MAGNETISM

MAGNETISMUS (MA)

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OVERVIEW OF INVITED TALKS AND SESSIONS

(lecture rooms HSZ 03, HSZ 103, HSZ 401, HSZ 403,
P1: the posters should be in place at 9:00 in the morning;
posters can be visited all day; kernel time of the poster session is 15:15 - 19:15)

Invited Talks

MA 1.1	Mon	09:30	(HSZ 03)	**Direct observation of Bose-Einstein condensation of parametrically driven magnons.**, Vladislav Demidov
MA 6.1	Mon	13:45	(HSZ 03)	**Read-out, relaxation and decoherence of electron spins in a quantum dot**, Lieven Vandersypen
MA 6.2	Mon	14:15	(HSZ 03)	**Electronic transport in ferromagnetic films and wires: An *ab initio* study**, Heike Herper
MA 13.1	Tue	09:30	(HSZ 03)	**Femtosecond electron and spin dynamics in ferromagnets**, Hermann A. Dürr
MA 19.1	Tue	14:00	(HSZ 03)	**Pressure and magnetic field effects on the magnetic and crystallographic structures of the R5(SixGe1-x)4 compounds**, Algarabel P. A., Morellon L., Magen C., Ibarra M. R., Ritter C., Arnold Z.
MA 19.2	Tue	14:30	(HSZ 03)	**Melt-spun materials for magnetic refrigeration near room temperature**, Oliver Gutfleisch
MA 23.1	Thu	09:30	(HSZ 03)	**Proteins and patients - new applications of low noise magnetic field sensors**, Meinhard Schilling
MA 28.1	Thu	14:00	(HSZ 03)	**Surprises in the Magnetism of Surface Supported Nanostructures**, Harald Brune
MA 28.2	Thu	14:30	(HSZ 03)	**Discrete media made from pre-patterned wafers: a promising route towards ultra high density magnetic recording**, Jerome Moritz, Mohamed Asbahi, Vincent Baltz, Bernard Rodmacq, Jean-Pierre Nozieres, Bernard Dieny
MA 34.1	Fri	10:15	(HSZ 03)	**The Earths magnetic field during the new satellite era**, Mioara Mandea

Invited Talks in the Internal Symposium "50 Years AG Magnetism"

MA 21.1	Wed	14:00	(HSZ 03)	**Spin Transport across interfaces**, B J Hickey, L Michez, K McKenna, G J Morgan, S Shatz, N Wiser
MA 21.2	Wed	14:30	(HSZ 03)	**Exchange bias in patterned magnetic structures**, Kristiaan Temst, Elena Popova, Steven Brems, Chris Van Haesendonck, Helmut Fritzsche, Marita Gierlings, Florin Radu, Hartmut Zabel, Peter Leunissen, Rik Jonckheere
MA 22.1	Wed	15:15	(HSZ 03)	**Fifty Years "Arbeitsgemeinschaft Magnetismus" - History of Magnetism in Germany**, H. Kronmüller
MA 22.2	Wed	15:45	(HSZ 03)	**Making magnets harder**, J. M. D. Coey
MA 22.3	Wed	16:15	(HSZ 03)	**Industrial Rare-Earth Permanent Magnets and their Applications**, Matthias Katter

MA 22.4	Wed	17:00	(HSZ 03)	**Spin transfer phenomena in layered magnetic structures**, Peter A. Grünberg, Daniel E. Bürgler, Claus M. Schneider
MA 22.5	Wed	17:30	(HSZ 03)	**Interplay between Incipient Magnetism and Superconductivity in Heavy Fermions**, Frank Steglich

Invited Talks in the Symposium SYMS: Magnetic Switching

SYMS 1.1	Mon	15:00	(HSZ 04)	**Manipulation of magnetization by spin transfer: switching, microwave generation**, Albert Fert, O. Boulle, V. Cros, M. Elsen, J. Grollier, A. Hamzic, H. Jaffrés, M. AlHajDarwish, J. Bass, H. Kurt, W. P. Pratt, J. Barnas, I. Gimtra, I. Weymann, R. Giraud, G. Faini, A. Lamaitre
SYMS 1.2	Mon	15:45	(HSZ 04)	**Spin-torque effects in single-crystalline Fe nanomagnets and nanopillars**, Daniel E. Bürgler, Henning Dassow, Ronald Lehndorff, Matthias Buchmeier, Peter A. Grünberg, Claus M. Schneider
SYMS 1.3	Mon	16:15	(HSZ 04)	**Current-induced spin-transfer torque and spin dynamics in spin-valve structures**, Jozef Barnas, Martin Gmitra, Vitaly Dugaev, Albert Fert
SYMS 2.1	Mon	17:00	(HSZ 04)	**Spin-Hall effect in a two-dimensional electron system**, Peter Schwab, Michael Dzierzawa, Roberto Raimondi, Cosimo Gorini
SYMS 2.2	Mon	17:20	(HSZ 04)	**Submicrometer ferromagnetic logic gates**, Russell Cowburn
SYMS 2.3	Mon	17:50	(HSZ 04)	**Spin torque: wall dynamics in nanowires vs. switching in nanopillars**, Jacques Miltat, André Thiaville
SYMS 2.4	Mon	18:20	(HSZ 04)	**Interactions between domain walls and spin currents**, M. Klaeui, M. Laufenberg, D. Backes, P.-O. Jubert, R. Allenspach, A. Bischof, L. Vila, C. Vouille, G. Faini, U. Ruediger

Invited Talks in the Symposium SYMM: Multi-ferroic materials

SYMM 1.1	Tue	14:30	(HSZ 04)	**Magnetoelectric Multiferroics from First Principles**, C. Ederer, N. Spaldin
SYMM 1.2	Tue	15:00	(HSZ 04)	**Electrostatic Interface Tuning in Superconducting Oxide Heterostructures**, N. Pavlenko
SYMM 1.3	Tue	15:30	(HSZ 04)	**Modelling realistic ferroic materials - multiscale approaches**, S. Gemming, I. I. Chaplygin, W. Alsheimer, G. Seifert
SYMM 2.1	Tue	16:15	(HSZ 04)	**Multifunctional Complex Oxide Heterostructures**, R. Ramesh
SYMM 2.2	Tue	16:45	(HSZ 04)	**Some Observations about Static Scaling: Domain Widths and Circular and Toroidal Ordering in Ferroelectrics, Ferromagnets, and Magnetoelectrics**, J. Scott
SYMM 2.3	Tue	17:15	(HSZ 04)	**Magnetoelectric Effect and Toroidal Ordering in Multiferroic Manganites**, M. Fiebig, Th. Lottermoser, Th. Lonkai
SYMM 2.4	Tue	17:45	(HSZ 04)	**Magnetoelectric Effects in Multiferroics**, A. Loidl, J. Hemberger, A. Pimenov, P. Lunkenheimer, A. A. Mukhin, V. Tsurkan

Sessions

MA 1	**Invited Talk Demidov**	Mon 09:30–10:00	HSZ 03	MA 1.1–1.1
MA 2	**Magnetic Thin Films I**	Mon 10:15–12:45	HSZ 03	MA 2.1–2.10
MA 3	**Spin-Dependent Transport Phenomena I**	Mon 10:15–13:00	HSZ 103	MA 3.1–3.11
MA 4	**Magnetic Materials I**	Mon 10:15–12:45	HSZ 401	MA 4.1–4.10
MA 5	**Spin-Structures and Magnetic Phase Transitions I**	Mon 10:15–13:00	HSZ 403	MA 5.1–5.11
MA 6	**Invited Talks Vandersypen / Herper**	Mon 13:45–14:45	HSZ 03	MA 6.1–6.2
MA 7	**Micro- and Nanostructured Magnetic Materials I**	Mon 15:00–18:00	HSZ 03	MA 7.1–7.12
MA 8	**Surface Magnetism**	Mon 15:00–17:15	HSZ 103	MA 8.1–8.9
MA 9	**Magnetic Imaging**	Mon 15:00–17:00	HSZ 401	MA 9.1–9.8
MA 10	**Micromagnetism / Computational Magnetism**	Mon 17:00–17:45	HSZ 401	MA 10.1–10.3
MA 11	**Spin-Structures and Magnetic Phase Transitions II**	Mon 15:00–16:30	HSZ 403	MA 11.1–11.6
MA 12	**Kondo / Heavy Fermions**	Mon 16:30–17:45	HSZ 403	MA 12.1–12.5
MA 13	**Invited Talk Dürr**	Tue 09:30–10:00	HSZ 03	MA 13.1–13.1

MA 14	**Magnetic Thin Films II**	Tue	10:15–13:00	HSZ 03	MA 14.1–14.11
MA 15	**Spin-Dependent Transport Phenomena II**	Tue	10:15–11:45	HSZ 103	MA 15.1–15.6
MA 16	**Micro- and Nanostructured Magnetic Materials II**	Tue	11:45–13:00	HSZ 103	MA 16.1–16.5
MA 17	**Magnetic Materials II**	Tue	10:15–13:00	HSZ 401	MA 17.1–17.11
MA 18	**Spin-Dynamics, Magnetization Reversal I**	Tue	10:15–13:00	HSZ 403	MA 18.1–18.11
MA 19	**Invited Talks Algarabel / Gutfleisch**	Tue	14:00–15:00	HSZ 03	MA 19.1–19.2
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-)**	Tue	15:15–19:15	P1	MA 20.1–20.165
MA 21	**Invited Talks Hickey / Temst**	Wed	14:00–15:00	HSZ 03	MA 21.1–21.2
MA 22	**Internal Symposium "50 Years AG Magnetism"**	Wed	15:15–18:00	HSZ 03	MA 22.1–22.5
MA 23	**Invited Talk Schilling**	Thu	09:30–10:00	HSZ 03	MA 23.1–23.1
MA 24	**Magnetic Thin Films III**	Thu	10:15–12:45	HSZ 03	MA 24.1–24.10
MA 25	**Spin-Electronics I**	Thu	10:15–13:00	HSZ 103	MA 25.1–25.11
MA 26	**Electron Theory**	Thu	10:15–13:15	HSZ 401	MA 26.1–26.12
MA 27	**Spin-Dynamics, Magnetization Reversal II**	Thu	10:15–13:00	HSZ 403	MA 27.1–27.11
MA 28	**Invited Talks Brune / Moritz**	Thu	14:00–15:00	HSZ 03	MA 28.1–28.2
MA 29	**Magnetic Thin Films IV**	Thu	15:15–18:15	HSZ 03	MA 29.1–29.12
MA 30	**Spin-Electronics II**	Thu	15:15–16:15	HSZ 103	MA 30.1–30.4
MA 31	**Magnetic Measuring Techniques**	Thu	16:15–17:00	HSZ 103	MA 31.1–31.3
MA 32	**Magnetic Particles / Clusters**	Thu	15:15–18:45	HSZ 401	MA 32.1–32.14
MA 33	**Spin-Dynamics, Magnetization Reversal III**	Thu	15:15–18:30	HSZ 403	MA 33.1–33.13
MA 34	**Invited Talk Mioara Mandea**	Fri	10:15–10:45	HSZ 03	MA 34.1–34.1
MA 35	**Magnetic Thin Films V**	Fri	10:45–12:45	HSZ 03	MA 35.1–35.8
MA 36	**Magnetic Coupling Phenomena / Exchange-Bias**	Fri	10:45–13:00	HSZ 401	MA 36.1–36.9
MA 37	**Molecular Magnetism**	Fri	10:45–13:15	HSZ 403	MA 37.1–37.10

Annual General Meeting of the Section Magnetism

Thu 18:45–19:45 HSZ 103

Top1 report of the head of the magnetism section
Top2 upcoming meetings
Top3 miscellaneous

Sessions

– Invited, Contributed Talks and Posters –

MA 1 Invited Talk Demidov

Time: Monday 09:30–10:00 Room: HSZ 03

Invited Talk MA 1.1 Mon 09:30 HSZ 03

Direct observation of Bose-Einstein condensation of parametrically driven magnons. — •Vladislav Demidov — Institut fuer Angewandte Physik, Universitaet Muenster, Corrensstrasse 2/4, 48149 Muenster, Germany

In thin ferromagnetic films the spectrum of magnons shows a minimum with non-zero energy at wavevectors of about $10^4 cm^{-1}$. The system of magnons in a film can be efficiently driven by means of the microwave parametric pumping. The resulting state of the driven magnon system can be considered as a quasi-equilibrium and is described by Bose-Einstein statistics with the non-zero chemical potential.

Using Brillouin light scattering technique we are able directly to measure the distribution of parametrically driven magnons over the spectrum. We show that, as the power of the parametric pumping increases, the system of magnons is characterized by the increasing chemical potential. Finally, if the pumping power exceeds a certain threshold, the chemical potential reaches the energy of the bottom of the spectrum and the system undergoes a Bose-Einstein-condensation. For larger values of the power the magnons form a coherent condensate at the bottom of the spectrum, which manifests itself in the appearance of an intensive maximum of the magnon density at the corresponding energy.

MA 2 Magnetic Thin Films I

Time: Monday 10:15–12:45 Room: HSZ 03

MA 2.1 Mon 10:15 HSZ 03

Measuring the kernel of time-dependent density functional theory with X-ray absorption spectroscopy of 3*d* transition metals — •H. Wende[1], A. Scherz[2], E.K.U. Gross[1], H. Appel[1], C. Sorg[1], K. Baberschke[1], and K. Burke[3] — [1]Fachbereich Physik, Freie Universität Berlin, Arnimallee 14, D-14195 Berlin-Dahlem, Germany. — [2]SSRL, 2575 Sand Hill Road, Menlo Park, California 94025, USA — [3]Department of Chemistry and Chemical Biology, Rutgers University, 610 Taylor Rd, Piscataway, NJ 08854, USA

We showed that the induced magnetic moments in ultrathin films of the light 3d elements Ti, V and Cr at the interface to Fe cannot be determined by the XMCD sum rule analysis at the $L_{2,3}$ edges. The reasons are correlation effects which result in the deviation of the intensity ratio (branching ratio) from its statistical value. Therefore, we established a double-pole approximation within time-dependent density functional theory to investigate these effects in detail. A (2×2) matrix of the matrix elements of the unknown exchange correlation kernel is used to describe the shift of the two transitions (diagonal) and the change of the branching ratio (off-diagonal elements). We experimentally measure the branching ratios and level splittings for these films, and *deduce* these matrix elements. It turns out that off-diagonal matrix elements are much smaller (factor 5) than the diagonal ones which demonstrates that the change of the branching ratio for the light 3d elements is simply due to transition repulsion, as the two transitions near one another (reduced spin-orbit splitting). Supported by BMBF (05 KS4 KEB 5).

[1] A. Scherz *et al.*, Phys. Rev. Lett. in print

MA 2.2 Mon 10:30 HSZ 03

Acquisition of optic and magneto-optic constants of Co/Pt films — •S. Fiedler[1], H. Stillrich[1], G. Neuber[1], M. Linkerhand[2], P. Pahl[2], and H.P. Oepen[1] — [1]Institut für Angewandte Physik, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg, Germany — [2]Universität Hamburg, 20355 Hamburg, Germany

Ultrathin Co layers on fcc Pt buffers showing (111) texture exhibit a strong perpendicular magnetic anisotropy. We have created Pt-Co-Pt layers on silicon substrates utilizing ECR-sputtering. For experimental investigation of the magnetic properties we use an ex situ MOKE experiment with He-Ne laser. We measure Kerr ellipticity and rotation quantitatively in longitudinal and polar geometry at an angle of incidence of 45 degrees as well as in polar geometry at 0 degree. We have investigated the magneto-optic properties of sandwiched single Co layers with fixed thickness and varying buffer or cap layer thickness. A strong dependence of the Kerr signals on cap as well as buffer layer thickness is found. The experimental results are simulated numerically [1] taking into account the intermixing Co/Pt. The dependence on cap layer thickness will be described in the framework of a simplified analytical expression for ultrathin films [2].

[1] J. Zak, E. R. Moog, C. Liu, and S.D. Bader, J. Magn. Magn. Mat. 89, 107 (1990)
[2] C.-Y. You and S.-C. Shin, phys. stat. sol. (b) 241, No. 7, 1406-1410 (2004)

MA 2.3 Mon 10:45 HSZ 03

XPS investigation of the Mn valence in lanthanum manganite thin films under variation of the oxygen content — •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

The question whether $LaMnO_3$ accepts doping with tetravalent cations such as cerium and thus allows the preparation of electron-doped mixed-valent lanthanum manganites has been discussed controversially so far. Against the background of this problem, we present a comparative X-ray photoemission (XPS) study of epitaxial $La_{0.7}Ce_{0.3}MnO_3$ (LCeMO) and $La_{0.7}Ca_{0.3}MnO_3$ (LCMO) thin films. We focus on the exchange splitting of the Mn 3*s* core level peak, which is a direct indicator of the Mn valence [1] and allows us to quantify the Mn valence in the outermost 3 nm of the films. We demonstrate that, depending on the oxygen content, the Mn valence can be tuned between a mixed $Mn^{3+/4+}$ state and a mixed $Mn^{2+/3+}$ state in *both* the LCeMO *and* the LCMO film. The oxygen content was varied by heating in ultrahigh vacuum for deoxygenation and in an oxygen atmosphere for reoxidation. In the LCeMO film, the deoxygenation not only changes the Mn valence, but also the Ce valence is driven from the 4+ towards the 3+ state.

[1] V. R. Galakhov *et al.*, Phys. Rev. B **65**, 113102 (2002).

MA 2.4 Mon 11:00 HSZ 03

Spin-Polarized Scanning Tunneling Spectroscopy of Dislocation Lines in Fe Films on W(110) — •Oswald Pietzsch, Matthias Bode, Kirsten von Bergmann, André Kubetzka, and Roland Wiesendanger — Institute of Applied Physics, University of Hamburg, Jungiusstrasse 11, 20355 Hamburg

The magnetic properties of 1 - 2 atomic layers Fe on W(110) have recently been studied in many aspects by spin-polarized scanning tunneling microscopy (SP-STM) and spectroscopy (SP-STS). Here we use the high lateral and energy resolution of this method to address the structural, electronic, and magnetic properties of dislocation lines which occur before completion of the second layer, thereby releasing tensile strain arising from a 9.4 % lattice mismatch. The lines are found to be ferromagnetically ordered. The magnetic contrasts are related to the film's perpendicular domain configuration, but the electronic features are quite unique. In particular, from the well-known two-peak structure of the Fe film, the occupied LDOS-peak is recovered in the dislocation line while the unoccupied peak is strongly shifted towards the Fermi level.

As a consequence, the bias-voltage dependent magnetic asymmetry as determined from tunneling spectra is significantly altered in these lines.

MA 2.5 Mon 11:15 HSZ 03

Second-order magnetoelastic coupling of strained Fe — •Z. Tian, C.S. Tian, D. Sander, and J. Kirschner — Max-Planck-Institut für Mikrostrukturphysik,

Lattice strain is often the decisive factor which determines the magnetic anisotropy of ferromagnetic monolayers (ML). We performed combined cantilever bending beam and magneto-optical Kerr-effect measurements to determine the correlation between film stress, strain and the magnetic anisotropy of Fe ML deposited on Ir(001). The Fe ML are under compressive stress, as expected from the mismatch of 4.9% between bcc Fe and Ir. We use in-situ stress measurements to determine the lattice strain. The magnetoelastic coupling coefficient B_2 is determined from the change of crystal curvature upon switching the magnetization along the length and width of the sample. The value of B_2 deviates from the bulk value and depends on the film strain ϵ. The experimental data suggest a linear dependence of B_2 on lattice strain as given by $B_2^{eff}=B_2^{bulk}+D_2\,\epsilon$, with the bulk value B_2^{bulk}=7.83 MJ/m^3, D_2=-350 MJ/m^3. Our results extend the experimental data base[1] to compressive strain. This result indicates the decisive role of second-order magnetoelastic effects for the magnetic anisotropy of strained Fe ML, where reliable theoretical values have not been obtained yet[2].

[1] G.Wedler, J. Waly, A. Greuer and R. Koch: Phys. Rev. B **60**, R11313 (1999).
[2] M. Fähnle, M. Komelj: Z. Metallkd. **93**, 970 (2002).

MA 2.6 Mon 11:30 HSZ 03

Interface formation and its influence on magnetic anisotropy in ultrathin Fe films grown by TD and PLD on GaAs(001) — •Marek Przybylski[1], Jan Zukrowski[2], Bartlomiej Kardasz[3], Oleksandr Mosendz[3], Bretislav Heinrich[3], and Jürgen Kirschner[1] — [1]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany — [2]Solid State Physics Department, Faculty of Physics and Applied Computer Science, AGH University of Science and Technology, Mickiewicza 30, 30-059 Krakow, Poland — [3]Simon Fraser University, Department of Physics, 8888 University Drive, Burnaby, B.C., V5A 1S6 Canada

The role of the Fe/GaAs(001) interface atomic structure on the magnetic properties of ultrathin film of Fe was investigated by using a 2 ML of ^{57}Fe probe layer grown on a GaAs(001) substrates by thermal deposition (TD) or by pulsed laser deposition (PLD) techniques. To assure film continuity and a Curie temperature well above room temperature (RT), the probe layer was covered with an additional 8 ML of natural Fe. Conversion electron Mössbauer spectra (CEMS) were measured ex situ at RT. A broad low-magnetic field component was clearly present in the measured Mössbauer spectrum for the PLD probe layer. Most likely this component can be attributed to a high degree of atomic intermixing at the Fe/GaAs interface. A low-field component was not detected in the case of the TD-grown ^{57}Fe probe layer. Ferromagnetic resonance (FMR) was used to measure the magnetic anisotropies of the studied films. It will be shown that all anisotropies were strongly affected by TD and PLD deposition techniques.

MA 2.7 Mon 11:45 HSZ 03

Magnetic anisotropy of $Ga_{1-x}Mn_xAs$ on GaAs (311)A — •Christoph Bihler[1], Hans Huebl[1], Dieter Schlosser[1], Martin S. Brandt[1], Sebastian T. B. Goennenwein[2], Matthias Reinwald[3], Ursula Wurstbauer[3], Matthias Döppe[3], Dieter Weiss[3], and Werner Wegscheider[3] — [1]Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, 85748 Garching, Germany — [2]Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, Walther-Meissner-Str. 8, 85748 Garching, Germany — [3]Universität Regensburg, 93040 Regensburg, Germany

One approach to further improve the magnetic properties of $Ga_{1-x}Mn_xAs$ epilayers via optimized dopant incorporation is growth on higher index GaAs substrates. In this contribution we investigate the magnetic anisotropy of $Ga_{1-x}Mn_xAs$ grown by low-temperature molecular beam epitaxy (LT-MBE) on GaAs (311)A substrates by means of ferromagnetic resonance (FMR) spectroscopy. The angular dependence of the resonance fields observed can be explained by two main contributions to the magnetic anisotropy: a cubic magnetic anisotropy field $2K_{C1}/M = 240$ mT oriented along the crystallographic $\langle 001\rangle$ axes caused by the symmetry of the GaAs host lattice, and an effective uniaxial magnetic anisotropy field $2K_{eff}^{311}/M = 90$ mT along [311] presumably caused by the homoepitaxial growth of the layer. Even better agreement between simulation and experiment is obtained if additional uniaxial anisotropies along [100] and [$\bar{2}$33] are taken into account.

MA 2.8 Mon 12:00 HSZ 03

The temperature dependent magnetization process in small CoPt stripes observed by low temperature MFM — •Ulrike Wolff[1], Christoph Hassel[2], Mario Brands[2], Günther Dumpich[2], Ludwig Schultz[1], and Volker Neu[1] — [1]IFW Dresden, Institute for Metallic Materials, P.O. Box 270116, D-01171 Dresden, Germany — [2]Universität Duisburg-Essen, Standort Duisburg, Institut für Physik, AG Farle, Lotharstr. 1, 47048 Duisburg, Germany

In small structured CoPt stripes the magnetoresistive behaviour is governed by a combination of anisotropic magnetoresistance and domain wall resistance. In order to support the interpretation of magnetoresistive measurements, in this work the magnetization process in CoPt stripes with perpendicular magnetic anisotropy and varying stripe width of 300 to 2200 nm was investigated by low temperature magnetic force microscopy. At various temperatures the CoPt stripes were magnetized in a field of 1 T and MFM measurements were subsequently performed during demagnetizing field sweeps. The locally determined coercive field increases from 0.07 T at 238 K to 0.23 T at 10 K. Whereas the coercivity does not depend strongly on the stripe width, the magnetization process is strongly different for narrow and wide CoPt stripes. At 10 K the 300 nm narrow stripes switch via the nucleation of a reversed domain over the whole width of the stripe. The wider stripes form a more complicated, two dimensional domain pattern during magnetization reversal.

MA 2.9 Mon 12:15 HSZ 03

Combined magneto-optical and magnetic force microscopy study on patterned $SmCo_5$ and $PrCo_5$ thin films — •V. Neu[1], A. Singh[1], A. Patra[1], S. Dreyer[2], U. Wolff[1], S. Sievers[3], Ch. Jooss[2], U. Siegner[3], and L. Schultz[1] — [1]IFW Dresden, P.O. Box 270116, Dresden, Germany — [2]Institute for Materials Physics, University of Goettingen, Germany — [3]Physikalisch-Technische Bundesanstalt, Braunschweig, Germany

The direct microscopic observation of magnetization processes is the most meaningful way to understand macroscopic magnetic behavior. Whereas magnetic force microscopy (MFM) offers high spatial resolution for domain imaging — an essential feature for studying modern permanent magnet materials with domain sizes in the sub 100 nm regime — magneto-optical methods allow large overview images, and with the use of calibrated indicator films, also quantitative stray field measurements. We present a magnetization study of highly coercive epitaxial $SmCo_5$ and $PrCo_5$ films. The films are laser deposited on heated MgO single crystal substrates and possess a well defined easy axis orientation in the film plane with coercivities of 2 to 3 T [1]. Arrays of micron sized square elements are structured by electron beam lithography and ion beam etching. Stray field measurements of individual elements are performed in subsequent higher remanent states throughout the magnetizing process by magneto-optical indicator film (MOIF) technique. This study is combined with an analysis of the domain structure imaged by MFM.

[1] A. Singh, et al., Appl. Phys. Lett. 87, 072505 (2005).

MA 2.10 Mon 12:30 HSZ 03

Study of domain patterns: A discussion of coherent and incoherent averaging in PNR and MOKE. — •Katharina Theis-Bröhl[1], Boris Toperverg[1], Jeffrey McCord[2], and Hartmut Zabel[1] — [1]Department of Experimental and Solid State Physics, Ruhr-University Bochum, 44780 Bochum — [2]Material Research Institute, Helmholtzstr. 20, 01169 Dresden

Specular Polarized Neutron Reflectivity (PNR) provides information similar but not identical to vector-MOKE. MOKE coherently averages magnetic fluctuations over the laser spot illuminating the surface, while the coherency range of the neutron beam is determined by its collimation and monochromatization. The neutron beam is well collimated in the reflection plane ($x - z$), while the collimation is usually relaxed along the $y-$axis. Due to the strong asymmetry in the coherency properties polarized neutron reflectivity is the result of an incoherent average over the $y-$ direction of the coherent reflection from the optical potential. The incoherent averaging over a coherent signal has a big advantage for the study of domain patterns. While coherent averaging over fluctuations

from domains may lead to a vanishing signal, incoherent averaging, on the contrary, does not.

In the talk we will discuss the averaging procedure for PNR using model simulations for different domain patterns. Furthermore we will compare experimental results from PNR and vector-MOKE measurements concerning the different averaging performed on patterned magnetic structures.

We acknowledge funding by DFG, SFB 491 and BMBF 032AE8BO.

MA 3 Spin-Dependent Transport Phenomena I

Time: Monday 10:15–13:00 Room: HSZ 103

MA 3.1 Mon 10:15 HSZ 103

Characterisation of ion beam sputtered Fe/MgO/Fe magnetic tunnel junction — •Alexandra Steeb, Henning Dassow, Diana Rata, Franz-Josef Köhne, Daniel Bürgler, and Claus M. Schneider — Institute for solid state research, Electronic Properties, Research Centre Jülich

The tunnel magnetoresistance effect (TMR) in magnetic tunnel junctions (MTJs) is the key to developing magnetoresistive random-access-memory. In single-crystal Fe/MgO/Fe MTJs prepared by MBE a TMR up to 180% at room temperature was measured [1]. The sputtered polycrystalline CoFe/MgO/CoFe MTJs exhibit TMR values of up to 220% at room temperature [2]. We report on Fe/MgO/Fe trilayers prepared by ion beam sputtering in ultra high vacuum conditions. Using the crystalline GaAs substrate the trilayers grow epitaxially as confirmed by LEED. We work with 300Å Fe/25Å MgO/100Å Fe samples, the MgO layer is sputtered directly from a MgO target. With XPS we proved, that there is no FeO between the Fe and MgO layers. To apply an exchange bias on the upper Fe layer, an antiferromagnetic layer FeMn is deposited on the trilayer. After post-annealing 1h@250°C we found a typically exchange bias field of 50 mT. First TMR measurements on this single crystalline TMR structures will be presented.

[1] S. Yuasa et al. Nature Materials 3, 868 (2004)
[2] S. Parkin et al. Nature Materials 3, 862 (2004)

MA 3.2 Mon 10:30 HSZ 103

Magnetic tunnel junctions with MgO barriers — •Volker Drewello, Xinli Kou, Jan Schmalhorst, Andy Thomas, and Günter Reiss — Bielefeld University, Nano Device Group, 33615 Bielefeld

Recently, there has been much excitement about the high tunneling magnetoresistance (TMR) values observed in magnetic tunnel junctions (MTJs) with crystalline magnesium oxide (MgO) barriers. These MTJs show vary large TMR values compared to those with amorphous aluminum oxide barriers.

We have investigated the TMR in MTJs with MgO barriers and several different electrode materials. The MTJs are prepared at ambient temperature in our DC magnetron sputtering chamber with a base pressure of 1.0×10^{-7} mbar. In this process the lower electrode is covered with a thin layer of Magnesium (Mg) to prevent oxidation during the sputtering of MgO. Then, the latter is directly sputtered on the Mg layer.

The different FM/Mg/MgO/FM layer systems show TMR values of up to about 120% depending on the electrode material. Furthermore, the thickness of the Mg and the MgO layers as well as the annealing temperature have been optimized yielding high TMR ratios. The results are compared with standard Alumina junctions.

MA 3.3 Mon 10:45 HSZ 103

Ab initio calculations of spin-dependent tunneling conductance in Fe/FeCo/MgO/Fe: Role of the interfaces — •Daniel Wortmann[1], Jussi Enkovaara[1,2], and Stefan Blügel[1] — [1]Institut für Festkörperforschung, Forschungszentrum Jülich, Germany — [2]CSC – Scientific Computing,Espoo, Finland

Magnetic tunneljunctions based on epitaxially grown MgO are currently the most promising system for magnetoelectonic applications like magnetic random access memory cells. Record high tunneling magnetoresistance values at room temperature have been achieved in such junctions [1]. We will present *ab initio* calculations of electron tunneling in Fe/MgO based tunneljunctions with the focus on the details of the interface structure and its influence on the the tunneling conductance. In particular we will show the differences which can be expected between a pure Fe/MgO/Fe junction and a Fe/Co/MgO/Fe system in which one or two monolayers of Co have been added at the interface as well as a Fe/FeCo/MgO/Fe junction in which a two-dimensional FeCo alloy is present at the interface. The calculations are carried out within the density-functional theory with the full-potential linearized augmented plane wave (FLAPW) method. The novel embedded Green function method enables us to treat semi-infinite junctions and to calculate the spin-dependent conductance[2].

