of these films was studied using ferromagnetic resonance (FMR) and time resolved magneto optic Kerr effect (TR-MOKE) in a frequency range from 1 to 35 GHz. In agreement with earlier work [1] we find that the rare earth doping of Permalloy leads to a large increase of the damping parameter α. Our measurements can be well described using the Gilbert damping term in the equation of motion. This strongly suggests that the increased damping is due to an increased rate of transfer of angular momentum from the spin system to the lattice.

In addition, we studied a series of samples where the doped Py layer was exchange coupled to a ferromagnetic layer without rare earth doping. In such samples the doped layer acts as an additional drain for the angular momentum and leads to a faster relaxation of the magnetization dynamics of the undoped layer.
[1] W. Bailey et al. IEEE Trans. Mag. 37, 1749(2001)

MA 20.74 Tue 15:15 P1

Bloch- to cross-tie wall transformation by pulsed magnetic fields — •Andreas Neudert, Jeffrey McCord, Rudolf Schäfer, and Ludwig Schultz — IFW Dresden, Postfach 270116, 01171 Dresden

The internal structure of 180° domain walls in ferromagnetic films depends strongly on the thickness of the film. In thick films (thickness > 100 nm) domain walls of the asymmetric Bloch type are energetically favoured compared to cross-tie walls. We investigated an asymmetric Bloch wall in a 80x160 μm^2 permalloy rectangle of 160 nm thickness using static and time-resolved Kerr microscopy. By applying a repetitive pulsed magnetic field (amplitude 1.6 kA/m, width 800 ps, repetition rate 23 MHz) the Bloch wall is unexpectedly transformed into a cross-tie wall. After switching off the pulsed magnetic field this new domain wall still exists, although for permalloy films of this thickness asymmetric Bloch walls are energetically favoured. The influence of magnetic inhomogeneities and pulsed field parameters on this wall transformation will be discussed.

MA 20.75 Tue 15:15 P1

Progress in micro-focus Brillouin light scattering spectroscopy — •H. Schultheiss[1], H.T. Nembach[1], M.C. Weber[1], P.A. Beck[1], P. Candeloro[1], B. Leven[1], V.E. Demidov[2], S.O. Demokritov[2], and B. Hillebrands[1] — [1]Fachbereich Physik und Forschungsschwerpunkt MINAS, TU Kaiserslautern, Erwin-Schrödinger-Str. 56, 67663 Kaiserslautern, Germany — [2]Institut für Angewandte Physik, Westfälische Wilhelms-Universität Münster, Corensstr. 2-4, 48149 Münster, Germany

Brillouin light scattering microscopy combines the high magnetic sensitivity of conventional Brillouin light scattering spectroscopy, i.e., detection of thermally excited spin waves, with the high spatial resolution of a scanning microscopy technique. Imaging of periodic nanostructures for the optical characterization of the developed micro-BLS setup yields a spatial resolution of 300 nm. Numerical calculations within the framework of Fourier optics including spin wave induced phase shifts reveal an enhancement of the optical contrast while studying spin wave mode profiles. The implementation of high bandwidth picoprobes into the microscope allows for a local investigation of large angle spin dynamics in magnetic nanostructures due to broadband microwave excitations.

Support by the DFG within the SPP 1133 and by the EC-RTN ULTRASWITCH is acknowledged.

MA 20.76 Tue 15:15 P1

Kerr domain imaging of microwave assisted switching — •P. Martin Pimentel, H.T. Nembach, S. Hermsdörfer, and B. Hillebrands — Fachbereich Physik and Forschungsschwerpunkt MINAS, TU Kaiserslautern, Erwin-Schrödinger-Str. 56, 67663 Kaiserslautern, Germany

We present Kerr microscopy studies of the quasi-static switching behavior of a micropattened $Ni_{81}Fe_{19}$ ellipsoid under the influence of a microwave field. The microwave field is applied perpendicular to the quasi-static magnetic field, which is oriented parallel to the long axis of the ellipsoid. The long axis of the ellipsoid is 160 μm and the short is 80 μm, with a thickness of 10 nm. The frequency of the microwave field is 800 MHz and the microwave power is 5 dBm and 35 dBm, respectively. A strong modification of the reversal process of the magnetization behavior is observed. For low power big domains are observed orientated parallel to the quasi-static applied field in the range from 6 Oe to 9 Oe. In contrast, for high microwave power, formation of ripples is observed during the magnetization reversal taking place in the field range from 1 Oe to 4 Oe. These two different behaviors can be described by modification of the domain nucleation and growth process due to the microwave field. We show that the applied transversal microwave field can stimulate the domain nucleation and propagation process in a confined element. This work is supported by the EU-RTN ULTRASWITCH (HPRN-CT-2002-00318).

MA 20.77 Tue 15:15 P1

Pulsed inductive measurement of large angle precession in magnetic thin films — •Tobias Martin, Ingo Neudecker, Björn Becker, Matthias Sperl, and Günther Bayreuther — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, 93040 Regensburg

To further increase writing speeds in magnetic storage devices it has been proposed to use precessional switching of the magnetization. To understand this switching behaviour, it is important to understand the time-domain motion of the magnetization after the excitation with large pulse amplitudes. Here Permalloy as well as epitaxial FeCo films are investigated in the large angle regime with the PIMM (pulsed inductive microwave magnetometer). The epitaxial films are examined in hard axis direction near the anisotropy field to reduce the internal effective field and thus achieve large precession angles. The observed variation of the precessional amplitude with increasing pulse field can not be explained within the linear theory. On the other hand, it is shown that the experimental data are well described by a numerical simulation based on a macrospin model.

In fully epitaxial magnetic double layer films two separate precession frequencies are resolved by PIMM. The data are analysed in order to identify the interlayer coupling between both layers.

This work is supported by the Deutsche Forschungsgemeinschaft (SPP1133).

MA 20.78 Tue 15:15 P1

Spin-, energy- and timeresolved photo electron emission microscopy of 3d-transition metals — •Lutz Heyne, B Heitkamp, H. A. Dürr, and W. Eberhardt — Bessy, Berlin, Germany

Early optical pump-probe experiments[1] (tr-MOKE) indicate a breakdown of ferromagnetic order on an fs timescale after an ultra short laser pulse excitation. An intensive pump pulse heats the electronic subsystem, which interacts with the spin system and induces magnetic quenching.

For the future of magneto electronic devices it is important to understand the physics of these ultra fast processes. Our approach to this topic is to directly analyse the spin of the photoelectrons emitted by the probe beam.

Therefore we employ a photo electron emission microscope (PEEM) in combination with a spin analyser (SPLEED). Fs time resolution is obtained by a Ti:Saphier in our pump-probe setup. Analysing the spin of the emitted photoelectrons gives a direct measure of the magnetism in the sample. In combination with the PEEM a spatial resolution of 50nm can be obtained. Alternatively the dynamics of the excited electrons can be observed by time-of-flight spectroscopy using a delay line detector. Experiments on Nickel and Cobalt show a demagnetization on a sub-ps timescale, while the electronic system is still not thermalized.

[1] E. Beaurepaire et.al. Phys. Rev. Lett. 76, 4250 (1996)

MA 20.79 Tue 15:15 P1

Influence of surface roughness to the decay of precessional magnetization motion — •Bjoern Becker, Tobias Martin, Matthias Sperl, Philipp Kotissek, and Guenther Bayreuther — Institut fuer Experimentelle und Angewandte Physik, Universitaet Regensburg, Regensburg, Germany

A non-exponential decay of the uniform precessional motion of the magnetization in ferromagnetic films according to $\exp\left(-|t/\tau|^{3/2}\right)$ has been predicted recently [1]. The decay time τ should be related to the surface roughness [1]. In the present study an attempt was made to test the prediction of such a correlation. Epitaxial Fe films were grown by MBE on clean GaAs(110) wafers and on GaAs(110) surfaces prepared by cleaving in ultra high vacuum. The cleaved edges are atomically flat with terrace widths up to 2 μm x 2 μm as shown by STM. The roughness of the upper surface of the Fe films was altered by variation of the growth temperature. Magnetic anisotropies were determined by MOKE. A pulsed inductive microwave magnetometer (PIMM) was used to measure the frequency, the amplitude and the decay time of the precession following a short field pulse. Intrinsic and extrinsic contributions to the observed decay time are discussed as well as the effect of structural defects and interface roughness.

[1] A. Dobin, Phys. Rev. Lett. 92, 257204 (2004)

MA 20.80 Tue 15:15 P1

Spin Dynamics of Quadratic $Ni_{80}Fe_{20}$ Thin Film Elements: Experiment and Simulation — •Korbinian Perzlmaier[1], Matthias Buess[1,2], Rainer Höllinger[1], Michael R. Scheinfein[3], and Christian H. Back[1] — [1]Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Universitätsstr. 31, 93040 Regensburg, Germany — [2]Paul Scherrer Institut, 5232 Villigen PSI, Switzerland — [3]Simon Fraser University, 8888 University Drive, V5A 1S6 Burnaby BC, Canada

We examine the magnetization dynamics of quadratic $Ni_{80}Fe_{20}$ thin film elements upon external magnetic excitation. Results from experiments using Time Resolved Scanning Kerr Microscopy (TRSKEM) and Micro Focus Brillouin Light Scattering (μBLS)[1] are compared to simulations using the LLG Micromagnetics Simulator [2]. While experiment and simulation show good agreement, simulations themselves offer further insights into the dynamic behavior in regimes which are not yet easily accessible to experimental investigation: Evaluating Fourier spectra of simulations at different points in time, one can find some modes that just decay exponentially. However, other modes will decrease in their amplitude and then gain amplitude again, showing strong signs for a mechanism of exchange mediated mode conversion on a time scale of several nanoseconds.

[1] Phys. Rev. Lett. **94**, 057202 (2005)
[2] http://llgmicro.home.mindspring.com

MA 20.81 Tue 15:15 P1

Magnetic Co nanoparticles in solution — •Mikhail Feygenson, Klaus Pollmeier, Emmanuel Kentzinger, Wiebke Sager, and Thomas Brückel — Forschungszentrum Jülich GmbH,Institut für Festkörperforschung, Streumethoden, Leo-Brandt-Straße, 52428 Jülich, Germany

Magnetic nanoparticles are of the high current interest for both possible applications as magnetic storage materials as well fundamental research. An open question and a challenge to experiment and theory is the magnetization density distribution within single particles, which is expected to be non-uniform. Here we report progress towards the aims to determine the averaged magnetization density within single particles and the response of the ensemble to an external field. Co nanoparticles were synthesized by employing the interior of water-in-oil (w/o) microemulsions as nanoreactors. Particle size and morphology depend on the microemulsion composition and the concentrations of the reactants. To separate the particles from the microemulsion medium we used dodecanethiol and/or octadecanethiol as stabilizing ligands and redispersed the particles after precipitation in either hexane or toluene. The Co nanoparticles were characterized by magnetization measurements, electron microscopy and scattering experiments. The re-dispersed Co nanoparticles display a relatively high saturation field (more then 1 T) and the absence of a net magnetization at room temperature in the SQUID magnetometer. Scattering experiments (small angle X-ray and neutron scattering) are reported for the microemulsion system employed as well as for the re-dispersed nanoparticles

MA 20.82 Tue 15:15 P1

Resonant magnetic x-ray scattering on switchable magnetic gratings patterned by keV-He-ion bombardment — •Tanja Weis[1], Dieter Engel[1], Arno Ehresmann[1], Volker Höink[2], Marc D. Sacher[2], Jan Schmalhorst[2], and Günter Reiss[2] — [1]Institute of Physics and Centre for Interdisciplinary Nanostructure Science and Technology, University of Kassel, Heinrich-Plett-Str. 40, 34132 Kassel, Germany — [2]Department of Physics, University of Bielefeld, P.O. Box 100131, 33501 Bielefeld, Germany

KeV-He-ion bombardment in an external magnetic field enables the local manipulation of the exchange bias effect in ferromagnet / antiferromagnet-bilayer systems. With this technique a patterning of the magnetization direction of the ferromagnetic layer without change in surface topography is possible, the ion bombardment induced magnetic patterning (IBMP) [1,2]. These magnetic patterns (lines and squares), showing an alternating antiparallel orientation of the magnetization, were investigated with resonant magnetic x-ray scattering in remanence and in an applied magnetic field. It will be shown that these lateral magnetic patterns act as magnetically switchable reflection gratings for soft x-ray radiation.

[1] A. Mougin et.al., Phys. Rev. B, 63 (2001) 060409
[2] A. Ehresmann, Recent Res. Dev. Appl. Phys. 7 (2004) 401

MA 20.83 Tue 15:15 P1

Magnetic domains and magnetization reversal of ion-induced magnetically patterned $Ni_{81}Fe_{19}$/Ru/$Co_{90}Fe_{10}$ films — •K. Kuepper[1], L. Bischoff[1], R. Mattheis[2], P. Fischer[3], and J. Fassbender[1] — [1]Institut für Ionenstrahlphysik und Materialsorschung, Frschungszentrum Rossendorf e. V., Dresden, Germany — [2]Institut für physikalische Hochtechnologie Jena e. V., Jena, Germany — [3]Center for X-ray Optics, Lawrence Berkeley National Laboratory, Berkeley, CA, USA

Pure magnetic patterning by means of ion beam irradiation of magnetic thin films and multilayers result often from a post deposition local modification of the interface structure with only minor effects on the film topography. In the study presented here a 60 keV fine focused Co ion beam was used to change the coupling in a $Ni_{81}Fe_{19}$/Ru/$Co_{90}Fe_{10}$ structure from antiferromagnetic to ferromagnetic on a micron scale. Thereby an artificial structure with locally varying interlayer exchange coupling and therefore magnetization alignment is produced. High-resolution full-field x-ray microscopy is used to determine the magnetic domain configuration during the magnetization reversal process locally and layer resolved dueto the element specific contrast in circular x-ray dichroism. In the magnetically patterned structure there is in addition to the locally varying interlayer exchange coupling across the Ru layer also the direct exchange coupling within each ferromagnetic layer present. Therefore the magnetization reversal behaviour of the irradiated stripes is largely influenced by the surrounding magnetic film.

MA 20.84 Tue 15:15 P1

Magnetic domains in CrO_2 microstructures — •Alexander Biehler[1], Mathias Kläui[1], Mikhail Fonin[1], Christian König[2], Markus Laufenberg[1], Wolfgang Bührer[1], Gernot Güntherodt[2], and Ulrich Rüdiger[1] — [1]Fachbereich Physik; Universität Konstanz; 78457 Konstanz — [2]2. Physikalisches Institut; RWTH Aachen; 52056 Aachen

In half-metallic ferromagnetic materials, the majority-spin electrons exhibit metallic character while the minority-spin electrons show a semiconducting gap or vice versa, which leads to complete spin polarization at the Fermi level [1]. This class of materials is thus ideally suited for spin-polarized emitters in magnetic tunneling applications and for investigation of the interaction between highly spin-polarized currents and magnetic domain walls. We have probed the magnetization configuration in CrO_2 microstructures using magnetic force microscopy and have observed alternating domains with 180 degree domain walls in wires parallel to the magnetic hard axis. The magnetization switching and domain wall pinning at constrictions has been studied in wires along the easy axis. We have measured the magnetoresistance effects related to domain walls in these elements and have injected current pulses to study current-induced domain wall propagation due to the spin torque effect.