[1] S. Yuasa *et al.*, Nature Materials **3**, 868 (2004); and S. Parkin *et al.*, *ibid*, 862 (2004)
[2] D. Wortmann, H. Ishida, and S. Blügel, Phys. Rev. B **65**, 165103 (2002); *ibid* **66**, 075113 (2002)

MA 3.4 Mon 11:00 HSZ 103

Noncollinear interface magnetism in Fe/FeO/MgO/Fe tunnel junctions: Effect on ballistic transport. — •Bogdan Yavorsky and Ingrid Mertig — Martin-Luther-Universität Halle-Wittenberg, Fachbereich Physik, Fachgruppe Theoretische Physik, D-06099, Halle, Germany

On the basis of *ab initio* total energy calculations made within the screened Korringa-Kohn-Rostoker method we discuss the possibility of formation of noncollinear magnetic structures near the FeO layer in the Fe/FeO/MgO/Fe tunnel junction. The competition between intrinsic antiferromagnetism of iron oxide and ferromagnetism of pure iron was shown to result in stabilization of an intermediate tilted configuration at the interface. Variation of the angle of tilting θ causes significant changes in the ballistic conductance of the junction. In particular, at $\theta \approx 75°$ the local density of states of Fe in the FeO layer has an interface state which forms a resonance of the conductance.

MA 3.5 Mon 11:15 HSZ 103

Co_2FeSi an alternative for the Co_2MnSi Heusler electrode integrated in magnetic tunnel junctions — •Daniel Ebke[1], Ning-Ning Liu[1], Marc Sacher[1], Jan Schmalhorst[1], Günter Reiss[1], and Andreas Hütten[2] — [1]Universität Bielefeld, Universitätsstrasse 25, D-33615 Bielefeld, Germany — [2]Forschungszentrum Karlsruhe GmbH, Institut für Nanotechnologie, Hermann-von-Helmholtz-Platz 1, D-76021 Karlsruhe, Germany

Recently, we have shown that the tunnel magnetoresistance of magnetic tunnel junctions containing the half metallic Heusler alloy Co_2MnSi as lower magnetic electrode is limited to about 108% TMR-effect at 20K. This can be associated with the oxygen affinity of the Mn resulting in a MnSiOx- enriched layer at the tunnel barrier. To avoid this step like barrier we have started to integrate another Heusler alloy, Co_2FeSi, as a magnetic electrode which is very promising due to its high Curie temperature of 1100K. In this presentation the evolution of the TMR-effect amplitude at room temperature is discussed as a function of preparation conditions and the width of the AlOx-tunnel barrier. We will present XAS measurements revealing the Vanadium diffusion through the Co_2FeSi layer deteriorating the atomic order at the Co_2FeSi/AlOx-interface. Thus, to enhance the TMR-effect MgO was tested as a new seed layer so as to avoid the Vanadium. In addition, multilayered Heusler electrodes consisting of $\{Co_2MnSi_{xnm}/Co_2FeSi_{xnm}\}_N$ have been prepared to increase the atomic ordering of the Co_2FeSi compound. The resulting TMR-effect amplitudes will be shown as a function of temperature and will be discussed in combination with magnetic and XRD measurements.

MA 3.6 Mon 11:30 HSZ 103

Characteristics of the half-metallic character of Co_2MnSi Heusler alloy — •Ning-Ning Liu[1], Daniel Ebke[1], Marc Sacher[1], Jan Schmalhorst[1], Günter Reiss[1], and Andreas Hütten[2] — [1]Fakultät für Physik, Universität Bielefeld, D-33615 Bielefeld, Germany — [2]Institut für Nanotechnologie, Forschungszentrum Karlsruhe GmbH, Hermann-von-Helmholz-Platz 1, D-76021 Karlsruhe, Germany

Co_2MnSi is an attractive material to be used as magnetic electrode in magnetic tunnel junctions (MTJs). This is due to the half metallic character predicted by band structure calculation and to its high Curie temperature of 986K, indicating the potential for future magnetoelectronic and spintronic applications. A tunnel magnetoresistance (TMR)

of currently 108% at 20K has been achieved, and is associated with a Co_2MnSi spin polarization of 70%. The corresponding room temperature value of TMR is 42%. A new technique has been used in order to relay on a wedge shaped AlOx tunnel barrier. The current limitation to achieve larger TMR has been identified as a direct consequence of the oxygen affinity of the Co_2MnSi - Heusler element Mn. Dependences of annealing temperatures, different oxidation times, and additional interlayers between heusler alloy and tunnel barrier on the TMR behavior have been investigated and will be discussed in detail.

MA 3.7 Mon 11:45 HSZ 103

How many crystalline interface layers are necessary to create high TMR? — •Christian Heiliger, Peter Zahn, and Ingrid Mertig — Martin Luther University, FB Physik, FG Theorie, D-06099 Halle, Germany

Recent experiments [1-3] based on epitaxially grown Fe/MgO/Fe samples shed light on the subject of tunneling magnetoresistance (TMR). First of all, the obtained TMR ratios exceed the predictions by Julliere's model. Second, the measured bias voltage characteristic shows features which could be related to the electronic structure of the system. The high crystallinity of the samples [1-3] seemed to be the reason. New experiments [5], however, demonstrate that even amorphous electrodes attached to a crystalline MgO barrier show a TMR of more than 230%. The question that is addressed in this talk is: How many crystalline metal layers close to the interface are necessary to obtain high TMR?

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.

The results demonstrate that only a few crystalline ferromagnetic layers cause a significant spin-polarisation and TMR.

[1] J. Faure-Vincent et al., Appl. Phys. Lett. **82**, 4507 (2003)
[2] S. Yuasa et al., Nature Materials **3**, 868 (2004)
[3] S.S.P. Parkin et al., Nature Materials **3**, 862 (2004)
[4] K. Tsunekawa et al., Appl. Phys. Lett. **87**, 072503 (2005)

MA 3.8 Mon 12:00 HSZ 103

Tunneling Magneto Resistance in Co-Fe-B/Al-Ox Magnetic Tunnel Junctions — •Oliver Schebaum[1], Andy Thomas[1], Hubert Brückl[2], and Günter Reiss[1] — [1]Bielefeld University, Nano Device Group, Universitätsstrasse 25, 33615 Bielefeld — [2]ARCS research GmbH, Division "Nano System Technology", Tech Gate Vienna, Donau-City-Strasse 1, 1220 Vienna, Austria

We investigated the effect of Co-Fe-B as the free and the pinned magnetic layer in magnetic tunnel junctions (MTJs). The lower electrode was exchange-bias coupled to MnIr and Al-Ox was used as a tunnel barrier. The samples were prepared by dc/rf-magnetron sputtering in a UHV chamber with a base pressure of 1×10^{-7} mbar. The metallic Aluminum was oxidized utilizing electron cyclotron plasma oxidation in a pure Oxygen.

We measured the influence of different B compositions of the electrodes using sputter-targets with 5% and 12% of B [Co 70%/Fe 25%/B 5%; Co 62%/Fe 26%/B 12%]. Furthermore, we optimized the samples yielding high TMR ratios by varying the thickness of the Al-Ox barrier.

The TMR effect of the samples prepared with a 5% B target decreased (38% @ RT) compared with standard MTJs consisting of Co-Fe and Ni-Fe electrodes (52% @ RT). However, the 12% B electrodes raised the TMR ratio to 72% at RT when reducing the Al thickness (before oxidation) to 1.2nm (compared to 1.4nm in our standard MTJs). Low temperature measurements showed a TMR value of 114% at 21K and possible explanations for this behavior are discussed.

MA 3.9 Mon 12:15 HSZ 103

Interfacial microstructure of Fe/AlOx/Fe-magnetic tunnel junctions in high resolution — •Holger Schmitt[1], Jens Ellrich[1], and Horst Hahn[1,2] — [1]Forschungszentrum Karlsruhe GmbH, Institute for Nanotechnology, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany — [2]Technische Universität Darmstadt, Joint Research Laboratory Nanomaterials, Petersenstrasse 23, 64287 Darmstadt, Germany

Tunneling Magneto Resistance (TMR) systems were prepared by deposition of a Ta-buffered Fe-AlO_x-Fe-trilayer on a thermally oxidized Silicon wafer. In order to investigate the influence of the different Fe-oxides on the TMR effect, a ^{57}Fe tracer was deposited at the lower barrier interface. Using Conversion Electron Mössbauer Spectroscopy (CEMS) the chemical, structural and magnetic changes were followed from the as-prepared state and after several annealing steps. The nuclear probe technique can resolve different phases at the interface with submonolayer resolution. In addition, Transmission Electron Microscopy and X-Ray Reflectivity have been applied to complete the insight into the interfacial structure and to correlate to magnetoresistance of the trilayers. The results indicate the formation of a spinel-like phase and a spinel (Hycernite), in expense of the pure iron oxide Fe_2O_3, produced by a slight overoxidation of the barrier during its preparation. The changes at the interface are correlated to the changes of the TMR effect during annealing.

MA 3.10 Mon 12:30 HSZ 103

Induced magnetic anisotropy effects on the transport properties of magnetic tunnel junctions — •Voicu Popescu and Hubert Ebert — Department Chemie/Physikalische Chemie, University of Munich, Butenandtstr. 5-13, 81377 Munich, Germany

We report results of calculations on the electronic, magnetic and transport properties of Fe/GaAs/Fe and Fe/GaAs/Au/Fe magnetic tunneling junctions (MTJs) that have been obtained using the tight-binding Korringa-Kohn-Rostoker Green function method in a spin-polarised fully relativistic formulation (TB-SPR-KKR). This approach, by coupling the electron spin and orbital degrees of freedom, allows one to properly account for the changes induced in the electronic transport when different magnetic configurations, e.g., in-plane and out-of-plane, are considered.

Recent experimental work on MTJs based on diluted magnetic semiconductors have shown that, while keeping the orientation of the magnetisation in the plane of the junction but varying its azimuthal angle, a measurable dependence of the resistance with respect to this angle can be observed. This phenomenon is now commonly termed as Tunneling Anisotropic Magnetoresistance (TAMR).

We have performed analogous theoretical investigations on MTJs based on metallic (ferromagnetic or non-magnetic) leads. Our results show that a similar dependence is obtained also for such systems and it can be related to the spin-orbit coupling induced magnetic anisotropy at the metal/semiconductor interface. This, in turn, is shown to vary for different terminations (As or Ga) of the semiconductor, revealing the role of the covalent bonding at the interface.

MA 3.11 Mon 12:45 HSZ 103

Anisotropic magnetoresistance and spin-valve effect in all-metal mesoscopic spin-valve devices — •Alexander van Staa, Ulrich Merkt, and Guido Meier — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Jungiusstraße 11, 20355 Hamburg

Only in a few experiments all-electrical spin injection and detection in normal metal structures has been demonstrated [1]. We investigate all-metal lateral spin-valve devices with and without tunneling barriers. The devices consist of two permalloy electrodes and an interconnecting aluminum strip. The micromagnetic behavior of the device has been imaged with a magnetic-force microscope in external magnetic fields at room temperature. During a single cooling cycle at temperatures between 2 and 120 K we have measured the anisotropic magnetoresistance of both electrodes and the magnetoresistance of the entire device. In the latter we can clearly identify the contributions of the anisotropic magnetoresistance and the mesoscopic spin-valve effect [2].

[1] F.J. Jedema, M.S. Nijboer, A.T. Filip, and B.J. van Wees, Phys. Rev. B **67**, 085319 (2003).
[2] A. van Staa, C.M.S. Johnas, U. Merkt, and G. Meier, Superlatt. Microstruct. **37**, 349 (2005); A. van Staa and G. Meier, submitted (2005).

MA 4 Magnetic Materials I

Time: Monday 10:15–12:45 Room: HSZ 401

MA 4.1 Mon 10:15 HSZ 401

Observation of two ferromagnetic phases in Co-doped rutile TiO_2 — •A. Nefedov[1], N. Akdogan[1], A Westphalen[1], R. Khaibullin[2], L. Tagirov[2], and H. Zabel[1] — [1]Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, 44780 Bochum, Germany — [2]Kazan Physical-Technical Institute of RAS, 420029 Kazan, Russia

Oxide based diluted magnetic semiconductors have recently attracted considerable attention because of reports of room temperature ferromagnetism in several systems and their projected potential for spintronic devices. However, subsequent reports have raised concerns about the initially suggested intrinsic nature of ferromagnetism in this material.

The magnetic properties of Co-doped TiO_2 synthesized by ion implantation with different implantation doses have been studied using MOKE, SQUID and XRMS methods. We observe paramagnetic behaviour for low dose doped sample, but obtain clear ferromagnetic behaviour for intermediate and high dose doped samples. The drastical change of the hysteresis loop shape at the transition from the intermediate to high Coimplantation doses, demonstrating a presence of 2 ferromagnetic phases in Co-doped rutile TiO_2, has been observed. Origin of these 2 phases will be discussed during the talk.

This work was partially supported by DFG through SFB 491 and by RFBR through grant no. 04-02-97505. N Akdogan acknowledges a fellowship through the Max-Planck Research School "SurMat".

MA 4.2 Mon 10:30 HSZ 401

Correlation in the transition metal based Heusler compounds Co_2MnSi and Co_2FeSi — •Hem Chandra Kandpal, Gerhard H. Fecher, and Claudia Felser — Johannes Gutenberg - Universität, 55099 Mainz, Germany

Half-metallic ferromagnets like the full Heusler compounds are supposed to show an integer value of the magnetic moment. Calculations reveal for Co_2FeSi a non-integer value, in contrast to experiments. In order to explain deviations of the calculated magnetic moment, the dependency of the electronic structure on the lattice parameter was studied theoretically. In LSDA, the minimum total energy of Co_2FeSi is found for the experimental lattice parameter, but the calculated magnetic moment is about 12% too low. Half-metallic ferromagnetism and a magnetic moment equal to the experimental value of $6\mu_B$ are found, however, only after increasing the lattice parameter by more than 6%.

To overcome this discrepancy, the LDA+U scheme was used to include electron correlation in the calculations. The calculations revealed that an effective Coulomb-exchange interaction $U_{eff} = U - J$ in the range of about 2eV to 5eV leads to half-metallic ferromagnetism and the measured, integer magnetic moment at the measured lattice parameter. Finally, it is shown in the case of Co_2MnSi that correlation may also serve to destroy the half-metallic behaviour if it becomes too strong (for Co_2MnSi above 2eV and for Co_2FeSi above 5eV). These findings indicate that on-site correlation may play an important role in the description of Heusler compounds with localized moments. (This work is funded by the DFG in FG 559.)

MA 4.3 Mon 10:45 HSZ 401

Structural and physical properties of the quarternary Heusler alloys $Co_2Mn_{1-x}Fe_xSi$: A search for the optimal material for spintronic devices — •Benjamin Balke, Hem Chandra Kandpal, Vadim Ksenofontov, Gerhard H. Fecher, and Claudia Felser — Johannes Gutenberg - Universität, 55099 Mainz, Germany

The strucural and magnetic properties of the quarternary Heusler alloys $Co_2Mn_{1-x}Fe_xSi$ ($x = 0, 0.1, \ldots, 1$) were investigated by means of X-ray diffraction, SQUID magnetometry, ESCA, ^{57}Fe Mößbauer spectroscopy, and differential scanning calometry messurments. The pure Co_2MnSi compound is allready used as an electrode in magnetic tunnel juctions. Previous LSDA calculations predicted Co_2MnSi to be a half-metallic ferromagnet with a spinpolarisation of 100%, a value that could not be verified by experiments up to now. Recent investigations of the electronic strucutre of Heusler compounds gave advice that on-site correlation plays a role in these componds and may serve to destroy the half-metallic properties of Co_2MnSi. At the same time Co_2FeSi becomes a half-metallic ferromagnet if on-site correlation is respected in electronic structure calculations.

This investigation focuses on the search of a mixed compond where the half-metallic behaviour is stable against the variation of on-site correlation. (This work is funded by the DFG in FG 559.)

MA 4.4 Mon 11:00 HSZ 401

Structural properties of the quaternary Heusler alloy $Co_2Cr_{1-x}Fe_xAl$. — •Jonder Morais[1], Sabine Wurmehl[2], Maria do Carmo M. Alves[1], Sergio R. Teixeira[1], Giovanna Machado[1], Vadim Ksenofontov[2], Gerhard H. Fecher[2], and Claudia Felser[2] — [1]Universidade Federal do Rio Grande do Sul, 91501-970 Porto Alegre, Brazil — [2]Johannes Gutenberg - Universität, 55099 Mainz, Germany

The structural and chemical properties of the Heusler alloy $Co_2Cr_{1-x}Fe_xAl$ (x=0, 0.4, and 1) were investigated comparing powder and bulk samples. The long range order was determined by means of X-ray diffraction and neutron diffraction, while the site specific (short range) order was proved by the extended X-ray absorption fine structure method (EXAFS). The magnetic structure was determined by means of ^{57}Fe Mößbauer spectroscopy in transmission mode as well as in X-ray scattering mode in order to compare powder and bulk properties. The chemical composition was analysed by means of X-ray photo emission spectroscopy (XPS) combined with Auger electron spectroscopy (AES) depth profiling. The results from these methods are compared explain the differences between surface and bulk properties and the appearance of disorder in such alloys. (This work is funded by the DFG in FG 559.)

MA 4.5 Mon 11:15 HSZ 401

Bulk sensitive photoemission spectroscopy of the quaternary Heusler alloy $Co_2Cr_{0.6}Fe_{0.4}Al$. — •Sabine Wurmehl[1], Gerhard H. Fecher[1], Kristian Kroth[1], Florian Kronast[2], Hermann A. Dürr[2], Yukiharu Takeda[3], Yuji Saitoh[3], Keisuke Kobayashi[3,4], Gerd Schönhense[1], and Claudia Felser[1] — [1]Johannes Gutenberg-Universität, 55099 Mainz, Germany — [2]BESSY, 12489 Berlin, Germany — [3]Spring-8 / JAERI, Hyogo, 679-5198, Japan — [4]Spring-8 / JASRI, Hyogo, 679-5198, Japan

Quaternary Heusler alloy $Co_2Cr_{0.6}Fe_{0.4}Al$ was investigated experimentally and theoretically. The electronic structure and spectroscopic properties were calculated using the full relativistic Korringa-Kohn-Rostocker method with coherent potential approximation to account for the random distribution of Cr and Fe atoms as well as random disorder.

Resonant (560eV - 800eV) soft X-ray as well as high resolution - high energy (3.5keV, 8keV) hard X-ray photoemission was used to probe the density of the occupied states in $Co_2Cr_{0.6}Fe_{0.4}Al$. It was found by resonant and high energy photoemission that there is a discrepancy between the experimentally observed and the theoretically calculated density of states in $Co_2Cr_{0.6}Fe_{0.4}Al$. This observation suggests the presence of correlation in Heusler compounds being not accounted for by local (spin) density approximation in its current form. Moreover, strong differences in surface and bulk photoemission spectra reveal the loss of the bulk and structure signature if emission takes mainly place from the surface layer. (This work is funded by the DFG in FG 559.)

MA 4.6 Mon 11:30 HSZ 401

Directional solidification of Ni48Mn30Ga22 — •Martin Pötschke, Uwe Gaitzsch, Stefan Roth, Bernd Rellinghaus, and Ludwig Schultz — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

NiMnGa alloys are among the most intensively studied magnetic shape memory (MSM) materials. The MSM effect is caused by the movement of twin boundaries in a magnetic field. So far, this effect has only been observed in single crystals. The preparation of single crystals, however, is a long time process and thus expensive, and compositional changes along the crystal axis may arise.To expand the MSM effect to polycrystals, directional solidification was applied in order to prepare coarse grained, textured samples. The technique of stationary casting in a preheated ceramic mold mounted on a copper plate was chosen to provide a heat flow towards the bottom of the mold and therefore a directional solidification in the opposite direction. In order to allow for a direct investigation of the resulting microstructure by EBSD measurements, an alloy composition with a martensitic transformation temperature below room temperature was chosen. The transformation temperature was checked by DSC. The preferred growth direction was determined by EBSD.

MA 4.7 Mon 11:45 HSZ 401

Magnetic switching by twin boundary motion in NiMnGa shape memory ferromagnets — •Uwe Gaitzsch, Martin Pötschke, Stefan Roth, Bernd Rellinghaus, and Ludwig Schultz — IFW Dresden, P.O. Box 270116, 01171 Dresden

Magnetic shape memory materials gained a large research interest owing to their capability to deform by some percent via twin boundary motion under the influence of a magnetic field. Concurrently, they are supposed to react faster than conventional shape memory materials because neither heating nor cooling are involved. In our case off-stoichiometric Ni5Mn3Ga2 is used to produce a polycrystalline textured samples. Upon cooling this alloy transforms to a martensitic state at roughly 100°C. The evolving martensitic structure is either orthorhombic or tetragonal and depends on the thermomechanical history of the sample. Since only one of the two possible structures is suitable of providing the mandatory highly moblile twin boundaries, it is important to understand and control the phase formation process by appropriate thermal and mechanical treatment. Once the sample is given a suitable structure, samples for magnetomechanical testing are cut and investigated in magnetic fields of up to 0,8 T in compression tests. In this device the strain up to the crystallographic limit of reference samples could be determined.

MA 4.8 Mon 12:00 HSZ 401

Magnetic shape memory effect in the paramagnetic state of $R\mathrm{Cu}_2$ (R = rare earth) — •Sebastian Raasch[1], Mathias Doerr[1], Andreas Kreyssig[1], Michael Loewenhaupt[1], Martin Rotter[2], and Jens-Uwe Hoffmann[3] — [1]Germany, Technische Universität Dresden, Institut für Festkörperphysik — [2]Austria, University of Vienna, Institute for Chemistry — [3]Germany, Hahn-Meitner-Institut Berlin

We like to present $R\mathrm{Cu}_2$ (R = rare earth) as the first magnetic shape memory (msm) alloy with the magnetic anisotropy of rare earth ions as impelling force. Besides $\mathrm{La}_{2-x}\mathrm{Sr}_x\mathrm{CuO}_4$ $R\mathrm{Cu}_2$ is the second known antiferromagnetic msm-compound class. However, magnetic order is not necessary for the msm effect here. Microstructural changes are possible even above magnetic ordering temperature because the magnetic anisotropy is effective also in the paramagnetic state. $R\mathrm{Cu}_2$ compounds have a pseudohexagonal orthorhombic structure which leads to the fact of three twin variants, each rotated about 60 deg to the others along the pseudohexagonal b axis. To our knowledge $R\mathrm{Cu}_2$ compounds exist exclusively in the martensitic pseudohexagonal state. To move the twin boundaries, a magnetic field of about 3.2 T and a temperature of typical 30 K is necessary. This moving of twin boundaries correlates with magnetostriction measurements, showing a typical length change of two percent. Depending on the field direction a certain twin variant is favored. We will present neutron data from $\mathrm{Tb}_{0.5}\mathrm{Dy}_{0.5}\mathrm{Cu}_2$ confirming a change of the volume fraction of the three twin-variants. The combination of rare earth magnetizm with the msm effect defines a promising field of science.

MA 4.9 Mon 12:15 HSZ 401

NiMnGa fibres for use in polymer composites — •Nils Scheerbaum, Dietrich Hinz, Oliver Gutfleisch, and Ludwig Schultz — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

Composites made of polymer and magnetic shape memory particles (MSM particles) may be used as actuators or as mechanical energy absorber for damping applications. Ideally, the MSM particles should be, at the operating temperatures, in the martensitic state and single-crystalline when in the austenitic state. Fibres of 51Ni-27Mn-22Ga (at.%) were prepared by crucible melt extraction. Their size is about 60μm in diameter and 1cm in length. The structural and magnetic properties of the fibres are similar to those of bulk material with the same composition. The grain size of the meltextracted fibres was determined by SEM to about 5μm. In order to achieve grain growth, the fibres were annealed at 1000-1100°C. After annealing, the grain size is in the order of the diameter of the fibres. Also the martensite start and the Curie temperature are affected by the annnealing (varified by DSC and susceptometry). They increase from 30°C to 45°C and from 88°C to 98°C respectively. XRD analyses reveal that the austenite is cubic and that the martensite is tetragonal with the 5M modulation and c/a=0.94. First composites were prepared using different polymers and the fibres applying various magnetic fields to align the MSM particles.

MA 4.10 Mon 12:30 HSZ 401

First-principles investigation of Co wires at Pt(111) step-edges — •Gustav Bihlmayer[1], Stéphanie Baud[2], Christophe Ramseyer[2], and Stefan Blügel[1] — [1]Forschungszentrum Jülich, Institut für Festkörperforschung, Jülich, Germany — [2]Laboratoire de physique moléculaire, UMR CNRS 6624, Besançon, France

We investigate Co wires of different width deposited on step-edges of Pt(111), simulated by a Pt(664) surface. The calculations were preformed within the framework of the density functional theory using the FLAPW method. An adsorbed Co chain showed a magnetic anisotropy energy (MAE) and easy axis in good agreement with experimental data [1]. Inclusion of relaxations turned the easy axis even more in the direction of the upper terrace and quenched the orbital moments and their anisotropy. While this seems unfavorably in comparison to experiment, we argue – based on a decomposition of the contribution to the MAE of the different atoms (Pt or Co) – that relaxations might be an essential part of the calculations including orbital polarizations. We investigated also the evolution of the easy axes and the MAE as function of the number of Co chains deposited on the stepped surface. The results nicely compare to those obtained experimentally [2]. We present a simple model to account for the experimentally observed oscillations of the easy axis.

[1] P.Gambardella et al. Nature 416, p.301 (2002)
[2] P.Gambardella et al. Phys. Rev. Lett. 93 077203 (2004)

MA 5 Spin-Structures and Magnetic Phase Transitions I

Time: Monday 10:15–13:00 Room: HSZ 403

MA 5.1 Mon 10:15 HSZ 403

Field induced incommensurate to commensurate magnetic transition in multiferroic TbMnO_3 — •Nadir Aliouane, Dimitri Argyriou, and Sven Landsgesell — Hahn-Meitner-Institut, Glienicker Str. 100, Berlin D-14109, Germany

TbMnO_3 is an improper ferroelectric that exhibits a flop in its electric polarization (P) with applied magnetic field (H) from $P\|c$ to $P\|a$. It is argued that ferroelectricity here arises from a spiral spin phase that breaks inversion symmetry. We have used in-field neutron single crystal diffraction to monitor changes in the complex magnetic structure of this material as a function of magnetic field up to 14T and temperature. We show that the flop in the electric polarization that occurs at ∼9T and ∼5T for H along the $a-$ and $b-$axis respectively coincides with a 1st order transition to a commensurate magnetic phase with propagation vector $(0, \frac{1}{4}, 0)$. On the basis of this commensurate magnetic phase we propose a model of structural distortions that correctly predicts the polarization direction of the high field phase.

MA 5.2 Mon 10:30 HSZ 403

Magnetic field induced linear magneto-elastic coupling in multiferroic TbMnO_3 — •J. Strempfer[1], N. Aliouane[2], B. Bohnenbuck[1], D. Argyriou[2], I. Zegkinoglou[1], and M. von Zimmermann[3] — [1]MPI/FKF, Heisenbergstr. 1, 70569 Stuttgart — [2]HMI, Glienicker Str. 100, 14109 Berlin — [3]HASYLAB/DESY, Notkestr. 85, 22605 Hamburg

The multiferroic compound TbMnO_3 was investigated in high magnetic fields up to 10T using high-energy x-ray diffraction, with the field oriented along all three crystallographic directions. Structural superlattice reflections at positions $(0, \delta_m, 1)$ and $(0, 2\delta_m, 1)$ were investigated as a function of field and temperature. For $H||a$ and $H||b$, a transition from incommensurate to commensurate wave vectors is observed which coincides with the polarization flop from $P||c$ to $P||a$. Whereas at zero field only second order structural superlattice reflections are observed, first order superlattice reflections appear at finite fields which are linearly increasing in intensity with the applied magnetic field. This suggests that the quadratic magneto-elastic coupling breaks down with applied magnetic field and linear magneto-elastic coupling is induced.

MA 5.3 Mon 10:45 HSZ 403

Phase diagram of the multiferroic $GdMnO_3$ studied by thermal expansion and magnetostriction — •J. Baier[1], D. Meier[1], V. Ivanov[2], A. Mukhin[2], A. Balbashov[3], J. Hemberger[1,4], and T. Lorenz[1] — [1]II. Phys. Institut, University of Cologne, Germany — [2]General Physics Institute, Russian Academy of Sciences, Moscow, Russia — [3]Moscow Power Engineering Institute, Moscow, Russia — [4]Institut f. Physik, University of Augsburg, Germany

Recently, the discovery of very large magnetoelectric effects in rare earth manganites $R\mathrm{MnO_3}$ has reopened the field of the so called multiferroic materials [1]. We present a study of the phase diagram of multiferroic $GdMnO_3$ by thermal expansion $\alpha(T,H)$ and magnetostriction $\epsilon(H,T)$. $GdMnO_3$ shows an incommensurate antiferromagnetic order (ICAFM) below $T_N \simeq 43\,\mathrm{K}$. Further decrease of temperature leads to a canted A-type antiferromagnetic ordering (cAFM) below $T_{\mathrm{lock}} \simeq 23\,\mathrm{K}$. Above a critical magnetic field along the b direction ferroelectric order (FE, $\boldsymbol{P}||a$) emerges below $T_c \simeq 10\,\mathrm{K}$ [1]. In zero magnetic field, we already observe an anomalous and anisotropic thermal expansion, but upon applying a magnetic field, very strong, new anomalies arise at the cAFM and ferroelectric phase boundary. Both phase transitions are of first-order type and display a very strong hysteresis. Furthermore we observe a down-bending of the ICAFM-to-cAFM boundary (T_{lock}) at low magnetic fields.

[1] T. Kimura *et al.*, Nature **426**, 55 (2003), T. Kimura *et al.*, PRB **71**, 224425 (2005)

Supported by the DFG through SFB 608

MA 5.4 Mon 11:00 HSZ 403

Elastomagnetic coupling of the ferrimagnetic semiconductor $FeCr_2S_4$ studied with surface acoustic waves — •Claus Müller[1], Veaceslav Zestrea[2], Vladimir Tsurkan[1,2], Siegfried Horn[1], Reinhard Tidecks[1], and Achim Wixforth[1] — [1]Institut für Physik, Universität Augsburg, D-86159, Augsburg, Germany — [2]Institute of Applied Physics, Academy of Sciences of Moldova, MD-2028, Chisinau, R. Moldova

A thin single crystalline plate of the ferrimagnetic semiconductor $FeCr_2S_4$ was attached to the sound path of a surface acoustic wave (SAW) delay line. We investigated the attenuation and frequency tracking of the probing SAW in the temperature range from 4.2K to 200K. The same anomalies as in low-field magnetization measurements were seen. Since there is no coincidence of these anomalies with changes of the sheet conductance, they are related to structural transformations.

MA 5.5 Mon 11:15 HSZ 403

Complex Magnetic Ordering Process in the Frustrated A-Site Thiospinel $MnSc_2S_4$ — •M. Mücksch[1,2], A. Krimmel[1], A. Podlesnyak[3], D. Sheptyakov[3], A. Cervellino[3], V. Tsurkan[1,4], C. Ritter[2], M.M. Koza[2], H. Mutka[2], S. Horn[1], and A. Loidl[1] — [1]Institut für Physik, Universität Augsburg, D-86159 Augsburg, Germany — [2]Institut Laue-Langevin, BP 156 X, F-38042 Grenoble, France — [3]Laboratory for Neutron Scattering, ETHZ & PSI, CH-5232 Villigen PSI, Switzerland — [4]Institute of Applied Physics, Academy of Sciences of Moldova, MD-2028 Chisinau, Moldova

Extensive neutron scattering experiments have been performed to study the frustration effects in the magnetic A-site sulphur spinel compound $MnSc_2S_4$. Starting from the paramagnetic state above 23K a crossover to a fluctuating spin liquid phase is observed for $T \leq 23\mathrm{K} \approx |\theta_{CW}|$. Approaching the magnetic ordering temperature at $T_{N2} = 2.3\mathrm{K}$ we discovered a broad double peak structure of the magnetic intensity around Q-positions corresponding to the $(0.75, 0.75, 0)$ and $(1, 0, 0)$ reciprocal lattice positions, respectively. On further cooling, for $1.9\mathrm{K} = T_{N1} \leq T \leq T_{N2} = 2.3\mathrm{K}$ the peak at $(0.75, 0.75, 0)$ sharpens and becomes dominant in intensity, whereas the intensity centered around $(1, 0, 0)$ remains broad before completely vanishing at $T_{N1} = 1.9\mathrm{K}$. This behaviour can be interpreted as a lock-in transition from an incommensurate to a commensurate structure with decreasing temperature at T_{N1}. The ground state magnetic structure of $MnSc_2S_4$ is a cycloid within the (a, b)-plane characterised by a propagation vector $\mathbf{q} \approx (0.75, 0.75, 0)$. Below T_{N1} well defined dispersive spin-wave excitations emerge.