[1] Y. Dedkov et al., Appl. Phys. Lett. 80, 4181 (2002)

MA 20.85 Tue 15:15 P1

Experimental realization of a model system for a two-dimensional two-phase magnet — •Sven Schnittger[1], Sebastian Dreyer[1], Christian Jooss[1], and Sibylle Sievers[2] — [1]Institut für Materialphysik, Universität Göttingen — [2]Physikalisch-Technische Bundesanstalt, Braunschweig

Two-phase magnets play an important role in the production of permanent magnet applications; especially the interplay of the different magnetostatic interactions is of great interest. In this contribution, the fabrication of a model system for a two-dimensional two-phase ferromagnet is presented. The sample consists of patterned hard magnetic structures ($L1_0$-CoPt) embedded in a soft magnetic film (Permalloy, $Fe_{19}Ni_{81}$). The size, the number and the distribution of the structures in the film as well as their spacing are varied. The fabrication process is done as follows: a magnetron-sputtered CoPt film on a (100)-MgO substrate is structured by electron beam lithography. The negative structure is etched into the film by reactive ion etching using an aluminum mask. The permalloy film is deposited by electron beam evaporation. The magnetic characterization is mainly accomplished by the magneto-optical indicator film technique using the Faraday Effect and by magnetic force microscopy. First results concerning the size-dependent remagnetization behaviour are presented.

MA 20.86 Tue 15:15 P1

FePt nanoparticles from a Haberland type gas aggregation source: Morphological and structural characterization — •Franziska Schäffel, Elias Mohn, Thomas Gemming, Bernd Rellinghaus, and Ludwig Schultz — IFW Dresden, P.O. Box 270116, D-01171 Dresden

FePt nanoparticles are synthesized from a gas aggregation source of the type designed by H. Haberland [1]. The particles grow from a supersaturated metal vapor provided by sputtering from an alloy target at pressures of roughly p = 1 mbar. After nucleation and growth of the particles within an aggregation volume, they are ejected via ultrasonic expansion through an orifice into high vacuum (10^{-4}mbar $\geq$ p $\geq$ 10^{-5}mbar). As a consequence and in contrast to other gas phase techniques [2], further agglomeration of the particles is suppressed. Size fractionation of the particles can be obtained by using a quadrupole mass spectrometer for masses as high as 4×10^6 amu [3]. The morphology and crystal structure of the particles were investigated by means of conventional and high resolution transmission electron microscopy. The effect of the gas pressure in the aggregation chamber, the aggregation volume, the gas type, the orifice size, and the sputtering power on particle size, particle morphology, and particle size distribution was investigated. The system parameters were optimized to obtain non-agglomerated particles with diameters of $d_P \simeq 5$ nm, spherical morphology, and a narrow particle size distribution.

[1] "NC200U Nanocluster source application note", Oxford Applied Research Ltd., UK. [2] S. Stappert et al., J. Cryst. Growth 252 (2003) 440. [3] S.H. Baker et al., Rev. Sci. Inst. 68 (1997) 1853.

MA 20.87 Tue 15:15 P1

Micromagnetic structures of nanocrystalline ferromagnets - comparison of experiment and simulation — •Srinivasa Rao Saranu[1], Andreas Grob[1], Ulrich Herr[1], and Jörg Weissmüller[2] — [1]Werkstoffe der Elektrotechnik, Universität Ulm, Ulm, Germany — [2]Institut für Nanotechnologie, Forschungszentrum Karlsruhe, Karlsruhe, Germany

Bulk nanocrystalline ferromagnetic materials show both hard and soft magnetic behavior depending upon the grain size and exchange length of the magnetic material. Small Angle Neutron Scattering (SANS) experiments show that the local orientation of magnetization averages over many grains at remnant state, whereas some magnetic fluctuations from applied field direction exists even at high external magnetic field. Micromagnetic simulations using the OOMMF code have been done to better understand the experimental results. Irregular random anisotropy nanocrystalline model systems with average grain size of 10 to 100 nm have been generated using a Voronoi construction. The total simulated cell size is 300x300x100 nm. In order to represent bulk nanocrystalline materials, we included anisotropy and exchange energy contributions whereas demagnetizing field energy contributions have been neglected. Magnetic microstructures of the model systems have been investigated at different applied fields and in the remnant state. Correlations of the spatial variations of magnetic moments at different applied magnetic fields were analysed by Fourier transformation. The simulated power spectra agree well with the SANS experimental results. This work has been supported by the Landesstiftung Baden-Württemberg.

MA 20.88 Tue 15:15 P1

Collective behavior of artificial magnetic dipoles — •Alexandra Schumann[1], Arndt Remhof[1], Andreas Westphalen[1], Thorsten Last[2], Ulrich Kunze[2], and Hartmut Zabel[1] — [1]Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum — [2]Lehrstuhl für Werkstoffe und Nanoelektronik, Ruhr-Universität Bochum

We have studied the remanent state and the remagnetization behavior of periodic arrays of rectangular shaped Py magnetic dipoles ($Ni_{80}Fe_{20}$, 0.3μm$\times 3\mu$m$\times$30nm) arranged in an open window type structure. The magnetic islands were prepared by e-beam lithography and ion-beam etching. The magnetic hysteresis was analyzed by vector MOKE and SQUID magnetometry. Images of the domain structure in remanence were taken by MFM. The open window like dipole array is a frustrated system, and several ground states can be realized, such as the onion-state, the horseshoe-state and the vortex state. The aim of the present work was to analyze the stability of each of the states as a function of field direction and gap size between the dipoles. Furthermore, we have studied the long range order of the magnetic dipole arrangement via Bragg-MOKE.

This project was supported by the DFG via SFB491.

MA 20.89 Tue 15:15 P1

Tailoring the domain structure in magnetic multilayers. — •Denis Korolkov[1], Emmanuel Kentzinger[1], Lutz Willner[1], Ralf Lehmann[2], Andre van der Hart[2], and Thomas Brückel[1] — [1]Forschungszentrum Jülich GmbH, Institut für Festköperforschung, D-52425, Jülich — [2]Forschungszentrum Jülich GmbH, Institut für Schichten und Grenzfläschen, D-52425, Jülich

Epitaxially grown Fe/Cr/Fe layered structures are known to exhibit the giant magnetoresistance effect. Magnetoresistance effects have attracted great interest due to their applications, for example, in magnetic random access memory. Due to the necessary miniaturization of such a device, the magnetic interaction between the neighbouring cells is becoming a more and more important parameter that has to be controlled [1].

Here we report on the preparation of lateral nanostructures on top of Fe/Cr multilayers. Self organization of diblock-copolymers with different ratios of molecular weights of the chains has been employed as "bottom-up" technique [2]. Electron-beam lithography with ion-beam etching has been used as "top-down" approach. We could produce nanostructures with a periodicity smaller than 50 nm on a large surface area.

The nanostructures were made visible with the surface sensitive technique of atomic force microscopy (AFM).

For the depth-resolved investigation of the lateral structure we used grazing incidence small angle neutron scattering GISANS.

[1] N. Ziegenhagen, U. Rücker, E. Kentzinger, R. Lehmann, A. van der Hart, B. Toperverg, Th. Brückel Physica B 335 (2003) 50-53 [2] I. W.

Hamley Nanotechnology 14 (2003) R39-R54

MA 20.90 Tue 15:15 P1

Magneto-optical investigation of magnetic properties of patterned CoPt thin films with special edge profiles — •Jonas Norpoth, Sebastian Dreyer, Sven Schnittger, and Christian Jooss — Institut für Materialphysik, Universität Göttingen

The presence of edge roughness is of great importance for the magnetic properties of patterned structures. This work studies the influence of defined recesses in the edges of patterned CoPt thin films on the magnetic behavior like magnetization processes and strayfield distributions. We have systematically modified several geometrical parameters: the recesses have the shape of rectangles, triangles or half-cylindric solenoids. Furthermore their number and positions are varied, as well as the ratio of typical recess diameter to overall edge length. The epitaxially grown CoPt thin films (c-axis orientation) are patterned by e-beam lithography and subsequent ion etching. The specimens strayfield distribution is investigated by magneto-optical imaging (using the Faraday effect) up to a resolution of ˜500nm; the obtained data is compared with theoretical calculations and is used to analyze the related magnetization distribution. In future prospects we think about a scale down of the patterns to the submicron length scale by means of Focused Ion Beam and Magnetic Force Microscopy.

MA 20.91 Tue 15:15 P1

Competition between shape anisotropy and magnetoelastic anisotropy in Ni nanowires electrodeposited within alumina templates — •Amit Kumar, Sebastian Fähler, Heike Schlörb, Karin Leistner, and Ludwig Schultz — IFW Dresden

Ordered arrays of magnetic nanowires deposited in porous alumina are attracting increasing interest due to potential applications in high density magnetic storage or in micro electromechanical systems. We have produced self-assembled nanopores in alumina on Al and filled them with Ni using AC electrodeposition. Due to the high aspect ratio, the magnetization lies preferentially along the wire axis and a strong magnetic anisotropy is observed. Temperature dependent measurements show an unexpected decrease of out-of-plane coercivity at lower temperatures. A model is proposed that takes into account the magnetoelastic anisotropy induced in the wire during cooling. Due to the difference in thermal expansion of Ni, alumina and Al, stresses are induced in the Ni wire during cooling. The resulting magnetoelastic anisotropy is acting opposite to the shape anisotropy and can well explain the experimental results.

MA 20.92 Tue 15:15 P1

Maximisation of stray field modulation in periodic arrays of magnetic particles — •Nikolai Mikuszeit[1], Juan José de Miguel[1], Robert Frömter[2], and Hans Peter Oepen[2] — [1]Dpto. Física de la Materia Condensada, Universidad Autónoma de Madrid, E-28049 Madrid, Spain — [2]Institut für Angewandte Physik, Universität Hamburg, D-20355 Hamburg, Germany

There are many possible applications for periodic arrays of magnetic particles. They can create modulated magnetic potentials for magneto-transport experiments e.g. to realise Hofstadter butterflies; they can be used as storage media or as molecule traps in quantum optics, and therefore in quantum computing. Especially in the first two cases it is not only important to create a strong stray field, but furthermore a strong field modulation e.g. to have a clear separation between neighbouring bits. The stray field of a periodic array can be calculated with standard Fourier methods [1]. However, the typical application is to calculate the stray field of a given experimental structure [2]. In the presented poster we give a systematic study of array symmetries, particle shapes and particle sizes. We show that a large gain in stray field modulation can be achieved by choosing the correct particle size.

[1] R. L. Wallace Jr, Bell Syst. Tech. J. **30** 1145 (1951)
[2] R. R. Gerhardts, Phys. Rev. B **53**, 11064 (1996)

MA 20.93 Tue 15:15 P1

Magnetization reversal of individual permalloy particles by coherent rotation — •Joachim Stahl, Werner Wegscheider, and Dieter Weiss — University of Regensburg, Institute for Experimental and Applied Physics, D-93040 Regnsburg

Nanostructured ferromagnetic disks show a transition of the remanent magnetization configuration from a vortex to a single domain state with decreasing dimensions. Here, the magnetization reversal of individual permalloy particles entering this single domain range is studied by means of micro-Hall magnetometry. In contrast to integral methods which are averaging over a large number of nanomagnets [1] the results obtained here are not affected by broadening of the switching field.

By reducing the thickness to diameter ratio the single domain limit can be entered. For studying this regime disks with different diameter and thickness were fabricated. Therefore the Hall signal U_{H} caused by the stray field of one single disk during magnetization reversal in an external magnetic in-plane field H_{ext} is measured. For example a disk with a diameter of 100 nm and a thickness of 10 nm was fabricated on a sub-μm Hall sensor. As in the experiment simulations with LLG [2] also show an abrupt switching of the disk's magnetization without indicating any curling effects. Hence micro-Hall magnetometry proves to be a simple tool to investigate individual true single domain particles.

[1] R. P. Cowburn, et al., Phys. Rev. Lett. **83**, 1042 (1999)
[2] LLG Micromagnetics Simulator by M. Scheinfein, see http://llgmicro.home.mindspring.com/

MA 20.94 Tue 15:15 P1

Imaging the non uniform excitations of the ferromagnetic resonance of Cobalt and Permalloy structures using scanning near field thermal microscopy — •R. Meckenstock[1], I. Barsukov[1], O. Posth[2], C. Hassel[2], J. Lindner[2], G. Dumpich[2], M. Farle[2], J. Podbielski[3], D. Grundler[3], D. Dietzel[4], and D. Spoddig[1] — [1]Institut für Experimentalphysik, Ruhr-Universität Bochum, 44780 Bochum, Germany — [2]Fachbereich Physik, Universität Duisburg-Essen, 47048 Duisburg, Germany — [3]Institut für Angewandte Physik, Universität Hamburg, 20355 Hamburg, Germany — [4]Physikalisches Institut, Universität Münster, 48149 Münster, Germany

Near field thermal microscopy has been applied on the analysis of the magnetic properties of Co stripe arrays and Permalloy (Py) ring arrays on GaAs. The samples were prepared using the standard lithography lift off processes. The Co stripes were 50μm long and 10μm apart. The stripe width was between 0.6 and 2μnm and the thickness between 10 and 30nm. The Py rings had an inner diameter of 0.8μm and an outer of 2μm, and a thickness of 15 nm. The conventional ferromagnetic resonance (FMR) measurements show additional FMR modes as function of Co thickness if the external field was applied perpendicular to the stripes. The origin of these modes was then deduced locally resolved in the single structures using a scanning thermal microscope (SThM), which features a lateral resolution of 100nm. The modes could be correlated by SThM-FMR to different excitation states in the Co stripe. The Py ring exhibits in the conventional FMR experiment one resonance line, which could be linked to the thermal excitation of parts of the ring by SThM-FMR.

MA 20.95 Tue 15:15 P1

Two-dimensional electron gases subjected to modulated magnetic potentials — •R. Dinter, S. Pütter, H. Stillrich, H.P. Oepen, and W. Hansen — Institute for Applied Physics, University of Hamburg, Jungiusstr. 11, 20355 Hamburg

We study two-dimensional electron gases (2DEGs) subjected to modulated potentials and magnetic fields. The goal is to investigate the energy splitting of the Landau levels due to field modulations with periods less than 100 nm by magneto-transport measurements. The 2DEGs are prepared in GaAs/AlGaAs and InAs shallow HEMTs grown by MBE, where they are located some ten nanometres below the surface. A modulated potential is achieved by preparing nanomagnets with mask techniques directly on the samples. The nanomagnets are produced by sputter-deposition of Co/Pt multilayers through different types of masks. The magnetic properties of the nanostructures are studied via the magneto-optical Kerr effect and scanning electron microscopy with polarization analysis. Transport measurements are performed in Hall bar geometry at temperatures between 4.2 K and 30 mK.