MA 5.6 Mon 11:30 HSZ 403

LDA+U Picture of the Moment and Volume Collapse under Pressure in MnO — •Deepa Kasinathan[1], Jan Kunes[1], Klaus Koepernik[2], and Warren Pickett[1] — [1]University of California,Davis, CA 95616 — [2]IFW Dresden, P.O.Box 270116, D-01171, Dresden, Germany

The transition metal monoxide MnO crystallizes in the rock-salt structure and is a high-spin antiferromagnetic insulator at low temperatures. Under pressure, experimentally it is observed to undergo a metal-insulator transition after a structural change to the nickel arsenide phase. As the first step in a concerted effort to obtain a realistic theory of the pressure behavior of MnO, we have performed full potential local orbital (FPLO) LDA+U calculations in the rock-salt phase. Within the rocksalt phase we obtain a first order moment and volume collapse at specific volume $\mathrm{V/V_0} \approx 0.61$, very close to the experimental volume. The moment collapse is from high spin state 5/2 to a low spin state 1/2, along with a 8% decrease in volume. The magnetic transition is mainly governed by the oxygen coordination. The strong influence of symmetry-lowering (cubic to rhombohedral) by antiferromagnetism is noticed with the single occupancy of the five 3d orbitals before and after collapse (*i.e.* total L = 0). Calculations in the high pressure regime shows that the system stabilizes in the antiferromagnetic NiAs structure, in par with the observed experimental results.

MA 5.7 Mon 11:45 HSZ 403

Orbital polarization and the metal-insulator transition in Ti2O3 — •Chun-Fu Chang[1], Holger Ott[1], Zhiwei Hu[1], Maurits W. Haverkort[1], Hua Wu[1], H. H. Hsieh[2], H. -J Lin[3], C. T. Chen[3], and Liu Hao Tjeng[1] — [1]II. Physikalisches Institut, Universität zu Köln, Zülpicher Str. 77, 50937 Köln, Germany — [2]Chung Cheng Institute of Technology, National Defense University, Taoyuan 335, Taiwan — [3]National Synchrotron Radiation Research Center, 101 Hsin-Ann Road, Hsinchu 30076, Taiwan

Ti2O3 undergoes a broad metal-insulator transition (MIT) at around 400-600 K without a change in the symmetry of the corundum structure. There is a long-standing debate about the mechanism of this unusual MIT. We have set out to do polarization-dependent x-ray absorption spectroscopy measurements and cluster calculations using the configuration interaction model. We have found that the dimer effect of the vertical Ti-Ti pairs play a crucial role in the MIT. Our results point out that a gradual change of the orbital occupation of the Ti 3d states accompanies this abnormally broad transition. This orbital redistribution assists the MIT in a manner that the intersite exchange interaction of Ti-Ti pair is reduced and the effective in-plane band widths of the Ti 3d states are increased.

MA 5.8 Mon 12:00 HSZ 403

Orbital ordering and spin gap in ruthenate $La_4Ru_2O_{10}$ — •Hua Wu[1], T. Burnus[1], Z. Hu[1], J.D. Denlinger[2], L.-Y. Jang[3], H.H. Hsieh[4], P.G. Khalifah[5], F. Wang[6], J.W. Allen[6], K.S. Liang[3], D.I. Khomskii[1], and L.H. Tjeng[1] — [1]II. Physikalisches Institut, Universität zu Köln, Zülpicher Str. 77, 50937 Köln, Germany — [2]Advanced Light Source, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA — [3]National Synchrotron Radiation Research Center, 101 Hsin-Ann Road, Hsinchu 30076, Taiwan — [4]Chung Cheng Institute of Technology, National Defense University, Taoyuan 335, Taiwan — [5]Department of Chemistry, University of Massachusetts, Amherst, MA 01003, USA — [6]Randall Laboratory of Physics, University of Michigan, Ann Arbor, Michigan 48109, USA

It was discovered [P. Khalifah *et al.*, Science **297**, 2237 (2002)] that $La_4Ru_2O_{10}$ undergoes a rare 4*d*-orbital ordering transition below 160 K and acquires a spin gap. We study this interesting orbital-ordered spin-gap state both by x-ray absorption spectroscopy measurements and by LDA+U band calculations. Our results show that the Ru^{4+} ions remain in the normal spin=1 state. A distinct orbital ordering is identified, which leads to a significant anisotropy of antiferromagnetic exchange couplings. As a result, the spin gap is opened due to formation of the Ru^{4+}-Ru^{4+} spin-singlet dimers but not to the originally assumed spin-state transition. Thus, $La_4Ru_2O_{10}$ appears to be a novel orbital-ordering-assisted spin-ladder material.

MA 5.9 Mon 12:15 HSZ 403

Magneto-optical Anisotropy of UPtGe — •M. Marutzky[1], J. Schoenes[1], and R. Troc[2] — [1]Institut für Physik der Kondensierten Materie und Hochmagnetfeldanlage, TU Braunschweig, Mendelssohnstr. 3, D-38106 Braunschweig — [2]Institute for Low Temperature and Structure Research, Polish Academy of Sciences, P.O. Box 1410, 50-950 Wrocław, Poland

UPtGe crystallizes in an orthorhombic EuAuGe structure. It has an incommensurable helical spin structure with $T_N = 50$ K and two uranium sites with different magnetic moments. The magnetic and electrical properties of UPtGe are anisotropic [2]. Thereby the temperature dependence of the magnetization is similar along the *a*- and the *c*-direction, while *b* is the magnetic hard axis. Also the electrical properties are similar for *a* and *c* and different for *b*. The optical conductivity is anisotropic and merges in the dc-conductivity [3].
In this contribution the polar Kerr-rotation and -ellipticity from 1 to 4 eV of UPtGe single crystalls near T_N at 12 T are presented, with various orientations of the crystal axes relative to the magnetic field and the polarization vector of the light. The Kerr-spectra are affected by the magnetic and optical anisotropy and exhibit rotations up to 0.15°. The off-diagonal elements of the optical conductivity are calculated in order to discuss the electronic structure of UPtGe.
[1] D. Mannix et al., Phys. Rev. B **62**, 3801 (2000)
[2] R. Troć et al., Phys. Rev. B **69**, 094422 (2004)
[3] M. Marutzky et al., to be published

MA 5.10 Mon 12:30 HSZ 403

An NMR analysis of magnetically ordered $RMn_6Ge_{6-x}Ga_x$-compounds — •Jens Schnelzer, Richard Montbrun, and Elmar Dormann — Physikalisches Institut, Universität Karlsruhe (TH), D-76131 Karlsruhe

The $RMn_6Ge_{6-x}Ga_x$-compounds (R: Rare earth element) crystallize in the $HfFe_6Ge_6$-type structure, in which the Mn-sites are located in ferromagnetic Kagomé-nets. The R and the three inequivalent Ge-sites are arranged in hexagonal lattice sites. The influence of the variable Ga-proportion on the type of magnetic order is known and that on the NMR spectra are examined here. Spectra obtained by Nuclear Magnetic Resonance, showing zero-field ^{73}Ge,^{55}Mn and $^{69,71}Ga$ resonance positions, as well as the rf-power dependent behavior, will be presented for R=Lu,Tm,Er and Ho. They can be related to the x-dependent varying magnetic structure of these compounds.
We thank G. Venturini, Nancy, for providing the samples and the Graduiertenkolleg 284 (DPG) for financial support.

MA 5.11 Mon 12:45 HSZ 403

Skyrmionic textures in chiral magnets — •U.K. Rössler[1], A.N. Bogdanov[1], and C. Pfleiderer[2] — [1]IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany — [2]Physik Department E21, TU München, Germany

In certain non-linear field models particle-like localized states, so-called Skyrmions, can be stabilized. In condensed matter systems, Skyrmions and extended Skyrmionic textures exist, e.g., under non-equilibrium conditions in turbulent fluids, induced by external fields in Quantum Hall magnets, or stabilized by topological defects in the blue phases of liquid crystals. The talk presents new theoretical results on Skyrmionic magnetization structures in magnets with broken inversion symmetry. In these chiral systems, a particular exchange, so-called Dzyaloshinskii-Moriya interactions, stabilize vortex-like Skyrmions as string-like excitations and condensates of Skyrmions with the appearance of multiply modulated states. In phenomenological models for weakly ferromagnetic metals, Skyrmion lattices spontaneously arise as equilibrium phases. The theory explains the "partial magnetic order", recently found in the chiral ferromagnet MnSi, as a Skyrmionic texture. Magnetic Skyrmion lattices are predicted to exist quite generally in magnetic metal films owing to the broken inversion symmetry at surfaces.

MA 6 Invited Talks Vandersypen / Herper

Time: Monday 13:45–14:45 Room: HSZ 03

Invited Talk MA 6.1 Mon 13:45 HSZ 03

Read-out, relaxation and decoherence of electron spins in a quantum dot — •Lieven Vandersypen — Kavli Institute of NanoScience, Delft University of Technology, Lorentzweg 1, 2628 CJ Delft, The Netherlands

We have recently demonstrated two different techniques for single-shot measurement of the state of an individual electron spin in a semiconductor quantum dot, with measurement fidelities up to ˜90% [1,2]. The measurement relies on spin-to-charge conversion, combined with real-time detection of single-electron charges with a quantum point contact electrometer.

Using this readout technique, we have characterized the relaxation time, T1, for a single electron spin, as well as for two-electron spin states. In both cases, very long T1's are observed, of order 1 ms [1,2], consistent with theoretical predictions of spin-orbit dominated spin relaxation.

Phase randomization (characterized by T2), in contrast, is expected to be dominated by the randomly fluctuating hyperfine field caused by the nuclei in the semiconductor material. We have probed the effect of the nuclei via transport measurement through two dots in series, and observe a hyperfine field of about 1 mT. When averaging over different nuclear configurations, this implies an apparent dephasing time T2* of 25 ns. We can suppress its effect by applying a small external magnetic field or by increasing the interdot tunnel coupling [3].
[1] J. Elzerman et al., Nature 430, 431-435 (2004)
[2] R. Hanson et al., Phys. Rev. Lett. 94, 196802 (2005)
[3] F. Koppens, J. Folk, et al., Science, 309, 1346 (2005)

Invited Talk MA 6.2 Mon 14:15 HSZ 03

Electronic transport in ferromagnetic films and wires: An *ab initio* study — •Heike Herper — Theoretische Tieftemperaturphysik, Universiät Duisburg-Essen, Campus Duisburg, 47048 Duisburg, Germany

Domain walls can be viewed as special type of interfaces. In case of relatively thin domain walls a magnetoresistance effect can be expected due to the domain wall, which has been addressed in a considerable number of experimental and theoretical studies. However, only a few *ab initio* investigations have been done in this field. We have determined the influence of domain walls on the resistance of ferromagnetic Co and Ni layers employing the fully-relativistic, spin-polarized Screened Korringa-Kohn-Rostoker method (SKKR) and the Kubo-Greenwood formula. In order to investigate the magnetoresistance in systems with reduced dimensions like thin wires we have used a real-space SKKR and Kubo-Greenwood method. The magnetoresistance and the formation energy of the domain walls have been calculated depending on the thickness and the type of the domain wall. As expected, the formation energy decreases with increasing number of FM layers. Throughout the calculations all domain walls are assumed to be oriented parallel to the planes of the layers. To avoid contributions from the anisotropic magnetoresistance, the current is assumed to flow perpendicular to the domain walls, i.e. parallel to the surface normal. The domain wall resistance shows the same width dependence as predicted by Zhang and Levy.
This work is supported by the SFB 491.

MA 7 Micro- and Nanostructured Magnetic Materials I

Time: Monday 15:00–18:00 Room: HSZ 03

MA 7.1 Mon 15:00 HSZ 03

Electronic and Magnetic Properties of Single Cr, Triangles and Chains on W(110) — •Tim Wehling, Sergey Okatov, and Alexander Lichtenstein — I. Institut für Theoretische Physik, Universität Hamburg, Jungiusstraße 9, 20355 Hamburg

We study nano-scale systems of Cr single atoms, triangles and chains on the W(110) surface in comparison to bulk and film properties of chromium within the density functional theory. Total energy, magnetic and electronic properties as well as the crystal and the band structure of the system in question have been considered. Among the results the most interesting are the following: (i) In all the systems Cr appeared to be magnetic with $\mu = 3.0 - 3.4\mu_B$; (ii) The magnetic ordering of the chains strongly depends on their orientation. The type of magnetic ordering changes from antiferromagnetic (for chains along the $[1\bar{1}1]$-direction) to ferromagnetic (chains along [001]) likely according to the change in the distance between the Cr atoms.

MA 7.2 Mon 15:15 HSZ 03

Electronic structure of Co in ZnO Thin Films — •Huijan Zhou[1], Christoph Knies[1], Detlev M. Hofmann[1], Niklas Volbers[1], Jan Stehr[1], Swen Graubner[1], Bruno K. Meyer[1], Peter J. Klar[2], and Wolfram Heimbrodt[2] — [1]I. Physics Institute, Justus-Liebig-University Giessen, Heinrich-Buff-Ring 16, D-35392 Giessen, Germany — [2]Material Research Center and department of semiconductor physics, Renthof 5, LB2, D-35032 Marburg/Lahn, Germany

The concern of this work is to investigate cobalt doped ZnO thin films prepared via sol-gel methods. X-ray diffraction (XRD) and Raman spectroscopy are applied to monitor the crystal quality and the segregation phase of the film. Within the concerned doping concentration (0.5%-10%) XRD shows mainly the diffraction peaks from wurtzite ZnO (0002) and (0004) planes without secondary phases. No Co-related phonon modes are observed, as proved by Raman measurements in comparison with those of a pure CoO thin films. The ZnO:Co films have a typical grain size of 20-50 nm with a thickness of 300-500 nm. Fine structures of Co^{2+} (3d7) internal d-d absorption are well resolved. All zero phonon lines (ZPL) and phonon replica related to $^4T_1(F) \rightarrow {}^4A_2$ are observed, which demonstrates high crystal quality and the incorporation of Co^{2+} on Zn^{2+} lattice sites in a tetrahedral symmetry with a trigonal distortion. In the visible region transitions due to $^4A_2 \rightarrow {}^2T_1(G)$, $^4T_1(P)$, $^2A_1(G)$ processes are observed. Magnetic properties of ZnO:Co have been characterized. Electron paramagnetic resonance measurements are in agreement with the simulation of Co-doped ZnO powder. So far no evidence for ferromagnetism is obtained.

MA 7.3 Mon 15:30 HSZ 03

Control of magnetic anisotropy and magnetic patterning of perpendicular Co/Pt multilayer films by laser irradiation — •I. Guhr[1], C. Schuppler[1], A. Habenicht[1], M. Maret[2], P. Leiderer[1], J. Boneberg[1], and M. Albrecht[1] — [1]University of Konstanz, Department of Physics, 78457 Konstanz, Germany — [2]Laboratoire de Thermodynamique et Physico-Chimie Métallurgiques, 38402 Saint Martin d'Heres, France

We report an approach to altering the magnetic properties of (111) textured Co/Pt multilayer films grown on sapphire (0001) substrates in a controlled way using a single laser pulse ($\lambda = 532$ nm) at fixed FWHM of about 10 ns.The as-grown films reveal a strong perpendicular magnetic anisotropy induced by interfacial anisotropy. We show that laser irradiation can chemically mix the multilayer structure, leading to a reduction of the perpendicular magnetic anisotropy and coercivity and a rise in the saturation magnetization depending on the laser fluence as confirmed by XRD and SQUID magnetometry investigations.

As a result, the films can also be patterned into hard and soft magnetic regions using a regular 2D lattice of polystyrene particles acting as an array of microlenses. Regularly spaced submicrometer-sized regions of magnetically altered material have been produced over areas of a square millimeter. In this way, magnetic patterning with periods smaller than the wavelength can be achieved.

This project is funded by the DFG through SFB 513 and the Emmy-Noether program at the University of Konstanz.

[1] C. Schuppler et al., Appl. Phys. Lett. (2005) accepted for pub.

MA 7.4 Mon 15:45 HSZ 03

Magnetic patterning of interlayer exchange coupled Fe/Cr/Fe-trilayers induced by ion irradiation — •S. Blomeier[1], B. Hillebrands[1], V. E. Demidov[2], S. O. Demokritov[2], B. Reuscher[3], A. Brodyanski[3], and M. Kopnarski[3] — [1]Fachbereich Physik, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Institut für Angewandte Physik, Westfaelische Wilhems-Universitaet Muenster, 48149 Muenster, Germany — [3]Institut für Oberflaechen- und Schichtanalytik, TU Kaiserslautern, 67663 Kaiserslautern, Germany

We demonstrate the fabrication of small ferromagnetic elements embedded in a continuous, antiferromagnetically coupled epitaxial Fe/Cr/Fe-trilayer with a zero net-magnetic moment in remanence. The trilayer is locally irradiated with 30 keV Ga^+ ions within a fluence range of $1.25 - 6 \cdot 10^{16}$ ions/cm^2, using a focused ion beam source. According to a previously established model [1], the irradiation leads to interfacial intermixing and to a change of the interlayer thickness. As a result, a local transition from antiferromagnetic to ferromagnetic coupling due to direct exchange through ferromagnetic pinholes is achieved. Micron-sized areas with different geometries are irradiated in this way and analyzed with atomic force microscopy and magnetic force microscopy. It is shown that small ferromagnetic elements embedded into a smooth, antiferromagnetically coupled film can be created with this technique.

This work was supported by the EC-RTN NEXBIAS and by the Alexander von Humboldt Foundation.

[1] Demokritov et al., Phys. Rev. Lett. 90, 097201 (2003).

MA 7.5 Mon 16:00 HSZ 03

Magnetic reversal of microstructured patterns — •Andreas Westphalen, Arndt Remhof, Katharina Theis-Bröhl, and Hartmut Zabel — Institut für Experimentalphysik/Festkörperphysik,

We have investigated the magnetization reversal of regular arrays of magnetic continuous and discontinuous open triangles using the magneto-optical Kerr effect in Vector-MOKE and Bragg-MOKE configuration. With Vector-MOKE both components of the magnetization vector, m_x and m_y, yield the vector sum of the average magnetization vector. We performed Vector-MOKE not only at the specular reflection, but also at diffraction spots where we obtain information about the Fourier components of the magnetization distribution. For the analysis we have combined MOKE measurements with micromagnetic simulations. A satisfactory agreement between the experiments and the predictions from the micromagnetic model allows the interpretation of the experimental data. By interrupting the triangular structure with one or more notches the remagnetization breaks down into individual reversals in different parts of the structure. The continuous triangles are characterized by a narrow switching field distribution; the formation of domains is more favored in the discontinuous triangles than in the continuous ones.

We acknowledge financial support through SFB 491.

MA 7.6 Mon 16:15 HSZ 03

Real space observation of dipolar interaction in arrays of iron and permalloy elements — •Guido Meier[1], Markus Bolte[1], Rene Eiselt[1], Ulrich Merkt[1], Dong-Hyun Kim[2], and Peter Fischer[2] — [1]University of Hamburg, Institute of Applied Physics and Microstructure Advanced Research Center Hamburg, Jungiusstr. 11, 20355 Hamburg — [2]Center for X-Ray Optics, Lawrence Berkeley National Lab, 1 Cyclotron Road, Mail Stop 2R0400, Berkeley, CA 94720, USA

Square lattice arrays of thin micro- and nanoelements of iron and permalloy are investigated by magnetic transmission x-ray microscopy. The influence of dipole interaction is analyzed by varying the inter-element distance, the angle of the applied magnetic field, and the lattice configuration. For the iron squares the magnetostatic field caused by inter-element interaction leads to a substantial stabilization of the center elements of the array [1] comparable to the magnetization process previously found by numerical solution of the Landau-Lifshitz equation for magnetic dot arrays. Micromagnetic simulations show, that for high field strengths the dipolar interaction is collinear with the external field, while in the low-field-regime the strayfields have significant perpendicular components leading to a complex reversal mechanism.

[1] Markus Bolte, Rene Eiselt, Guido Meier, Dong-Hyun Kim, and Peter Fischer, J. Appl. Phys., accepted

MA 7.7 Mon 16:30 HSZ 03

Intergrain interactions in nanocomposite Fe-Pt alloys — •Julia Lyubina, Kirill Khlopkov, Oliver Gutfleisch, Karl-Hartmut Müller, and Ludwig Schultz — IFW Dresden, Institute for Metallic Materials, P.O. Box 270016, D-01171 Dresden, Germany

The structure and magnetic properties of nanocomposite $Fe_{100-x}Pt_x$ (x=40-60) powders prepared by mechanical alloying followed by annealing are investigated. Different microstuctures were obtained depending on the Pt concentration: a combination of the hard magnetic $L1_0$ FePt and paramagnetic $L1_2$ $FePt_3$ phases, essentially single phase $L1_0$ FePt and a mixture of $L1_0$ FePt and soft magnetic $L1_2$ Fe_3Pt phases. For ferromagnetic phases, a domain structure comprised of elongated interaction domains was observed by magnetic force microscopy (MFM). MFM data and remanence curves were used to provide insight into the nature of intergrain interactions in such powders. The analysis points to strong intergrain coupling in the $Fe_{100-x}Pt_x$ powders. An additional small magnetostatic contribution can be observed for the Pt-rich powders.

MA 7.8 Mon 16:45 HSZ 03

Neutron scattering and modeling of dipole-field-induced spin disorder in Nanoperm — •Andreas Michels[1], C. Vecchini[2], O. Moze[2], K. Suzuki[3], P.K. Pranzas[4], J. M. Cadogan[5], and J. Weissmüller[6] — [1]Technische Physik, Universität des Saarlandes, Saarbrücken, Germany — [2]Physics Department, University of Modena and Reggio Emilia, Italy — [3]Department of Materials Engineering, Monash University, Melbourne, Australia — [4]GKSS Research Center, Geesthacht, Germany — [5]School of Physics, University of New South Wales, Sydney, Australia — [6]Institut für Nanotechnologie, Forschungszentrum Karlsruhe, Karlsruhe, Germany

We present temperature and magnetic-field-dependent small-angle neutron scattering data for the ferromagnetic nanocomposite Nanoperm ($Fe_{89}Zr_7B_3Cu_1$). The spin-misalignment scattering in the approach-to-saturation regime unexpectedly reveals pronounced lobes of high intensity at angles $\pm 30 - 40°$ relative to the magnetic-field axis. Based on numerical calulations, the four-fold angular symmetry of the scattering pattern can be explained in terms of local spin misalignment, which originates from dipolar stray fields due to the mismatch of the saturation-magnetization values between the bcc Fe particles and the amorphous magnetic matrix.

[1] A. Michels *et al.*, Europhys. Lett. **72**, 249 (2005).
[2] C. Vecchini *et al.*, Appl. Phys. Lett., in press (2005).

MA 7.9 Mon 17:00 HSZ 03

Preparation of single-crystalline Fe nanopillars for Spin-Transfer Switching — •Henning Dassow, R. Lehndorff, D. E. Bürgler, M. Buchmeier, P. Grünberg, and C. M. Schneider — Institut für Festkörperforschung, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany

We report on the preparation of single-crystalline Fe nanopillars and on the first measurements of spin-transfer effects in this system. By using molecular beam epitaxy, we first deposit a layered magnetic system containing three Fe layers on top of a thick Ag buffer layer: Ag(150)/Fe(14)/Cr(0.9)/Fe(10)/Ag(6)/Fe(2) [thicknesses in nm]. The measurement of the Magneto Optical Kerr Effect (MOKE) yields the magnetic properties of the samples. In various cleanroom steps we fabricate nanopillars of a diameter of 150 nm by a combined optical / e-beam lithography technique in which the pillars are defined by Ion Beam Etching (IBE). Redeposition of etched material is observed with Atomic Force Microscopy (AFM) and can significantly broaden the structure. After planarization we open the isolation and contact the top of the nanopillar with lift-off of Au. The effect of dipolar stray fields can be estimated by comparison of the Giant Magneto Resistance (CPP-GMR) and MOKE hysteresis loops. The stray fields also have direct influence on the spin-transfer switching of the nanopillars which is observed at current densities of $j \sim 2 \cdot 10^7$ A/cm^2 and can increase the critical current density by a factor of 10.

MA 7.10 Mon 17:15 HSZ 03

In flight optical heating of FePt nanoparticles — •Elias Mohn, Franziska Schäffel, Christine Mickel, Bernd Rellinghaus, and Ludwig Schultz — IFW Dresden, P.O. Box 270116, D-01171 Dresden

Monodisperse fractions of FePt nanoparticles are prepared by DC magnetron sputtering in an inert gas atmosphere at elevated gas pressures. Subsequent ejection into high vacuum results in an increase of the mean free path of the particles and thereby allows to substantially suppress inter-particle coalescence and sintering. In order to benefit from the high magnetic anisotropy of $L1_0$ ordered FePt without sacrificing monodispersity, the particles are to be subjected to in-flight thermal annealing prior to their deposition to establish the chemically ordered tetragonal phase. Since convective in-flight heating [1] is no longer efficient in high vacuum, optical heating is applied. We have therefore developed a UHV compatible light furnace, in which the light of 3 halogen lamps (with a power of up to 1.2 kW each) is focussed on the particles' flight path at a length of 150 mm. The crystal structure of the particles is characterized by means of TEM. The status quo of these experiments is reported. First investigations reveal the occurrence of recrystallization twins in the particles upon switching on the light furnace. This indicates an effective heat transfer from the electromagnetic field to the particles. The experimental results are corroborated by model calculations of the energy transfer based on classical electrodynamics. The dependence of the heating rate on the particle size is discussed.

[1] S. Stappert et al., J. Cryst. Growth 252 (2003) 440-450.

MA 7.11 Mon 17:30 HSZ 03

Arrays of magnetic nano particles using self-organised semiconductor surfaces — •Nikolai Mikuszeit[1], Miguel Angel Niño[1], Julio Camarero[1], Juan José de Miguel[1], Rodolfo Miranda[1], Christian Hofer[2], Christian Teichert[2], Thomas Bobek[3], and Stepan Kyrsta[4] — [1]Dpto. Física de la Materia Condensada, Universidad Autónoma de Madrid, E-28049 Madrid, Spain — [2]Institut für Physik, Montanuniversität, A-8700 Leoben, Austria — [3]Institut für Halbleitertechnik, RWTH-IHT, D-52056 Aachen, Germany — [4]Lehrstuhl für Werkstoffchemie, RWTH-MCh, D-52056 Aachen, Germany

The self-organisation of semiconductor surfaces has been used to create arrays of magnetic nano particles [1]. The surface structure and magnetic properties are amongst others investigated by AFM and MOKE. In a first approach we use strain induced self-assembled SiGe surfaces as growth templates. Shadow deposition onto these surfaces results in elongated magnetic dots [2]. In a second approach the formation of self-organised hexagonal dots of GaSb surfaces, due to Ar^+ sputtering, are used [3]. Deep trenches between the dots cut an embedded magnetic layer into discs. Both systems show dipolar coupling between the dots. To overcome the dipolar coupling a high magnetic anisotropy energy is required. In order to enhance the magnetic anisotropy, CoPt-multilayers with perpendicular anisotropy and Co/CoO in-plane systems are studied. The dot magnetic behaviour is compared to micromagnetic simulations.

[1] C. Teichert Appl. Phys. A **76**, 653 (2003)
[2] A. M. Mulders et al. Phys. Rev. B , **71**, 214422 (2005)
[3] S. Facsko et al. Science **285**, 1551 (1999)

MA 7.12 Mon 17:45 HSZ 03

Magnetic nanostructures produced by micelle masks — •S. Pütter[1], H. Stillrich[1], A. Frömsdorf[2], C. Menk[1], R. Frömter[1], S. Förster[2], and H. P. Oepen[1] — [1]Institut für Angewandte Physik, Jungiusstr. 11, 20355 Hamburg — [2]Institut für Physikalische Chemie, Grindelallee 117, 20146 Hamburg

The production of magnetic nanostructure arrays on the length scale of centimeters is a challenge of today's research. Usually, lithography is used though it is very time consuming. We follow an alternative way by utilizing self organized micelle patterns as masks. The micelles consist of diblock copolymers and can be produced in the diameter range from 20 nm to 100 nm. By dip coating single layers of micelles are deposited onto the substrates. The micelles form an almost hexagonal array with height modulation smaller than the micelle diameter.

Various ways to produce nanostructures are possible and applied. The growth of magnetic films on top of the micelles preserves the morphology. By sputtering the sample at grazing incidence the caps of the micelles are taken off and an antidot array is produced. An alternative way is to use filled micelles (e.g. with SiO_2). These micelles are deposited onto magnetic films. Sputtering at normal incidence produces a dot array due to different sputtering yields.

We have investigated the morphology and topography of the nanostructure arrays by SEM and AFM. We correlate the results of the afore mentioned studies with the magnetic behaviour obtained via magneto optical Kerr effect as well as scanning electron microscopy with polarization analysis.

MA 8 Surface Magnetism

Time: Monday 15:00–17:15 Room: HSZ 103

MA 8.1 Mon 15:00 HSZ 103

The magnetic surface of a non-magnetic bulk material: $YCo_2(111)$ — •Josef Redinger[1], Sergii Khmelevskyi[1], Peter Mohn[1], and Michael Weinert[2] — [1]Inst. f. Allgemeine Physik, Vienna University of Technology, Getreidemarkt 9/134, A-1060 Vienna, Austria — [2]Department of Physics, University of Wisconsin - Milwaukee, P.O. Box 413, Milwaukee, WI 53201, USA

A material with a magnetic surface and non-magnetic bulk would be highly desirable for technological applications since thin films of such a material would provide a natural magnetic multilayer with perfect matching of the electronic potentials at the magnetic/nonmagnetic interface. Using full-potential DFT calculations, we predict the existence of a stable magnetic (111) surface of the intermetallic compound YCo_2 which is nonmagnetic in the bulk with large magnetic moments in the topmost Co layer for both Y- and Co-terminated (111) surfaces. The magnetism does not extend beyond two Co layers, and despite a rather large contraction of the top Co-Y interlayer distance which tends to suppress magnetism, we find only a slightly reduced surface moment as compared to an ideal bulk truncated surface. The Y-terminated surface shows rather moderate interlayer relaxations, while intralayer relaxations are negligible for both terminations. The $YCo_2(111)$ surface matches perfectly to Cu(111) thus facilitating the use of magnetically dead Cu cap layers, which will not kill the Co moments at the interface, according to our DFT results.
[1] S. Khmelevskyi, P. Mohn, J. Redinger, and M. Weinert, Phys. Rev. Lett. 94,146403 (2005)

MA 8.2 Mon 15:15 HSZ 103

Polarised Synchrotron Radiation and Angle-Resolved Photoemission for Spin Resolution on Valence Band States without Mott Detectors — •Mattia Mulazzi[1,2], Michael Hochstrasser[3], Ivana Vobornik[2], Jun Fujii[2], Martina Corso[4], Jürg Osterwalder[4], and Giorgio Rossi[1,2] — [1]Department of Physics, University of Modena, Modena, Italy — [2]INFM-TASC, Trieste, Italy — [3]Laboratorium für Festkörperphysik, ETH Zürich, Zürich, Switzerland — [4]Physik-Institut, Universität Zürich, Zürich, Switzerland

Magnetic dichroism in core-level photoemission proved to be a very powerful technique to investigate the properties of magnetic crystals. To equivalent experiments on the valence bands less efforts have been devoted because of the intrinsic complexity of the electron states. In this work we report on angle-resolved photoemission data taken with polarised synchrotron light on the Ni(111) valence band. At particular k-vectors Ni(111) shows sp states spin split by the exchange interaction. Momentum distribution curves have been measured as a function of the azimuthal emission angle, of the photon energy and polarisation and of the magnetisation state of the crystal to detect a signature of the sp states spin in a spin-integrated experiment. As soon as the photon polarisation or energy are changed, matrix elements intervene mixing to the purely magnetic effects. A comparison of data to calculated spectra obtained from a layer-KKR computational scheme resulted necessary to disentangle the two phenomena giving a better understanding of the magnetic dichroism in valence band and the Ni(111) sp states spin polarisation without a time-consuming Mott scattering experiment.

MA 8.3 Mon 15:30 HSZ 103

XMCD at O K edge of Fe, Co, and Ni films grown with O surfactant — •C. Sorg[1], N. Ponpandian[1], M. Bernien[1], J. Kurde[1], K. Baberschke[1], R. Q. Wu[2], and H. Wende[1] — [1]Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, D-14195 Berlin, Germany — [2]Department of Physics and Astronomy, University of California, Irvine, California 92697, USA

We have grown ultrathin ferromagnetic films of Fe, Co, and Ni with oxygen as a surfactant on Cu(100) and studied the systematics of their near edge X-ray absorption fine structure (NEXAFS) and X-ray magnetic circular dichroism (XMCD) at the O K edge [1,2]. It was shown earlier that using O as a surfactant improves the growth of these films toward a more layer-by-layer one [3]. Angular-dependent NEXAFS measurements at the O K edge give final evidence that the O does not form a bulk-like oxide with the 3*d* ferromagnet, and the O atoms stay on top of the growing film. The spectral features of the NEXAFS are identified with the help of density functional calculations. Due to the hybridization with the ferromagnet, the O acquires an induced magnetic moment that can be probed by XMCD at the O K edge. The calculations reproduce the experimental spectra very well and yield spin and orbital moments of the ferromagnetic films as well as the induced moments of the oxygen surfactant [2]. – Supported by BMBF (05 KS4 KEB 5).
[1] C. Sorg *et al.*, Surf. Sci. **565**, 197 (2004).
[2] C. Sorg *et al.*, Phys. Rev. B, submitted (2005).
[3] R. Nünthel *et al.*, Surf. Sci. **531**, 53 (2003); *ibid.* **566-568**, 100 (2004).

MA 8.4 Mon 15:45 HSZ 103

Magnetization and neutron reflectivity of AuFe films — •V. N. Gladilin[1,2], V. M. Fomin[1,2,3], J. T. Devreese[1,3], K. Temst[4], and C. Van Haesendonck[4] — [1]TFVS, Departement Fysica, Universiteit Antwerpen, B-2610 Antwerpen, Belgium — [2]Department of Theoretical Physics, State University of Moldova, MD-2009 Kishinev, Moldova — [3]Department of Semiconductor Physics, TU Eindhoven, NL-5600 MB Eindhoven, The Netherlands — [4]Laboratorium voor Vaste-Stoffysica en Magnetisme, Katholieke Universiteit Leuven, B-3001 Leuven, Belgium

We examine the effect of surface-induced anisotropy on the impurity-spin magnetization in spherical grains of dilute AuFe alloys. The strength of the surface-induced anisotropy is analysed as a function of the ratio between the elastic mean free path for conduction electrons and the radius of a grain. Based on our results for the impurity-spin magnetization, we calculate polarised-neutron reflectivity of AuFe films, which consist of closely packed spherical grains. We show that microstructure of a film has a crucial effect on the temperature-dependent spin asymmetry in the polarised-neutron reflectivity. This work has been supported by the Concerted Action (GOA) and the Interuniversity Attraction Poles (IAP) research programmes, and also by the Fund for Scientific Research – Flanders (FWO projects G.0306.00, G.0274.01, G.0435.03, and WOG WO.035.04N).

MA 8.5 Mon 16:00 HSZ 103

Magnetization reorientation in Au/Co: in-situ prepared ultrathin films — •D. Arvanitis[1], C. Andersson[1], T. Konishi[2], E. Holub-Krappe[3], O. Karis[1], and H. Maletta[3] — [1]Department of Physics, Uppsala University, Uppsala, Sweden — [2]Department of Chemistry, Chiba University, Inage, Chiba, Japan — [3]Hahn-Meitner-Institut, Berlin, Germany

We present X-ray Magnetic Circular Dichoism (XMCD) results to characterize the Spin Reorientation Transition (SRT) in ultra-thin in-situ prepared epitaxial Au/Co sandwich structures. The samples are prepared on an epitaxial Au(111) layer grown in-situ on a W(110) single crystal. We have investigated modifications in magnetic properties induced both by varying the Co film thickness (2-4 atomic layers) and thickness of the Au cap (0 to 5 atomic layers). For our in-situ samples, the SRT upon Au capping, at 300K, takes place around 4 atomic layers in contrast to related samples prepared ex-situ [1]. We present a novel phase diagram for the SRT for our in-situ grown films. An in-plane easy direction is observed for the whole investigated thickness range for the in-situ prepared Co films without cap, in contrast to work on in-situ Co/Au(111) [2]. Around 4 atomic layers Co, the addition of a small amount of a Au cap induces the system to exhibit a stable remanence both with an in-plane and an out-of-plane easy direction.
[1] R. Sellmann, H. Fritzsche, H. Maletta et al. Phys. Rev. B 64, 054418/1 (2001)
[2] R. Allenspach, M. Stampanoni, A. Bischof, Phys. Rev. Lett. 65, 3344 (1990)

MA 8.6 Mon 16:15 HSZ 103

Coordination effects in low-dimensional Fe-Pt alloys — •Axel Enders, Jan Honolka, Klaus Kuhnke, Violetta Sessi, Diego Repetto, and Klaus Kern — Max-Planck-Institut fuer Festkoerperforschung, Heisenbergstrasse 1, D-70569 Stuttgart

FePt alloys are in the focus of extensive research due to their remarkably large magnetic anisotropy. Our results on atomically thin FePt monolayers demonstrate that a large anisotropy is achieved also in nanostructures which do not exhibit the often-discussed L10 structure. The key for large anisotropy values rather seems to be the alloying of iron with a constituent that (i) is magnetically polarizable and (ii) exhibits large spin-orbit coupling, such as Pt. To support this we have performed XMCD measurements on Fe-Pt nanostructures with varying Fe-Fe and

Fe-Pt coordination. The investigated structures include Fe impurities, Fe chains, Fe/Pt surface alloy and Fe/Pt bulk alloy on Pt substrates. As a general trend, we observe that Fe-Pt coordination stabilizes the magnetic order, while Fe-Fe coordination decreases the net magnetization significantly. The latter may be attributed to a low-spin state or even antiferromagnetism in small Fe clusters on Pt. The magnetic anisotropy and orbital magnetic moments are compared for all structures.

MA 8.7 Mon 16:30 HSZ 103

The influence of step edges and strain on the domain wall width — •Wulf Wulfhekel, Simona Bodea, and Jürgen Kirschner — MPI für Mikrostrukturphysik, Weinberg 2, 06120 Halle

The influence of substrate steps and epitaxial strain on magnetic domain walls in thin Fe films was investigated by means of spin polarized scanning tunneling spectroscopy. Domain walls in a 2 ML film grown on a W(001) substrate were imaged. The domain wall width is reduced when the wall is located at a substrate step edge. This is explained by the atomic arrangement at the step edges and the influence on the ferromagnetic exchange and magnetic anisotropy. Measurements of the width of domain walls in 4 ML Fe films indicate a reduced exchange constant compared to bulk Fe. This is related in parts to the reduced dimensionality and the huge strain of 10% in the Fe films.

MA 8.8 Mon 16:45 HSZ 103

Structural and electronic properties of pseudomorphic $Cr_{1-x}Fe_x$-submonolayers on W(110) — •T. Methfessel and H.J. Elmers — Johannes Gutenberg-Universität Mainz, Institut für Physik, Staudingerweg 7, D-55099 Mainz

Submonolayer coverages of $Cr_{1-x}Fe_x$-random-alloys have been investigated using low energy electron diffraction (LEED), scanning tunneling spectroscopy (STS) and Kerr-magnetometry. The Curie-temperatures of the alloys strongly depend on the composition and vary surprisingly similar to the bulk behavior. We observe a maximum of T_C at $x = 0.95$.

Characteristic peaks in the STS spectra, indicating unoccupied surface states, show up at constant energy values independent on the composition. Assuming a *rigid-band*-model, the Fermi-energy should decrease with respect to the 3*d*-states for increasing Cr concentration. But this behavior was not observed. Thus the rigid-band model fails. However, with the assumption that the 4*s*-states are shifted above E_F the observation of a nearly composition-independent electronic structure can be tentatively explained.

We compare the results obtained here with previous results for Fe_xMn_{1-x}/W(110) submonolayers [1].

[1] M. Pratzer and H.J. Elmers, Phys.Rev.B **69**,134418(2004).

MA 8.9 Mon 17:00 HSZ 103

Probing surface magnetism using nonlinear optics: an *ab initio* study of Fe/W(110) — •Torsten Andersen and Wolfgang Hübner — Fachbereich Physik, TU Kaiserslautern, Box 3049, 67653 Kaiserslautern

The nonlinear optical response of a structurally optimized Fe/W(110) thin film is investigated numerically using *ab initio* methods. The thin films consist of a monolayer of Fe on top of four monolayers of W, with different directions of the magnetization in the Fe layer. The calculation is based on eigenstates obtained using the full-potential linearised augmented plane-wave method, converged self-consistently to an accuracy better than 10 μRy, including the spin-orbit interaction. The magnetic ground state shows an easy axis in the $1\bar{1}0$-direction, in agreement with experiment. From the eigenstates we are able to calculate the magneto-optical transition matrix elements, the nonlinear optical susceptibility, and the second-harmonic response.

MA 9 Magnetic Imaging

Time: Monday 15:00–17:00 Room: HSZ 401

MA 9.1 Mon 15:00 HSZ 401

High resolution imaging of 3d magnetic domain structures in multilayers and ultrathin films — •C. Menk[1], R. Frömter[1], K. Morrison[1], H. Stillrich[1], S. Pütter[1], H.P. Oepen[1], and J. 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

We have investigated the magnetic microstructure of Co(5 Å)/Pt(20 Å)-multilayer films using our new scanning electron microscope with polarization analysis (SEMPA or spin-SEM). The films have been grown by ECR sputtering on a silicon substrate. The characterization with magneto-optic Kerr effect has shown a predominantly perpendicular behavior. Looking spatially resolved at remanence we find the well-known maze pattern, but in the in-plane components. So actually the magnetization turns out to be canted. As the multilayer has been covered in-situ by an ultrathin Fe layer before domain structure investigation, we have systematically studied the influence of the Fe layer on magnetization canting.

Our spin-SEM is designed for measuring two orthogonal in-plane magnetization components. We will demonstrate that the improved image quality can be used to extract information about the square of the vertical polarization component as well. This, together with the lateral resolution of 10 nm, will be demonstrated by a 3d vectorial analysis of the magnetic vortex structure of cross-tie walls in thin polycrystalline Fe films.

MA 9.2 Mon 15:15 HSZ 401

Quantitative imaging of magnetization distributions of micro- and nanostructured ferromagnetic films — •Sebastian Dreyer[1], Christian Jooss[1], Sibylle Sievers[2], Martin Albrecht[2], Uwe Siegner[2], and Volker Neu[3] — [1]Institut f. Materialphysik, Universität Göttingen, D-37077 — [2]Physikalisch-Technische Bundesanstalt, D-38116 Braunschweig — [3]IFW Dresden, D-01171 Dresden

An important issue of nanomagnetism is a full quantitative mapping of magnetization distributions also with a great importance for high-density recording applications. We report on the development of a quantitative spatially resolved measurement technique and its application to the mapping of magnetization distributions of patterned ferromagnetic films. This quantitative magnetic imaging is based on magneto-optics, using the Faraday effect in advanced sensor films, with a spatial resolution of about 300nm, which is refined by MFM measurements down to a spatial resolution of 20nm. The stray field imaging was performed on PrCo, SmCo and CoPt structures in the thickness range of 200nm to 50nm. PrCo and SmCo serve as test systems for purely inplane magnetized structures, the CoPt for pure out-of-plane and more complicated mixed magnetization distributions. Results of an advanced inversion method, based on the Fourier transform ansatz, for the determination of magnetization distributions from the measured stray field are presented for these systems and compared with theoretical values.

MA 9.3 Mon 15:30 HSZ 401

MFM tip calibration with structured CoPt stripes — •Silvia Sasvári[1], Mario Brands[2], Günther Dumpich[2], Christoph Hassel[2], Ulrike Wolff[1], Ludwig Schultz[1], and Volker Neu[1] — [1]IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany — [2]Fachbereich Physik, Experimentalphysik, AG Farle, Universität Duisburg-Essen, 47048 Duisburg, Germany

The quantitative measurement of magnetic stray fields with Magnetic Force Microscopy (MFM) requires calibrated MFM tips. Within the point dipole model, the two describing parameters, the dipole moment of the tip and its distance δ from the tip apex, depend on the stray field geometry, which makes a characterization with well-known structures of different length scales necessary. Therefore, a systematic study has been performed on perpendicularly magnetized CoPt stripes with different width between 30 to 2200 nm. Line profiles have been scanned across the CoPt stripes in varying heights and the measured signal is compared with simulation results of the same structures. It was found that a small planar component of the tip magnetization had to be included to achieve reasonable fits. The full analysis leads to a complete description of the tip in the simple dipole model. Since these results are only valid for perpendicular field geometries and can not necessarily be generalized for arbitrary field geometries, further investigations of other magnetization structures will be necessary to achieve a complete description of the used MFM tip.

MA 9.4 Mon 15:45 HSZ 401

High-frequency MFM characterization of magnetic recording write poles — •Michael R. Koblischka[1], Jiandong Wei[1], Thomas Sulzbach[2], and Uwe Hartmann[1] — [1]Institute of Experimental Physics, University of Saarbrücken, P.O.Box 151150, D-66041 Saarbrücken, Germany — [2]Nanoworld Services GmbH, Schottkystrasse 10, D-91058 Erlangen, Germany

A high-frequency MFM (HF-MFM) is built up for the observation of the high-frequency stray fields of harddisk write heads. An amplitude-modulated current was applied to the head coil to detect the force gradient induced by the HF magnetic field. The achieved spatial resolution is comparable to that of standard MFM when using advanced MFM cantilevers fabricated by means of focused-ion beam milling. This treatment yields a high-aspect ratio. Dynamic HF magnetic fields emerging at the poles of the write heads were clearly imaged; especially along the P2 pole shape on the air-bearing surface. The frequency dependence of the head-field distributions are measured up to 1 GHz. This work is part of the EU-funded project "ASPRINT".

MA 9.5 Mon 16:00 HSZ 401

Spin structure of surface atoms of equatomic NiMn films on Cu(001) — •Chunlei Gao, Hagen Wald, Wulf Wulfhekel, Aimo Winkelman, Marek Przybylski, and Jürgen Kirschner — Max Planck Institute of Microstructure Physics, Halle, Germany

Equiatomic MnNi crystallizes in the face centered tetragonal CuAu-I-structure with Mn and Ni atoms occupying alternating planes perpendicular to the tetragonal axis. The magnetic moments of nearest-neighbor manganese atoms (in planes normal to the tetragonal axis) are antiparallel to each other and the moments of nickel almost vanish[1]. In this contribution, $Mn_{50}Ni_{50}$ thin films with the thickness between 8 to 20 monolayers were epitaxially grown on Cu(001) by co-evaporation. A $(\sqrt{2} \times \sqrt{2})R45°$ superstructure was observed with low energy electron diffraction (LEED) which was attributed to the chemical order of $Mn_{50}Ni_{50}$ thin films. The surface was investigated by scanning tunneling microscopy (STM) and spin polarized STM with in-plane sensitivity[2]. Mn and Ni planes were found perpendicular to the surface resulting in two structural domains. An additional $p(2 \times 2)$ superstructure was observed in both topography and spin. A possible noncollinear antiferromagnetic arrangement of the surface moments is proposed to explain the experimental results.

[1] J. S. Kasper and J. S. Kouvel, J. Phys. Chem. Solids. 11, 213 (1959)
[2] U. Schlickum, W. Wulfhekel, and J. Kirschner, Appl. Phys. Lett. 83, 2016 (2003)

MA 9.6 Mon 16:15 HSZ 401

Atomic Spin Structure of Antiferromagnetic Domain Walls — •M. Bode, E. Vedmedenko, K. von Bergmann, A. Kubetzka, P. Ferriani, S. Heinze, and R. Wiesendanger — Institute of Applied Physics and Microstructure Research Center, University of Hamburg, Jungiusstrasse 11, 20355 Hamburg, Germany

The search for uncompensated magnetic moments on antiferromagnetic surfaces is of great technological importance as they are responsible for the so-called exchange-bias effect which is widely used in state-of-the-art magnetic storage devices. We have studied the atomic spin structure of phase domain walls in the antiferromagnetic Fe monolayer on W(001) by means of spin-polarized scanning tunneling microscopy and Monte-Carlo simulations. The domain wall width amounts to 6-8 atomic rows only. While walls oriented along ⟨100⟩ directions are found to be fully compensated, the detailed analysis of ⟨110⟩ walls reveals an uncompensated perpendicular magnetic moment. This finding may lead to a detailed understanding of the exchange-bias effect.

MA 9.7 Mon 16:30 HSZ 401

Element Specific Imaging of Vortex Dynamics in Ferromagnetic Multilayer Systems — •Kang Wei Chou[1], Aleksandar Puzic[1], Hermann Stoll[1], Bartel Van Waeyenberge[2], Tolek Tyliszczak[3], Karsten Rott[4], Günter Reiss[4], Hubert Brückl[5], Ingo Neudecker[6], Dieter Weiss[6], Christian H. Back[6], and Gisela Schütz[1] — [1]Max-Planck-Institut für Metallforschung, Stuttgart — [2]Ghent University — [3]Chemical Science Division, LBNL, Berkeley — [4]Universität Bielefeld — [5]ARCS, Nano System Technology, Tech Gate, Vienna — [6]Universität Regensburg

Magnetization dynamics in micron-sized ferromagnetic multilayer structures was studied by time-resolved scanning transmission X-ray microscopy (TR-STXM, ALS, Berkeley). The movement of the magnetic vortex in individual ferromagnetic layers and the coupling between these layers were investigated by taking advantage of the element specificity of the XMCD effect (X-ray Magnetic Circular Dichroism). Square-shaped $1\mu m \times 1\mu m$ trilayer elements consisting of Co(20 nm)/Cu(10 nm)/Permalloy $Ni_{80}Fe_{20}$(20 nm) showed a Landau-like domain configuration in both ferromagnetic layers. A translational gyrotropic vortex motion was excited with an in-plane alternating magnetic field. By tuning the photon energy to the L_3 absorption edges of Ni and Co respectively, element specific images of vortex dynamics in each ferromagnetic layer were recorded. A 180 degrees phase shift between the gyrotropic vortex motions in the Permalloy and the Co layer was observed, caused by magnetic coupling of the layers.

MA 9.8 Mon 16:45 HSZ 401

Imaging Magnetic Nanostructures via Resonant Soft X-Ray Spectro Holography — •Olav Hellwig[1,2], Stefan Eisebitt[1], Wolfgang Eberhardt[1], Jan Luning[3], William F. Schlotter[3,4], and Joachim Stohr[3] — [1]BESSY GmbH, Albert Einstein Str. 15, 12489 Berlin, Germany — [2]San Jose Research Center, Hitachi Global Storage Technologies, 650 Harry Road, San Jose CA 95120, USA — [3]SSRL, Stanford Linear Accelerator Center, 2575 Sand Hill Road, Menlo Park CA 94025, USA — [4]Department of Applied Physics, 316 Via Pueblo Mall, Stanford University, Stanford, CA 94305-4090, USA

I will present how to exploit the coherence and tunable polarization of soft X-ray synchrotron radiation for imaging magnetic nanostructures via holography. This new lensless imaging technique is based on the direct Fourier inversion of a holographically formed soft x-ray interference pattern [1]. Our implementation is particularly simple and is based on placing the sample behind a lithographically manufactured mask with a micron-sized sample aperture and a nano-sized reference hole. By exploiting the magnetic dichroism in resonance at the L3 edges of the magnetic transition metals (wavelength ˜ 1-2 nm (700-900 eV), images of magnetic nanostructures have been obtained with a spatial resolution of 50 nm. The technique is transferable to a wide variety of specimen, appears scalable to diffraction-limited resolution (about 2 nm), and is well suited for ultra-fast single-shot imaging with future X-ray free electron laser sources. [1] S. Eisebitt, J. Luening, W. F. Schlotter, M. Loergen, O. Hellwig, W. Eberhardt and J. Stoehr, Nature, 432 (2004) 885.

MA 10 Micromagnetism / Computational Magnetism

Time: Monday 17:00–17:45 Room: HSZ 401

MA 10.1 Mon 17:00 HSZ 401

Simulation of vortex structures in Permalloy, Fe and Co nanoparticles — •Sebastian Macke, Dagmar Goll, and Gisela Schütz — MPI für Metallforschung, Stuttgart

Recently, magnetic vortex structures have attracted much attention because of their influences on magnetization processes in nanostructures as used in data storage and spintronics.

By the methods of computational micromagnetism based on the finite element method the distribution of magnetization within a vortex in small square particles of permalloy, iron and cobalt has been studied systematically.

The magnetization distribution within the vortex and the vortex energy sensitively depend on the dimensions and the material parameters of the particles. It is shown that there exists a periodic fluctuation of the out-of-plane magnetization due to the dipolar interactions and the vortex contracts at the surfaces in the case of thicker films. The results are compared with analytical approaches.

Finally the interactions between vortices in rectangular nanodots and patterns of nanodots are investigated.

MA 10.2 Mon 17:15 HSZ 401

Ferromagnetic Hollow Cylindrical Nanoparticles — •D. Goll, G. Schütz, and H. Kronmüller — Max-Planck-Institut für Metallforschung, Heisenbergstr. 3, 70569 Stuttgart, Germany

Magnetic ground states of hollow cylindrical nanoparticles with a non-magnetic core have been analytically calculated on the basis of the the-

ory of micromagnetism. As a function of the three material parameters, spontaneous polarization, magnetocrystalline anisotropy constant and the exchange constant, the phase diagrams of three types of magnetic configurations have been determined. For uniaxial perpendicular anisotropy a single-domain homogeneous state, a curling configuration and a homogeneous multidomain state may exist as a function of the above material constants. The critical radii where the transitions between these configurations take place are determined as a function of the material parameters. The special cases of soft and hard magnetic materials are discussed in relation to the exchange lengths. The analytical results are compared with numerical micromagnetic simulations on the basis of the finite element method.

MA 10.3 Mon 17:30 HSZ 401

The Jacobs-Bean model of chains of magnetic spheres, revisited — •Riccardo Hertel — Institut für Festkörperforschung,Forschungszentrum Jülich, D-52425 Jülich

The field-driven magnetization reversal in a chain of perfectly aligned magnetic nano-spheres is studied by means of micromagnetic simulations. The diameter of the Fe spheres is 10 nm, the spacing is 1 nm. Chains of different length (up to 20 spheres) have been simulated. The only coupling between the spheres is given by the magnetostatic dipole interaction. According to the analytical Jacobs-Bean (JB) model for chains of magnetic spheres [1], the reversal is expected to occur by means of an inhomogeneous, so-called fanning mode. While the principal predictions of the JB model are confirmed by the simulations, a number of interesting additional features are observed. According to the simulations, the reversal of each individual sphere is given by a precessional reorientation towards the external field. The phase of the precession of each sphere is non-trivially coupled to the phase of the other spheres. The inhomogeneous reversal mode is symmetric with respect to the central plane perpendicular to the chain axis, leading to qualitative differences depending on whether the number of spheres in the chain is even or odd. The reversal begins in the central part of the chain. This is in striking contrast to the case of magnetic nanowires of similar size, where magnetization reversal has been shown to start at the wire ends.

[1] I.S. Jacobs and C.P. Bean, Phys. Rev 100 (4) 1060 (1955)

MA 11 Spin-Structures and Magnetic Phase Transitions II

Time: Monday 15:00–16:30 Room: HSZ 403

MA 11.1 Mon 15:00 HSZ 403

Magneto-optic measurement of magnetic phase transition and domain structure of liquid $Co_{80}Pd_{20}$ — •Lucian M. Stefan and Karl Maier — Helmholtz Institut für Strahlen- und Kernphysik, Rheinische Friedrich-Wilhelms-Universität Bonn, Nußallee 14-16, D-53115 Bonn, Germany

The temperature dependence of the magnetisation of liquid $Co_{80}Pd_{20}$ was obtained and the domain structure of the liquid phase was investigated. The spherical samples (mass: 10 - 11mg) were processed in an electromagnetic levitation device in pure H_2 atmosphere, which allows an undercooling of $\Delta T \approx 360$K below the liquidus temperature ($T = 1610$K). The magnetisation on the surface across the magnetic phase transition was measured via the magneto-optical Kerr effect.

A significant increase of the Kerr-angle was observed at the magnetic phase transition which reflects the appearance of magnetic order in the liquid. The Curie temperature found for the liquid phase is $T_C^{\mathrm{l}} = 1253$K and compares to similar values found in earlier experiments (stray field measurements). All Kerr data indicate a plateau in a region of ≈ 0.5K at the low-temperature end of the magnetisation curve. This is interpreted as the presence of an identical domain structure in all independent measurements (measuring area diameter about 10μm). Our results agree with computer simulations, which predict a vortex structure of domains for a liquid spherical sample. In this structure the spins are oriented parallel to the surface along an imaginary equator due to the absence of domain walls in a ferromagnetic liquid.

MA 11.2 Mon 15:15 HSZ 403

Helimagnetsm and metamagnetic transitions in novel bulk GMR alloys based on MnAu2. — •Sergii Khmelevskyi, Laslo Udvardi, Laslo Szunyogh, Peter Mohn, and Peter Weinberger — Center for Computational Material Science, Vienna University of Technology, Getreidemarkt 5/134, A-1060 Vienna, Austria

Magnetic exchange interactions in helimagnetic MnAu2 compound and their dependence upon alloying with Fe and Cr are studied from first principles using General Perturbation Method within Surface Korringa-Kohn-Rostoker formalism for band structure calculations. The calculated interactions well reproduce the results of neutron diffraction experiments concerning periodicity of the helix in MnAu2 and its weakening with Fe substitution, providing background for conventional model interpretations of metamagnetic processes in this systems responsible for Giant Magneto-Resistance effect. However, for (Mn,Cr)Au2, alloys our results reveal entirely different picture suggesting that experimentally observed magnetization process in the Cr doped alloys may follows a scenario predicted theoretically few decades ago for nearly orthogonal helimagnetics.

MA 11.3 Mon 15:30 HSZ 403

Spin State Transformations of a 3d Ion in the Pyramidal Environment under Lattice Distortions — •Karina Lamonova, Helen Zhitlukhina, Sergei Orel, and Yurii Pashkevich — A.A. Galkin Donetsk Phystech NASU, 83114 Donetsk, Ukraine

The spin state (SS) transitions in the metal-containing pyramidal complexes originated from the crystal structure deformations are the research subject of this work. As the metal ions, we considered the transition metals with the 3d6 and 3d4 configurations. The SS transitions of the metal ions from low spin (LS, S=0) to the intermediate spin (IS, S=1) and high spin (HS, S=2) under change of the metallic ion effective charge Zeff and displacements of the oxygen ions has been investigated in the frame of crystal field approximation. The features of the SS stability have been calculated without spin-orbit interaction accounting, and then with the accounting one. Some critical points over Zeff at which an accident degeneracy of SSs have been revealed. Near these critical points, the negligible distortions can crucially influence on the SS changing. The ground SS of pyramidal Me-O complex is very sensitive to the symmetry and magnitude of the oxygen cage distortions. We probed the breathing like distortions, the displacement of the 3d-ion along Z axis, Jan-Teller like ion displacements, and the displacements like pyramidal plane corrugation. The SS diagrams in the parameter space "effective charge"-"distortion magnitude" have been built. It is revealed the IS ground state exists for all kind considered distortions at the corresponding choice of the Zeff value. Jan-Teller distortions stabilize the IS state in a wide range of Zeff that consistent with experimental data on layered cobaltites.

MA 11.4 Mon 15:45 HSZ 403

Bulk Properties and Neutron Diffraction of the Magnetic Phase Diagram of MnSi — •Daniel Lamago[1], Christian Pfleiderer[1], Robert Georgii[2], and Peter Böni[1] — [1]Physics Department E21, TU München, D- 85747 Garching, Germany — [2]FRM-II, Lichtenbergstr. 1 D-85747 Garching, Germany

MnSi develops itinerant-electron magnetism below $T_C = 29$ K that supports a long wavelength helical modulation. In recent years the properties of MnSi have attracted great scientific interest:[1](i) well above T_C chiral magnetic fluctuations have been observed; (2) the magnetic ground state appears to switch abruptly from a weakly spin-polarized Fermi-Liquid to an extended non-Fermi liquid (NFL) phase at a pressure of 14.6 kbar; (3) neutron scattering shows that large magnetic moments survive far into the NFL-phase, where the scattering intensity observed everywhere on the surface of a small sphere suggests partial order analogous to liquid crystals. Motivated by recent efforts [2] we revisit reorientational processes of the helical modulation in MnSi at ambient Pressure as funtion of field. We combine small-angle neutron scattering with AC susceptibility, DC and Torque magnetisation data. This provides unexpected, new insights into the nature of the helical modulation and its possible connection to the NFL phase and the partial magnetic order at high pressure.

[1] B. Roessli et al., Phys. Rev. Lett. 88, 237204 (2002); C. Pfleiderer et al., Nature 414, 427 (2001); N. Doiron-Leyraud et al., Nature 425, 595 (2003); C. Pfleiderer et al., Nature 427, 227 (2004).
[2] A.I. Okorokov et al. Physica B 356, 259 (2005).

MA 11.5 Mon 16:00 HSZ 403

Frustration in R_2PdSi_3 (R = Tb, Er): Spin-glass or magnetic short-range order? Neutron diffraction studies — •Matthias Frontzek[1], Andreas Kreyssig[1], Jens-Uwe Hoffmann[2], and Michael Loewenhaupt[1] — [1]TU Dresden, Institut für Festkörperphysik, 01062 Dresden — [2]Hahn-Meitner-Institut, 14109 Berlin

The series R_2PdSi_3 (R = rare earth), crystallizing in an AlB_2 derived hexagonal structure, have been found to exhibit strong anisotropic magnetic properties. Below their respective Néel temperatures Tb_2PdSi_3 (24 K) and Er_2PdSi_3 (7 K) feature a second phase transition at 7 K and 2 K, respectively. This second transition shows a strong frequency dependence in ac-susceptibility measurements. Several authors assume a spin-glass state below this second phase transition.

We performed neutron diffraction experiments on E2 at HMI Berlin within a temperature range from 0.4 K to 300 K and magnetic fields up to 6.5 T on Tb_2PdSi_3 and Er_2PdSi_3 single crystals.

Tb_2PdSi_3 orders antiferromagnetically at 24 K with a magnetic moment direction in the basal plane and a propagation vector $\tau = (1/2\ \ 1/2\ \ 1/16)$. Furthermore, we observe additional short-range magnetic order (SRO) at low temperatures. The second phase transition is correlated to the temperature dependence of the SRO. The SRO becomes long range ordered when a magnetic field (>1.5 T) is applied.

Er_2PdSi_3 orders antiferromagnetically at 7 K with a magnetic moment direction along the hexagonal $\boldsymbol{c}$-axis and a propagation vector $\tau = (0.11\ \ 0.11\ \ 0)$. In this case the second phase transition is correlated to a "squaring up"of the antiferromagnetic structure.