We discuss the preparation in detail and results of the magnetic characterization as well as magneto-transport measurements.

MA 20.96 Tue 15:15 P1

Development of new magnetic layer systems for the manipulation and detection of magnetic particles — •Michael Schilling, Astrit Shoshi, Andreas Hütten, and Günter Reiss — Department of physics, Bielefeld University, Postfach 100131, D-33501 Bielefeld

Modern experiments with magnetic nanoparticles need customized magnetic layer systems for the detection and manipulation of single particles. New GMR and TMR stacks are developed to enhance sensitivity and reproducability of the magnetic sensors. The layer stacks are then patterned using e-beam and laser lithography. First experiments with the

resulting XMR-sensors show promising results for future single marker detection.

In order to create higher forces for an on-chip manipulation of magnetic beads, magnetic layer systems are sputtered below conducting lines. The magnetic layer system, that is aligned by a current through the conducting line, allows a better magnetization of the magnetic particles and therefore to apply higher forces.

MA 20.97 Tue 15:15 P1

Interacting ferromagnetic nanoparticles in the superspin limit: from modified superparamagnetism to collective magnetic states — •S. Bedanta[1], X. Chen[1], W. Kleemann[1], O. Petracic[1], E. kentzinger[2], P. Fischer[3], S. Cardoso[4], and P. P. Freitas[4] — [1]Universität Duisburg-Essen, 47048 Duisburg, Germany — [2]Forschungszentrum Jülich, 52425 Jülich, Germany — [3]Lawrence Berkeley National Laboratory, Berkeley CA 94720, USA — [4]INESC, 1000 Lisbon, Portugal

Discontinuous multilayers $[CoFe(t_n\ nm)/Al_2O_3(3\ nm)]_{10}$ of soft ferromagnetic $Co_{80}Fe_{20}$ nanoparticles embedded in an Al_2O_3 matrix are considered as homogeneously magnetized superspin systems exhibiting randomness of size (viz. moment), position and anisotropy. With increasing particle concentration (viz. nominal CoFe layer thickness t_n), but prior to physical percolation, one observes superparamagnetic (SPM), superspin glass (SSG) and finally superferromagnetic (SFM) domain state behavior. Dipolar interaction weakly modifies the SPM relaxation properties at $t_n \leq 0.5$ nm, but dominates the SSG state at $0.7 \leq t_n \leq 1.1$ nm, which is unambiguously characterized by memory and aging effects. Tunneling exchange between the nanoparticles due to atomically small magnetic clusters around the nanoparticles is suspected to mediate the SFM interaction at $1.2 \leq t_n \leq 1.6$ nm. SFM domains have been imaged by transmission X-ray microscopy. They show temporal relaxation as evidenced by SQUID magnetometry and polarized neutron reflectometry. Owing to random pinning their walls reveal different dynamic modes as identified by the complex ac susceptibility in Cole-Cole presentation.

MA 20.98 Tue 15:15 P1

Magnetic Nanoclusters in Organic Thin Films — •D. Rosu[1], R. Pacurariu[2], B. Bräuer[1], D.R.T. Zahn[1], and G. Salvan[1] — [1]Chemnitz University of Technology, D-09107 Chemnitz, Germany — [2]Babes-Bolyai University, RO-400085 Cluj-Napoca, Romania

The magnetic properties exhibited by small magnetic clusters, in particular their large magnetic moments, are of fundamental importance for the design of high-density recording memories [1]. The surrounding medium can have a significant influence on the magnetic properties. In this work transition elements such as Ni and Co and organic molecules are co-evaporated in ultra high vacuum to obtain thin hybrid films. One of the molecules used, fullerene, consists of solely C atoms and has an icosahedral symmetry. The other molecule, pentacene, contains additionally H atoms and has a planar structure. The mixed films contain metallic clusters the size of which is controlled by the evaporation rates. Raman spectroscopy is employed to study aspects such as chemical bond formation or charge transfer at the metal-organic interface and transmission electron microscopy is used to probe the cluster size and structure. The magnetic properties of the hybrid films are assessed by magneto-optical Kerr effect spectroscopy. It was found for example that Ni clusters in fullerene matrix are ferromagnetic at room temperature when the cluster diameter exceeds an average value of 5 nm. [1] J.L. Rodriguez-Lopez, F. Aguilera-Granja, A. Vega, J.A. Alonso, Solid State Communications 116 (2000) 309.

MA 20.99 Tue 15:15 P1

EPR spectrum of tetramer CENI — •Oksana Kravchyna[1], M. Orendach[2], A. Orendachova[2], and M. Kajnakova[2] — [1]B. Verkin Institute for Low Temperature Physics and Engineering of the National Academy of Sciences of Ukraine,47 Lenin Ave., Kharkov 61103 Ukraine — [2]Center of Low Temperature Physics, Faculty of Sciences, P. J.Safarik University, Park Angelinum 9, 04154, Kosice, Slovakia

The results of investigation of EPR spectrum of metal-organic complex CENI are reported. This investigation has been done at frequency 72.8 GHz and in the temperature region from 2 to 40 K. For T > 15 K the EPR spectrum possess features that are typical for a polycrystalline $S = 1/2$ paramagnet with a slight axial anisotropy of the g-factor. In other words, the spectra is a wide band with a rather narrow peak at $H_\perp$ and a broad shoulder at $H_\parallel$ if DH is small. At low temperatures, the form of main absorption band was changed. The additional peak is raised near shoulder beginning and small absorption low-field "tail"is observed. At the same time, the high field region shifts to higher magnetic field. This unusual behaviour might be associated with the formation of intracluster magnetic correlations that lead to transitions between the energy levels of the tetrameric unit. That is why the eigenvalues En were calculated by using a numerical diagonalization of the matrix Hamiltonian. The matrix of transition for our work frequency was found. According to our calculation additional resonance transition in spectra of tetramer appeared in intermediate fields. The intensity of this transition must increase with decreasing temperature.

MA 20.100 Tue 15:15 P1

Influence of the growth temperature on the morphology and the magnetic properties of vertically aligned Fe-filled MWNTs grown on silicon substrates — •Radinka Kozhuharova-Koseva, Dieter Elefant, Matthias Hofmann, Albrecht Leonhardt, Ingolf Mönch, Manfred Ritschel, Thomas Mühl, and Bernd Büchner — Leibniz-Institute of Solid State and Material Research Dresden, P.O. Box 270016, D-01171 Dresden, Germany

Arrays of vertically aligned Fe-filled multi-walled carbon nanotubes on oxidized silicon substrates were prepared by pyrolysis of ferrocene in a dual furnace system and characterized by electron microscopy and magnetization measurements. The effect of the growth temperature on the filled nanotube morphology and magnetic properties was studied. Increasing the growth temperature in the range of 845-1035 Centigrade the nanotube diameter increases from 20 to 110 nm and the diameter of the encapsulated Fe nanowires becomes larger (from 8 to 40 nm), respectively. Moreover, at higher growth temperature, lower coercivities and remanence ratios of the studied samples were obtained. Factors causing the observed magnetic behavior will be discussed.

MA 20.101 Tue 15:15 P1

Exchange spring behaviour of magnetic nanoclusters embedded in a soft magnetic matrix — •Dmitrij N. Ievlev, Alexey N. Dobrynin, Christian Hendrich, Kristiaan Temst, and Peter Lievens — Laboratorium voor Vaste-Stoffysica en Magnetisme, Katholieke Universiteit Leuven, B-3001 Leuven, Belgium

We have investigated the magnetization behaviour of Co nanoclusters embedded in a soft magnetic matrix (Fe, permalloy) at different temperatures from 300 K down to 5 K. Magnetic nanoclusters with average size between 2.0 and 2.5 nm were produced in a laser vaporization cluster source and co-deposited with magnetically soft matrix material at low kinetic energy (<1 eV/atom) at UHV conditions. The cluster size distribution was monitored by time-of-flight mass spectrometry in beam, and with transmission electron microscopy and small angle x-ray scattering after deposition. For certain nanocluster concentrations smooth hysteresis curves were observed, indicating good exchange coupling between the magnetically hard nanoclusters and magnetically soft matrix material. Dependences of coercivity on cluster concentration were investigated at low and high temperatures.

MA 20.102 Tue 15:15 P1

Structural and Magnetic Properties of Dipolar Nanoparticles — •Stephan Buschmann, Fred Hucht, and Peter Entel — Theoretische Physik, Universität Duisburg-Essen, D-47048 Duisburg

In this work the collective behavior and the structural and magnetic properties of dipolar nanoparticles are investigated. The dynamics of the considered systems are determined by differential equations for the translational and rotational degrees of freedom. Within a molecular dynamics simulation these differential equations are solved using the Verlet algorithm. The interaction potential of the nanoparticles consists of both an anisotropic dipolar interaction and the isotropic hard-sphere potential. Dependent on the temperature and an external magnetic field, the system is found to be in different states. These states can be characterized by their respective structural ordering of the dipolar particles, that is closely related to the magnetic and energetic properties. In the ground state the particles arrange in closed rings due to the anisotropy of the interaction. Beside the ring configuration also the formation of metastable chains and network-like structures consisting of several chain segments can be observed at zero temperature. Thermal excitations lead to a destabilization while the influence of an external magnetic field depends on its relative orientation with respect to the observed structures. In this work the phase diagrams of the various structures are determined as function of temperature and external field by means of molecular dynamic simulations and energetic arguments.

MA 20.103 Tue 15:15 P1

Ab initio investigation of structural and magnetic properties of nanosized Fe-clusters — •Markus E. Gruner, Georg Rollmann, Alfred Hucht, and Peter Entel — Theoretische Physik, Universität Duisburg-Essen, 47048 Duisburg

We report on the structural and magnetic properties of iron clusters of icosahedral, cuboctahedral and Bain-transformed cuboctahedral shape with up to 309 atoms. The results are obtained within the framework of density functional theory using the Vienna ab Initio Simulation Package (VASP) including full structural relaxation. We find that from 147 atoms on the bcc-like structures have the lowest energy while there is an second minimum for a closed packed structure which is only slightly higher in energy. This structure appears to be shell-wise transformed along the Mackay path with the inner shells being closer to the cuboctahedral structure and the outer shells being more icosahedral. For the bcc structures the moments agree well with experimental data, while in the other case the magnetic moment is reduced due to antiferromagnetic ordering.

Parts of the calculations have been carried out on the IBM BlueGene/L supercomputer at the Forschungszentrum Jülich.

MA 20.104 Tue 15:15 P1

First-principles study of binary transition metal clusters — •Sanjubala Sahoo, Georg Rollmann, and Peter Entel — Physics Department, University of Duisburg-Essen, Duisburg Campus, 47048 Duisburg, Germany

Structural, magnetic, and electronic properties of 55-atom icosahedral Fe-Ni clusters have been investigated within density functional theory in the generalized gradient approximation in combination with the projector augmented wave method. The structural optimisation of the clusters was performed by allowing for non-collinear arrangements of the spin moments in each atom. In the lowest-energy isomers found, the central position of the clusters is always occupied by an Fe atom. With respect to the distribution of atoms in these clusters, different trends are encountered for different parts of the composition range. Whereas on the Fe-rich side, the Ni atoms tend to occupy surface positions, they dissolve maximally in the Fe surroundings on the Ni-rich side. In contrast to earlier observations of non-collinear arrangements of local magnetic moments in Fe-Ni bulk systems, the clusters investigated in this study turn out to be ferromagnetic with a collinear magnetization density.

MA 20.105 Tue 15:15 P1

***A*b-initio calculations on transition metal atom doped silicon clusters** — •Sanjeev K. Nayak, Markus E. Gruner, and Peter Entel — Physics Department, University of Duisburg-Essen, Duisburg Campus, 47048 Duisburg, Germany

It has been demonstrated in experiments that transition metals can stabilize silicon clusters with open cage structures where the transition metal atom occupies an endohedral site in the cluster [1]. Theoretical studies predicting the stability for certain symmetric structures suggest that these clusters can act as a building block for silicon nanorods [2]. We perform calculations based on the density functional theory to study the structural and magnetic properties of transition metal atom doped silicon clusters, like $Si_{10}Fe$ and $Si_{12}Fe$, which are of $C_{5\nu}$ and $C_{6\nu}$ symmetry, respectively. Linear rod structures formed by repetition of $Si_{10}Fe$ and $Si_{12}Fe$ were found to be stable. The magnetic properties of Fe atoms shows different trends for $Si_{30}Fe_5$ and $Si_{36}Fe_5$. Similar calculations are performed with other transition metal atoms.

[1] H. Hiura, T. Miyazaki, and T.Kanayama, Phys. Rev. Lett. **86**, 1733 (2001).

[2] G. Mpourmpakis, G.E. Froudakis, A.N. Andriotis, and M. Menon, Phys. Rev. B **68**, 125407 (2003).

MA 20.106 Tue 15:15 P1

Preparation of superparamagnetic ferrofluids for the use in magnetorelaxometry for biological analysis — •Kai Pöhlig, Erik Heim, Wenzhong Liu, Frank Ludwig, and Meinhard Schilling — TU Braunschweig, Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, Hans-Sommer-Str. 66, D-38106 Braunschweig, GERMANY

Nowadays, immunoassays are widely used to detect concentrations of biomolecules with specific markers. As markers we use superparamagnetic nanoparticles (SPIOs). SPIOs have the advantages of being nontoxic, that they can be used in opaque medium and that they are suitable for fluid phase assays at the same time. For this method superparamagnetic nanoparticles with 20 nm core diameter with a narrow particle size distribution are needed to obtain relaxation signals with high amplitude and high signal-to-noise ratio. So far, it is not possible to get a commercial monodispersive ferrofluid with these characteristics. For this reason we use commercial ferrofluids with a broad size distribution made of magnetite (Fe_3O_4) or hematite (Fe_2O_3) and extract the desired particle size via magnetic fractionation. For this purpose we use magnetic separation columns. In magnetic fields up to 1 T the ferrofluids are fractionalised. The resulting particle size and size distribution is evaluated by the methods of AFM, TEM and STEM. Additionally, we verify the results with our differential fluxgate magnetorelaxometry system.

Financial support by the DFG via SFB578 is acknowledged.