MA 11.6 Mon 16:15 HSZ 403

Domain imaging and symmetry reduction in $LiNiPO_4$ — •Bas B. van Aken, Takuya Satoh, and Manfred Fiebig — Max-Born-Institut, Max-Born-Straße 2a, 12489 Berlin

Second harmonic generation (SHG) has been applied to study the magnetic symmetry and domain structure of magnetoelectric $LiNiPO_4$. Up to now a simple collinear AFM spin order was assumed. Our SHG data indicate the symmetry is lower. The lower symmetry allows the presence of additional types of domains and toroidal ordering. The lower symmetry is confirmed by the dependence of the domain structure on the magnetic field. Without field AFM plate-like domains are observed. Field cooling leads to a single domain state, which is not allowed by the simple magnetic model. Measuring the magnetic field - temperature phase diagram reveals a first order phase transition to an incommensurate phase. In a magnetic field this transition temperature is reduced, indicating that the magnetic field stabilises the incommensurate phase, which is unusual.

MA 12 Kondo / Heavy Fermions

Time: Monday 16:30–17:45 Room: HSZ 403

MA 12.1 Mon 16:30 HSZ 403

Magnetic ground state of the frustrated one dimensional binary compound $CuCl_2$ — •Michael Banks[1], Reinhard K Kremer[1], and Bachir Ouladdiaf[2] — [1]MPI-FKF, 70569 Stuttgart — [2]ILL Grenoble, CEDEX 9

Historically, the binary $CuCl_2$ and the structurally similar $CuBr_2$ are among the very first systems the magnetic properties of which were analyzed in terms of a linear spin chain arrangements. Low-dimensional magnetism with typical signatures, e.g. a broad short-range ordering maxima in the susceptibility and heat capacity, have been found. The antiferromagnetic (afm) intra-chain exchange parameters are significant (e.g. ≈320K for $CuBr_2$). However, both systems are far from representing ideal one-dimensional magnets as must be concluded from the rather high transition temperatures to long-range ordering (e.g. 24 K for $CuCl_2$) indicating appreciable inter-chain coupling. To the best of our knowledge, the magnetic structures of $CuCl_2$ and $CuBr_2$ remain unsolved until now. We studied the afm ordering of $CuCl_2$ and $CuBr_2$ in detail by neutron powder diffraction using ILL's high flux powder diffractometer D20 in its high resolution option. Using single crystals of $CuCl_2$, we used the 4-circle diffractometer D10 also at the ILL to conclusively solve the magnetic structure. The magnetic structure of $CuCl_2$ will be presented as showing helicoidal ordering along the chain direction with an incommensurate propagation vector $\tau = [0.5,0.224,0]$. The magnetic phase diagram will be presented showing a spin-flop phase along the chain direction at $H_{SF} \approx 4\,T$.

MA 12.2 Mon 16:45 HSZ 403

High-resolution Fermi-Edge and energy dependent photoemission spectra of $Fe_{1-x}Co_xSi$ — •D. Zur[1], I. Jursic[1], D. Menzel[1], L. Patthey[2], and J. Schoenes[1] — [1]Institut für Physik der Kondensierten Materie, TU Braunschweig, Germany — [2]Swiss Light Source, Paul Scherrer Institut, Villigen, Switzerland

The interest on FeSi is renewed because of similarities with some rare-earth compounds known as Kondo insulators. In spite of several photoemission investigations, the size of the gap is still not clear. In addition, the influence on the electronic structure by doping with a 3d transition metal is interesting due to the changes in electronic and magnetic properties. We present high resolution photoemission spectra at 11 K of the Fermi edge of $Fe_{1-x}Co_xSi$ crystals with 0, 5 and 20 at.% Co, using synchrotron radiation at the SLS. Photon energies of 21.2 eV and 40.8 eV have been used. A gap of about 80 meV has been found, which is consistent with some theoretical predictions. This gap closes with increasing Co concentrations. Furthermore, changes in the electronic structure owing to different Co concentrations have been studied with angle- and photoenergy-resolved photoemission.

MA 12.3 Mon 17:00 HSZ 403

Field-induced parity breaking in isotropic frustrated spin chains — •Oleksiy Kolezhuk[1,2] and Temo Vekua[3] — [1]Physics Dept.., Harvard University, Cambridge MA 02138, USA — [2]Inst. f. Theor. Physik, Univ. Hannover, 30167 Hannover, Germany — [3]Univ. Louis Pasteur, Lab. de Physique Theorique, 67084 Strasbourg Cedex, France

It is argued that an external magnetic field applied to an isotropic zigzag spin chain with an arbitrary spin S and antiferromagnetic nearest-neighbor and next-nearest-neighbor exchange couplings J_1 and J_2 induces a quantum phase transition into a phase with spontaneously broken parity, characterized by long-range ordering of vector chirality. To show that, we use a bosonization approach for $S = 1/2$ and $S = 1$, valid in the limit of a weak zigzag interaction $J_1/J_2 \ll 1$, as well as an effective large-S theory applicable in the vicinity of the saturation field. Relevance to real materials and the possibility of experimental observation of chiral phases are discussed.

MA 12.4 Mon 17:15 HSZ 403

Thermodynamic properties of the magnetic layered compound $BaNi_2V_2O_8$ — •William Knafo[1,2], Stephanie Drobnik[1,2], Kai Grube[1], Hilbert von Löhneysen[1,2], Christoph Meingast[1], Paul Popovich[1], Peter Schweiss[1], and Thomas Wolf[1] — [1]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe, Germany. — [2]Physikalisches Institut, Universität Karlsruhe, D-76128 Karlsruhe, Germany.

$BaNi_2V_2O_8$ is a quasi two-dimensional magnetic system which consists of a planar honeycomb arrangement of spin-1 ions of Ni^{2+}. Although a small inter-plane interaction leads to three-dimensional magnetic order below $T_N = 47$ K, this system has been recently proposed as a candidate for a two-dimensional XY magnetic model where a Kosterlitz-Thouless transition should occur [1]. To test this scenario, we have grown large single crystals of $BaNi_2V_2O_8$ and have investigated their thermodynamic properties. We present here specific heat, thermal expansion, magnetostriction, and magnetization measurements, which were carried out for temperatures T between 3 and 300 K and magnetic fields $\mathbf{H}$ up to 14 T. The main features of the resulting $(\mathbf{H}, \mathbf{T})$ phase diagram are (i) an increase of T_N when the field is applied in the plane and (ii) a cross-over to a "spin-flop"phase below T_N for fields higher than $\mathbf{H_{SF}} \approx 1.4$ T. The anisotropy of the magnetic moments and the dimensionality of their interactions will be considered carefully to discuss if a two dimensional XY model is relevant or not for this system.

[1] N. Rogado et al., Phys. Rev. B **65**, 144443 (2002).

MA 12.5 Mon 17:30 HSZ 403

Bose glass vs. Mott glass in site-diluted S=1 Heisenberg antiferromagnets — •Tommaso Roscilde[1,2] and Stephan Haas[2] — [1]Max-Planck-Institut fuer Quantenoptik, Garching (Germany) — [2]University of Southern California, Los Angeles

Making use of large-scale quantum Monte Carlo simulations, we investigate the ground-state phase diagram of the square-lattice S=1 Heisenberg antiferromagnet with strong single-ion anisotropy and in presence of site dilution of the magnetic lattice. Mapping the spins onto Holstein-Primakoff bosons, the single-ion anisotropy is seen to play the role of a repulsive on-site potential for the bosons. The clean limit of the model shows an anisotropy-driven quantum phase transition from an XY ordered (superfluid) phase to a quantum disordered (Mott insulating) phase. A similar transition is also driven by the application of a uniform field on the disordered state. Adding site dilution to the model, the non-trivial interplay between quantum fluctuations and lattice randomness gives rise to a novel quantum-disordered *Mott glass* phase in zero field, with a gapless spectrum and yet a vanishing uniform susceptibility. Upon applying a field, such phase is turned into a *Bose glass*, with gapless spectrum and finite susceptibility. The above picture is directly relevant for experiments on doped quasi-low-dimensional Ni compounds, as the recently investigated $NiCl_2$-4SC$(NH_2)_2$ (V.S. Zapf et al., cond-mat/0505562).

MA 13 Invited Talk Dürr

Time: Tuesday 09:30–10:00 Room: HSZ 03

Invited Talk MA 13.1 Tue 09:30 HSZ 03

Femtosecond electron and spin dynamics in ferromagnets — •Hermann A. Dürr — BESSY, Berlin, Germany

Disentangling the influence of many-particle interactions in solids remains a formidable challenge in modern physics. Interactions, such as Coulomb, exchange and spin-orbit coupling are of various strength and lead to different characteristic time scales for energy transfer between orbital, spin and lattice degrees of freedom. The use of fs laser excitation of magnetic solids leads to the exciting prospect of being able to observe the interplay of magnetic and purely electronic interactions in the relaxation processes following optical excitation in real-time.

Of particular interest is whether the relatively weak spin-orbit coupling can cause a fs breakdown of ferromagnetic order via an ultrafast transfer of angular momentum from the spins to the lattice. Such studies are of direct relevance for establishing the ultimate time scale for magnetic switching in future data storage devices. An overview will be given how fs laser based time and spin resolved photoemission spectroscopy as well as time resolved soft x-ray spectroscopy can probe the evolution of electronic and magnetic interactions following fs laser excitation. The combination of pump-probe techniques and photoemission electron microscopy allows us to achieve the necessary spatial resolution for studying nanoscale magnetic structures. Here the excitation is strongly affected by the dielectric response of the nanoparticles.

MA 14 Magnetic Thin Films II

Time: Tuesday 10:15–13:00 Room: HSZ 03

MA 14.1 Tue 10:15 HSZ 03

Thin epitaxial films of the Heusler compound Co_2FeSi — •Horst Schneider[1], Sabine Wurmehl[2], Gerhard Jakob[1], Claudia Felser[2], and Hermann Adrian[1] — [1]Institut für Physik, Universität Mainz, Staudinger Weg 7, 55128 Mainz, Germany — [2]Institut für Anorganische Chemie und Analytische Chemie, Universität Mainz, Staudinger Weg 9, 55128 Mainz, Germany

Bulk samples of the Heusler compound Co_2FeSi (CFS) possess a high Curie temperature of 1100 K. An integer magnetic moment of $6\,\mu_B$/fu suggests halfmetalicity. By using pulsed laser deposition in UHV as well as RF sputtering we prepared thin CFS films on $Al_2O_3(11\bar{2}0)$ and MgO (100). X-ray analysis reveals that these films grow (110)-oriented on sapphire or (100)-oriented on MgO. They exhibit the fully ordered $L2_1$ structure. Magnetic properties were investigated by VSM- and SQUID-measurements, electronic properties by transport measurements. AFM and SEM allowed the analysis of the films' surfaces.

MA 14.2 Tue 10:30 HSZ 03

Covalent bonding and the nature of band gaps in some half-Heusler compounds — •Claudia Felser — Johannes Gutenberg - Universität, 55099 Mainz, Germany

Half-Heusler compounds XYZ, also called semi-Heusler compounds, crystallize in the MgAgAs structure belonging to the space group $F\bar{4}3m$. A systematic examination of band gaps and the nature (covalent or ionic) of bonding in semiconducting 8- and 18- electron half-Heusler compounds through first-principles density functional calculations is reported. The most appropriate description of these compounds - from the viewpoint of electronic structures - is found from a YZ zincblende lattice stuffed by an X ion. Simple valence rules are obeyed for bonding in the 8-electron compound. For example, LiMgN may be written Li^+ + $(MgN)^-$, and (MgN)*, which is isoelectronic with (SiSi), forms a zinc blende lattice. The 18-electron compounds may similarly be considered as obeying valence rules. A semiconductor such as TiCoSb can be written Ti^{4+} + $(CoSb)^{4-}$; the latter unit is isoelectronic and isostructural with zincblende GaSb. For both the 8- and 18-electron compounds, when X is fixed as some electropositive cation, the computed band gap varies approximately as the difference in Pauling electronegativities of Y and Z. What is particularly exciting is that this simple idea of a covalently bonded YZ lattice can also be extended to the very important magnetic half-Heusler phases; these are described as valence compounds, but only in one spin direction. The local moment in these magnetic compounds resides on the X site.

MA 14.3 Tue 10:45 HSZ 03

Magnetism and Phonons at Fe/InAs(001) Interfaces — •R. Peters[1], W. Keune[1], E. Schuster[1], K. Westerholt[2], W. Sturhahn[3], T. S. Toellner[3], J. Zhao[3], E. E. Alp[3], S. Kashiwada[4], and K. Yoh[4] — [1]Applied Physics, University of Duisburg-Essen, 47048 Duisburg, Germany — [2]Experimentalphysik, Ruhr-Universität-Bochum, 44780 Bochum, Germany — [3]APS, Argonne National Laboratory, Argonne, IL 60439 , USA — [4]RCIQE, Hokkaido University, Sapporo 060-8628, Japan

Fe/InAs(001) is a potential candidate for electron spin injection [1]. The properties of the interface play a decisive role. By MBE growth of an isotopically enriched ^{57}Fe(4 ML) probe layer in the Fe layer at different distances from the Fe/InAs interface and by employing Mössbauer spectroscopy (CEMS) and nuclear resonant inelastic X-ray scattering (NRIXS) we have probed the magnetic hyperfine field, B_{hf}, and the phonon density of states, g(E), respectively. Although substantial structural disorder is reflected in g(E) near the interface, the magnitude of the average B_{hf} (and the corresponding local moment $\mu_{Fe} \propto B_{hf}$) remains high. For optical detection of spin injection at magnetic remanence in the Faraday geometry we have grown $[Fe/Tb]_n$ multilayers on p-InAs(001) with perpendicular remanent magnetization at low T, as evidenced by CEMS and SQUID magnetometry. After processing a lateral line-and-space pattern of the multilayer by Ar^+ ion etching a typical Schottky-contact diode I-V characteristics was observed at 1.5 K, which is promising for spin injection. *Supported by DFG (SFB 491 and GRK 277).* [1] H. Ohno et al., Jpn. J. Appl. Phys. **42** (2003) L87.

MA 14.4 Tue 11:00 HSZ 03

Soft magnetic vapor phase co-deposited polymer-metal nanocomposites for high frequency applications — •Henry Greve[1], Vladimir Zaporojtchenko[1], Michael Frommberger[2], Eckhard Quandt[2], and Franz Faupel[1] — [1]Chair for Multicomponent Materials, CAU Kiel, Kaiserstr. 2, 24143 Kiel, Germany — [2]Smart Materials Group, caesar, Ludwig-Erhard-Allee 2, 53175 Bonn, Germany

Recent growing markets for mobile communication handsets and portable information tools require further miniaturization and lower in-

sertion losses for inductive components installed in Monolithic Micowave Integrated Circuits (MMIC). The possible carrier frequency range is from 800 MHz to 3 GHz. Due to potential size reduction, improved quality factor and reduced magnetic stray fields, thin-film inductors will be better than air-core spirals if loss generation in the magnetic film is low at the frequency of interest. Two main loss mechanisms, eddy currents and ferromagnetic resonance (FMR), limit the applicability of soft magnetic films at frequencies $\geq$ 1 GHz. Two component nanocomposites with either a particulate or a multilayer nanostructure could play important roles in such high frequency applications. Here, we present a vapor phase co-deposition method in which we prepare such particulate or multilayer structured, softmagnetic nanocomposite films. These films are several hundred nanometers thick and consist of $Fe_{54}Ni_{27}Co_{19}$ as ferromagnetic and a fluoropolymer as the insulating material component. Up to now we obtained cut-off frequencies above 2 GHz and hf-permeabilities above 100 for the multilayer films.

MA 14.5 Tue 11:15 HSZ 03

Properties of sputtered softmagnetic trilayer sensors and their influence of the GMI-Effect — •Christian Schiefer, Henadzi Yakabchuk, and Erhard Kisker — Institut für Angewandte Physik, Heinrich-Heine Universität Düsseldorf, 40225 Düsseldorf

The GMI-effect gains more and more interest in research due to its characteristics in the detection of small magnetic fields. Compared to amorphous wires, sputtered trilayer structures have the advantage that they can be easily integrated in microchip structures. Annealed soft magnetic thin films based on FeSiBNbCu alloys show a GMI-Effect of about 100% with a sensitivity of 20%/Oe. The Influence of annealing, as well as the occurrence of an aging effect on the GMI effect are presented. The aging effect lead to an improvement in the GMI effect. This is a rarely discussed phenomenon in literature. Its occurrence is determined by various factors. Besides GMI-Mesurements, also other methods like STM or MOKE were applied to characterize the thin films.

MA 14.6 Tue 11:30 HSZ 03

Investigating pinning dominated domain reversal in epitaxial SmCo thin films — •Aarti Singh[1], Volker Neu[1], Roland Tamm[2], Karavati Subbarao[2], Sebastian Fähler[1], Werner Skrotzki[2], Ruben Hühne[1], Ludwig Schultz[1], and Bernhard Holzapfel[1] — [1]IFW Dresden, Institute of Metallic Materials, P.O. Box 270116, D-01171 Dresden, Germany — [2]Institute of Structural Physics, Dresden University of Technology, 01062 Dresden, Germany

Epitaxially grown $SmCo_5$ thin films with strong magnetic anisotropy serve as suitable candidates for understanding the basic mechanisms governing coercivity development in these films. The films were epitaxially prepared by pulsed laser deposition on Cr buffered MgO(110) substrates. The epitaxial relation : $MgO(110)[001] \| Cr(211)[011] \| SmCo(100)[001]$ is confirmed by pole figure measurements and magnetic measurements. The remanence ratio for the two in-plane directions ($\|MgO[110]$ and $\|MgO[001]$) is as low as 0.05, and the estimated in-plane anisotropy is 28 T. Along the easy axis, the maximum energy product, $(BH)_{max}$ is $160kJ/m^3$, remanence is 0.96 T and coercivity more than 3 T. For evaluating the cause of high coercivities, a temperature dependent coercivity analysis and angle dependent coercivity analysis were done. In both the analyses the results contradict the simple nucleation dominated coercivity mechanism and are better explained by a pinning dominated magnetisation reversal. The large number of grain boundaries due to small grain sizes and stacking faults within the $SmCo_5$ crystallites are discussed as possible pinning centres.

MA 14.7 Tue 11:45 HSZ 03

Extrinsic and intrinsic properties of epitaxial Pr-Co films — •Ajit Patra, Volker Neu, Sebastian Fähler, and Ludwig Schultz — IFW Dresden, Institute for Metallic Materials, P.O. Box 01171, Dresden, Germany

Detailed investigations of the effect of deposition temperature for Cr buffer (TB) and Pr-Co layer (TD) on the phase formation, textured growth and magnetic properties of epitaxial Pr-Co films are performed by X-ray diffraction (XRD), pole figure measurements and vibrating sample magnetometry (VSM), respectively. Films have been prepared by pulsed laser deposition (PLD) on Cr buffered MgO (100) substrate. Unlike the buffer deposition temperature, the Pr-Co deposition temperature has a large influence on the structure and magnetic properties of the Pr-Co films. For the extreme temperatures, i.e. 300 °C and 700 °C, no Pr-Co phase formation is observed. However films prepared between 300 °C and 700 °C develop a hexagonal Pr-Co phase and grow epitaxially on MgO substrate. Due to the four fold symmetry of the MgO(100) substrate, the c axis is found to be along both, the MgO[010] and MgO[001] direction, which is also confirmed by magnetic measurements. Optimum magnetic properties, $\mu_0 H_c \approx 2.24$ T, $J_R \approx 1.01$ T, $(J_R/J_S) \approx 0.84$ and magnetic texture ($J_R^{hard\ axis}/J_R^{easy\ axis} \approx 0.04$) have been obtained for films deposited at 600 °C.

MA 14.8 Tue 12:00 HSZ 03

Layer-resolved magnetization of a Heisenberg film from magnetic Laue profiles — •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

Layer-dependent properties of magnetic films have been the subject of extensive theoretical studies since the work of Binder and Hohenberg [1]. Using resonant magnetic soft x-ray scattering, we studied the temperature-dependent magnetization of the individual layers in thin (111) films of the prototypical Heisenberg antiferromagnet EuTe [2]. The high magnetic sensitivity at the lanthanide M_5 resonance [3] can be exploited and for the x-ray wavelength of the resonance, the magnetic signal appears exactly at the Brewster angle, which allows to measure magnetic scattering virtually free of charge background. Thus, the magnetic Laue profile of a 20-layer thick film can be measured with unprecedented quality over a large range of momentum transfer. The real-space magnetization profile across the film is obtained from the corresponding Patterson function, yielding the temperature-dependent magnetization of each individual layer. The results are in agreement with Monte-Carlo calculations that show reduced magnetization and enhanced critical exponents for the temperature dependence in the surface region.

[1] K. Binder and P.C. Hohenberg, Phys. Rev. B 9, 2194 (2004).
[2] H. Kepa et al., Phys. Rev. B 68, 24419 (2003).
[3] E. Weschke et al., Phys. Rev. Lett., 93 (157204), 2004.

MA 14.9 Tue 12:15 HSZ 03

TEM investigations of epitaxially grown Sm-Co/Cr films on MgO single crystal substrates — •K. Subba Rao[1], R. Tamm[1], C.-G. Oertel[1], W. Skrotzki[1], A. Singh[2], V. Neu[2], S. Faehler[2], and B. Holzapfel[2] — [1]Institute of Structural Physics, TU Dresden, D-01062 Dresden, Germany — [2]IFW Dresden, Helmholtzstr. 20, D-01069 Dresden, Germany

Hard magnetic Sm-Co/Cr films were epitaxially grown on MgO(100) and (110) substrates. They were characterized by X-ray pole figure measurements and transmission electron microscopy. For films deposited on MgO(100) at 700 °C, orientations are found with the c-axis aligned in-plane and out-of-plane. By lowering the deposition temperature to 370 °C, the out-of-plane orientations disappeared. Further lowering to 350 °C leads to the formation of amorphous regions in the Sm-Co film. For films grown on MgO(110) the Cr buffer deposition temperature plays an important role. When deposited at 700 °C Cr(211) and (100) orientations are observed leading to two different types of Sm-Co in-plane orientations. By lowering the Cr-buffer deposition temperature to 300 °C only one buffer and one Sm-Co orientation exists: Cr(211) and Sm-Co(10-10). The exact orientation relationships between substrate, buffer and films will be explained and its correlation with magnetic properties will be discussed.

MA 14.10 Tue 12:30 HSZ 03

Effect of composition on Nd-Fe-B hard magnetic thin films — •Ah-Ram Kwon, Sebastian Fähler, Volker Neu, and Ludwig Schultz — IFW Dresden, , Institute for Metallic Materials, P.O. Box 270116, D-01171 Dresden, Germany

While for bulk $Nd_2Fe_{14}B$ the influence of composition on microstructure, phase formation and texture is understand quite well, only little work exists on thin films. The $Nd_2Fe_{14}B$ phase has only a very narrow existing range, thus in bulk materials a derivation from stoichometry (2:14:1) results in the formation of additional phases. Nd-Fe-B hard magnetic thin films were deposited on a combinded Cr/Ta buffer layer on heated MgO(100)substrates by pulsed laser deposition. On this buffer system $Nd_2Fe_{14}B$ grows epitaxial in one single orientation. This allows a detailed examination of the intrinsic properties and results in an almost perfect magnetic texture. The effect of composition on phase formation, morphology and magnetic properties was investigated. Optimum phase formation is obtained at a Nd/Fe ratio around 0.3. For this Nd content

an excellent magnetic texture and a coercivity up to 1 T can be obtained; however, films have a granular microstructure with high roughness. Also a certain B surplus is of benefit; though with a too high B or Nd surplus phase formation is more difficult.

MA 14.11 Tue 12:45 HSZ 03

Perpendicular magnetic anisotropy induced by tetragonal distortion of FeCo alloy films grown on Pd(001) — •Aimo Winkelmann, Marek Przybylski, Feng Luo, Yisheng Shi, Jochen Barthel, and Jürgen Kirschner — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany

We grew tetragonally distorted Fe_xCo_{1-x} alloy films on Pd(001). The films were grown at 295 K by molecular beam epitaxy using thermal evaporation from two effusion cells. Theoretical first-principles calculations for such films predict a high saturation magnetization and a high uniaxial magnetic anisotropy energy for specific values of the lattice distortion c/a and the alloy composition x. The magnetic anisotropy was investigated using the magneto-optical Kerr effect. For films of varying composition, we observed a spin-reorientation transition from in-plane to out-of-plane and back to in-plane with increasing cobalt content. Out-of-plane anisotropy was observed for $Fe_{0.5}Co_{0.5}$ films in the thickness range of 4 to 14 ML. Using low energy electron diffraction Kikuchi patterns, the c/a value of about 1.13±0.02 obtained for the tetragonal distortion is consistent with the results formerly obtained for pure Fe (1.11) and Co (1.15) films on Pd(001). The magnetic anisotropy energy induced by the tetragonal distortion is estimated to be almost two orders of magnitude larger than the value for bulk FeCo alloys. A decrease of the tetragonal distortion with thickness can be related to a decrease of the out-of-plane anisotropy energy which is overturned by the in-plane magnetostatic energy above the thickness of 14 ML.

MA 15 Spin-Dependent Transport Phenomena II

Time: Tuesday 10:15–11:45 Room: HSZ 103

MA 15.1 Tue 10:15 HSZ 103

Domain wall resistance in $(Co/Pt)_n$-multilayer-nanowires — •C. Hassel, M. Brands, and G. Dumpich — Experimentalphysik, Universität Duisburg-Essen (Campus Duisburg), Lotharstr. 1, 47048 Duisburg

Nanostructured $(Co/Pt)_n$-multilayer-wires with perpendicular magnetic anisotropy are prepared by means of high resolution electron beam lithography (HR-EBL). Structural analysis of $(Co/Pt)_n$-multilayer-films yields a polycrystalline morphology with a mean grain size of 6 ± 2 nm. The magnetic properties of single $(Co/Pt)_n$-multilayer-nanowires are investigated by magnetic force microscopy. The implantation of Ga-ions (FIB) is used to locally modify the coercive field of the wires. These areas can subsequently be used as domain nucleation centres. The pinning of single domain walls is achieved by preparing $(Co/Pt)_n$-multilayer-wires on top of thin platinum wires in a three-step EBL-process and is verified by magnetic force microscopy investigations. Magnetoresistance measurements in perpendicular magnetic fields at room temperature clearly show a positive contribution of a single domain wall with a relative resistance increase of 1.8% inside a single domain wall.

This work is supported within SFB 491.

MA 15.2 Tue 10:30 HSZ 103

Domain wall resistance of nanosize contacts — •Michael Czerner, Bogdan Yu. Yavorsky, and Ingrid Mertig — Martin Luther University, FB Physik, FG Theorie, D-06099 Halle, Germany

Recent experimental results show a large ballistic magnetoresistance in nickel single-atom conductors [1,2]. The magnetic structure of low-dimensional systems, e.g., nanowires, influences the transport properties drastically [3]. Because of the complex geometry of nanocontacts stabilization of noncollinear magnetic configurations is highly possible. In this respect first-principle calculations of the magnetic order of nanowires are of great interest.

We present calculations of the electronic and magnetic structure of suspended nanowires based on density functional theory in the frame of a screened Korringa-Kohn-Rostoker method modified to noncollinear magnetic order [4]. Furthermore, ballistic conductance was calculated within the Landauer approach by means of KKR Green's functions [5] generalized for noncollinear magnetic structures. We consider Fe,Co, and Ni chains suspended between two semi-infinite leads of the same material. We show that the realistic noncollinear magnetic order has considerable effect on the ballistic transport in the nanowires.

[1] N. Garcia et al., Phys.Rev.Lett. **82**, 2923 (1999)
[2] M.R. Sullivan et al., Phys.Rev.B **71**, 024412 (2005)
[3] V. Rodrigues et al., Phys.Rev.Lett. **91**, 096801 (2003)
[4] B.Yu. Yavorsky et al., Phys.Rev.B **70**, 014413 (2004)
[5] P. Mavropoulos et al., Phys.Rev.B **69**, 125104 (2004)

MA 15.3 Tue 10:45 HSZ 103

Point contact Andreev-reflection spectroscopy of ferromagnetic thin films — •Jan M. Scholtyssek, Lars Bocklage, Rainer Anton, Ulrich Merkt, and Guido Meier — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg

The spin polarisation at the Fermi energy is one of the key properties of ferromagnetic materials in the field of spintronics. We measure the spin polarisation of the conduction electrons using point contact Andreev-reflection spectroscopy (PCAR) [1]. To verify the accuracy of the method measurements on 100 nm thick Ni and Au films are performed. For the interface between the halfmetallic Heusler alloy Ni_2MnIn and InAs a spin polarisation of 100% is predicted [2]. We fabricate Ni_2MnIn films with thicknesses between 30 nm and 100 nm by coevaporation of Ni and a MnIn alloy from two independent sources [3]. Stoichiometric and morphological investigations of the Heusler films deposited on amorphous carbon films are performed in a transmission electron microscope. We present resistivity and PCAR measurements of samples grown on Si exhibiting an enhanced spin polarisation in comparison to the 3d-ferromagnets.

[1] R.J. Soulen, et. al. Science **282**, 85(1998)
[2] K.A. Kilian and R.H. Victora. J. Appl. Phys. **87**, 7064(2000)
[3] M. Kurfiß, et. al. JMMM **290**, 591(2005)

MA 15.4 Tue 11:00 HSZ 103

Current-Induced Excitations in Single Ferromagnetic Layer Nanopillars — •A. Parge and M. Münzenberg — IV. Phys. Inst., Universität Göttingen

Angular momentum transfer studies in magnetic nanostructures have mainly been performed on ferromagnet/ normal magnet/ ferromagnet bilayer junctions so far. But due to spin accumulation on either side of a ferromagnet in the cpp geometry, spin wave excitations have also been predicted theoretically and observed experimentally for junctions with only a single ferromagnetic layer.

We used e-beam lithography and evaporation in order to pattern normal metal/ ferromagnet/ normal metal pillars with a diameter of ˜100 nm on an Au bottom electrode. PMMA served as an insulating template for these structures. Thus a Cu electrode could be smoothly deposited on top of each structure.

All the experimental results presented were obtained in a four point measurement configuration, where the differential resistance dV/dI was measured by a lock-in technique in an external magnetic field. For sufficiently large DC current densities anomalies in dV/dI were observed. The correlation between these phenomena and spin transfer will be discussed in terms of field and current dependence as well as structural asymmetries.

MA 15.5 Tue 11:15 HSZ 103

Structure and dynamics of magnetic polarons in one-dimensional antiferromagnetic semiconductors — •Yaroslav Prylepskiy[1], Alexander Kovalev[1], Magnus Johansson[2], and Yuri Kivshar[3] — [1]B.I. Verkin Institute for Low Temperature Physics and Engineering, 61103, Kharkov, Ukraine — [2]Department of Physics, Chemistry and Biology (IFM), Linköping University, SE-581 83 Linköping, Sweden — [3]Nonlinear Physics Center, Research School of Physical Sciences and Engineering, Australian National University, Canberra ACT 0200, Australia

Based on the one-dimensional Anderson-Hasegawa (AH) double-exchange model we present several families of polaron-type localized solutions, which have collinear and canted arrangement of lattice spins. To study the stability and nontrivial dynamics of magnetic polarons we propose a generalization of the AH model, within which the lattice spins

have a finite magnitude. By means of this generalized approach we derive the self-consistent quasiclassical dynamical equations for both the itinerant currier and (classical) lattice spin fields. Then we proceed to find the stationary localized solutions being focused, in particular, on the mobile solutions. Eventually we address the issue of dynamical stability for the several typical polarons having collinear and canted structure and find the solution recognized as a stable mobile polaron.

MA 15.6 Tue 11:30 HSZ 103

Stress vs Coulomb Interaction in La-manganite Films — •Vasily Moshnyaga[1], Kai Gehrke[1], Oleg Shapoval[2], Alexandr Belenciuc[2], Bernd Damaschke[1], and Konrad Samwer[1] — [1]I. Physikalisches Institut, Universitaet Goettingen, Friedrich-Hund-Platz 1, 37077 Goettingen, Germany — [2]Institute of Applied Physics, AS RM, str. Academiei 5, MD-2028, Chisinau, Republic of Moldova

La-deficient La(1-δ)MnO(3) (LMO) (δ=0-0.2) films were epitaxially grown on SrTiO(3) (STO) and MgO substrates by metalorganic aerosol deposition technique. The films grown on STO substrate show metal-insulator transition and ferromagnetic ordering for T<Tc=260-285 K, whereas those grown on MgO are insulating and exhibit only weak ferromagnetism for T<100 K. X-ray diffraction reveal a stress-free state of the films grown on MgO with lattice constant c=0.389 nm, which does not depend on *δ*. In contrast the LMO/STO films are biaxially strained and possess c=0.386 nm. Predominant role of Coulomb interaction in the growth of manganite films is elucidated. In the case of MgO substrate the charge compensation leads to the formation of stoichiometric LaMnO(3) phase and second phase of MnO(x). The La-deficiency can be stabilized only by an additional elastic contribution (stress) due to substrate/film lattice misfit. The obtained results open a promising possibility to control the structure and magnetotransport in manganites by the interplay between elastic and Coulomb interaction. SFB 602, TP A2 is acknowledged.

MA 16 Micro- and Nanostructured Magnetic Materials II

Time: Tuesday 11:45–13:00 Room: HSZ 103

MA 16.1 Tue 11:45 HSZ 103

In-situ measurements of magnetoresistive effects in ferromagnetic microstructures by Lorentz TEM — •Thomas Haug, Anton Vogl, Josef Zweck, and Christian H. Back — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, D-93040 Regensburg, Germany

Recently large magnetoresistive values exceeding 10.000% have been discovered in ferromagnetic nanocontacts. In these experiments it is assumed that the contact area supports almost atomically sharp domain walls, where the conduction electrons suffer strong spin scattering. However, this theory is discussed controversially, as some other reasons could be listed as well, which might explain these extraordinary high effects. Apart from that, many other magnetoresitive experiments can only be explained theoretically or on the basis of micromagnetic simulations. So there is a strong need for direct observation of the micromagnetic behavior of the samples during the magnetoresistance measurement. We report on a four point resistance measurement inside a transmission electron microscope (TEM) and during the imaging process which uses a newly developed specimen holder. Lorentz microscopy allows us to observe the micromagnetic configuration of the ferromagnetic samples. Two different imaging techniques, Fresnel imaging and differential phase contrast (DPC) are used. The latter one allows lateral magnetic resolution down to 10 nm. We present first experiments on ferromagnetic Nickel structures where we can show the direct correlation between the appearance of magnetic domains and anisotropic magnetoresistance.

MA 16.2 Tue 12:00 HSZ 103

Magnetic anisotropy and tunneling anisotropic magnetoresistance in CoPt systems. — •Alexander Shick[1], František Maca[1], Jan Mašek[1], and Tomas Jungwirth[2,3] — [1]Institute of Physics ASCR, Na Slovance 2, 182 21 Praha 8, Czech Republic — [2]Institute of Physics ASCR, Cukrovarnická 10, 162 53 Praha 6, Czech Republic — [3]School of Physics and Astronomy, University of Nottingham, University Park, Nottingham NG7 2RD, UK

First principles full-potential linearized augmented plane wave (FP-LAPW) calculations are used to investigate the magnetic anisotropy energy (MAE) and tunneling anisotropic magnetoresistance (TAMR) for several model systems ranging from simple hcp-Co to more complex ferromagnetic structures with enhanced spin-orbit coupling, namely bulk and thin film $L1_0$-CoPt ordered alloys and a monatomic-Co wire at a Pt surface step edge. Based on ab initio calculations of the anisotropy in the density of states we predict sizable TAMR effects in CoPt-based metallic ferromagnets. This opens prospect for new spintronic devices with a simpler geometry as these do not require antiferromagnetically coupled contacts on either side of the tunnel junction. We also investigate the relation between the TAMR and MAE, and evaluate reliability of the predicted density of states anisotropies by comparing quantitatively our ab initio results for the magnetocrystalline anisotropies in these systems with experimental data.

MA 16.3 Tue 12:15 HSZ 103

Simulation of magnetoelastic properties of magnetic hollow microspheres — •Markus E. Gruner and Peter Entel — Theoretische Physik, Universität Duisburg-Essen, 47048 Duisburg

We investigate the properties of magnetic hollow micropheres consisting of a self-supporting closed packed arrangement of nanoparticles on a surface of a shell. Based on the setup of a recent experiment [1], we propose a model taking into account the dipolar magnetic coupling and a Lennard-Jones-like pair interaction between the individual particles. Computer simulations using the hybrid Monte Carlo method [2] allow us to obtain information on the magnetoelastic properties. Depending on the strength of the attractive interactions considerable deformations are observed. Using a rotating homgeneous magnetic field, a controlled athermal destruction of the structures is achieved, possibly making magnetic microspheres candidates for magnetically targeted drug carriers.

[1] A. Schlachter, M. E. Gruner, M. Spasova *et al.*, Phase Transitions **78**, 741 (2005)

[2] B. Mehling, D. W. Heermann, and B. M. Forrest, Phys. Rev. B **45**, 679 (1992)

MA 16.4 Tue 12:30 HSZ 103

Preparation and characterization of Mn ferrite nano particles via coprecipitation method — •Behshid Behdadfar[1], Morteza Mozaffari[1,2], and Jamshid Amighian[1,2] — [1]Phys. Dept., The University of Isfahan, Isfahan (81746-73441), Iran. — [2]Nanphysics Recearch Group, Center for Nanosciences and Nanotechnology, The University of Isfahan, Isfahan (81746-73441), Iran.

Soft magnetic oxides, MFe2 O4, where M is a divalent metallic ion, have a spinel structure and in the bulk form have many applications in telecommunication and electronics. Nano particles of these ferrites have different characteristics in comparison with the bulk ones. The use of magnetic particles to induce hyperthermia in biological tissues is an important factor for tumor therapy. Hyperthermia is a therapeutic procedure, which is used to raise the temperature of a region of the body affected by cancer to 42-46oC. This method involves the introduction of ferromagnetic particles in to tissues, and their subsequent irradiation with an alternating electromagnetic field. In this work we have prepared and characterized Mn ferrite nanopowders with a mean particle size of 5 nm. The powders were characterized by XRD method and particle size was calculated by Scherrer*s formula.

MA 16.5 Tue 12:45 HSZ 103

Calculation of the spontaneous magnetization of zinc ferrite unit cells with different distributions of cations at 0 K — •Morteza Mozaffari, Seid Ahmad Rastghalam, and Jamshid Amighian — Phys. Dept., The University of Isfahan, Hezarjarib st., Isfahan 81746-73441, IRAN.

In this work we have calculated spontaneous magnetization of ensembles of zinc ferrite unit cells having one-, ten- and a hundred-million members. For a unit cell of zinc ferrite, about 76.5 % of the cations are on the surface. On the other word broken bond density (BBD), which is the fraction of broken exchange bonds between surface spins with exchange bonds between surface and core spins unaffected, is nearly equal

to 1. Bulk zinc ferrite has a normal spinel structure and as zinc ion has no magnetic moment, it has an antiferromagnet order with a Néel temperature of less than 10 K. Experimental studies have shown that nanometer size of zinc ferrite could have an inverse spinel structure with a non zero spontaneous magnetization. This is due to the canting and/or redistribution of spins on different sublattices. For each of the ensembles a pair of cations have been changed randomly for each member. For unit cells with a distribution according to a normal spinel structure we obtained a spontaneous magnetization (4πM,sub,0) of 1319.5 G. For others we obtained a range of spontaneous magnetizations from 188.49 to 4913.45 G. Spontaneous magnetization mean values for the all ensembles were obtained that is 1543.40 G.

MA 17 Magnetic Materials II

Time: Tuesday 10:15–13:00 Room: HSZ 401

MA 17.1 Tue 10:15 HSZ 401

Magnetism without d-electrons — •Martin Sieberer, Josef Redinger, Sergii Khmelevskyi, and Peter Mohn — Center for Computational Materials Science, Vienna University of Technology, Getreidemarkt 9/134, A-1060 Vienna, Austria

On the basis of ab-initio calculations employing density functional theory (DFT) we investigate half metallic ferromagnetism in zinc-blende and wurtzite compounds composed of group I/II metals as cations and group V elements as anions. We find that the formation of ferromagentic order requires large cell volumes, high ionicity and a slight hybridization of anion p and cation d states around the Fermi energy. Our calculations show that a ferromagnetic alignment of the spins is energetically always more stable than simple AF arrangements, which makes these materials possible candidates for spin injection in spintronic devices. To clarify the conditions for the flat p-band carrying the magnetism, we present results of a tight binding analysis.

MA 17.2 Tue 10:30 HSZ 401

Complex magnetic order and transition to half-metallicity in Mn-doped Fe_3Si — •Phivos Mavropoulos, Marjana Ležaić, and Stefan Blügel — IFF, Forschungszentrum Jülich, D-52425 Jülich, Germany

Fe_3Si is a ferromagnetic material with possible applications in magnetic tunnel junctions [1]. When doped with Mn, the material shows a complex magnetic behavior, as suggested by older experiments [2]. Motivated by the above, we employed the Korringa-Kohn-Rostoker Green function method within density-functional theory in order to study the alloy $Fe_{3-x}Mn_xSi$, with $0 \leq x \leq 1$. The Mn atoms are positioned at the octahedral site of the $L2_1$ crystal structure. Chemical disorder is described within the coherent potential approximation (CPA); magnetic disorder is considered within the disordered local moment (DLM) state, again using the CPA. We find that, for $x \leq 0.3$, the Mn atoms align antiferomagnetically ($Mn^{\downarrow}$) to the Fe atoms, while for $x \geq 0.75$ the alignment is ferromagnetic ($Mn^{\uparrow}$). For intermediate Mn concentrations, the energy minimum is at a DLM state of the form $Fe_{3-x}(Mn^{\downarrow}_{x-y}Mn^{\uparrow}_{y})Si$, in which only a fraction y of the Mn atoms is ferromagnetically coupled to Fe. In the concentrated limit ($x = 1$), the (ordered) alloy is half-metallic. For lower concentrations the spin polarization at the Fermi level is also considerable: for $x = 0.65$, $P = 0.93$, and for $x = 0.55$, $P = 0.85$.

We discuss the origin of the transition to ferromagnetic behavior, the exchange interactions and the spin polarization.

[1] A. Ionescu et al., Phys. Rev. B **71**, 094401 (2005)
[2] S. Yoon and J. G. Booth, J. Phys. F: Met. Phys. **7**, 1079 (1977)

MA 17.3 Tue 10:45 HSZ 401

XMCD study of the 5*d* magnetism at the B′ site in double perovskites $A_2CrB'O_6$ — •P. Majewski[1], S. Geprägs[1], O. Sanganas[1], M. Opel[1], R. Gross[1], G. Vaitheeswaran[2], V. Kanchana[2], A. Delin[2], F. Wilhelm[3], A. Rogalev[3], and L. Alff[4] — [1]Walther-Meissner-Institut, Bavarian Academy of Sciences, Walther-Meissner-Str. 8, 85748 Garching, Germany — [2]Department of Materials Science and Engineering, Royal Institute of Technology (KTH), 10044 Stockholm, Sweden — [3]European Synchrotron Radiation Facility (ESRF), 6 Rue Jules Horowitz, BP 220, 38043 Grenoble, Cedex 9, France — [4]Darmstadt University of Technology, Petersenstr. 23, 64287 Darmstadt, Germany

We have investigated the magnetic moment of the ′non-magnetic′ B′ ion W (resp. Re) in the ferrimagnetic double perovskites Sr_2CrWO_6, Ca_2CrWO_6 and Sr_2CrReO_6 by X-ray magnetic circular dichroism (XMCD) at the L2/3 edges. In all compounds, a negative spin and a positive orbital moment for the B′ ion was detected. Our results are in good agreement with recent band-structure calculations and confirm that the magnetism in these materials is determined by an electronic configuration with localized, highspin 3*d* electrons on the magnetic ion (Cr) and delocalized 5*d* electrons on the ′non-magnetic′ site, which are polarized antiparallel. We find that these double perovskites follow the scaling law of the spin magnetic moment at the site of the ′non-magnetic′ B′ ion with Curie temperature.

This work was supported by the DFG (GR 1132/13), the BMBF (project 13N8279) and the ESRF (HE-1658, HE-1882)

MA 17.4 Tue 11:00 HSZ 401

Rare-earth ferroborates $RFe_3(BO_3)_4$: A novel route to multiferroism — •R. Klingeler[1], C. Hess[1], N. Tristan[1], Y. Skourski[1], B. Büchner[1], E. Popova[2], A. Vasiliev[2], L.N. Bezmaternykh[3], N.A. Stolbovaya[3], and V.L. Temerov[3] — [1]Leibniz-Institute for Solid State and Materials Research IFW Dresden, Postfach 270116, — [2]Faculty of Physics, M.V. Lomonosov, Moscow State University, — [3]L.V. Kirensky Institute of Physics, Siberian

$GdFe_3(BO_3)_4$ is known to be a new multiferroic compound since it exhibits both ferroelectric and antiferromagnetic properties. Little is known about other members of the $RFe_3(BO_3)_4$ family (R=Eu, Tb, Dy, Ho, ...). We report on thermodynamic properties of Tb- and Y based compounds, i.e. specific heat and magnetization measurements in high magnetic fields and in a wide temperature range.

MA 17.5 Tue 11:15 HSZ 401

Direct imaging of stripe-like features in $La_{0.75}Ca_{0.25}MnO_{3-y}$ by scanning tunneling microscopy — •Lakshmana Sudheendra[1], Vasily Moshnyaga[1], Sigrun Koester[1], Kai Gehrke[1], Bernd Damaschke[1], O Shapoval[2], A Belenchuk[2], and Konrad Samwer[1] — [1]I. Physikalisches Institut, University of Goettingen, Friedrich-Hund-Platz 1, D-37077, Germany — [2]Institute of Applied Physics, Academy of Sciences of Moldova, Academiei Str. 5, MD-2028, Chisinau, Moldova

We have performed high resolution scanning tunneling microscopy (STM) and spectroscopy on pseudo-cubic and orthorhombic $La_{0.75}Ca_{0.25}MnO_{3-y}$ films. In the ferromagnetic regime, we observe stripe-like features for the pseudo-cubic film. The typical stripe dimensions are 3-5 unit cells. This charge-stripe dimension observed under STM is consistent with the length scale of 'correlated polarons' observed in manganites from various diffraction techniques [1]. The room temperature images show unusual charge modulation at the atomic scale. The formation of stripes and the unusual charge modulations are discussed based on the charge, orbital and the vacancy ordering [2]. The orthorhombic film, on the other hand, shows stripe-like features at room temperature, which is consistent with the stabilization of the polarons due to the greater structural distortion.

Acknowledgement: We acknowledge the support of DFG-SFB 602 TP A2, the Leibniz programm and the A.v Humboldt foundation (L.S)

1. R. Kajimoto et al., Phys. Rev. B 66, 180402(R) (2002) 2. Takashi Hotta et al., Phys. Rev. Lett. 86, 4922 (2001)

MA 17.6 Tue 11:30 HSZ 401

Electronic structure of highly ordered Sr_2FeMoO_6: XPS and XES studies — •K. Kuepper[1,2], M. Kadiroglu[2], A. V. Postnikov[2,3], K. C Prince[4,5], M. Matteucci[6], V. R. Galakhov[3], H. Hesse[2], G. Borstel[2], and M. Neumann[2] — [1]Forschungszentrum Rossendorf e. V., D-01328 Dresden, Germany — [2]University of Osnabrück, Department of Physics, D-49069 Osnabrück, Germany — [3]Institute of Metal Physics, 620219 Yekaterinburg GSP-170, Russia — [4]Laboratorio TASC-INFM, I-34012 Basovizza (Trieste), Italy — [5]Sincrotrone Trieste, I-34012 Basovizza (Trieste), Italy — [6]ICGEB, I-34012 Trieste, Italy

We have investigated the electronic structure of Sr_2FeMoO_6. In order to probe the partial densities of states we applied soft x-ray emission

spectroscopy (XES) to the Fe L, the Mo M and the O K edges. We discuss the results in the light of complementary measurements of the valence band by means of x-ray photoelectron spectroscopy (XPS) and first-principles generalized gradient approximation (GGA) and LDA + U band structure calculations [1].

[1] K. Kuepper *et al.*, J. Phys.: Condens. Matter **17**, 4309 (2005).

MA 17.7 Tue 11:45 HSZ 401

Microscopic magnetism of the multiferroic spinel CdCr2S4 — •E. Goering[1], S. Gold[1], J. Deisenhofer[2], J. Hemberger[2], V. Tsurkan[2], and A. Loidl[2] — [1]MPI für Metallforschung, 70569 Stuttgart — [2]Institiut für Korrelationen und Magnetismus, Uni-Augsburg, 86135 Augsburg

The coexistence of ferromagnetism and ferroelectricity, has recently attracted much interest in perovskite rear earth manganites [1]. This is connected to a possible new generation of promising electronic devices, where electronic polarization and magnetism are coupled to each other. For CdCr2S4 a colossal magnetocapacitive coupling has been observed close to the ferromagnetic ordering temperature of about [2]. We will show here X-ray magnetic circular dichroism results at the Cr L2,3 edges performed at 33K and 1T external magnetic field, in order to investigate the microscopic magnetic properties of CdCr2S4. The magnetic spectra exhibit unusual and very complex structures (see figure). By the use of sum rules and a self consistent j3/2 j1/2 mixing correction a slightly reduced, compared to the bulk value of 3*B [2], spin moment of 2.2*B has been found. The orbital moment exhibits a nearly vanishing value of 0.037*B, consistent to the theoretically predicted high spin configuration with fully occupied majority t2g orbitals.

[1] T. Kimura, et al.; Nature 426 (2003) 55. T. Goto, et al.; Phys. Rev. Lett 92 (2004) 257201 [2] J. Hemberger, et al.; Nature 434 (2005) 364.

MA 17.8 Tue 12:00 HSZ 401

Characterization of boron-free Fe-based metallic glasses using small-angle neutron scattering — •Giovanni Mastrogiacomo[1], Joachim Kohlbrecher[2], and Jörg F. Löffler[1] — [1]Laboratory of Metal Physics and Technology, Department of Materials, Swiss Federal Institute of Technology (ETH) Zürich, Wolfgang-Pauli-Strasse 10, CH-8093 Zürich, Switzerland — [2]Paul Scherrer Institute, CH-5232 Villigen-PSI, Switzerland

According to structural models, the development of Fe-based metallic glasses is strongly correlated to the amount of metalloids. However, a higher amount of metalloids causes deterioration not only in magnetic properties but also in plasticity. Starting from a Fe-Cr-Co system, which exhibits a decomposing tendency in the solid state, several boron-free Fe-based metallic glasses of composition (Fe0.582Co0.418)100-x-yCrxZry (10<x<28 and 8<y<11) were developed. The development of these alloys was based on destabilization of the solid state via the application of the Hume-Rothery rule, where low solubility is achieved for alloying elements with atomic size ratios differing by more than 15%. Alloying of zirconium in the Fe-Cr-Co system, which satisfies the Hume-Rothery rule, causes a decrease in the liquidus temperature. The resulting magnetization measurements of a boron-free Fe-based metallic glass of composition (Fe0.582Co0.418)80Cr10Zr10 reveal a saturation magnetization of up to 1.1 T and an inverted hysteresis. According to small-angle neutron scattering measurements, the inverted hysteresis can be attributed to the presence of two phases, resulting from the decomposing tendency of the Fe-Cr-Co system.

MA 17.9 Tue 12:15 HSZ 401

Orbital magnetic moment anisotropy in (GaMn)As — •F. Kronast[1], R. Ovsyannikov[1], A. Vollmer[1], H.A. Dürr[1], W. Eberhardt[1], G.M. Schott[2], C. Ruester[2], C. Gould[2], G. Schmidt[2], K. Brunner[2], L.W. Molenkamp[2], and J. Cesar[3] — [1]BESSY GmbH, Albert Einstein Strasse 15, 12489 Berlin, Germany — [2]Physikalisches Institut III, Universität Würzburg, Germany — [3]ESRF, BP 220, 38043 Grenoble Cedex, France

Using x-ray absorption spectroscopy (XAS) and x-ray magnetic circular dichroism (XMCD) we studied the ferromagentic ordering in (GaMn)As, the most prominent member of the III-V series of ferromagnetic dilute magnetic semiconductors (DMS). Mn replacing the trivalent Ga atoms provides a local spin magnetic moment and as an acceptor it creates itinerant holes [1]. The exchange coupling of holes to the Mn 3d shell by pd-hybridization mediates the long range ferromagnetic order. The pd-hybridization is usually assumed to be spherically isotropic [2].

Only recently Mahadevan et al. predicted a strongly anisotropic pd-hybridization due to p-d hopping interactions that depend on the specific lattice orientation (Phys. Rev. Lett., 93, 177201, 2004). In angle dependent XMCD measurements we find a variation of the Mn 3d orbital moment with the in-plane azimuthal lattice direction that is correlated with distinct spectroscopic features. Both can be interpreted by a spin-orientation dependent spatial anisotropy of the Mn acceptor state influencing the ferromagnetic ordering. This is the first experimental indication for an anisotropic pd-hybridization in (GaMn)As and, therefore, magnetic exchange coupling.

MA 17.10 Tue 12:30 HSZ 401

Crystal growth and physical properties of cuprates grown under high pressure — •Nadja Wizent[1], Günther Behr[1], Lutz Schramm[1], Mircea Apostu[1], Anja Waske[1], Thomas Doerte[2], Michael Ruck[2], Bernd Büchner[1], and Wolfgang Löser[1] — [1]Leibniz Institute for Solid State and Materials Research (IFW) Dresden, Germany — [2]Technische Universität Dresden Institut für Anorganische Chemie Dresden, Germany

The copper oxide-based compounds are known for interesting properties like superconductivity, spin and charge ordering. Single crystals of cuprates with Co and Ca were grown with the travelling floating zone method under high oxygen pressure. Phase diagram studies were carried out on the basis of CALPHAD calculations. Magnetic and heat capacity measurements were accomplished on as grown and annealed crystals. Different growth strategies and heat treatments for the metastable phase $CoCu_2O_3$ were elaborated, which show the striking effect of growth rate on the constitution. A $CaCu_2O_3$ type phase was grown under 50 bar oxygen pressure with the composition of $(Ca_{0,75}Cu_{0,25})Cu_2O_3$. Magnetic measurements revealed antiferromagnetic ordering below T_N= 31 K . From structure investigations it is concluded that 11% of all Cu-atoms are on Ca-sites. Whereas, only 1/3 of them display magnetic moments.

MA 17.11 Tue 12:45 HSZ 401

Influence of texture on corrosion behaviour of highly anisotropic sintered magnets — •Mihaela Rada[1], Annett Gebert[1], Irina Mazilu[1], Kirill Khlopkov[1], Oliver Gutfleisch[1], Ludwig Schultz[1], and Werner Rodewald[2] — [1]Leibniz-Institute for Solid State and Materials Research IFW Dresden, P.O. Box 270016, D-01171 Dresden, Germany — [2]Vacuumschmelze GmbH & Co KG, P.O. Box, D-63412 Hanau, Germany

The anisotropic corrosion behaviour of highly textured sintered Nd-Fe-B magnets in weakly acidic solutions has been evaluated by investigations of magnet surfaces, which are parallel or perpendicular to the crystallographic c-axis of the aligned ferromagnetic grains. The total corrosion process progresses more pronouncedly at the perpendicular magnets surfaces (the pole faces). Under free corrosion and anodic polarization conditions the parallel magnet surfaces exhibit a stronger active dissolution tendency due to an enhanced reactivity of grain surfaces parallel to the (100) plane of the Nd2Fe14B crystals. Single misoriented grains dissolve preferentially at both magnet sides. Under cathodic conditions the hydrogenation process progresses more rapidly at the perpendicular sides, suggesting a local preferential penetration of atomic hydrogen into the material.

MA 18 Spin-Dynamics, Magnetization Reversal I

Time: Tuesday 10:15–13:00 Room: HSZ 403

MA 18.1 Tue 10:15 HSZ 403

Modal Spectrum of Permalloy Disks with and without Vortex — •Frank Hoffmann, Korbinian Perzlmaier, Georg Woltersdorf, Ingo Neudecker, and Christian Back — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Universitätsstrasse 31, 93040 Regensburg

The mode spectrum of micron-sized ferromagnetic permalloy disks, exhibiting a vortex ground state, was investigated. In equilibrium the magnetization is in the plane of the sample, except for a small region in the center, where it is aligned perpendicular.
Time resolved scanning Kerr microscopy was used to measure the temporal evolution of the magnetization after application of a fast rise time in-plane field pulse. Spatially resolved amplitude and phase spectra reveal the mode structure, that consists of modes with circular nodes and modes with diametric nodes.
It is shown, that the lowest order azimuthal mode, a mode with only one diametric node, splits into a doublet as the disk diameter decreases. Ivanov and Zaspel [1] have shown theoretically, that this splitting is due to interaction with the gyrotropic motion of the vortex core. By removing the vortex core the splitting of the modes vanishes. This behaviour was found both in micromagnetic simulations and experiments.
[1] PRL 94, 027205 (2005)

MA 18.2 Tue 10:30 HSZ 403

Microwave assisted switching in $Ni_{81}Fe_{19}$ — •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 the study of the quasi-static switching behavior of a $Ni_{81}Fe_{19}$ ellipsoid under the influence of a microwave field by longitudinal magneto-optic Kerr effect magnetometry. The long axis of the ellipsoid is parallel to the quasi-static field in the plane of the element. The dimensions of the element are 160 μm x 80 μm x 10 nm. The switching behavior of the element is studied by measuring hysteresis curves with an applied microwave field perpendicular to the quasi-static magnetic field. The frequency of the microwave field was varied in the range of 500 MHz to 2.0 GHz in steps of 100 MHz and the microwave power is increased from -5 dBm to 35 dBm for each frequency. A strong reduction of the coercive field is observed for the microwave frequencies between 650 MHz to 900 MHz for the maximum output power of 35 dBm. This reduction can be described by two different mechanisms. The most important one is the enhancement of domain nucleation by the microwave field. The second, weaker mechanism is an enhanced growth of the reversed domain. This is due to the fundamental principle that every physical system favors the state with the lowest Gibbs free energy. We demonstrate that the switching process of elements, which is dominated by domain nucleation and propagation, can be stimulated by applying a transversal microwave field. This work is supported by the EU-RTN ULTRASWITCH (HPRN-CT-2002-00318).

MA 18.3 Tue 10:45 HSZ 403

Brillouin light scattering microscopy investigations of quantized spin waves in small magnetic ring structures — •H. Schultheiss[1], C. Bayer[1], H.T. Nembach[1], M.C. Weber[1], B. Leven[1], J. Podbielski[2], F. Giesen[2], D. Grundler[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 und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg, Germany

Spin wave quantization due to geometrical confinement and the presence of spin wave wells has been studied spatially and frequency resolved in mesoscopic magnetic ring structures. Brillouin light scattering microscopy with a spatial resolution of 300 nm allows for a local study of the spin dynamics within a single ring magnetized in the onion or the vortex state. The measured spin wave spectra do not change significantly along the ring in the vortex state, whereas in the onion state a strongly inhomogeneous internal field along the ring perimeter leads to different spin wave frequencies primarily in the pole and equatorial ring regions. Spin wave quantization in radial direction within the equatorial region of the onion state was found by comparing the experimental spectra with calculated spin wave dispersions. Moreover, effective spin wave wells caused by the inhomogeneous internal field distribution are responsible for spin wave localization in the pole region of the onion domain pattern. Hence, there is strong evidence for the coexistence of localized eigenmodes within a single microstructure due to two different quantization mechanisms.
Financial support by the DFG within the SPP 1133 and by the EC-RTN ULTRASWITCH is gratefully acknowledged.

MA 18.4 Tue 11:00 HSZ 403

Spatially resolved dynamic eigenmode spectrum of Co rings — •Ingo Neudecker[1], Mathias Kläui[2], Korbinian Perzlmaier[1], Dirk Backes[2,3], Laura J. Heyderman[3], Carlos A. F. Vaz[4], J. Anthony C. Bland[4], Ulrich Rüdiger[2], and Christian H. Back[1] — [1]Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Universitätsstrasse 31, D-93040 Regensburg, Germany — [2]Fachbereich Physik, Universität Konstanz, Universitätsstrasse 10, D-78457 Konstanz, Germany — [3]Paul Scherrer Institut, CH-5232 Villingen PSI, Switzerland — [4]Cavendish Laboratory, University of Cambridge, Madingley Road, Cambridge, CB3 0HE, United Kingdom

We determined the spatially resolved eigenmode spectrum of micrometer-sized Co ring magnets by means of vector network analyzer ferromagnetic resonance combined with time resolved magneto-optic Kerr effect measurements. In doing so up to five resonant eigenmodes were observed in the frequency range from 45 MHz to 20 GHz as a function of an external magnetic bias field. Well defined spatial modes were found both in the vortex and in the onion remanent states. The observed modes correspond to four longitudinal modes, with magnetostatic backward-volume character, and a transverse mode, localized in the transverse domain wall of the onion state. Finally the effect of inter-ring coupling on the modes in the remanent states was investigated. Good agreement between the experimental results and micromagnetic simulations was found. The study demonstrates that the ring representing a high symmetry structure exhibits simple eigenmode behavior.

MA 18.5 Tue 11:15 HSZ 403

Correlation of ferromagnetic precessional modes and domain wall density in patterned ferromagnetic films — •Ute Queitsch[1], Jeffrey McCord[1], Rudolf Schäfer[1], Ludwig Schultz[1], Karsten Rott[2], and Hubert Brückl[2] — [1]Leibniz Institut für Festkörper- und Werkstoffforschung (IFW), Helmholtzstrasse 20, 01069 Dresden — [2]Universität Bielefeld, Lehrstuhl für Dünne Schichten und Nanostrukturen, Universitätsstrasse 25, 33615 Bielefeld

Understanding the correlation between magnetic microstructure and hf-response of patterned soft magnetic thin films is crucial for hf applications. The hf response of arrays of $CoZrTa$ single and bi-layer thin film elements ($200\mu m \times 50\mu m \times 80nm$) was investigated by means of pulsed inductive microwave magnetometry and directly compared to the domain structure analyzed by time resolved wide field Kerr microscopy. Different domain states were preset by varying the magnetic field history. Characteristic changes in the hf response depending on the domain wall density were observed. Domain walls were found to have a lower permeability compared to freely rotatable regions, leading to an additional contribution to the acting anisotropy field which leads to a drastic rise in the dominating ferromagnetic resonance frequency of the film. The demagnetizing field of the 90°-closure domain walls causes different modes of excitation and relaxation. Domain wall movements during the dynamic remagnetization process cause frequency components in the 100 MHz range. Due to stray field coupling the bilayers show an irregular domain pattern without closure domains which leads to a strong reduction of the number of precessional modes and domain wall movements.