MA 20.107 Tue 15:15 P1

Preparation of Homogeneous Arrays of fct FePt Nanoparticles Using a Micellar Approach — •Birgit Kern, Ulf Wiedwald, Luyang Han, Frank Weigl, Hans-Gerd Boyen, and Paul Ziemann — Abteilung Festkörperphysik, Universität Ulm, Albert-Einstein-Allee 11, D-89069 Ulm, Germany

Within the last years worldwide efforts have been directed towards the preparation of fct FePt nanoparticlate systems due to their huge magnetic anisotropy energy promising applications in data storage technology. The so-called colloidal approach represents a simple, cost-efficient method to prepare highly ordered arrays of such FePt nanoparticles. It turns out, however, that the FePt particles natively show the fcc phase and have to be annealed at 600-800°C to achieve the magnetically appealing fct phase. Such a heat treatment, however, is likely to result in the formation of larger agglomerates due to very small interparticle distances of about 2-3 nm. Here, we present an alternative method to prepare ordered arrays of well-separated and chemically pure FePt alloy particles with diameters of 3-10 nm and interparticle distances of 20-100 nm. These nanomagnets are synthesized by exploiting the selforganization of metal salt-loaded diblock copolymer reverse micelles, followed by plasma-aided removal of the polymer matrix after deposition of the loaded micelles onto native Si substrates. Although the micellar approach yields FePt particles in the low-anisotropy fcc phase as well, the subsequent annealing step towards the fct phase at 700°C can safely be performed without any agglomeration of particles or loss of the array quality.

MA 20.108 Tue 15:15 P1

Ion beam synthesis of Fe nanoparticles in MgO and YSZ — •kay potzger[1], Helfried Reuther[1], Shengqiang Zhou[1], Arndt Mücklich[1], Rainer Grötzschel[1], Frank Eichhorn[1], Maciej Oskar Liedke[1], Jürgen Fassbender[1], Hannes Lichte[2], and Andreas Lenk[2] — [1]Institute of Ion Beam Physics and Materials Research, Forschungszentrum Rossendorf, P.O. box 510119, 01314 Dresden, Germany — [2]Technical University Dresden, Institut für Strukturphysik, 01062 Dresden, Germany

In order to prepare epitaxially oriented Fe nanoparticles embedded below the surface of an oxide single crystalline host material the method of ion beam synthesis has been explored for MgO(001) and YSZ(001). At a fixed implantation energy and fluence the implantation temperature has been varied between *room temperature* and 1273 K. It was found, that for MgO substrates the fraction of metallic Fe increases up to a maximum of 60% (at 1073 K) as a function of implantation temperature, whilst the Fe depth profile remains the same. The Fe nanoparticles are nonmagnetic at room temperature exhibiting fcc structure. They show a mean diameter of 5 nm and an exclusive orientation relationship to the host. In YSZ the fraction of metallic Fe increases with increasing implantation temperature reaching 100% at 1273 K. However, the nanoparticles formed are of bcc structure with a mean diameter of 13 nm located mainly close to the sample surface. The ferromagnetic behavior is reflected by a magnetic hyperfine field of 330 kOe and a hysteretic magnetization reversal. Electron holography measurements have been carried out in order to visualize the stray field of the particles.

MA 20.109 Tue 15:15 P1

Measurement of the viscosity with magnetic microparticles — •Nils Mellech, Michael Schilling, Andreas Hütten, and Günter Reiss — Department of Physics, Bielefeld University, Universitätsstr. 25, 33615 Bielefeld

Magnetic microparticles, which are commercial available in different configurations, can be transported to magnetic sensors through a microfluidic system. In the vicinity of the sensors they can be manipulated by external magnetic fields. XMR-sensors are patterned on a wafer with

laser lithography and covered by a protective SiO_2-layer. A sensor-array, directly below the microchannels, measures the movement of the magnetic particles, which flow in a solvent over the sensors. Because the movement depends on the applied external magnetic field as well as on the viscosity of the solvent, exact measurements of the viscosity can be done.

MA 20.110 Tue 15:15 P1

Combined optical and force microscopy of patterned magnetic films — •Sibylle Sievers[1], Martin Albrecht[1], Uwe Siegner[1], Sebastian Dreyer[2], and Christian Jooss[2] — [1]Physikalisch-Technische Bundesanstalt, D-38116 Braunschweig — [2]Institut für Materialphysik, Universität Göttingen, D-37077 Göttingen

A magnetic analysis of arrays of microscopic ferromagnetic elements requires characterization techniques that yield quantitative local stray field and magnetization values combined with a large-area overview. To understand the micromagnetic processes that are at the origin of the magnetic properties of individual elements, a complementary high-resolution characterization of the domain structure is required. The magneto-optical indicator film-technique (MOIF) allows for quantitative stray field imaging of individual micron sized magnetic elements and provides a large area overview of the patterned films. MOIF microscopy is combined with magnetic force microscopy (MFM), which provides domain imaging with a resolution in the sub-100-nm range. In order to demonstrate the potential of this approach, lithographically patterned $L1_0$ CoPt films with out-of-plane anisotropy were characterized. The large-scale MOIF images reveal variations among individual magnetic elements regarding the magnetic properties. The switching behaviour of single elements was characterized and remanent remagnetization curves of individual elements were determined. The respective domain structure was analyzed by MFM. The results show that magnetization reversal is governed by nucleation and growth of domains with reversed magnetization.

MA 20.111 Tue 15:15 P1

Design and characterization of a miniaturized spin-detector for high-resolution SEMPA — •Robert Frömter[1], Christian Menk[1], Hans Peter Oepen[1], and Jürgen Kirschner[2] — [1]Institut für Angewandte Physik, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg, Germany — [2]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany

The potential for magnetic imaging in SEMPA (or Spin-SEM) is generally limited by the low efficiency of all applicable spin-detection schemes known today. However, the combination of the high primary beam current from a modern UHV-compatible field-emission SEM with an optimized spin detector [1], based on LEED scattering, yields a compact instrument, which allows for sub 10 nm lateral resolution at acquisition times of some ms per pixel. The physical properties of our new spin-detector are modeled, based upon the energy distribution of the spin-polarized secondary electron emission and the scattering properties at the W(100) surface, and compared with measurements from an Fe sample. Design criteria like changes of geometry (sample tilt, working distance) or the choice of primary beam energy are discussed. Recent results will be presented, together with examples for Fe-decoration, which gives access to imaging contaminated "real-life" samples.

[1] R. Frömter, H.P. Oepen, and J. Kirschner, Appl. Phys. A 76, 869 (2003)

MA 20.112 Tue 15:15 P1

Spin-polarized scanning tunnelling spectroscopy of ultrathin Fe/Mo(110) films — •A. Kukunin, J. Prokop, and H.J. Elmers — Johannes Gutenberg-Universität Mainz, Institut für Physik, Staudingerweg 7, D-55099 Mainz

Using W/Au/Co tips we have performed low-temperature spin-polarized scanning tunneling spectroscopy (SP-STS) of ML and DL Fe nanostripes, and thicker (3-6 ML) Fe islands grown by step flow on a Mo(110) single crystal. We focus our studies on the range of positive voltages (-0.2 V$< U <$ 1 V), where the unoccupied states of the sample are probed by the occupied tip states. The spin-resolved spectra for the perpendicularly magnetized ML and DL Fe nanowires have been obtained using W/Au/Co tips with out-of-plane sensitivity, whereas spin-resolved spectra for the in-plane magnetized Fe islands have been measured with an in-plane sensitive W/Au/Co tips.

We find that the spin-resolved spectra for the ML, DL and thicker Fe/Mo films are different. Spectra for the ML Fe stripes reveal prominent peak that shows up at U = +0.38 V or at U = +0.42 V. Spectra for the DL Fe stripes reveal two large peaks at -0.08 V and 0.78 V, and two smaller peaks at 0.06 V and 0.2 V. Peak positions and intensities depend on the relative orientation of tip and sample magnetization. In contrast to the ML and DL Fe spectra, spectra for the Fe islands do not show any pronounced peaks for positive voltages. However, they strongly differ from each other, depending on the relative orientation of the tip and Fe island magnetization. Spin-resolved spectroscopic data are compared with the spectroscopic data obtained using other tips and discussed.

MA 20.113 Tue 15:15 P1

High wave vector spin waves excitation in submonolayer Fe-islands on Co/W(110) — •Y. Zhang, M. Etzkorn, W. Tang, P.S. Anil Kumar, and J. Kirschner — Max-Planck-Institut für Mikrostrukturphysik,

We investigated the surface spin waves of submonolayer Fe-islands on Co thin films on W(110) with a spin-polarized electron energy loss spectroscopy (SPEELS). Our results can be understood by two individual contributions of Co and Fe rich areas on the sample surface. We find a significant signal from about 1/4 of a monolayer of Fe, which demonstrates the high sensitivity of SPEELS especially on surface. The spin wave intensities coming from the Fe and the Co change with the coverage of Fe, while the spin wave energies remain independent. We also found no significant changes in the spin wave loss features coming from the Co part of the surface compared to the spin waves in a clean Co-film.

MA 20.114 Tue 15:15 P1

Magnetic and chemical disorder in diluted magnetic semiconductors — •Martin Mücke and Wolfgang Nolting — Institut für Physik, Humboldt-Universtät zu Berlin, 12489 Berlin, Germany

We use the Kondo-lattice model for calculating the magnetic properties of diluted magnetic semiconductors. On the basis of recently developed many-body theories we determine the influence of magnetic moment concentration x on the quasiparticle density of states and the magnetic phase diagram for the ground state at $T = 0\,\mathrm{K}$. The disorder is treated by applying the coherent potential approximation to our model. We estimate the dependence of Curie temperature on moment concentration x and the number of itinerant charge carriers n, which are indirectly coupled to the localized magnetic moments. The results show, that ferromagnetism is possible for all moment concentrations, but charge carrier compensation is necessary for getting sufficiently high Curie temperatures.

MA 20.115 Tue 15:15 P1

Magnetism and Jahn-Teller induced band splitting in CMR materials — •Martin Stier and Wolfgang Nolting — Institut für Physik, Humboldt-Universität zu Berlin, Newtonstraße 15, 12489 Berlin, Germany

A model analysis is presented for the class of the manganites. Starting point is a correlated Kondo lattice model, which is extended by a Jahn-Teller term. In view of the electronic and magnetic properties, it is solved approximatly but self-consistently by use of finite Hund coupling and quantum spins. Explicit results are given for the Curie temperature, the band splitting, the electrical resistance and the quasi particle density of states. The outcome for realistic parameters is compared with experimental data. The Jahn-Teller splitting normally weakens the Curie temperature but there can also be an increase under special circumstances.

MA 20.116 Tue 15:15 P1

Photoinduced magnetism in diluted magnetic semiconductors — •Oliver Pieper and Wolfgang Nolting — Institut für Physik, AG Theoretische Festkörperphysik, Humboldt-Universität zu Berlin, Newtonstraße 15, 12489 Berlin

We present a many-body-approach for a system of photogenerated electrons and holes in a diluted magnetic semiconductor. Photomagnetization is calculated selfconsistently by an effective field ansatz. While the magnetic impurity ions are treated in a virtual crystal approximation, the magnetic s-d-interaction is treated within an interpolating self-energy approach. (Quasipartical-)density of states as well as the polarisation of the photogenerated electrons and the magnetization of the local moments are calculated as a function of photonpower, photonfrequency, temperature and band-gap. The results are compared with experimental data.

MA 20.117 Tue 15:15 P1

Model study of EuB_6 and half-metals in general — •Michael Kreissl and Wolfgang Nolting — Institut fü Physik, Humboldt-Universität zu Berlin, 12489 Berlin, Germany

By means of a recently developed many-body-theory for the Kondo lattice model, the electronic and magnetic properties of half-metals were studied.
We present temperature dependant quasiparticle density of states, band structure and magnetization, as well as the Curie temperature for various coupling strengths. With a specific parameter set, motivated through experimental data, we were able to reproduce the electronic properties of EuB_6 which undergoes a half-metal to semiconductor transition concomitant with the magnetic phase transition.

MA 20.118 Tue 15:15 P1

Ferromagnetism in transparent Fe- and Co-doped SnO_2 thin films — •U. Pelzer, D. Menzel, and J. Schoenes — Institut für Physik der Kondensierten Materie, TU Braunschweig, Mendelssohnstr. 3, D-38106 Braunschweig

Diluted magnetic semiconductors have attracted great interest in recent years due to the possibility of inducing room temperature ferromagnetism for spintronic applications. Iron and cobalt ions were inserted by ion implantation into thin SnO_2 films, which were grown by magnetron sputtering, resulting in various transition metal concentrations. In both types of samples SQUID measurements reveal a giant magnetic moment of up to 18 μ_B per transition metal atom. Optical ellipsometry and transmission spectroscopy show that the band gap of 3.6 eV is independent on the Co/Fe concentration. After annealing the samples at 400°C we observe an increase of the magnetic moment of up to 22 μ_B for 3 at.% Fe and a decrease to 8 μ_B per transition metal atom for 7 at.% Fe. A model is proposed to account for this unexpected behaviour.

MA 20.119 Tue 15:15 P1

Nearest neighbor exchange in Co- and Mn-doped ZnO — •Mahdi Sargolzaei[1], Thomas Chanier[2], Ingo Opahle[1], Roland Hayn[2], and Klaus Koepernik[1] — [1]IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany — [2]Laboratoire Materiaux et Microelectronique de Provence, Faculte St. Jerome, Case 142, F-13397 Marseille Cedex 20, France

We calculate the magnetic interactions between two nearest neighbor substitutional magnetic ions (Co or Mn) in ZnO by means of density functional theory and compare it with the available experimental data. Using the local spin density approximation we find a coexistence of ferro- and antiferromagnetic couplings for ZnO:Co, in contrast to experiment. For ZnO:Mn both couplings are AFM but deviate quantitatively from measurement. That points to the necessity to account better for the strong electron correlation at the transition ion site which we have done by applying the LSDA+U method. We show that we have to distinguish two different nearest neighbor exchange integrals for the two systems in question which are all antiferromagnetic with values between -1.0 and -2.0 meV in reasonable agreement with experiment. [arXiv:cond-mat/0511050]

MA 20.120 Tue 15:15 P1

Phenomenological analysis of reorientation transitions, multidomain states and switching processes in diluted magnetic semiconductor films — •I.E. Dragunov[1], U.K. Rössler[2], and A.N. Bogdanov[2,1] — [1]Donetsk Institute for Physics and Technology, R. Luxemburg 72, 83114 Donetsk, Ukraine — [2]IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

Magnetization switching processes in diluted magnetic semiconductors materials like (Ga,Mn)As films and devices are strongly influenced by specific reorientation effects due to a competition between uniaxial and cubic anisotropies. The magnetic phase diagrams of such systems, calculated within a phenomenological theory, include a region of four-phase domain structure with four adjoining areas of two-phase domains as well as several regions with coexisting metastable states. Equilibrium parameters of the domain structures as functions of applied field and ratios between the different types of magnetic anisotropies have been used to analyze the magnetization processes observed in diluted magnetic semiconductors. We propose that a remarkable transformation of the internal domain wall structure within the metastable regions of the magnetic phase diagram could be used in (Ga,Mn)As microdevices based on domain walls pinned in constrictions. For (Ga,Mn)As epilayers with perpendicular anisotropy the parameters of the stripe domain structures have been derived as functions of a bias field.