MA 18.6 Tue 11:30 HSZ 403

Fast Resonant Vortex Core Switching — •H. Stoll[1], A. Puzic[1], K.W. Chou[1], B. Van Waeyenberge[2], T. Tyliszczak[3], I. Neudecker[4], K. Rott[5], H. Brückl[6], D. Weiss[4], G. Reiss[5], C.H. Back[4], and G. Schütz[1] — [1]MPI for Metals Research, Stuttgart — [2]Ghent University — [3]LBNL, Berkeley, CA — [4]Regensburg University — [5]Bielefeld University — [6]ARCS, Nano System Technology, Vienna

New ways were developed to switch the out-of-plane polarization of vortex cores in micron-sized ferromagnetic vortex structures either (i) by

altering the amplitude of an alternating magnetic field at a frequency close to the eigenfrequency of the gyrotropic vortex motion or (ii) by applying a short burst (e.g., one single period) of this resonant ac magnetic field. Switching of the vortex core corresponds to a change of the chirality or handedness of the vortex structure. Experiments were performed on 1 to 2 micron large, 50 nm thick Permalloy circles and squares located on a Cu stripline. The polarization of the vortex core was detected with a scanning transmission X-ray microscope (STXM, ALS, Berkeley) by monitoring the sense of rotation of the vortex motion [1]. Magnetic vortex cores have already been discussed as candidates for magnetic data storage, but for switching of the vortex core polarization large magnetic fields in the order of half a Tesla were required so far [2,3]. The resonant vortex core switching schemes presented here need much lower magnetic fields (in the order of 10 mT) and allow in addition high switching speeds.
[1] A. Puzic et al., J. Appl. Phys. 97, 10E704 (2005)
[2] T. Okuno et al., J. Appl. Phys. 95, 3612 (2004)
[3] A. Thiaville et al., Phys. Rev. B 67, 094410 (2003)

MA 18.7 Tue 11:45 HSZ 403

Spin wave logic gates — •T. Schneider, M. Kostylev, B. Leven, A. Serga, and B. Hillebrands — Fachbereich Physik, TU Kaiserslautern, 67663 Kaiserslautern

We present a new approach for magnetic logic gates either using the phase or the amplitude of the spin-waves. A XNOR gate has been realized using the spin-wave phase as logical “1” and “0”. The necessary phase-shifts can be realized by a weak, locally confined magnetic field, e.g. the field of a current carrying conductor. Using this current controlled phase shifter (CPS), the XNOR gate can be constructed as a Mach-Zehnder interferometer with a CPS in each of the branches. In addition, we have created a NAND gate using the spin-wave amplitude as logical signal. We demonstrate that by applying a magnetic field which is stronger than in the case of the XNOR gate the spin-wave amplitude can be suppressed thus realizing the required input negation. We have constructed prototypes of both logic gates based on yttrium-iron-garnet waveguides and we demonstrate the performance.

This work has been supported by the Deutsche Forschungsgemeinschaft and by the European Community within the EU-project MAGLOG (FP6-510993).

MA 18.8 Tue 12:00 HSZ 403

Ballistic Bit Addressing in a Magnetic Memory Cell Array — •Hans Werner Schumacher — Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig

A ringing free bit addressing scheme for magnetic random access memories (MRAM) is proposed. As in standard MRAM addressing schemes the switching of a selected cell is obtained by the combination of two half-select field pulses. Numerical solutions of a single spin model of an MRAM cell show that the pulse parameters can be chosen such that the application of the half select pulse induces a full precessional turn of the magnetization (no switch) whereas the superposition of two half select pulses induces a half precessional turn (switch) [1]. With well adapted pulse parameters both full-select and half-select switching occurs on ballistic trajectories characterized by the absence of ringing after magnetic pulse decay. Such ballistic bit addressing allows ultra high MRAM write clock rates and a highly parallel write operation [2].

References: [1] H. W. Schumacher, Appl. Phys. Lett. 87, 042504 (2005). [2] H. W. Schumacher, J. Appl. Phys. 98, 033910 (2005).

MA 18.9 Tue 12:15 HSZ 403

Current assisted switching of magnetic tunneling cells with MgO barriers — •Guenter Reiss and Karsten Rott — Bielefeld University, Department of Physics, P.O. Box 100 131, 33501 Bielefeld, Germany

The CMOS and scaling compatibility of the magnetic switching of the soft electrode in magnetic tunneling junctions is one of the major challenges in the development of both Magnetic Random Access Memory as well as Field Programmable Logic Gate Arrays. Because the traditional method of switching by field pulses generated by current lines requires large currents and is not scalable, alternative schemes such as heat assisted switching have been porposed and demonstrated. Here, we show, that the spin torque of the spin polarized current driven through a magnetic tunneling junction with low resistive MgO barriers with a of TMR around 130% can both reduce considerably the apparent coercive field of the soft layer and is even capable of switching the magnetization of the soft electrode. The currents needed for switching are in the range of some mA per square micron and thus open a way for CMOS compatibility of ultrasmall tunneling junctions.

MA 18.10 Tue 12:30 HSZ 403

Precessional switching in arrays of iron nano-magnets. — •Fabrizio Porrati and Michael Huth — Physikalisches Institut, J. W. Goethe-Universität, Max-von-Laue-Strasse 1, 60438 Frankfurt am Main

We present a bit addressing scheme for magnetic ram based on the application of two successive unipolar field pulses. We employ micromagnetic simulations to study the switching behaviour of an isolated nanomagnet as function of the pulses length. We discuss the role of the dipolar interaction by varying the relative distance of memory cells in an array of nanomagnets.

MA 18.11 Tue 12:45 HSZ 403

Domain Wall generation and movement in narrow GMR lines — •Roland Mattheis, Marco Diegel, Uwe Huebner, Dominique Schmidt, and Hardy Koebe — Institute for Physical High Technology, A.-Einstein-Str. 9, D-07745 Jena

Well defined motion of domain walls in narrow lines offer chances for new magneto electronic applications like magnetic logic [1] or multiturn counters for automotive and automation applications [2]. To analyse the behaviour of the domain walls we investigate the generation and movement of the 180° domain walls in 10 and 20 nm thick Ni81Fe19 layers as a part of a GMR stack. The structures consist of 150 x 250 nm wide lines with and without a domain generator at one end of the 0.500 mm line. By measuring the time and magnetic field dependence of the resistance we determine the distribution of the magnetic field necessary for the generation of a domain wall and the field dependence of the domain wall movement (domain wall mobility). Pinning and depinning of the domain walls was used to characterize geometrical perfection of the used structures. \Zitat{1}{Allwood D. A., Xiong G., Cooke M. D., Faulkner C. C., Atkinson D., Vernier N. and Cowburn R. P., Science, 296 (2002) 2003} \Zitat{2}{M. Diegel, R. Mattheis, E. Halder, IEEE Trans. Magn. 40 (2004) 2655}

MA 19 Invited Talks Algarabel / Gutfleisch

Time: Tuesday 14:00–15:00 Room: HSZ 03

Invited Talk MA 19.1 Tue 14:00 HSZ 03

Pressure and magnetic field effects on the magnetic and crystallographic structures of the R5(SixGe1-x)4 compounds — •Algarabel P. A.[1], Morellon L.[1], Magen C.[1], Ibarra M. R.[1], Ritter C.[2], and Arnold Z.[3] — [1]Instituto de Ciencia de Materiales de Aragón, Universidad de Zaragoza and Consejo Superior de Investigaciones Científicas, 50009 Zaragoza, Spain — [2]Institut Laue-Langevin, Boîte Postale 156, 38042 Grenoble Cédex 9, France — [3]Institute of Physics AS CR, Na Slovance 2, 182 21 Prague 8, Czech Republic

The astonishing properties discovered in the R5(SixGe1-x)4 rare-earth intermetallic materials have triggered a great research activity due to an exceptional magnetoresponsive behavior such as the giant magnetocaloric effect , strong magnetoelastic effects, and giant magnetoresistance. This phenomenology has been associated with the intrinsically sub-nanometer-layered crystallographic structure combined with a magnetic-martensitic first-order phase transformation. The strong magnetoelastic coupling responsible for these phenomena allows the magnetic-crystallographic transition to be reversibly induced by the change of external parameters such as temperature, external magnetic field, or hydrostatic pressure. A review of the most outstanding properties arising from the strong interplay between the crystallographic structure and magnetism in the system R5(SixGe1-x)4 (R=Gd, Tb, Er) is presented. In addition to compositional and magnetic-field effects, we will emphasize the significance of the hydrostatic pressure as a new control parameter of the properties of these compounds.

Invited Talk

MA 19.2 Tue 14:30 HSZ 03

Melt-spun materials for magnetic refrigeration near room temperature — •Oliver Gutfleisch — IFW Dresden, P.O. Box 270016, D-01171 Dresden, Germany

The development of giant magnetocaloric effect (MCE) materials could open the path for magnetic refrigeration near ambient temperature as an energy efficient, easily scaleable, mechanically simple and environmentally friendly cooling technology, by this replacing conventional refrigeration. Unlike in Gd5Ge2Si2, no magnetic-field induced crystallographic structural changes are involved in the large values of magnetic entropy change reported for LaFe13-xSix compounds of NaZn13-type structure and for MnFePAs compounds of Fe2P-type structure. LaFe11.8Si1.2 shows a thermally-induced first-order phase transition as well as an itinerant-electron metamagnetic transition accompanied by a significant volume change. A prolonged heat treatment is usually necessary to develop the NaZn13-phase in the bulk. Here, LaFe13-xSix was prepared by melt-spinning. Melt-spinning can yield refined microstructure, extended solute solubility, reduced macro- and micro-segregation and metastable phases. We succeeded in the preparation of the 1:13 phase by a much reduced annealing and in enhanced values of magnetic entropy changes. Curie temperature and the nature of the magnetic phase transition (shift from first-order to second-order) is adjusted by increasing Si content, by partially substituting Co for Fe or by interstitial hydrogen. These changes have not only consequences for the thermal and magnetic hysteresis but also affect the final net refrigerant capacity. A similar evaluation was done when replacing toxic As with Ge in melt-spun MnFePGe.

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 ap-

plied 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 Bi$MO3$ (M = Fe, Cr) thin films — •S. Geprägs, M. Opel, S.T.B. Goenenwein, 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 $BiCrO_3$.

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[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.

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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 ≈ 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.

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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 ≈ 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 al-

loys 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_2O_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 depen-

dence 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.

[1] N. Garcìa et al., Phys. Rev. Lett. **82**, 2923 (1999)
[2] M. R. Sullivan et al., Phys. Rev. B **71**, 024412 (2005)
[3] M. Viret et al., Phys. Rev. B **66**, 220401 (2002)
[4] A. Bagrets et al., cond-mat/0510073 (2005)
[5] H. U. Baranger and A. D. Stone, Phys. Rev. B **40**, 8169 (1989)

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 — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Universitätsstr. 31, 93053 Regensburg

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 tempera-

tures) 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×3μm×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 $[CoFe(t_n\ \mathrm{nm})/Al_2O_3(3\ \mathrm{nm})]_{10}$ 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

***Ab*-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
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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.

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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.

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[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.

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[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 de-

creases with increasing field angle for the diameters investigated which is in agreement with experimental results.
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[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].
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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 ($T_N = 88$K) serving as a reference compound. $\mathrm{GdMnO_3}$ shows antiferromagnetic order for $T < T_N = 43$K. Application of a magnetic field $H \| b$ induces an electric polarization $\mathbf{P}$ below $T \approx 10$K. In contrast, $\mathrm{TbMnO_3}$ shows intrinsic ferroelectricity for $T < T_{lock} = 28$K 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.
This work was supported by the DFG through SFB 608.

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.
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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 $LuMn_6Ge_{6-x}Ga_x$ 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 {$\to$} 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.

supported by the DFG through SPP 1166

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.

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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 reduc-

tion 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.

[1] K. Potzger, A. Weber, H. H. Bertschat, W.-D. Zeitz, and M. Dietrich, Phys. Rev. Lett. 88, 247201 (2002).

[2] Ph. Mavropoulos, J. Phys.: Condsened Matter 15, 8115 (2003).

[3] V. Bellini, S. Cottenier, M. Cakmak and F. Manghi and M. Rots, Phys. Rev. B 70, 155419 (2004).

MA 21 Invited Talks Hickey / Temst

Time: Wednesday 14:00–15:00 Room: HSZ 03

Invited Talk

MA 21.1 Wed 14:00 HSZ 03

Spin Transport across interfaces — •B J Hickey[1], L Michez[1], K McKenna[1], G J Morgan[1], S Shatz[2], and N Wiser[2] — [1]E C Stoner Laboratory, Department of Physics and Astronomy, University of Leeds, Leeds LS2 9JT, UK — [2]Department of Physics, Bar-Ilan Univeristy, Ramat Gan, Israel

A fundamental aspect of the operation of any spintronic device is the transport of electrons across an interface. It is accepted that spin-dependent scattering, mainly at interfaces, is at the heart of spintronics but there are many experimental examples that theory cannot easily explain. In this talk we shall review some of the more intriguing results and discuss how well they are presently understood. It is well-known that the accumulation of spin near interfaces is an intrinsic feature of transport in magnetic multilayers. It has, until recently, been thought that this feature was intimately connected with electron scattering. It was thought that for currents applied perpendicular to the plane of the layers, the relaxation length for the spin accumulation, the spin diffusion length, was also the length scale for determining the electron transport. We shall present new experimental data which investigates the effects of interface scattering as a function of the number of interfaces and the proximity of the scattering interfaces. We shall show that these results can be understood without the need to introduce spin-flip scattering and that the length scale for the transport is the momentum relaxation length - the mean free path. Additionally, we shall confirm these results in calculations where we have developed models of transport in spintronic devices which incorporate spin-relaxation through spin-orbit scattering.

Invited Talk

MA 21.2 Wed 14:30 HSZ 03

Exchange bias in patterned magnetic structures — •Kristiaan Temst[1], Elena Popova[1], Steven Brems[1], Chris Van Haesendonck[1], Helmut Fritzsche[2], Marita Gierlings[2], Florin Radu[3], Hartmut Zabel[3], Peter Leunissen[4], and Rik Jonckheere[4] — [1]Laboratorium voor Vaste-Stoffysica en Magnetisme, K.U.Leuven, Belgium — [2]BENSC, Hahn-Meitner-Institut, Berlin, Germany — [3]Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, Germany — [4]IMEC vzw, Leuven, Belgium

We have studied the influence of finite dimensions and shape anisotropy on the exchange bias effect in patterned polycrystalline Co/CoO ferromagnet/antiferromagnet exchange bias systems prepared by combining electron beam lithography and thin-film deposition methods. A particular feature of Co/CoO exchange bias systems is that they exhibit a strong asymmetry in the magnetization reversal mechanism: the magnetization reversal mechanism is different in the two branches of the hysteresis loop. We have investigated by polarized neutron reflectivity experiments if and how this asymmetry is affected by the finite size and shape anisotropy of the Co/CoO structures. We will demonstrate that the asymmetry re-

mains present even down to very small structure size, but that the shape anisotropy does have a strong influence on the presence of the asymmetry. This effect may be explained by the presence of interfacial domains at the Co/CoO interface. Anisotropic magnetoresistance measurements and magnetization experiments show that it is possible to re-induce the untrained state by applying a field in the direction perpendicular to that of the initial cooling field.

MA 22 Internal Symposium "50 Years AG Magnetism"

Time: Wednesday 15:15–18:00 Room: HSZ 03

Invited Talk

MA 22.1 Wed 15:15 HSZ 03

Fifty Years "Arbeitsgemeinschaft Magnetismus" - History of Magnetism in Germany — •H. Kronmüller — Max-Planck-Institut für Metallforschung, Heisenbergstr. 3, 70569 Stuttgart, Germany

The "Arbeitsgemeinschaft Magnetismus (AM)" has been founded in 1956 as a united organization of four different scientific societies (DPG, DGM, VDE, VDEH). The AM supports basic research and technical applications of magnetism. To promote advanced knowledge on magnetism the AM organizes conferences and workshops and participates in international conferences. From the first meeting held in 1957 the central idea was the interdisciplinary collaboration between basic and applied research. Within the last 50 years the AM has been involved in all innovative developments in the field of magnetic materials. The main activities so far are the following ones: 1. Investigation of magnetic ground states and excited states by ab-initio electron theory and model Hamiltonians, as e.g. the Hubbard model. 2. High-coercivity intermetallic compounds, high-permeability ferrites, (nano-)crystalline and amorphous alloys. 3. High-quality magnetic materials with outstanding properties as spin glasses, heavy-fermion compounds, perovskites, invar and shape memory alloys. 4. Thin film systems for sensor applications and high-density recording, GMR and CMR systems. 5. Micromagnetic analysis of domain patterns, domain walls and magnetization processes in thin films and small particles, development of computational micromagnetism. 6. Development of high-standard measuring techniques as NMR, Mößbauer effect, STM, MFM, Lorentz microscopy, neutron diffraction, XMCD, spin-polarized electron methods.

Invited Talk

MA 22.2 Wed 15:45 HSZ 03

Making magnets harder — •J. M. D. Coey — School of Physics and CRANN, Trinity College, Dublin 2, Ireland

The 20th century was a period when the energy product of permanent magnets, the simplest figure of merit, improved exponentially. This growth is now over, and the prospects of another doubling look dim. Permanent magnets however have myriad uses in electromagnetic drives, and hundreds of millions of them are produced annually. Further progress may come from integrating micron-scale magnets into silicon-based MEMS structures, especially in view of the favorable scaling of dipole-dipole interactions. Current challenges to produce useful magnetic thick films will be discussed, and potential for further materials development will be reviewed.

Invited Talk

MA 22.3 Wed 16:15 HSZ 03

Industrial Rare-Earth Permanent Magnets and their Applications — •Matthias Katter — Vacuumschmelze GmbH Co. KG, Grüner Weg 37, 63450 Hanau

The production route and the main applications of high end sintered permanent magnets based on Nd-Fe-B and Sm-Co are reviewed. For Nd-Fe-B, the influence of the grain size on the magnetic properties and the corrosion resistance is reported. Commercial Nd-Fe-B magnets meanwhile reach energy densities of up 53 MGOe, whereas for lab magnets about 58 MGOe are obtained which is close to the theoretical limit of 64 MGOe. The magnetization behaviour of Sm2(Co,Fe,Cu,Zr)17 magnets, which is determined by pinning of domain walls, is discussed. Industrial magnet grades of this type can be applied up to 350 - 550°C. The main applications for Nd-Fe-B magnets are in hard disc drives and in any kind of motors. A large increase is expected in the next years for automotive applications like steering by wire and hybrid electric vehicles. From the scientific side, there are challenging demands for very homogenous magnets for beam guiding systems like wigglers and undulators.

— 15 min. Break —

Invited Talk

MA 22.4 Wed 17:00 HSZ 03

Spin transfer phenomena in layered magnetic structures — •Peter A. Grünberg, Daniel E. Bürgler, and Claus M. Schneider — FZ-Jülich, IFF

The discovery of interlayer exchange coupling (IEC) in 1986 was followed in 1988 by the first detection of "Giant Magnetoresistance" (GMR) and in 1995 by a rediscovery of tunnel magnetoresistance (TMR). Finally after its theoretical prediction in 1995, in 1999 there was the first experimental observation of current induced magnetic switching (CIMS). All mentioned phenomena rely on the transfer of electron spin between neighbouring magnetic layers across nonmagnetic interlayers in layered magnetic structures. Here we want to give an overview of this worldwide activity.

The phenomena can be classified according to the nature of the interlayer material used: metallic, semiconducting, insulating. Generally IEC is only obtained across metallic interlayers, but there are exceptions like IEC of Fe across Si and MgO. Furthermore IEC across well ordered Si turns out to be surprisingly strong. Likewise TMR is expected and indeed observed across semiconductors and insulators but so far could not be detected across Si, despite many efforts due to technical relevance. On the other hand values as big as a few hundred percent have been observed for TMR across MgO, in agreement with a theoretical prediction. We shall present and discuss the mentioned phenomena in the framework of associated band structures, where emphasis will be given to a basic physical understanding. Already existing and possible future applications will also be considered.

Invited Talk

MA 22.5 Wed 17:30 HSZ 03

Interplay between Incipient Magnetism and Superconductivity in Heavy Fermions — •Frank Steglich — Max Planck Institute for Chemical Physics of Solids, 01187 Dresden, Germany

Strong electronic correlations on partially filled 4f or 5f shells, weakly hybridized with ligand valence-electron orbitals, cause the formation of extremely heavy quasiparticles composed of a dominating local f part as well as contributions from conduction-band states. As discovered in 1979 for $CeCu_2Si_2$, these "heavy fermions" (HF) may form Cooper pairs. In most HF metals, the superconducting glue seems to be of magnetic origin. In fact, for UPd_2Al_3 magnetic-exciton mediated pairing could be convincingly demonstrated, i.e. by comparing quasiparticle-tunneling and inelastic neutron-scattering results.

For a number of Ce-based HF metals superconductivity was found to be intimately related to the existence of an antiferromagnetic (AF) instability which, at least in the case of $CeCu_2Si_2$, is of the conventional (spin-density-wave) type. On the other hand, an AF magnetic-field induced "quantum critical point" of unconventional nature originating in a break up of the "composite" HFs was recently established in $YbRh_2Si_2$. For this compound, we found dominating 2D ferromagnetic quantum critical fluctuations in wide regions of the phase diagram, but no superconductivity at temperatures down to 10 mK.

Work done in collaboration with: M. Deppe, G. Donath, J. Ferstl, P. Gegenwart, C. Geibel, H.S. Jeevan, R. Küchler, T. Lühmann, M. Nicklas, N. Oeschler, J. Sichelschmidt, O. Stockert, P. Thalmeier, F. Weickert, S. Wirth.

MA 23 Invited Talk Schilling

Time: Thursday 09:30–10:00 Room: HSZ 03

Invited Talk MA 23.1 Thu 09:30 HSZ 03

Proteins and patients - new applications of low noise magnetic field sensors — •Meinhard Schilling — TU Braunschweig, Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, Hans-Sommer-Str. 66, 38106 Braunschweig

For many years biomagnetism has been a motor of progress in the development of low-noise magnetic field sensors, like superconducting quantum interferometers working at low temperature. In recent years also room temperature magnetic sensors like fluxgates have been improved considerably. Exciting new applications of these sensors in biotechnology, medical diagnosis and therapy are at hand in combination with magnetic nanoparticles, which are already used in the clinical routine. Also, new imaging techniques using low noise magnetic sensors like magnetic particle imaging and low-field magnetic resonance imaging will be adressed.

MA 24 Magnetic Thin Films III

Time: Thursday 10:15–12:45 Room: HSZ 03

MA 24.1 Thu 10:15 HSZ 03

Spin-polarized grain boundary transport in reversibly strained $La_{0.7}Sr_{0.3}MnO_3$ polycrystalline films — •Gangineni Ramesh Babu, K. Dörr, K. Nenkov, N. Kozlova, K.-H. Müller, and L. Schultz — IFW Dresden, PF 270116, D-01171 Dresden, Germany

$La_{0.7}Sr_{0.3}MnO_3$ (LSMO) is a ferromagnetic manganese oxide with half-metal like character, with a ferromagnetic Curie temperature T_C of about 370 K. The high spin polarization has been demonstrated using tunnelling experiments in epitaxial trilayer structures of LSMO with $SrTiO_3$ (STO) insulating barrier, where a huge value of tunnelling magnetoresistance of TMR = 1800 % at low temperature has been found recently [1]. Polycrystalline LSMO films contain a network of many grain boundaries typically acting as tunnel barriers. Thus, they also show large TMR at low temperature. In this work, we have prepared polycrystalline films of LSMO on monocrystalline actuator platelets of $Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$(001) (PMN-PT) [2] in order to study the grain boundary tunnelling transport in dependence on controlled in-plane strain. Reversible strain by up to 0.15 % has been applied to the films using the inverse piezoelectric effect of the substrates. Temperature-dependent resistance and magnetoresistance data in dependence on applied strain will be discussed with regard to the microstructure of the films. Further, it has been tried to prepare epitaxial trilayer tunnel junctions on PMN-PT(001) and measure their current-voltage characteristics under various strain states.
This work is supported by DFG, FOR 520.
[1] Bowen M et al., Appl. Phys. lett, 82, 233 (2003)
[2] Thiele C, Dörr K et al., Appl. Phys. Lett (in press)

MA 24.2 Thu 10:30 HSZ 03

Modeling of structural domains in $La_{1-x}Sr_xMnO_3$ thin films — •Nayel Farag[1], Manfred Bobeth[1], and Alexei E. Romanov[2] — [1]Institut für Werkstoffwissenschaft, Technische Universität Dresden, Germany — [2]Ioffe Physico-Technical Institute, St. Petersburg, Russia

The magnetic behavior of $La_{1-x}Sr_xMnO_3$ (LSMO) thin films is essentially affected by elastic strain within the film. Besides a uniform strain contribution due to the lattice-parameter misfit between LSMO and a cubic substrate, additional non-uniform strain contributions arise from the formation of structural domains in coherently grown rhombohedral LSMO films. Observations of domain patterns reported in the literature show perpendicular and inclined domain walls on (100) and (110) oriented $SrTiO_3$ substrates, respectively. We have calculated the domain-related strain fields by applying the coherency-defect technique. The strain exhibits peaks at the triple junctions of the domain walls and the film/substrate interface. On the base of a model by Millis et al (1998), the corresponding spatial variation of the transition temperature to the ferromagnetic state has been estimated. Furthermore, the domain widths for the different domain patterns on (100) and (110) $SrTiO_3$ have been calculated as a function of the film thickness. Comparison of the predicted domain width with experimental findings permits to estimate the domain-wall energy.

MA 24.3 Thu 10:45 HSZ 03

EXAFS on electron-doped $La_{0.7}A_{0.3}CoO_3$ — •Christian Pinta[1,2], Dirk Fuchs[1], Eric Pellegrin[1], Peter Adelmann[1], Stefan Mangold[3], and Stefan Schuppler[1] — [1]Forschungszentrum Karlsruhe, Institut für Festkörperphysik, D-76021 Karlsruhe — [2]Universität Karlsruhe, Fakultät für Physik,D-76128 Karlsruhe — [3]Forschungszentrum Karlsruhe, Institut für Synchotronstrahlung, D-76021 Karlsruhe

Cobaltites are currently receiving intense interest. Especially intriguing is the large number of interactions in this mixed-valent family of compounds (like Hund's coupling, double exchange, correlation, and crystal field) that occur on similar energy scales and may lead to a number of mutually competing phases. Up until recently it was impossible to dope cobaltites with electrons, and it still is for bulk material. For epitaxial thin-film systems, however, we have performed the first successful synthesis of single-phase electron-doped lanthanum cobaltites, $La_{1-x}A_xCoO_3$ (A=Ce or Te). These films exhibit ferromagnetic order with transition temperatures T_C of about 85K and 20K for Te and Ce doping, respectively. To better understand the interplay between local structure, doping, and magnetism, we performed Co K-edge EXAFS measurements on three cobaltite thin-film systems: $La_{0.7}Ce_{0.3}CoO_3$, $La_{0.7}Te_{0.3}CoO_3$, and $LaCoO_3$. For further comparison to bulk material, we also carried out measurements on powder samples of undoped $LaCoO_3$. Partial substitution of La by Ce and Te as well as the epitaxial growth clearly affect the local structure; possible implications for the doping-related electronic structure and spin states will be discussed.

MA 24.4 Thu 11:00 HSZ 03

Piezoelectrically induced strain effects in ferromagnetic manganite films — •C. Thiele[1], L. Schultz[1], A. A. Levin[2], and K. Dörr[1] — [1]IFW Dresden, PF 270116, 01171 Dresden — [2]Institut für Strukturphysik, TU Dresden, 01062 Dresden

Ferromagnetic perovskite manganites like $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) have been predicted to be extremely sensitive to distortions of the crystal lattice due to strong electron-phonon coupling [1]. This has been verified by experiments on biaxially strained films grown epitaxially on monocrystalline substrates with slightly mismatching lattice parameter. Active electric control of in-plane strain in thin films on a piezoelectric substrate is very promising, since it avoids additional effects of changing microstructure and would allow direct recording of strain dependent properties. Lee and Dale have earlier chosen BTO crystals for this purpose [2]. In this contribution, the effect of dynamically induced in-plane strain in epitaxial LSMO films on piezoelectric substrates $Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$ (100) is analyzed [3]. In-plane lattice constants have been reversibly varied by up to 0.15 % by application of an electrical voltage to the substrate, leading to a strong impact on the resistive and magnetic behavior of the studied LSMO films. Resistance and Magnetization show strain-dependent hysteresis with an amplitude of several % at 300 K. T_C increases by several degrees due to release of in-plane tensile strain. This work is supported by DFG, FOR 520.

[1] A. J. Millis et al., JAP 83 (1998) 1588; A.J. Millis, Nature 392 (1998) 147. [2] M. K. Lee et al., APL 77 (2000) 3547; D. Dale et al., APL 82 (2003) 3725. [3] C. Thiele et al. (subm).

MA 24.5 Thu 11:15 HSZ 03

Structure and magnetism of epitaxial $HoMnO_3$ films grown by pulsed laser deposition — •J.-W. Kim, K. Dörr, K. Nenkov, and L. Schultz — IFW-Dresden, PB 270116, 01171 Dresden

Hexagonal $HoMnO_3$ is one of the most studied multiferroic materials. It is ferroelectric below Curie temperature of T_C 860K and antiferromagnetic below Néel temperature of T_N 76K. Some experiments have been done with $HoMnO_3$ bulk crystals to reveal strong magneto-electric coupling, even switching to ferromagnetic order of Ho^{3+} spins by an applied electric field [1]. To our knowledge, no epitaxial $HoMnO_3$ film has been made so far.

We have tried to grow epitaxial hexagonal $HoMnO_3$ films by pulsed laser deposition on Y-stabilized ZrO_2 (111) substrates. The optimum deposition temperature was 850°C and oxygen pressure was $1x10^{-1}$mbar. We found that lower oxygen pressure disturbs the proper hexagonal phase growth. A beautiful crystallinity of untwined, epitaxially grown $HoMnO_3$ films was found by X-ray diffraction and pole figure measurement. Low temperature SQUID measurements (down to 1.7K) show some magnetic anomalies in dependence on temperature and applied magnetic field below 6K. These might be related to Ho^{3+} spin ordering and/or reorientation.

The author, J.-W. Kim, thanks to Deutscher Akademischer Austausch Dienst(DAAD) for a fellowship.

[1] Th. Lottermoser, Nature 430 (2004), 541-544

MA 24.6 Thu 11:30 HSZ 03

Fe-doped MgO thin films in the impurity limit — •R. Sutarto[1], T. Haupricht[1], H. Ott[1], M. W. Haverkort[1], A. Tanaka[2], H. -H. Hsieh[3], H. -J. Lin[4], C. T. Chen[4], and L. H. Tjeng[1] — [1]II. Physikalisches Institut, Universität zu Köln, Zülpicher Str. 77, 50937 Köln, Germany — [2]Department of Quantum Matter, ADSM, Hiroshima University, Higashi-Hiroshima 739-8530, Japan — [3]Chung Cheng Institute of Technology, National Defense University, Taoyuan 335, Taiwan — [4]National Synchrotron Radiation Research Center, 101 Hsin-Ann Road, Hsinchu 30077, Taiwan

Epitaxial Fe-doped MgO thin films at different doping levels from 1% to 30% have been successfully grown using Molecular Beam Epitaxy (MBE). Fe $L_{2,3}$ x-ray absorption spectra (XAS) of Fe-doped MgO at 1-2% Fe doping levels shows a striking narrow peak indicating that non-local effects of inter-Fe-site fluctuations are strongly suppressed. The experimental results in this impurity limit are well reproduced using FeO_6 cluster calculations with O_h symmetry, implying that the film is an excellent reference sample for a d^6 high spin state system. Moreover, this cluster model simulates well the observed temperature dependence of the XAS spectra caused by thermal population of the spin-orbit split initial states.

MA 24.7 Thu 11:45 HSZ 03

Antiferromagnetic centers in $Fe_{3-\delta}O_4$ magnetite films — •Ivo Knittel[1], Jiandong Wei[1], Michael R. Koblischka[1], Yang Zhou[2], Igor V. Shvets[2], and Uwe Hartmann[2] — [1]Department of Experimental Physics, University of Saarbrücken, Saarbrücken, Germany — [2]SFI Nanoscience Laboratory, School of Physics, Trinity College Dublin, Dublin 2, Ireland

Structures of magnetite ($Fe_{3-\delta}O_4$) and many other ferrites contain characteristic defects called anti-phase boundaries (APB) resulting from the symmetry mismatch between substrate and ferrite. In magnetic films containing APB, there is evidence of strong antiferromagnetic coupling across the APB. These antiferromagnetic defects essentially determine the magnetism and magnetoresistance of the films. However, direct demonstration of the magnetic frustration at the APB was not achieved so far. We report the first imaging of antiferromagnetic coupling across APB. We employed epitaxial films of Fe_3O_4 grown on MgO(100) substrates. By postprocessing, the magnetite films acquire a stripe domain pattern. This is indicative of a low density of magnetically active APB. As imaging tool we used a MFM in a variable magnetic field. By observing (rare) remagnetization events we demonstrate the presence of dipolar centers resulting from the APB. Magnetization reversal of isolated and interacting groups of dipolar centers is shown. The observed centers are stable up to the maximum value of the applied fields. This work is supported by the EU-funded project 'ASPRINT'.