MA 20.121 Tue 15:15 P1

Fully epitaxial TMR stacks based on NiMnSb — •F. Lochner, P. Bach, C. Gould, G. Schmidt, and L. W. Molenkamp — Physikalisches Institut (EP3), Universität Würzburg, Am Hubland, 97074 Würzburg, Germany

Fully epitaxial TMR stacks have been a challenge since a long time. Epitaxial growth of a tunnel barrier on a magnetic metal and vice versa are still a problem. We have grown stacks suitable for TMR geometries based on NiMnSb as a ferromagnet and II-VI semiconductor barriers. The samples we use consist of a sulfur doped InP substrate with a 100-200nm thick (In, Ga)As buffer (lattice matched to the substrate) [1] and the TMR structure. This TMR structure has a layer sequence of NiMnSb, tunnel barrier, NiMnSb. The NiMnSb alloy crystallizes in the C_{1b} structure [2] which is compatible to existing semiconductor technology. It has a high Curie temperature of 730K and a very high spin polarization (up to 100 % at the Fermi level). The TMR stack itself consists of two NiMnSb layers between which a II-VI semiconductor barrier is sandwiched. For the barrier ZnTe as well as ternary compounds like Zn(Se,Te) or ZnSe/ZnTe superlattices have been used. We acknowledge the support of BMBF grant 13N8284.
[1] P. Bach, C. Rüster, C. Gould, C. R. Becker, G. Schmidt, L. W. Molenkamp, Journal of Crystal Growth **251** (2003) 323-326
[2] R.A. de Groot, F.M. Mueller, P.G. van Engen, K.H.J. Buschow, Phys. Rev. Lett. **50** (1983) 2024

MA 20.122 Tue 15:15 P1

Ferromagnetic superexchange in Co doped TiO_2 — •Rebecca Janisch[1,2] and Nicola A. Spaldin[2] — [1]Institute for Electrical and Information Engineering, Technical University Chemnitz, 09107 Chemnitz, Germany — [2]Materials Department, University of California, Santa Barbara, CA 93106, USA

The origin of ferromagnetism in dilute magnetic semiconductors is often discussed in terms of a competition between short-ranged antiferromagnetic superexchange interactions, and mechanisms which promote ferromagnetic order, such as carrier-mediated or RKKY interactions, double exchange and magnetic polarons. Indeed in conventional, tetrahedrally-bonded, semiconductor hosts such as GaAs or ZnO, this competitive picture is appropriate. However, in this presentation, we revisit the well-established Goodenough-Kanamori-Anderson rules to show that, in many other hosts, the superexchange mechanism leads to *ferromagnetic* coupling between the magnetic moments of neighboring transition metal dopants. We illustrate this behavior using ab-inito electronic structure calculations for Co-doped TiO_2 anatase, and propose a range of other semiconductor hosts in which the short-range interactions should be ferromagnetic.

MA 20.123 Tue 15:15 P1

Ferromagnetism in desordered Kondo-lattice — •Vadym Bryksa and Wolfgang Nolting — Institut fur Physik, Humbolt-Univasitat zu Berlin, 12489 Berlin, Germany

For modeling the magnetic and electronic properties of diluted magnetic semiconductors (DMS), we use the Kondo-lattice model in combination with an effective Heisenberg model. The theory is based on a previous developed selfenergy approach with an additional CPA-like treatment of the disorder in the local moment system. We demonstrate the properties of the disordered ferromagnetic Kondo-lattice in terms of spectral densities and quasiparticle densities of states. The temperature and concentration dependence of the magnetic and electronic excitation spectrum of the diluted semiconductor will be worked out.

MA 20.124 Tue 15:15 P1

Temperature dependent correlation effects in Gadolinium Nitride — •Anand Sharma and Prof. Dr. Wolfgang Nolting — Institut für Physik, Humboldt Universität zu Berlin, Newtonstr. 15, 12489, Berlin, Germany

The Rare Earth Nitride materials have been under significant theoretical and experimental investigations due to their magnetic properties but in case of Gadolinium Nitride (GdN), there is a wide discrepancy regarding its electronic structure and nature of magnetic ground state. We present temperature dependent correlation effects in GdN based on the combination of many body analysis of the multiband Kondo lattice model and the first principles TB-LMTO bandstructure calculations. Some of the physical properties of interest like the quasi-particle density of states,

spectral density and quasi-particle band structure are calculated and discussed.

MA 20.125 Tue 15:15 P1

What determines the shape of temperature dependence of spontaneous magnetisation — •Michael Kuzmin[1], Manuel Richter[1], and Alexander Yaresko[2] — [1]IFW Dresden, PF 270116, 01171 Dresden — [2]MPI PKS, 01187 Dresden

Temperature dependence of spontaneous magnetization of ferromagnets can be described by a simple expression containing one free parameter. We demontrate how the form of this expression can be inferred from the basic theory of critical phenomena and spin waves.

MA 20.126 Tue 15:15 P1

Self-interaction correction in multiple scattering theory – Application to transition metal oxides — •Markus Däne[1,2], Guntram Fischer[1], Wolfram Hergert[1], Arthur Ernst[3], Martin Lüders[2], Walter M. Temmerman[2], and Zdzislawa Szotek[2] — [1]Fachbereich Physik, Martin Luther Universität Halle-Wittenberg, Friedemann-Bach-Platz 6, 06108 Halle, Germany — [2]Daresbury Laboratory, Daresbury, Warrington WA4 4AD, United Kingdom — [3]Max Planck Institute of Microstructure Physics, 06120 Halle, Germany

In this work we study the electronic structure of 3d-transition metal oxides as obtained with the SIC-LSD method, implemented within multiple scattering theory[1]. We briefly describe the formalism and discuss important technical issues of its implementation within the KKR band structure method.
We present results of such important properties as lattice constants, local magnetic moments, band gaps and magnetic exchange constants and discuss them in comparison with the LSD and the experimental values.

[1] M. Lüders, A. Ernst, M. Däne, Z. Szotek, A. Svane, D. Ködderitzsch, W. Hergert, B. L. Györffy, and W. M. Temmerman, Phys. Rev. B 71, 205109 (2005)

MA 20.127 Tue 15:15 P1

Second Harmonic Generation on NiO beyond the electric — •Georgios Lefkidis and Wolfgang Hübner — University of Technology of Kaiserslautern, Box 3049,

The discrete intragap states of both the bulk and (001) surface of NiO could be used with a four level ultrafast magnetic switching scenario [1]. For this a tool is needed, both to detect the magnetic state of the sample, and to monitor the process. Second harmonic generation (SHG) is a very well suited tool, for it couples linearly to the antiferromagnetic order parameter and can detect all NiO domains.

NiO is modelled as a doubly embedded cluster and its levels are obtained from ab-initio many-body theory. The discrete intragap d-states are obtained from the multiconfigurational complete active space method (MC-CAS), while the charge transfer states are computed employing the single excitation configuration - interaction technique with energy corrections from higher excitations [CIS(D)].

The second order susceptibility tensor is calculated beond the electric dipole approximation from first principles taking into account magnetic dipole and electric quadrupole transitions as well [2]. The dependence on the light polarization is given, as well as the effects of phonons within the frozen phonon approach, and the influence of nonlocalities. Finally the effect of spin-orbit coupling is discussed.

[1] R. Gómez-Abal, K. Satitkovitchai, O. Ney, and W. Hübner, Phys. Rev. Lett. **92**, 227402, (2004)
[2] G. Lefkidis and W. Hübner, Phys. Rev. Lett. **95**, 77401, (2005)

MA 20.128 Tue 15:15 P1

Simulations of spin structures in nano-structures with lateral constrictions — •Chr. Kircher[1], U. Nowak[2], M. Kläui[1], U. Rüdiger[1], H. Ehrke[1], D. Backes[1,3], L. J. Heydermann[3], R. E. Dunin-Borkowski[4], and P. Nielaba[1] — [1]Department of Physics, University of Konstanz, 78457 Konstanz, Germany — [2]Department of Physics, University of York, York YO10 5DD, UK — [3]Laboratory for Micro- and Nanotechnology, Paul Scherrer Institut, CH-5232 Villingen PSI, Switzerland — [4]Department of Material Science and Metallurgy, University of Cambridge, Cambridge CB2 3QZ, UK

In magnetic nano-structures many novel physical effects occur when reducing the spatial system size. The spin structure of geometrically confined domain walls can be controlled by the lateral dimensions [1].

To study systematically the influence of lateral dimensions on the spin structure of domain walls, computer simulations on a classical spin model were performed for ferromagnetic nano-structures with lateral constrictions. Thermal activations of the system were taken into account by the numerical solution of the Landau-Lifshitz-Gilbert equation with Langevin dynamics.

Acknowledgements: Work supported by the Landesstiftung Baden-Württemberg

[1] M. Kläui *et al.* APL **87**, 102509 (2005)

MA 20.129 Tue 15:15 P1

Monte-Carlo simulations of magnetic nanospheres with angular dependent hysteresis loops — •Jörg Neder and Peter Nielaba — University of Konstanz, Department of Physics, 78457 Konstanz, Germany

A Co/Pd multilayer evaporated onto a monolayer of self-assembled polystyrene nanoparticles has shown an angular dependence of its magnetic behaviour on an external magnetic field [1]. We investigate these structures in the diameter range of 20 to 100 nm via Monte-Carlo simulations. The magnetic system is described using a model of classical moments [2] which are localized on a spherical cap. The energy contains contributions from exchange and dipole-dipole interaction, the external magnetic field and crystalline anisotropies. To match the perpendicular anisotropy of the evaporated Co/Pd film the easy axis due to interface anisotropy is pointing radially away from the center of the nanosphere. The size of the cells constituting the system varies from 10 to 25 Å. In our simplified model for the single magnetic cap the coercitive field decreases with increasing field angle for the diameters investigated which is in agreement with experimental results.

[1] M. Albrecht et al., Nature Materials 4, 203-206 (2005)
[2] U. Nowak, Annual Reviews of Comp. Phys. IX, 105-151 (2001)

MA 20.130 Tue 15:15 P1

Theory of multidomain states in ferro- and antiferomagnetically coupled superlattices with perpendicular anisotropy — •U.K. Rössler[1], I.E. Dragunov[2], N.S. Kiselev[2,3], and A.N. Bogdanov[1,2] — [1]IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany — [2]Donetsk Institute for Physics and Technology, R. Luxemburg 72, 83114 Donetsk, Ukraine — [3]Lugansk State Pedagocial University, Oboronna 2, 91011 Lugansk, Ukraine

We develop a theory of the magnetic domain configurations in magnetic multilayers with perpendicular anisotropy. Integral transformations of the micromagnetic energy yield a system of equations convenient for direct numerical evaluation. A general micromagnetic approach is applied to calculate the parameters of the domain structures in ferromagnetically and antiferromagnetically coupled magnetic nanolayers and to investigate their behaviour under applied magnetic fields. Characteristic features of the multidomain states have been analyzed for different ratios of their characteristic lengths scale l with respect to the thickness of the individual layers h and the thickness of the non-ferromagnetic interlayers a. Simplifications of the theoretical description can be achieved in various limits of these ratios. In particular, many perpendicular multilayers investigated recently in experiments obey the relation $l > h \gg a$ which imposes strong magnetostatic couplings between adjacent nanolayers. Compared to bulk magnetic properties, these interactions are an uncommon feature of such multilayers. We discuss in detail the peculiarities of their magnetic properties.

MA 20.131 Tue 15:15 P1

Theoretical study of the influence of atomic disorder at the surfaces of magnetic Heusler alloys. — •Andrey Beznogov, Heike C. Herper, and Peter Entel — University of Duisburg-Essen, Campus Duiburg, Lotharstr. 1, 47048 Duisburg, Germany

We present first-principles calculation of atomic disorder effects at the surfaces of ferromagnetic Heusler alloys. Of particular interest are antisite defect structures at Co_2MnGa surfaces which are believed to be responsible for the reduction of the surface magnetic moments[1].

We compare results of calculations for Ni_2MnGa, which is of interest for magnetic shape memory technology, with corresponding results for Co_2MnGa, which is of interest for spintronic devices. The influence of disorder in half-metallic Heusler alloys was so far calculated for NiMnSb[2].

[1] J. Grabis, A. Bergmann, A. Nefedov, K. Westerholt, and H. Zabel, Phys. Rev. B **72**, 024438 (2005)
[2] D. Orgassa, H. Fujiwara, T.C. Schulthess, and H.W. Butler, Phys. Rev. B **60**, 13237 (1999)

MA 20.132 Tue 15:15 P1

Thermal expansion of multiferroic manganites in magnetic fields — •D. Meier[1], J. Baier[1], O. Heyer[1], J. Hemberger[2], D. Argyriou[3], N. Aliouane[3], A. Freimuth[1], and T. Lorenz[1] — [1]II. Physikalisches Institut, University of Cologne, 50937Cologne, Germany — [2]Institut für Physik, University of Augsburg, 86159 Augsburg,Germany — [3]Hahn-Meitner-Institut, 14109 Berlin, Germany

Strong coupling between magnetic and ferroelectric ordering in some perovskite rare-earth manganites $R\mathrm{MnO_3}$ (R = Gd, Tb) gave rise to intense investigation on these multiferroics. We present high-resolution measurements of thermal expansion and magnetostriction on $R\mathrm{MnO_3}$ (R=Nd, Gd, Tb). $\mathrm{NdMnO_3}$ is a non-multiferroic A-type antiferromagnet (T_N = 88K) serving as a reference compound. $\mathrm{GdMnO_3}$ shows antiferromagnetic order for $T < T_N$ = 43K. Application of a magnetic field $H \| b$ induces an electric polarization $\mathbf{P}$ below $T \approx$ 10K. In contrast, $\mathrm{TbMnO_3}$ shows intrinsic ferroelectricity for $T < T_{lock}$ = 28K already in zero magnetic field. Depending on strength and direction of the magnetic field, $\mathbf{P}$ can be suppressed or changes its direction. Our mesurements reveal a huge magnetoelastic coupling, a strong hysteretic behavior and an anisotropic thermal expansion of these compounds. The investigation on the phase boundaries as a function of the magnetic field identifies a new phase transition in $\mathrm{TbMnO_3}$, a bending down of the T_{lock}-phase boundary in $\mathrm{GdMnO_3}$ for low magnatic fields and a shift of the ferroelectric transition down to lower temperatures in high fields.

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MA 20.133 Tue 15:15 P1

Thermal transport in multiferroics — •K. Berggold[1], T. Lorenz[1], J. Baier[1], D. Meier[1], J. Hemberger[1], D. Argyriou[2], A. Vasiliev[3], and J. Hemberger[1,4] — [1]II. Physikalisches Institut, University of Cologne, Germany — [2]Hahn-Meitner-Institut, 14109 Berlin, Germany — [3]Moscow State University, Moscow 119992, Russia — [4]Inst. f. Physik, University of Augsburg, Germany

There is a growing interest in multiferroic systems, since they show large magnetocapacitive effects, and for this offer interesting prospects with respect to application. One tool to investigate the interplay between electric and magnetic excitations is to study the thermal conductivity κ in magnetic fields. Recently, large multiferroic effects have been found in $R\mathrm{MnO_3}$ compounds[1]. $\mathrm{TbMnO_3}$ has the most complex phase diagram of these series, and allows to flip the electric polarization by a magnetic field. We present measurements of κ along the a direction with magnetic fields applied in the different crystallographic directions. A huge magnetic-field dependence of $\kappa(B)$ is observed at the phase boundaries. Recently, $\mathrm{GdFe_3(BO_3)_4}$ was introduced as another multiferroic system[2]. In this compound several phase transitions occur at low temperatures. We present measurements of κ for different axes and magnetic fields, and find a highly unusual temperature dependence.

[1] T. Kimura et al., PRB **71**, 224425 (2005).
[2] A.K. Zvedzdin et al., JETP **81**, 272 (2005).

This work was supported by the DFG through SFB 608

MA 20.134 Tue 15:15 P1

Relevant and non-relevant magnetic interactions — •Ulrich Köbler[1], Andreas Hoser[1,2], and Jens-Uwe Hoffmann[3] — [1]Institut für Festkörperforschung, Forschungszentrum Jülich, D-52425 Jülich — [2]Institut für Kristallographie, RWTH-Aachen — [3]Hahn-Meitner-Institut Berlin

Due to the atomistic lattice structure the length scale of the paramagnetic dynamics is limited by the finite near neighbour distance. On this length scale the strong short range Heisenberg interactions are the relevant interactions. Curiously, these interactions can best be investigated in the ordered state using inelastic neutron scattering. The observed excitation spectra are dominated by microscopic features such as lattice symmetry and magnetic structure. In contrast to the material specific excitation spectra the order parameter shows universality at the stable fixed points $T = 0$ and $T = T_c$. Universality means independence of lattice symmetry and magnetic structure. This is a consequence of the large length scale of the dynamics for $T \to 0$ and $T \to T_c$. Continuum theories are therefore more appropriate than atomistic models. The discrepancy between the universality of the dynamics and the non universal magnetic excitations indicates that a new type of long range interaction becomes relevant in the ordered state. A further strong argument for this is the experimental observation that the dynamics is different for integer and half-integer spins in the ordered state but not in the paramagnetic phase. Dipole-dipole interaction is obviously not able to explain this difference.

MA 20.135 Tue 15:15 P1

A Monte Carlo study of the spinless Falicov-Kimball model in the perturbative regime. — •Lech Debski[1], Grzegorz Musial[1], and Jacek Wojtkiewicz[2] — [1]Institute of Physics, A. Mickiewicz University, ul. Umultowska 85, 61-614 Poznan, Poland — [2]Dept. for Math. Methods in Physics, Warsaw University, Hoza 74, 00-682 Warszawa, Poland

Finite-temperature properties of the Falicov-Kimball model on the square lattice have been studied in the perturbative regime, i.e. in the case: $t/U \ll 1$, where t is the hopping constant and U denotes the Coulomb interaction strength. For such a range of t and U parameters, it is possible to develop perturbation theory in the parameter t/U. As a result, the Ising-like model emerges. In the second order of the perturbation theory it is the antiferromagnetic Ising model in the magnetic field, whereas in the fourth order it constitutes the Ising model with more complicated frustrated antiferromagnetic interactions. The main observables examined were order parameters and their temperature (T) dependences for different values of the magnetic field (h). In our study, we have determined the phase diagram of the model in the second-order of the perturbation theory and partially in the fourth-order. We have employed the Monte Carlo method, that proved its accuracy in analysis of other spin models like Ashkin-Teller model, which we have recently investigated. To determine the type of ordering and phase boundaries, we have analysed the behavior of Binder cumulants based on the order parameters under consideration.

MA 20.136 Tue 15:15 P1

Analysis of ^{55}Mn and ^{69,71}Ga-Spectra of $\mathrm{LuMn_6Ge_{6-x}Ga_x}$ by means of NMR — •Richard Montbrun, Jens Schnelzer, and Elmar Dormann — Physikalisches Institut, Universität Karlsruhe (TH), D-76131 Karlsruhe

By varying the Ge:Ga ratio, the magnetic structure of the $LuMn_6Ge_{6-x}Ga_x$ samples (with $HfFe_6Ge_6$- type structure) experiences various ordering phenomena such as antiferromagnetic, helimagnetic or ferromagnetic structures. The effects of this doping are examined by means of low-temperature zero-field Nuclear Magnetic Resonance measurements . We present spectra covering the frequency range between 150 and 450 MHz and the effects of the variation of the excitation conditions as well as T_2 resolved and corrected spectra. The NMR observations can be related to the changes in the magnetic structure.

We thank G. Venturini, Nancy, for providing the samples.

MA 20.137 Tue 15:15 P1

Magneto-optical Kerr effect of DyS and EuTe — •P. Clodius, M. Marutzky, and J. Schoenes — Institut für Physik der Kondensierten Materie und Hochmagnetfeldanlage, TU Braunschweig, Mendelssohnstr. 3, D-38106 Braunschweig

DyS is a metallic antiferromagnet with a Néel temperature $T_N = 40K$ which crystallises in the rocksalt structure. Dy^{3+} has the electronic configuration $4f^9$, leading to a saturation moment of $10\mu_B$. Many of the rare earth sulfides have been investigated, e.g. NdS in which large magneto-optical effects have been found. In contrast, DyS has not been studied with magneto-optical methods yet.

The rare earth chalcogenide EuTe is a magnetic semiconductor ($E_g = 2,0eV$). It is an antiferromagnet ($T_N = 9,6K$) and has also rocksalt structure. The Eu^{2+} ground state ($4f^7$, $^8S_{7/2}$) leads to a large saturation moment of $7\mu_B$. The Faraday effect of EuTe has been extensively studied [1] but the magneto-optical Kerr effect of EuTe has not been measured yet.

The complex Kerr effect of DyS will be shown as well as the optical conductivity and the off-diagonal elements of the optical conductivity.

A Drude-Lorentz model will be fitted to get quantitative statements about the electronic structure of DyS.

First results of measurements of the magneto-optical-Kerr effect of EuTe will be presented.

[1] J.Schoenes, Z. Physik B 20. 345-368 (1975)

MA 20.138 Tue 15:15 P1

Spin-structure investigations by electron holography — •D. Backes[1,2], L.J. Heyderman[1], C. David[1], F. Nolting[3], M. Kläui[2], M. Laufenberg[2], H. Ehrke[2,4], D. Bedau[2], U. Rüdiger[2], C.A.F. Vaz[5], J.A.C. Bland[5], T. Kasama[4], R.E. Dunin-Borkowski[4], S. Cherifi[6], A. Locatelli[6], and S. Heun[6] — [1]Laboratory for Micro- and Nanotechnology, Paul Scherrer Institut, Switzerland — [2]FB Physik, Universität Konstanz — [3]Swiss Light Source, Paul Scherrer Institut, Switzerland — [4]Department of Materials Science and Metallurgy, University of Cambridge, UK — [5]Cavendish Laboratory, University of Cambridge, UK — [6]Sincrotrone Trieste, Basovizza, Italy

Domain walls of ferromagnetic curved-line elements exhibit two spin-configurations - the vortex and the transverse wall type. Systematical experimental studies have shown that the type depends on the geometry. We report on the fabrication of these curved-line elements on membranes which are essential to investigate them with electron holography. This measurement technique is able to visualize the magnetic induction in the elements and the magnetic stray fields outside of the elements. This allows us to study the interaction between domain walls which leads to interaction-induced transitions between the domain wall types. Small geometrical constrictions down to 30 nm have a large influence on the spin-structure of the domain walls [1]. With a resolution below 5 nm the spin-structure near and in the constrictions can be observed. Correlating this with magnetoresistance measurements reveals information about the interaction of spin-polarized charge carriers and domain walls.

[1] M. Kläui et al., Phys. Rev. Lett. 90, 97202 (2003)

MA 20.139 Tue 15:15 P1

Onset of geometric frustration in the spinels $Co(Al_{1-x}Co_x)_2O_4$ — •N. Tristan[1], V. Zestrea[1,2], R. Klingeler[1], B. Büchner[1], and V. Tsurkan[2,3] — [1]Leibniz-Institute for Solid State and Materials Research IFW Dresden, Postfach 270116, — [2]Institute of Applied Physics, Academy of Sciences of Moldova, — [3]Experimental Physics V, Center for Electronic

Very recently geometrical frustration has been shown to be an important factor for the MAl_2O_4 (M=Mn,Fe,Co) spinels, containing magnetic ions solely on the tetrahedral A-sites. The Co_3O_4 and $CoAl_2O_4$ are isostructural normal spinels with close lattice parameters a=8.0834 and 8.1045$\dot{A}$, respectively. Co_3O_4 is known to be an antiferromagnetic below 40 K, while $CoAl_2O_4$ is characterized by a large frustration parameter $f = 22$ and exhibits a spin-glass-like magnetic order below 5K. We present results of an experimental investigation of the structural, magnetic and thermodynamic properties of the solid solutions $Co(Al_{1-x}Co_x)_2O_4$ for $0 \leq x \leq 1$ with particular attention to compositions close to percolation threshold and onset of the long-range order. The role of the geometrical frustration on the formation of magnetic ground state is discussed.

MA 20.140 Tue 15:15 P1

Magnetic Phase Diagram of Paramagnetic Shape Memory Compounds — •W. Lorenz[1], M. Böttger[1], M. Dörr[1], S. Raasch[1], M. Rotter[2], and M. Loewenhaupt[1] — [1]Institut für Festkörperphysik, Technische Universität Dresden, D-01062 Dresden, Germany — [2]Institut für Physikalische Chemie, Universität Wien, A-1090 Wien, Austria

Magnetostriction measurements on $DyCu_2$ and $Tb_{0.5}Dy_{0.5}Cu_2$ have been carried out in order to construct the magnetic phase diagrams. These data very well complement and support earlier magnetization measurements on these Rare Earth-Transition Metal compounds.

The RCu_2 compounds (R = Rare earth) order antiferromagnetically at low temperatures. In fact, these compounds have been the first for which magnetic shape memory effects (MSM) could be shown in the antiferromagnetic as well as in the paramagnetic state. The transition field of the irreversible transition into several variants is enhanced in the antiferromagnetic state. As these antiferromagnets show complex magnetic phase diagrams their investigation is promising fundamental insights into the physical mechanisms of the shape memory magnetostriction.

The magnetostriction measurements have been accomplished at low temperature and high static magnetic fields by means of capacitive dilatometry. This method allows high resolution measurement. Further evaluation of the data was performed using the mean-field Monte-Carlo simulation program McPhase (http://www.mcphase.de).

MA 20.141 Tue 15:15 P1

Pulsed laser deposition of epitaxial $Fe_{70+x}Pd_{30-x}$ magnetic shape memory films — •Jörg Buschbeck, Martin Weisheit, Sebastian Fähler, and Ludwig Schultz — IFW Dresden, Institute for Metallic Materials, P.O. Box 270116, D-01171 Dresden, Germany

Magnetic shape memory materials like Ni-Mn-Ga and $Fe_{70}Pd_{30}$ reach high strains in a moderate applied magnetic field below 1 T due to a selective growth of martensite variants. Though the maximum strain is limited to about 5%, $Fe_{70}Pd_{30}$ films are interesting candidates for micro-actuators and sensors, because of the materials high ductility and the ability to compensate internal stresses during the straining process. First, to study their basic properties, $Fe_{70+x}Pd_{30-x}$ films are deposited by Pulsed Laser Deposition in UHV of $p = 10^{-9}$ mbar. It is observed, that films grow (100) epitaxially on MgO (100) substrates. Depending on the films composition ($x = -10...+10$), the bcc or fcc structure is observed in the as deposited state. Annealing experiments are carried out to transform the films into the martensitic phase. In order to allow an easy movement of twin boundaries required for a high strain free standing films are required. To achieve this, sacrificial buffer layers are used and dissolved to lift off the film from the substrate. Phase transformation and texture are analysed by x-ray diffraction measurements ($\theta - 2\theta$, texture) and temperature dependent magnetic measurements are used to examine phase transformations.

MA 20.142 Tue 15:15 P1

Piezo-controlled magnetization dynamics in epitaxial NiMnSb — •Bernhard Botters[1], Jan Podbielski[1], Fabian Giesen[1], P. Bach[2], G. Schmidt[2], L.W. Molenkamp[2], and Dirk Grundler[1] — [1]Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Jungiusstrasse 11, 20355 Hamburg, Germany — [2]Physikalisches Institut (EP3), Universität Würzburg, Am Hubland, 97074 Würzburg, Germany

Semiconductor spintronics is a research field of great attraction. Here, the ferromagnetic Heusler alloy NiMnSb is an interesting material due to its high Curie temperature and its possibility to grow it on InP(001). For spintronics applications in particular the magnetization dynamics and magnetic anisotropy of NiMnSb are of fundamental interest. We present broadband ferromagnetic resonance (FMR) measurements on NiMnSb ranging from 45 MHz up to 20 GHz. In particular we glued the nm-thick epitaxial film on a piezo-electric ceramic and varied the strain of the film in a controlled manner. We observe a characteristic shift of the FMR as a function of applied voltage. From this we evaluate the dependence of the magnetic anisotropy on the relative change in lattice constant. We will report our recent results. Financial support by the BMBF via 13N8283 and 13N8284 is gratefully acknowledged.

MA 20.143 Tue 15:15 P1

Defects and the CMR effect in irradiated by fast neutrons layered lanthanum manganite — •Yakov Mukovskii[1], V. Arkhipov[2], V. Dyakina[2], A. Karkin[2], and A. Pestun[1] — [1]Moscow State Institute of Steel and Alloys, Leninsky prosp. 4, Moscow, 119049, Russia — [2]Institute of Metal Physics, Ural Branch of RAS, S.Kovalevskaya st. 18, Ekaterinburg, 620219, Russia

Influence of radiation stimulated disorder (fast neutron irradiation with E {$>$} 1 MeV, T_{rad} {$\sim$} 300 K, flux F = 2*10^{19} neutron/cm^{2}) on temperature dependencies of AC susceptibility and electric resistance of single crystals of layered manganites La_{1.4}Sr_{1.6}Mn_{2}O_{7} in magnetic field up to 13.6 T. It was observed that the disorder leads to suppression of the magnetic order (T_C {$->$} 0) and to disappearing of metallic character of conductivity. In non magnetic state the CMR effect remains, and its value exceeds an original one. Also kinetics of the properties recovering under annealing was studied. The work was supported by the RFRB grant {\#}02-02-16425 and ISTC grant {\#}1859.

MA 20.144 Tue 15:15 P1

Transport and thermodynamic properties of rare-earth transition-metal magnetism — •I. Klassen[1], K. Berggold[1], H. Hartmann[1], O. Heyer[1], S. Jodlauk[1], K. Kordonis[1], T. Lorenz[1], A. Freimuth[1], T. Fickenscher[2], and R. Pöttgen[2] — [1]II. Phys. Inst., Universität zu Köln, Zülpicher Str. 77, 50937 Köln, Germany — [2]Anorg.-Chem. Inst., Universität Münster, Wilhelm-Klemm-Str. 8, D-48149 Münster, Germany

We present a study of the magnetoresistance, the magnetization, the specific heat, and the magnetocaloric effect of equiatomic $RETMg$

intermetallics with RE = La, Eu, Gd, Yb and T = Ag, Au and of GdAuIn. Depending on the composition these compounds are paramagnetic (RE = La, Yb) or they order either ferro- or antiferromagnetically with transition temperatures ranging from about 13 to 81 K. All of them are metallic, but the resistivity varies over 3 orders of magnitude. We find pronounced magnetoresistance effects around the ordering temperature. The magnetic ordering leads also to well-defined anomalies in the specific heat. An analysis of the entropy change leads to the conclusions that generally the magnetic transition can be described by an ordering of localized $S = 7/2$ moments arising from the half-filled $4f^7$ shells of Eu^{2+} or Gd^{3+}. The magnetocaloric effect is weak for the antiferromagnets and rather pronounced for the ferromagnets for low magnetic fields around the zero-field Curie temperature. The antiferromagnetic order of GdAuIn can be suppressed in a field about 15 T. Furthermore GdAuIn shows a new phase boundary inside the antiferromagnetic phase.

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MA 20.145 Tue 15:15 P1

Structural and magnetic properties of Mn_5Ge_3 clusters in a dilute magnetic germanium matrix — •Christian Jaeger[1], Christoph Bihler[1], Dieter Schlosser[1], Thomas Vallaitis[2], Mario Gjukic[1], Martin S. Brandt[1], Eckhard Pippel[3], Jörg Woltersdorf[3], and Ulrich Gösele[3] — [1]Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, 85748 Garching, Germany — [2]Universität Karlsruhe (TH), Institute of High-Frequency and Quantum Electronics, Engesserstr. 5, 76131 Karlsruhe, Germany — [3]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany

Measurements of the total magnetization of Ge:Mn show that in many samples ferromagnetic inclusions must be present. We have characterized the structural and magnetic properties of low-temperature molecular-beam epitaxy (LT-MBE) grown Ge:Mn by means of high-resolution transmission electron microscopy (HR-TEM), energy dispersive x-ray spectroscopy (EDXS), and superconducting quantum interference device (SQUID) magnetometry. We find a coherent incorporation of Mn_5Ge_3 clusters in an epitaxially grown Ge:Mn matrix, which shows the characteristics of a diluted magnetic semiconductor (DMS) phase of Mn-doped Ge. The clusters are preferentially oriented with the hexagonal [0001] direction parallel to the [001] growth direction of the Ge:Mn matrix, as determined from both HR-TEM and SQUID measurements.

MA 20.146 Tue 15:15 P1

Single crystal growth and magnetic structure investigations of Er_2PdSi_3 and Tm_2PdSi_3 intermetallic compounds. — •Irina Mazilu [1], Wolfgang Löser[1], Günter Behr[1], Matthias Frontzek[2], Jürgen Eckert[3], and Ludwig Schultz[1] — [1]IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany — [2]Institute for Physics of Solids, TU Dresden, D- 01062 Dresden, Germany — [3]Material Science Department, TU Darmstadt, D-64287 Darmstadt, Germany

R_2PdSi_3 (R = rare earth) intermetallic compounds exhibit a hexagonal AlB2 type crystal structure. They show strongly anisotropic magnetic properties and complex magnetic ordering. Er_2PdSi_3 and Tm_2PdSi_3 single crystals were grown by a floating zone technique with radiation heating in a vertical double ellipsoid configuration. The principal features of the growth process have been investigated and will be discussed.

Magnetic susceptibility and magnetization measurements of the single crystal samples reveal an antiferromagnetic order, with transitions temperatures for Er_2PdSi_3 and Tm_2PdSi_3 of 7 K and 2 K, respectively. The investigations which have been performed on samples with different crystallographic orientation, show a pronounced anisotropy of properties which primarily depends on the 4f-orbital shape of the rare earth element. Neutron diffraction experiments have been performed from 0.4 K to 300 K on the Er_2PdSi_3 and Tm_2PdSi_3 single crystals. The magnetic easy axis is along the c-axis of the hexagonal structure for both compounds, whereas the propagation vectors are τ = (0.11 0.11 0) for Er_2PdSi_3 and τ = (1/2 1/2 1/16) for Tm_2PdSi_3.

MA 20.147 Tue 15:15 P1

X-ray Magnetic Circular Dichroism (XMCD) study of Re and W in ferrimagnetic double perovskites Sr_2CrMO_6 (M = Re, W) — •S. Gepraegs[1], P. Majewski[1], O. Sanganas[1], M. Opel[1], R. Gross[1], F. Wilhelm[2], A. Rogalev[2], and L. Alff[3] — [1]Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, Walther-Meissner-Str. 8, 85748 Garching — [2]European Synchrotron Radiation Facility (ESRF), 6 Rue Jules Horowitz, BP 220, 38043 Grenoble, Cedex 9, France — [3]Darmstadt University of Technology, Petersenstr. 23, 64287 Darmstadt

Among the ferrimagnetic double perovskites in the compounds Sr_2CrReO_6 and Sr_2CrWO_6 high Curie temperatures well above room temperature have been found experimentally and half-metallicity (resp. pseudo-half-metallicity) was predicted by band-structure calculations. These strong ferromagnetic order can at least qualitatively be understood within a generalized double exchange or kinetic energy driven exchange model where the itinerant electrons mediate an antiferromagnetic alignment between the Cr or Fe and the W or Re moments.

We have measured Re and W 5d spin and orbital magnetic moments in the double perovskites Sr_2CrReO_6, Sr_2CrWO_6, and Sr_2FeWO_6 by X-ray magnetic circular dichroism (XMCD) at the L2,3 edges. Our results are in good agreement with recent band-structure calculations. We find that the Curie temperature in the double perovskites $A_2BB'O_6$ scales with the spin magnetic moment of the 'non-magnetic' B' ion. This work was supported by the DFG (GR 1132/13), the BMBF (project no. 13N8279), and the ESRF (HE-1658, HE-1882).

MA 20.148 Tue 15:15 P1

XPS and Mössbauer studies of grain boundary effects in highly ordered Sr_2FeMoO_6 — •M. Raekers[1], C. Taubitz[2], K. Kuepper[2], H. Hesse[1], I. Balasz[3], I. G. Deac[3], S. Constantinescu[4], M. Valeanu[4], E. Burzo[3], and M. Neumann[1] — [1]Universität Osnabrück, Fachbereich Physik, Barbarastr. 7, D-49069 Osnabrück, Germany — [2]Institut für Ionenstrahlphysik und Materialforschung, Forschungszentrum Rossendorf, 01314 Dresden, Germany — [3]Faculty of Physics, Babes-Bolyai University, 3400, Cluj-Napoca, Romania — [4]National Institute of Materials Physics, P.O. Box MG-07, Bucharest, Romania

Sr_2FeMoO_6 is magneto resistance (MR) compound which has attracted much attention in the last years. Our work group has already studied this compound intensely[1,2]. Here we present the oxidation states of Fe and Mo and the presence of grain boundaries in the magneto resistance (MR) compound Sr_2FeMoO_6 by means of x-ray photoelectron spectroscopy (XPS) and Mössbauer spectroscopy. XPS of the Mo 3d and Fe 3s core levels is indicating a mixed valence state involving around 30% Fe^{3+}- Mo^{5+} and 70% Fe^{2+}- Mo^{6+} states. Mössbauer studies confirm the presence of a valence fluctuation state and an essential amount of grain boundaries in the present Sr_2FeMoO_6 crystal. The influence of the grain boundaries will be discussed.

[1] J. Phys.: Condens. Matter 17 (27): 4309-4317 (2005)
[2] phys. stat. sol. (a), 201, No. 15, 3252-3256 (2004)

MA 20.149 Tue 15:15 P1

Dilatometry under magnetic field of the magnetic quasicrystal Zn-Mg-Tb — •William Knafo[1,2], Christoph Meingast[1], Paul Popovich[1], Hilbert von Löhneysen[1,2], Hiroyuki Takakura[3], and Akira Inaba[3] — [1]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe, Germany. — [2]Physikalisches Institut, Universität Karlsruhe, D-76128 Karlsruhe, Germany. — [3]Research Center for Molecular Thermodynamics, Graduate School of Science, Osaka University, Toyonaka, Osaka 560-0043, Japan.

The magnetic quasicrystal Zn-Mg-Tb is characterized by a freezing temperature $T_f \simeq 6$ K below which the moments localized on the Tb sites follow a spin glass behavior [1]. Short range magnetic correlations have also been reported below a second characteristic temperature $T_{corr} \simeq 20$ K [2]. The spin freezing behavior of Zn-Mg-Tb is probably related to the set up of competing magnetic correlations, such as in the Kagomé or pyrochlore geometrically frustrated systems. We present here a study of the magnetic quasicrystal Zn-Mg-Tb using thermal expansion and magnetostriction for magnetic fields up to 10 T. The effects of the temperature and magnetic field on the magnetic correlations will be related to those measurements.

[1] T. J. Sato, Acta Cryst. A **61**, 39 (2005). [2] Z. Islam et al., Phys. Rev. B **57**, R11047 (1998).

MA 20.150 Tue 15:15 P1

Magnetic and electronic properties of the iron-containing polyoxotungstate $[Fe_4(H_2O)_{10}(\beta\text{-}SbW_9O_{33})_2]^{6-}$ — •M. Prinz[1], A. F. Takács[1], J. Schnack[1], I. Balasz[2], E. Burzo[2], U. Kortz[3], and M. Neumann[1] — [1]University of Osnabrück, Department of Physics, Barbarastr. 7, D-49069 Osnabrück, Germany — [2]Babeş-Bolyai University, Faculty of Physics, RO-400084 Cluj-Napoca, Romania — [3]International University Bremen, P.O. Box 750561, D-28725 Bremen, Germany

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. Magnetic and X-ray photoelectron spectroscopic (XPS) studies on the transition metal substituted, dimeric polyoxotungstate $[Fe_4(H_2O)_{10}(\beta\text{-}SbW_9O_{33})_2]^{6-}$ are reported. Magnetic measurements of the salt $Cs_6[Fe_4(H_2O)_{10}(\beta\text{-}SbW_9O_{33})_2]$, containing Fe^{3+} ions, show a magnetization of approximately 10 μ_B/f.u. at $T = 4.2$ K and $B = 9$ T without saturation and were analysed by using an isotropic Heisenberg Hamiltonian. The ground state of the frustrated molecule has a total spin of $S = 2$. The XPS Fe 2p spectra suggest a 2+ formal valence state indicating that charge-transfer effects are involved.

MA 20.151 Tue 15:15 P1

Identification of different Mn 3d electronic configurations in (GaMn)As ferromagnetic semiconductors and their influence on the magnetism — •Ruslan Ovsyannikov[1], F. Kronast[1], A. Vollmer[1], H. Dürr[1], W. Eberhardt[1], P. Imperia[2], D. Schmitz[2], G. Schott[3], K. Brunner[3], M. Sawicki[3], and L. Molenkamp[3] — [1]BESSY, Berlin — [2]Hahn-Meitner-Institut, Berlin — [3]University of Würzburg

We studied the hybridisation of Mn 3d and Ga/As valence orbitals in (Ga$_{1-x}$Mn$_x$)As films with x between 0.007 and 0.062 using x-ray absorption techniques. The signature of Mn acceptor states responsible for long-range ferromagnetic order can be identified with x-ray magnetic circular dichroism at all Mn concentrations. An additional magnetically dead Mn species with a reduced number of 3d electrons is observed for 0.062 Mn. We provide evidence that this is due to Mn-Mn nearest neighbor pairs which bind valence holes and ultimately limit the size of the magnetic ordering temperature.

MA 20.152 Tue 15:15 P1

Diluted magnetic semi-conductors based on Half-Heusler compounds: $CoTi_{1-x}Y_xSb$ (Y=Fe,Mn) — •Kristian Kroth[1], Benjamin Balke[1], Fred Casper[1], Andrei Gloskowski[1], Vadim Ksenofontov[1], Der-Hsin Wei[2], Hong-Ji Lin[2], Gerhard H. Fecher[1], and Claudia Felser[1] — [1]Johannes Gutenberg - Universität, 55099 Mainz, Germany — [2]NSRRC, Hsinchu, 30076, Taiwan

CoTiSb is shown to be a semiconducting half Heusler compound. Doping by Mn or Fe is found to result in ferromagnetic order with metallic like conductivity. Polycristalline samples were produced by arc-melting and their chemical composition was checked by means of photoemission spectroscopy (ESCA) and microscopy (PEEM).

It was found that Ti can be replaced by up to 10% Fe while its crystal structure still remains $C1_b$, which was proved by X-ray powder diffraction and Mößbauer spectroscopy. The strucure stayed stable upon Mn doping up to 40%.

SQUID magnetometry revealed for $CoTi_{0.95}Fe_{0.05}Sb$ a magnetic moment of $0.2\mu_B$ per unit cell and a Curie temperature of above 700K. SCF calculations using the KKR-CPA method predict a half-metallic ferromagnetic character with only Fe atoms contributing to the total magnetization of the alloy, in agreement to experiments using XMCD at $L_{2,3}$ edges to determine the atomic resolved contribution of the 3d metals to the magnetic moment. Curie temperatures of about 470K were found upon partially replacement of Ti bei Mn.

MA 20.153 Tue 15:15 P1

Growth of Ni_2MnGa films on a-plane sapphire — •Gerhard Jakob and Hermann Adrian — Institute of Physics, Johannes Gutenberg-University of Mainz

Magnetic shape memory materials can change their shape on application of magnetic fields. Huge magnetostrictive effects as large as 10% have been achieved in Ni_2MnGa single crystals [1]. The shape change is related to the fact that the energy for motion of twin boundaries in these materials is lower than the magneto crystalline anisotropy energy. Using an appropriate Ni-Mn ratio the martensitic formation temperature is above room temperature opening the potential for actuators based on this effect.

We report our results concerning growth and characterization of Ni_2MnGa films deposited by sputtering on a-plane sapphire. Our samples grow with a (220) orientation and a rocking curve width of 1.1° for the out of plane orientation. Four circle diffractometry showed the presence of several competing in-plane growth directions. Magnetic measurements indicate the existence of the austenite martensite transformation in the films. Substrates suitable as sacrificing layers have been investigated.

[1] A. Sozinov et al, Appl. Phys. Lett. 80, 1746 (2002)

We thank Dr. S. Roth from IFW Dresden for providing the target material.

MA 20.154 Tue 15:15 P1

Is non-ideal Co_2MnSi still a half-metal? — •Björn Hülsen, Peter Kratzer, and Matthias Scheffler — Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, D-14195 Berlin, Germany

Material systems for spintronics applications have recently attracted much interest and one promising candidate is the full Heusler alloy Co_2MnSi. In its pure bulk phase, this material has a high Curie temperature and displays a gap in the density of states at the Fermi level in the minority spin channel leading to 100 % spin polarization. However, even in the cleanest sample the (theoretically) perfect configuration of atoms is disturbed due to a finite concentration of structural defects.

To see whether Co_2MnSi maintains its half-metallic character under more realistic conditions we performed all-electron density functional theory calculations for several disordered and non-stochiometric unit cells using the spin-polarized generalized gradient approximation and the full-potential LAPW+lo method. We investigated the stability, the magnetic properties, and the electronic structure of the $Co_{2+x}Mn_{1-x}Si$ ($-1 < x < 0.75$) compounds with i) exchanged Co and Mn atoms ii) Mn atoms replaced by Co, and iii) Co atoms replaced by Mn.

We find that in the Co-Mn-interchanged and Co-rich compounds, although there is still large spin polarization, the gap is closed, while it is preserved in the Mn-rich compositions.

MA 20.155 Tue 15:15 P1

Electronic structure and magnetism of $CeMnNi_4$ — •Elena Voloshina[1], Yury Dedkov[2], Manuel Richter[3], and Peter Zahn[4] — [1]Max-Planck-Institut für Physik komplexer Systeme, Nöthnitzer Str. 38, 01187 Dresden, Germany — [2]Institut für Festkörperphysik, Technische Universität Dresden, 01062 Dresden, Germany — [3]IFW Dresden e.V., P.O. Box 270 016, 01171 Dresden, Germany — [4]Fachgruppe Theoretische Physik, Fachbereich Physik, Martin-Luther-Universität Halle, 06099 Halle/Saale, Germany

Theoretical investigations of the electronic band structure and ferromagnetism of $CeMnNi_4$ have been performed by means of LSDA approach. Recent experiments show that this compound has relatively large transport spin polarization (of about 66%) that is in contradiction with present LSDA results. Calculated full magnetic moment of $4.88\,\mu_B$ is in good agreement with determined experimentally value. Since a parent compound $CeNi_5$ is a Pauli paramagnet, the ferromagnetic ordering in the ground state should arise due to the ordering of the high Mn^{2+} magnetic moments. This fact is confirmed by present calculations.

MA 20.156 Tue 15:15 P1

Effect of disorder on diluted magnetic system — •Guixin Tang and Wolfgang Nolting — Institute of Physics, Humboldt University of Berlin, Newton street 15, D-12439 Berlin, Germany

We introduce a Heisenberg Hamiltonian for describing the magnetic properites of diluted magnetic semiconductors. The equation of motion for the magnon Green's function is decoupled by Tyblikov approximation. The influence of disorder on the magnetic properties of diluted Heisenberg spin system is investigated using augment-space method in conjunction with the recursion technique. The resulting magnon spectral density is used to estimate the magnetizaion and Curie temperature of the three-dimension diluted magnetic system.

MA 20.157 Tue 15:15 P1

Magnetostrictive GMR sensors on flexible polyimid substrates — •Thomas Uhrmann[1,2], Ludwig Bär[1], Theodoros Dimopoulos[1,3], Nils Wiese[1,4], Manfred Rührig[1], and Alfred Lechner[2] — [1]Siemens AG Corporate Technology, Dept. CT MM 1, Erlangen, Germany — [2]University of Applied Sciences Regensburg, Regensburg, Germany — [3]ARC Seibersdorf research GmbH, Vienna, Austria — [4]Universität Bielefeld, Nano Device Group, Bielefeld, Germany

The feasibility of a stress sensor based on giant magnetoresistance (GMR) on a flexible polyimide substrate is presented. Therefore a stack system with a GMR effect of up to 8.4% has been deposited on a polyimide substrate and patterned to micrometer scaled sensor elements. An in plane tensile stress was applied to the sensor to achieve a rotation of the anisotropy of the magnetostrictive free-layer. The magneto-optical and magnetoresistive effect was measured. The stress dependence of the $Co_{50}Fe_{50}$ free layer magnetization was measured up to a elongation of 2.5% in a (CoFe/Cu/CoFe) GMR system. The magneto-optical results are compared to the resistance loops of the sample. Furthermore the normalized sensor output is shown as a function of the applied stress at several bias fields and the remanent state.

MA 20.158 Tue 15:15 P1

Fluxgate sensors with modulation frequencies up to 1 MHz — •Rainer Piel, Frank Ludwig, and Meinhard Schilling — TU-Braunschweig, Institut für elektrische Messtechnik und Grundlagen der Elektrotechnik, Hans-Sommer-Str. 66, D-38106 Braunschweig, Germany

Fluxgates measure magnetic vector fields in the DC and low frequency AC range. The measurement principle can be described as an amplitude modulation of measurement and excitation field. The arising signal is measured by a detection coil. Many applications, like nondestructive evaluation (NDE), compass, bioanalytics etc., require small sensors with high resolution. Smaller sensors, e.g., fabricated in thin-film or thick-film technology, however, limit the number of turns of the detection coil which in turn reduces their sensitivity and resolution. The increase of the modulation frequency offers a solution to this problem. Fluxgates are normally operated with modulation frequencies of some kHz. Furthermore, an increase of the modulation frequency up to 1 MHz allows one to achieve a higher measurement bandwidth which leads to an improvement in the dynamic behavior. The adjustment of sensor coils and electronics to these frequencies and the related difficulties are topic of this contribution. The measured sensor properties, such as sensitivity, noise and dynamics, are presented.

MA 20.159 Tue 15:15 P1

A New Approach to Grafting Isolated Mn_{12} Single Molecule Magnets on the Au surface — •Sönke Voss[1], Michael Burgert[2], Mikhail Fonin[1], Ulrich Groth[2], and Ulrich Rüdiger[1] — [1]Fachbereich Physik, Universität Konstanz, D-78457 Konstanz — [2]Fachbereich Chemie, Universität Konstanz, D-78457 Konstanz

During the last decade single-molecule magnets (SMMs) have attracted much attention due to their unique properties, such as quantum tunneling of magnetization, making these compounds attractive for applications in quantum computing [1]. Among them Mn_{12}-acetate [2] and its derivatives which possess high blocking temperatures and exhibit stepwise ferromagnetic hysteresis. Aside with the investigation of magnetic properties of SMMs in their bulk crystalline form considerable research has been recently focused on SMMs attached to metallic surfaces in attempt to address the electronic and magnetic properties of self-assembled layers as well as of isolated SMM molecules.

In this study Mn_{12} complexes with benzoic, propynoic, and phenylpropynoic acid ligands were prepared in order to modify the electronic properties of the complex and possibly affect the magnetic behavior in bulk as well as in thin films. SMM single crystals have been studied by SQUID showing stepwise hysteresis at low temperature. In addition Mn_{12} complexes were grafted onto the functionalized Au(111) surface and investigated by means of scanning tunneling microscopy as well as x-ray photoelectron spectroscopy at room temperature.

[1] M.N.Leuenberger and D.Loss, Nature (London) **410**, 789 (2001).
[2] R.Sessoli *et al.*, Nature (London) **365**, 141 (1993).

MA 20.160 Tue 15:15 P1

Magnetism of multi-center Ni- and Fe-based molecular complexes: Pulsed magnetic fieldstudies — •R. Klingeler[1,2], V. Kataev[1], C. Golze[1,3], B. Büchner[1], A. Alfonsov[1], H. Klauss[3], C. Mennerich[3], M. Goiran[2], H. Rakoto[2], J.M. Broto[2], S. Demeshko[4], G. Leibeling[4], F. Meyer[4], P. Körgerler[5], J. Schnack[6], and D.J. Price[7] — [1]IFW Dresden — [2]LNCMP Toulouse, France — [3]TU Braunschweig — [4]University Göttingen — [5]Ames Laboratory,USA — [6]University Osnabrück — [7]University Glasgow, UK

We performed measurements of the high frequency/high field ESR and of the magnetisation in pulsed magnetic fields up to 55 T in order to investigate the ground state and the low lying excitations of several novel polynuclear complexes. In particular, we studied the 2-leg ladder compound $Na_2Ni_2(C_2O_4)_3(H_2O)_2$, the $[L_2Ni_4(N_3)(O_2CR)_4](ClO_4)$-type tetranuclear-Ni(II) molecular complex and the giant Keplerate magnetic molecules $\{Mo_{72}Fe_{30}\}$ coupled to a square lattice. In Ni-oxalate, the $M(B)$ and ESR data imply spin level crossings at ∼29 T and ∼54 T. We find a non-magnetic ground state, sharp steps of the magnetisation at the spin-level crossings and a plateaux-like behaviour between. In the tetranuclear Ni(II) complex, our data imply a spin-level crossing at ∼25 T from a non-magnetic to a magnetic state. However, our $M(B)$ data show a finite susceptibility at $T = 1.5$ K and low fields which indicates a more complex ground state than the simple singlet state. For the giant Keplerate sample we concentrate on the intramolecular interactions. In particular, our data reveal signatures of long range AFM correlations and AFM order, respectively, at low T.

MA 20.161 Tue 15:15 P1

Magnetic properties of nitrid-clusterfullerene Dy_3N@C80 — •Y. Arango, S. Yang, V. Kataev, L. Dunsch, and B. Büchner — Leibniz Institute for Solid State and Materials Research IFW Dresden

Metal-cluster fullerenes in which paramagnetic rare-earth ions are trapped inside the carbon cage represent a novel class of molecular magnets. However little is known about their magnetic properties because conventional methods of synthesis have very small yields ($< 1\,\%$) and the product is often multiphase. However recent success of the synthesis of nitride-clusterfullerenes of high yield and purity opens a possibility to get insights into the magnetism of these compounds. Here we report on magnetic characterization of a clusterfullerene Dy_3N@C80 which was produced by a modified Krätschmer-Huffman DC-arc discharging method with the addition of NH_3 as the reactive gas atmosphere. The high purity of the product has been checked by a number of analytical techniques. We have studied the static magnetization of Dy_3N@C80 in the temperature range from 2 K to 300 K in magnetic fields up to 5 T. Measurements of the saturation magnetization as well the estimate of the Curie constant, both yield a strongly reduced value of the Dy magnetic moment $\mu_{eff} \approx 5\mu_B$ which amounts only to about a half of the free ion value $\mu_{eff}^{Dy3+} = 10.5\mu_B$. We discuss possible scenarios of the anomalous reduction of the moment, such as a strong frustration of magnetic exchange in the Dy_3N-cluster or an unusually large Dy single-ion anisotropy.

MA 20.162 Tue 15:15 P1

Spin relaxation in TiOCl — •Dmitry Zakharov[1,2], Joachim Deisenhofer[1], Hans-Albrecht Krug von Nidda[1], Peter Lunkenheimer[1], Markus Hoinkis[3], and Alois Loidl[1] — [1]Experimentalphysik V, Center for Electronic Correlations and Magnetism, University of Augsburg, 86135 Augsburg, Germany — [2]Kazan State University, 420008 Kazan, Russia — [3]Experimentalphysik II, Institut für Physik, Universität Augsburg, D-86135 Augsburg, Germany

We present detailed electron-spin resonance investigations on single crystals of the novel quasi-one-dimensional spin-Peierls compound TiOCl up to 500 K. The anisotropy of the g-factor indicates a stable orbital configuration below room temperature discarding strong effects due to orbital fluctuations. Combining our data with the results obtained by optical measurements we estimate the energy of the first excited state ruling out a possible degeneracy of the orbital ground state. The orientation and temperature dependence of the linewidth at temperatures below 250 K can be completely described in terms of anisotropic exchange interaction between Ti ions only. A strong additional increase of the linewidth at higher temperatures can be related to the conductivity determined from dielectric measurements.

MA 20.163 Tue 15:15 P1

Correlation of Transport and Magnetism in manganese pnictides and rare earth manganites - are they due to double exchange? — •Klaus Baerner[1], Vladimir Morchshakov[1], Murad Annaoasov[2], and Mostafa Boshata[3] — [1]Physical Department, University of Göttingen, F. Hund Platz 1, 37077 Göttingen, Germany — [2]Institute of Advanced Technologies Research and Development, Eastern Mediterranean University, Famagusta, Northern Cyprus, via Mersin 10, Turkey — [3]Solid State Physics Dept., National Research Center, NRC, 12332 Dokki, Cairo, Egypt

MnAs and its derivates enjoy a renewed interest because of their use as spininjectors, another surge in magnetocaloric cooling efforts and because recently for valence mixed manganites R1-xAxMnO3 (R: rare earth, A: alkaline earth), which exhibit a correlation of ferromagnetism and metallicity due to double exchange coupling, a new (recursive) approach to calculate the electronic and magnetic states has been proposed, combining spin fluctuation theory and spindependent bandstructure calculations1,2. In this contribution magnetisation, resistivity and phase diagrams of selected manganites R1-xAxMnO3 and pnictides MnIV (IV: As, P, Sb, Bi) are compared. The equivalencies strongly indicate that indeed the manganese pnictides, which are rich on phenomena like the doped rare eart h manganites are candidates for that new approach.

MA 20.164 Tue 15:15 P1

Ultrafast spin and lattice dynamics in antiferromagnetic Cr_2O_3 — •Bas B. van Aken, Takuya Satoh, Nguyen P. Duong, and Manfred Fiebig — Max-Born-Institut, Max-Born-Straße 2a, 12489 Berlin

The magnetisation and lattice dynamics of antiferromagnetic Cr_2O_3 was investigated with optical second harmonic generation. Intense 100 fs laser pulses excited the sample and probed the magnetic and crystallographic sublattices. Using the polarisation degrees of freedom, the amplitude of the magnetic and crystallographic order parameter and the phase between them can be resolved. Demagnetisation processes on three different time scales from $\ll 1$ ps to ~ 7 ps were distinguished. The different nature of the three demagnetisation channels is predominantly seen in the phase, which is determined by time-resolved interference experiments. The magnetisation dynamics exhibits distinct differences to that of ferromagnetic compounds.

MA 20.165 Tue 15:15 P1

Determination of the directions of the induced moments at Cd probes on Ni surface sites — •P. M. Imielski[1], Y. Manzhur[2], J. Schubert[2], W. D. Brewer[1], W.-D. Zeitz[2], and M. J. Prandolini[2] — [1]Institut für Experimentalphysik (WE1), Freie Universität Berlin, 14195 Berlin, Germany — [2]Bereich Strukturforschung, Hahn-Meitner-Institut Berlin GmbH, 14109 Berlin, Germany

In recent experiments the magnitude of the magnetic hyperfine fields (|Bhf|) of nonmagnetic Cd probe atoms, positioned at different sites onto Ni(111) and Ni(001) surfaces, were measured with atomic resolution, using perturbed angular correlation (PAC) spectroscopy [1]. These surface sites can be characterised by differing coordination numbers, (i.e., the number of Ni nearest neighbours (NN)) [1]. The initial proposition for the direction of the induced Cd moments with respect to the magnetisation of Ni at the coordination number 5 (the free step site) was found to be in conflict with density-functional theory (DFT) calculations [2]. These initial DFT calculations were performed without lattice relaxation. Later DFT estimates, with lattice relaxation, determined the opposite sign at this position [3]. In order to compare the experimental results with theory, we have measured the signs of the Bhf at coordination numbers NN= 9, 7, 5 and 4.

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