MA 24.8 Thu 12:00 HSZ 03

Influence of the antiphase grain structure on the domain configuration of Fe3O4 thin films — •Jiandong Wei[1], Ivo Knittel[1], Yang Zhou[2], Shane Murphy[2], Igor Shvets[2], and Uwe Hartmann[1] — [1]Department of Experimental Physics,University of Saarbrücken — [2]SFI Nanoscience Laboratory,School of Physics,Trinity College

A long-range ordered magnetic domain structure was found for the first time in magnetite (Fe3O4) thin films prepared by molecular beam epitaxy on MgO (100) substrates. The stripe-like magnetic domain structure arising after suitable postprocessing differs significantly from earlier observations. The field-dependent domain structure was investigated by magnetic force microscopy equipped with an in-situ magnetic field. The results cannot be explained by the standard theory of stripe domains based on mean-field magnetic parameters. The domain structure is determined by immobile pinning centers arising from the magnetite anti-phase grain structure.

MA 24.9 Thu 12:15 HSZ 03

Antiferromagnetic centers in Fe3-xO4 magnetite films — •Ivo Knittel[1], Jiandong Wei[1], Yang Zhou[2], Igor Shvets[2], and Uwe Hartmann[1] — [1]Department of Experimental Physics, University of Saarbrücken, Saarbrücken, Germany — [2]SFI Nanoscience Laboratory, School of Physics, Trinity College Dublin, Dublin 2, Ireland

Defects in ferrite can change the local magnetic coupling from ferromagnetic to strongly antiferromagnetic. In epitaxial films of magnetite (Fe3O4), defects with this property, antiphase boundaries (APB), essentially determine magnetic and magnetotransport properties. We imaged antiferromagnetic dipolar centers in epitaxial slightly oxidized Fe3O4/MgO films by magnetic force microscopy in external magnetic field. Magnetization reversal of isolated and interacting groups of dipolar centers is shown. The observed centers are stable up to the maximum value of the applied fields.

MA 24.10 Thu 12:30 HSZ 03

Magnetic and Charge Ordering at Digital Perovskite Interfaces — •Rossitza Pentcheva[1] and Warren E. Pickett[2] — [1]Section Crystallography, Dept. of Earth and Environmental Sciences, University of Munich — [2]Department of Physics, University of California, Davis, U.S.A.

Local charge mismatch can lead to unexpected phenomena even at the interfaces (IFs) of well understood 'simple' insulators: For example Ohtomo and Hwang [1] measured a metallic high mobility character at the n-type interface between the band-insulators $LaAlO_3$ and $SrTiO_3$, while the p-type interface was found to be insulating. To explain these experimental findings, we performed density-functional theory calculations employing the FP-LAPW-method within the WIEN2k implementation including a Hubbard-type on site Coulomb repulsion (DFT+U). Although both bulk materials are nonmagnetic, at the n-type interface, a charge and orbitally ordered (CO/OO) state is realized in the TiO_2-layer with ferromagnetically coupled Ti^{3+}-ions and nonmagnetic Ti^{4+}-ions arranged in a checkerboard manner. We show that at an ideal defect-free p-type IF only strong correlations in the oxygen $2p$-bands can account for the measured insulating behavior: A disproportionated, CO/OO magnetic oxygen hole is formed in the AlO_2-layer. Other mechanisms for charge accommodation such as ordered defects are also investigated.

[1] A. Ohtomo and H.Y. Hwang, Nature **423**, 378 (2002).

MA 25 Spin-Electronics I

Time: Thursday 10:15–13:00 Room: HSZ 103

MA 25.1 Thu 10:15 HSZ 103

Magnetism of ultrathin GaMnAs films on GaAs — •Michal Kosuth, Svetlana Polesya, Voicu Popescu, and Hubert Ebert — Department Chemie und Biochemie / Physikalische Chemie, Universität München, Butenandstr. 5-13, D-81377 München, Germany

The electronic and magnetic properties of ultrathin GaMnAs layers on GaAs have been studied using the fully-relativistic TB-KKR band structure method. We will present results of our theoretical investigations on the dependence of the magnetic anisotropy energy on the thickness of GaMnAs film, as well as on the concentration and on the position of Mn atoms in the GaMnAs film. It is shown that, in line with previous experimental findings, the occupation of interstitial positions by Mn leads to a reduction of magnetisation and influences also the magnetic anisotropy.

In addition, we will show results on the temperature dependence of magnetic properties of these systems, that have been obtained by Monte Carlo simulations within a classical Heisenberg spin model on the basis of exchange coupling parameters, calculated using the TB-KKR Green function method.

MA 25.2 Thu 10:30 HSZ 103

Magnetic properties and disorder effects in diluted magnetic semiconductors — •Lars Bergqvist[1,2], Olle Eriksson[2], Josef Kudrnovsky[3], Vaclav Drchal[3], Anders Bergman[2], Lars Nordström[2], and Ilja Turek[4] — [1]Institut für Festkörperforschung, Forschungszentrum Jülich,Forschungszentrum Jülich, D-52428 Jülich, Germany — [2]Department of Physics, Uppsala University, Box 530, S-75121 Uppsala, Sweden — [3]Institute of Physics, Academy of Sciences of the Czech Republic,Na Slovance 2, CZ-182 21 Prague 8, Czech Republic — [4]Institute of Physics of Materials, Academy of Sciences of the Czech Republic, Žižkova 22, CZ-616 62 Brno, Czech Republic

We present calculations of the exchange interactions and critical temperatures for several diluted magnetic semiconductor systems with an impurity band. It is shown that the exchange interactions are dominated by short ranged interactions that have a strong directional dependence. Using a combination of first principles calculations of the exchange interactions together with Monte Carlo simulations of the classical Heisenberg model, in which the positional disorder and spin fluctuations are properly included, the calculated critical temperatures are in good agreement with experimantal observations. It is showed that agreement between theory and experiment, as regards ordering temperatures, is obtained only when the magnetic atoms are randomly positioned in a simulation cell which proves that disorder effects play a very important role. The effect of strong electron-electron interaction has been studied by means of the LSDA+U scheme. We investigate in detail the nature of the anisotropic exchange interactions by means of a Fermi surface analysis.

MA 25.3 Thu 10:45 HSZ 103

Ferromagnetism in (GaV)As and (Zn,Co)O — •Brahim Belhadji[1], Peter H. Dederichs[1], Kasunori Sato[2], Voicu Popescu[3], and Hubert Ebert[3] — [1]Institut fuer Festkoerperforschung, Forschungszentrum juelich — [2]The institute of Scientific and Industrial Research, Osaka University, Osaka 567-0047, Japan — [3]Department Chemie/Physikalishe Chemie, University of Muenich, Butenandtstr. 5-13, D-81377 Muenich

The exchange interactions in dilute magnetic semiconductors can take very different forms. While in the model system (Ga,Mn)A s ferromagnetism is favored by Zener's p-d exchange, in systems with impurity bands in the bandgap the situation is more complicated. If the Fermi level lies in the impurity band, ferromagnetism is favored by Zener's double exchange. However if the F ermi level is outside the impurity band, the interaction is determined by super-exchange, and is usually antiferromagnetic, l ike e.g. in (Ga,Fe)As or (Cd,Mn)Te. However, in constrast to this we find that in (Ga,V)As and (Zn,Co)O, where the Fermi leve l lies between the eg and t2g states, that the interaction is ferromagnetic. Our calculations are based on the local density approximation the Korringa-Kohn-Rostoker method in connection with the Coherent-Potential-Approximation (KKR-CPA). For (Ga,V)As the calculated coupling constants Jij between two V atoms are ferromagnetic, short ranged and nearly independant of the V concentration. Due to the short range the Curie temperature is strongly suppressed for small V concentrations. We discuss th e reason for the occurrance of ferromagnetic super-exchange on these systems.

MA 25.4 Thu 11:00 HSZ 103

Low temperature ferromagnetism in Co-doped ZnO due to hopping — •Karl-Wilhelm Nielsen[1], Maike Luebbe[1], Sebastian Bauer[1], Juergen Simon[2], Werner Mader[2], Sebastian T. B. Goennenwein[1], Matthias Opel[1], and Rudolf Gross[1] — [1]Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching — [2]Institut fuer Anorganische Chemie, Universitaet Bonn, 53177 Bonn

Transition-metal doped ZnO is a promising candidate for the realization of a diluted magnetic semiconductor. According to a model by Coey *et al.* [1], the ferromagnetism is mediated through an impurity band and Curie temperatures above room temperature can be expected. We have fabricated homoepitaxial Co-doped ZnO thin films on ZnO substrates by pulsed laser deposition. The samples were grown in Ar atmosphere at different substrate temperatures to obtain various concentrations of oxygen vacancies. SQUID magnetometry and magnetotransport measurements showed clear ferromagnetic behavior below 50 K. Clusters as the source of ferromagnetism can be excluded by transmission electron microscopy.
Our detailed magneto-transport measurements show that correlated hopping in the oxygen vacancy band is essential for the ferromagnetic coupling. We critically compare these findings with the model of Coey *et al.* [1] and discuss the possibility of room temperature ferromagnetism. This work is supported by the DFG via SPP 1157.

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

MA 25.5 Thu 11:15 HSZ 103

Ferromagnetic Gd-implanted ZnO single crystals — •Shengqiang Zhou[1], K. Potzger[1], F. Eichhorn[1], F. Herrmann[1], D. Grambole[1], M. Helm[1], W. Skorupa[1], J. Fassbender[1], T. Herrmannsdörfer[2], and A. Bianchi[2] — [1]Institute of Ion Beam Physics and Materials Research, Forschungszentrum Rossendorf, P.O. Box 510119, 01314 Dresden, Germany — [2]Dresden High Magnetic Field Laboratory, Forschungszentrum Rossendorf, P.O. Box 510119, 01314 Dresden, Germany

In order to introduce ferromagnetic properties, ZnO single crystals have been implanted with Gd ions at 180 keV ion energy and two different fluences. Magnetization reversal hysteresis loops have been recorded using a superconducting quantum interference device. The virgin ZnO shows a pure diamagnetic behaviour. Besides the diamagnetic background, weak ferromagnetism has been observed for the as-implanted films. Post-implantation annealing greatly improved the magnetism. For a fluence of 5x10ˆ15 Gd/cm2, post implantation annealing at 820K in vacuum leads to an increase of the saturation moment up to 1.8 Bohr magneton per Gd at exactly 300 K thus excluding Gd, ZnGd or Gd2O3 secondary phases to be formed. The increase of the saturation moment can be explained along with changes in resistivity due to the annealing reported elsewhere. Moreover magnetic domains were observed up to 2 microns by atomic/magnetic force microscope, which again evidenced the formation of diluted magnetic semiconductor. [1]K. Potzger et al, submitted to J. Appl. Phys. (2005). [2]S. O. Kucheyev et al. J. Appl. Phys. 93, 2972 (2003).

MA 25.6 Thu 11:30 HSZ 103

Magnetic, structural and electronic properties of Fe implanted GaN — •Georg Talut, Helfried Reuther, Frank Eichhorn, Arndt Mücklich, and Kay Potzger — Institute of Ion Beam Physics and Material Research, Forschungszentrum Rossendorf e.V., Bautzner Landstraße 128, 01314 Dresden

The request for room-temperature diluted magnetic semiconductors resulted in a large interest in GaN containing transition metals. In contrast to the (Ga,Mn)N-system, the origin of the ferromagnetism in Fe implanted GaN is still not sufficiently investigated. The formation of secondary phases and valence states of Fe play an important role in the discussion of the source of the ferromagnetism.

In this study, the electronic, structural and magnetic properties of p-GaN implanted with Fe^+ ($1 - 16 \cdot 10^{16}$ cm^{-2}) at 350° C and subsequently annealed at 650° - 1000° C were examined by conversion electron Mössbauer spectroscopy, x-ray diffraction, transmission electron microscopy and magnetometry.

First experiments show ferromagnetic behaviour above room temperature in samples implanted with the highest amount of Fe. First x-ray diffraction and conversion electron Mössbauer spectroscopy measurements reveal the creation of α-Fe-clusters which are most likely responsible for the ferromagnetism.

MA 25.7 Thu 11:45 HSZ 103

Migration of Mn atoms by thermal treatment of ferromagnetic Mn-implanted TiO_2 single crystals — •D. Menzel[1], F. Iacomi[2], D. Cacaina[3], I. Jursic[1], and J. Schoenes[1] — [1]Institut für Physik der Kondensierten Materie, TU Braunschweig, Germany — [2]Al. I. Cuza University, Faculty of Physics, Iasi, Romania — [3]Babes-Bolyai University, Faculty of Physics, Cluj-Napoca, Romania

Single crystalline rutile-type TiO_2 was doped with Mn using ion implantation in order to prevent Mn clustering. The Mn doped TiO_2-layer orders ferromagnetically at room temperature. The magnetic moment of the as implanted samples (0.3 μ_B per Mn) is reduced after an annealing process at 400°C but recovers after annealing at higher temperatures reaching 0.4 μ_B per Mn which indicates an incorporation of Mn atoms on substitutional sites. This interpretation is corroborated by shifts of XRD peaks and changes in the peak intensities. ESR investigations show two types of signals which do not depend on the orientation of the magnetic field and correspond to isolated Mn^{2+} ($g = 1.98$) and to Mn^{2+}–O–Mn^{2+} ($g = 2.00$). In addition, four lines are strongly dependent on the orientation of the magnetic field and can be attributed to Mn^{4+}. The well-

resolved structure of Mn^{4+} may be interpreted in terms of the hyperfine interaction of the ^{47}Ti and ^{49}Ti ions which occupy the nearest sites along the crystalline c-axis.

MA 25.8 Thu 12:00 HSZ 103

Loss-Free Spin Injection From Co Into Organic Semiconductor CuPc — •Oleksiy Andreyev[1], Yongli Gao[2], Marina Sánchez-Albaneda[1], Mirko Cinchetti[1], Huanjun Ding[2], Jan-Peter Wüstenberg[1], Michael Bauer[1], and Martin Aeschlimann[1] — [1]Department of Physics, University of Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Department of Physics and Astronomy, University of Rochester, Rochester, NY 14627-0171, USA

We present experimental evidence for loss-free spin injection of hot electrons from ferromagnetic Co(001) surface into organic semiconductor copper phthalocyanine (CuPc). We used spin-resolved two-photon photoemission (SR-2PPE) spectroscopy, which allows us to study the dynamics of both electron and spin relaxation in solids and interfaces with femtosecond time resolution. With SR-2PPE, we investigated the energy distribution and spin polarization of hot electrons originally excited in Co and injected in CuPc, and observed an almost unchanged spin polarization in comparison to that of the initial Co surface. This demonstrates that interface spin scattering is insignificant. The loss-free spin injection into CuPc suggests that it can be a promising material for spin-based electronic devices. Moreover, we observed a surprising enhanced spin polarization induced by a submonolayer CuPc coverage on the Co surface. This phenomenon is attributed to spin-dependent charge transfer responsible for the bonding between CuPc admolecule and the Co surface. We further investigated CuPc/Co junctions with intentionally enhanced interface roughness, and we found that the junction quality did not affect the efficiency of the spin injection.

MA 25.9 Thu 12:15 HSZ 103

Magnetism and spin-polarization of half-metallic ferromagnets at finite temperatures — •Marjana Ležaić, Phivos Mavropoulos, Jussi Enkovaara, Gustav Bihlmayer, and Stefan Blügel — IFF, Forschungszentrum Jülich, D-52425 Jülich

Half-metallic ferromagnets (HMF) present a spin-polarization P of 100% at the Fermi level. At elevated temperatures, however, the spin-polarization is reduced. We investigate the effect of temperature on the band gap of HMF which contain more than one magnetic atom in the unit cell, and describe the mechanisms which lead to the drop of polarization.

We use the full-potential linearized augmented plane-wave method [1] to calculate the exchange constants of the Heisenberg model and apply a Monte Carlo method to find the magnetization $M(T)$ and the Curie temperature. Additionally, a mean-field like description of the system at $T > 0$ is obtained with the coherent-potential approximation to the disordered local moment state calculated within the Korringa-Kohn-Rostoker Green function method [2].

For multicomponent HMF we cannot confirm the proposed model which assumes that $P(T) \sim M(T)$ [3]. The presence of different magnetic components can lead to a drop of P at $T > 0$ which is much faster than the drop of $M(T)$. This effect can be drastic and depends largely on the strength of the hybridization among the components. We describe the effects of temperature in more detail for NiMnSb and Co_2MnSi.

[1] `http://www.flapw.de`
[2] H. Akai and P. H. Dederichs, Phys. Rev. B **47**, 8739 (1993)
[3] R. Skomski and P. A. Dowben, Europhys. Lett. **58**, 544 (2002)

MA 25.10 Thu 12:30 HSZ 103

Spin-filtering through multiferroic $BiMnO_3$ tunnel barriers — •Manuel Bibes[1], Martin Gajek[2], Martin Sirena[2], Gervasi Herranz[2], Karim Bouzehouane[2], Stéphane Fusil[3], Manuel Varela[4], Josep Fontcuberta[5], Agnès Barthélémy[2], and Albert Fert[2] — [1]Institut d'Electronique Fondamentale, Université Paris-Sud, 91405 Orsay, France — [2]Unité Mixte de Physique CNRS-Thales, Route départementale 128, 91767 Palaiseau, France — [3]Université d'Evry, rue du Père Jarlan, 91025 Evry, France — [4]Dept. de Fisica Aplicada i Optica, Universitat de Barcelona, Diagonal 647, 08028 Barcelona, Spain — [5]Institut de Ciència de Materials de Barcelona, CSIC, Campus de la UAB, 08193 Bellaterra, Spain

We will present the properties of $BiMnO_3$ (BMO) and $La_{0.1}Bi_{0.9}MnO_3$ (LBMO) epitaxial thin films grown onto conductive buffers like $La_{2/3}Sr_{1/3}MnO_3$ (LSMO). Both BMO and LBMO films are ferromagnetic and piezoresponse atomic-force microscopy also evidences their ferroelectric character, thereby confirming their multiferroic nature. Remarkably, these properties are preserved even for films a few nm thick that can thus be used as multiferroic tunnel barriers. We will show that tunneling from a Au electrode, through these ferromagnetic tunnel barriers, into a collecting ferromagnetic counter-electrode of LSMO, results in large tunnel magnetoresistance (TMR), observed upon switching the magnetic configuration of the barrier and LSMO magnetizations from parallel or antiparallel. This demonstrates a spin-filtering effect by the BMO and LBMO barriers. The possible influence of ferroelectricity on the tunnel process will also be discussed.

MA 25.11 Thu 12:45 HSZ 103

Spin-dependent transport in hybrid ferromagnetic and nonmagnetic nanowires — •O. Posth, M. Brands, and G. Dumpich — Experimentalphysik, Universität Duisburg-Essen (Campus Duisburg), Lotharstr. 1, 47048 Duisburg

In this work the spinaccumulation effect and the spin relaxation length in different nonmagnetic materials are determined. For this, polycrystalline nanowires are fabricated by means of high-resolution electron beam lithography (HR-EBL) in combination with electron beam evaporation and lift-off-technique. The measurements of the spinaccumulation effect are performed in a nonlocal geometry at T = 4,2 K using cobalt as ferromagnetic material and copper and aluminium as nonmagnetic materials.
To improve the quality of the interface between the cobalt-wire and the nonmagnetic wire *oblique evaporation* is used. Thus, both the cobalt- and the nonmagnetic wires are fabricated in one deposition-step. The spinaccumulation effect is detected in copper and aluminium and, assuming known values for the polarization of the interface between the ferromagnetic and the nonmagnetic material, an upper and a lower bound for the spin relaxation length can be calculated. In copper a spin relaxation length of 0,75 μm $\leq l_S^{Cu} \leq$ 1,1 μm is found and the spin relaxation length in aluminium is 1,0 μm $\leq l_S^{Al} \leq$ 1,4 μm.
This work is supported by the DFG within SFB 491.

MA 26 Electron Theory

Time: Thursday 10:15–13:15 Room: HSZ 401

MA 26.1 Thu 10:15 HSZ 401

Spin-polarised systems treated with a relativistic optimised potential method. — •D. Ködderitzsch and H. Ebert — Ludwig-Maximilians-Universität München, Department Chemie, Physikalische Chemie, Germany

The optimised effective potential (OEP) method (OPM) opens a way to explore orbital dependent exchange-correlation (xc) functionals (E_{xc}) within density-functional theory (DFT) in order to tailor new functionals for, e. g. an improved description of spin-orbit induced orbital magnetism.
Here we present the first implementation of a spin-polarised fully relativistic OPM-method (ROPM) for open-shell systems. We have reformulated the ROPM in terms of Green's functions and sketch our subsequent implementation within the framework of the KKR-scattering theory for spin-polarised solids. We adopted and extended different approaches for solving the ROEP-equation [1,2,3] and present first applications to open-shell systems (free atoms) using exact exchange in our approximation for E_{xc}. Further we outline our route towards an implementation for magnetic solids including the random-phase approximation for the correlation functional and make contact to current-DFT.
[1] J.D. Talman and W.F. Shadwick, Phys. Rev. A **14**, 36 (1976).
[2] T.Kreibich *et al.*, Phys. Rev A **57**, 138 (1998).
[3] S.Kümmel and J.P.Perdew, Phys. Rev Lett. **90**, 43004 (2003).

MA 26.2 Thu 10:30 HSZ 401

Orbital magnetism of Co impurities in Au — •Mahdi Sargolzaei, Ingo Opahle, Manuel Richter, Klaus Koepernik, Ulrike Nitzsche, and Helmut Eschrig — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

The electronic structure of cobalt impurities inside gold has been calculated in the framework of local spin density approximation including two dufferent variants of orbital polarization corrections [1,2]. Orbital and spin magnetic moments have been evaluated using the relativistic version of the full-potential local-orbital minimum-basis code. In agreement with recent experimental and theoretical findings, the orbital moment is considerably enhanced in comparison with Co metal. It is demonstrated that lattice relaxation around the impurities reduces the orbital moment by about 15%. Co in Au is also an example for systems with high anisotropy energy and large orbital moment which compared to hcp Co are one order of magnitude larger.

1- O. Eriksson, B. Johansson, M. S. S. Brooks, J. Phys. Cond. Mat. 1, 4005 (1989).

2- H. Eschrig, M. Sargolzaei, K. Koepernik, M. Richter, Europhys. Lett. 72, 611 (2005).

MA 26.3 Thu 10:45 HSZ 401

Fully relativistic one-step theory of ultraviolet (inverse) photoemission for correlated systems: Application to ferromagnetic Ni and Fe. — •Jürgen Braun, Jan Minar, and Hubert Ebert — Department Chemie/Phys. Chemie, Ludwig-Maximilians-Universität München, Butenandt Str. 11, 81377 München

An improved formulation of the one-step model of photoemission from crystal surfaces is proposed which overcomes different limitations of the original theory. Considering the electronic one-particle potential and the many-body self-energy as given quantities, we derive an explicit expression for the spin-polarized photocurrent. The theory is formulated within a fully relativistic framework for a general nonlocal and space-filling, complex and energy-dependent self-energy which is based on a self-consistent DFT-DMFT calculation. Using the relativistic version of the layer-dependent Korringa-Kohn-Rostocker (KKR) multiple scattering formalism, the theory applies to semi-infinite lattices with perfect lateral translational invariance and arbitrary number of atoms per unit cell. Here, we present a quantitative analysis of experimental photoemission data from ferromagnetic Ni and Fe.

MA 26.4 Thu 11:00 HSZ 401

Spontaneous magnetostriction in elemental ferromagnets investigated with a DLM approach — •Ulrike Nitzsche, Manuel Richter, Klaus Koepernik, and Helmut Eschrig — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

The large change of lattice parameters caused by magnetic order of elemental hcp Gd was been a subject of intensive studies in the past. In several ab-initio calculations the value of the spontaneous volume magnetostriction of Gd was overestimated by a factor of 2 to 4. An important point is the modelling of the paramagnetic state of Gd above T_C characterized by the non-vanishing fluctuating f-moments. Besides the usually used method to model this state by a supercell with ordered antiferromagnetic spin configurations one can simulate the magnetic disorder in the paramagnetic state by disordered local moments (DLM) within the coherent potential approximation (CPA).
Up to now no comparison of both models has been published using the same numerical method. Aim of this talk is to investigate the influence of the different models for the paramagnetic state on the value of the spontaneous magnetostriction for the elemental ferromagnets Gd, Fe and Ni. Additional contributions to the spontaneous magnetostriction are discussed.

MA 26.5 Thu 11:15 HSZ 401

Giant magneto-crystalline anisotropies in transition-metal monowires — •Yuriy Mokrousov[1,2], Gustav Bihlmayer[2], Stefan Heinze[1], and Stefan Blügel[2] — [1]Institute for Applied Physics, University of Hamburg, 20355 Hamburg, Germany — [2]Institut für Festkörperforschung, Forschungszentrum Jülich, D-52425 Jülich, Germany

We report on first-principles calculations of the magnetic properties of freestanding 3d, 4d and 5d transition-metal (TM) monoatomic chains. Our calculations were performed with the one-dimensional (1D) version of the full-potential linearized augmented plane-wave (FLAPW) method, as implemented in the FLEUR code [1]. The new 1D-FLAPW scheme is extremely fast and allows a natural treatment of structures with 1D geometry. We investigate the origin of magnetism in TM monoatomic wires, paying special attention to the influence of spin-orbit interaction on the magnetic properties. We present equilibrium interatomic distances, spin- and orbital moments and the values of the magneto-crystalline anisotropy energy (MAE). Across the series the easy axis of magnetization oscillates between two possible directions: perpendicular and along the wire axis. The largest values of the MAE occur at the end of the series. Giant values of 30-100 meV/atom can be obtained upon stretching of 4d- and 5d-TM wires. Certain chains change the magnetization direction upon wire stretching, opening new perspectives in controlling the spin-dependent ballistic conductance in these structures.

[1] Y. Mokrousov, G. Bihlmayer and S. Blügel, Phys. Rev. B, 72, 045402 (2005)

MA 26.6 Thu 11:30 HSZ 401

Pressure induced magnetic collapse in $ZrFe_2$ predicted by theoritical calculation — •Wenxu Zhang, Klaus Koepernik, Ulrike Nitzsche, and Manuel Richter — IFW Dresden, P.O. Box 270016, D-01171 Dresden,Germany

Electronic structure and magnetic properties of $ZrFe_2$ with the cubic Laves phase are investigated by scalar and full-relativistic full-potential local-orbital minimum basis band structure calculations. The total magnetic moment of $3.06\mu_B$ is obtained at experimental lattice constant ($7.06\mathring{A}$), which is a little larger than the one at equilibrium lattice constant($2.6\mu_B$ at $6.85\mathring{A}$). The scenario of a localized $3d$ magnetic moment in negative diffusive sp background moment is in accordance with previous results by P. Mohn. We predict a two steps magnetic collapse: one is from $3.06\mu_B$ to $1.26\mu_B$ at about 3.6GPa, and the other is from $1\mu_B$ to paramagnetic state at about 20 GPa. The magnetic moment(m) decreases under the pressure at the vinicity of the experimental lattice constant with $d\ln m/dp = -0.038GPa^{-1}$. The spantanous magnetostriction is 0.015. The Invar effect in this alloy is suggested to relate to the magnetic transition.

MA 26.7 Thu 11:45 HSZ 401

Exchange coupling and finite temperature magnetism in chromium-chalcogenide compounds — •Sergey Mankovsky[1], Svetlana Polesya[1], Hubert Ebert[1], Wolfgang Bensch[2], and Zhong-Le Huang[2] — [1]Dept. Chemie und Biochemie, Universität München, Butenandtstr. 5-13, D-81377 München, Germany — [2]Institute for Anorganic Chemistry, Olshausenstr. 40, D-24098, Kiel, Germany

Using the Korringa-Kohn-Rostoker (KKR) band structure method, a detailed theoretical investigation of the electronic and magnetic properties of $Cr_{1+x}Q_2$ (Q=(Te-Se), $x = 0.25 \div 1$) alloys having a trigonal crystal structure have been performed. The disorder in the system has been accounted for by means of the Coherent Potential Approximation (CPA). The influence of Cr content on structural and magnetic properties was studied within the whole region of Te and Se concentrations. The stability of magnetic structures in these alloys have been studied both for $T = 0K$ and $T \neq 0K$. The temperature dependent magnetic properties have been performed using the Monte Carlo simulations based on the Heisenberg model. The required exchange coupling parameters were obtained from ab-initio electronic structure calculations. The detailed analysis of our theoretical results have been done in comparison with the experimental data.

MA 26.8 Thu 12:00 HSZ 401

Organic Antiferromagnets, Diluted Magnetic Semiconductors, and Iron — Novel Features in the Magnetism in Correlated Electrons — •Avinash Singh — Department of Physics, Indian Institute of Technology Kanpur — Institute for Physics, Humboldt University at Berlin

There has been renewed interest in correlated electron systems on triangular lattices, as evidenced by recent studies of antiferromagnetism, superconductivity and metal-insulator transition in the organic systems $\kappa - (BEDT - TTF)_2X$, the discovery of "water superconductors" $Na_xCoO_2.yH_2O$, the observation of low-temperature insulating phases in some $\sqrt{3}$-adlayer structures such as K on Si[111], and quasi two-dimensional 120° spin ordering and spin-wave excitations in $RbFe(MoO_4)_2$ and the multiferroic material $HoMnO_3$. The discovery of ferromagnetism in Mn-doped III-V semiconductors such as $Ga_{1-x}Mn_xAs$, has led to considerable interest in these diluted magnetic semiconductors (DMS) in view of their potential applications such as optical isolators, magnetic sensors, non-volatile memories seamlessly integrated into semiconductor circuits etc. and the possibility of studying new magnetic cooperative phenomena such as spin-dependent tunneling, magnetoresistance, spin-dependent light emission etc. in semiconductor heterostructures arising from the new (spin) degrees of freedom. I will describe

some novel features in the magnetism of these materials of current interest, and also discuss recent progress in our understanding of the classic strong-coupling problem of a band ferromagnet such as iron.

MA 26.9 Thu 12:15 HSZ 401

Electronic structure of *RE*AuMg and *RE*AgMg (*RE* = Eu, Gd, Yb) — •Jan Gegner[1], T.C. Koethe[1], Hua Wu[1], H. Hartmann[1], T. Lorenz[1], T. Fickenscher[2], R. Pöttgen[2], and L.H. Tjeng[1] — [1]II. Physikalisches Institut der Universität zu Köln, Germany — [2]Institut für Anorganische und Analytische Chemie,Westfälische Wilhelms-Universität Münster, Germany

We have investigated the electronic structure of the equiatomic EuAuMg, GdAuMg, YbAuMg and GdAgMg intermetallics using x-ray photoelectron spectroscopy. The spectra revealed that the Yb and Eu are divalent while the Gd is trivalent. The spectral weight in the vicinity of the Fermi level is in all cases dominated by the mix of Mg *s*, Au/Ag *sp* and *RE spd* bands, and not by the *RE* 4*f*. We also found that the Au and Ag *d* bands are extraordinarily narrow, as if the noble metal atoms were impurities submerged in a low density *sp* metal host. The experimental results were compared with band structure calculations, and we found good agreement provided that the spin-orbit interaction in the Au an Ag *d* bands is included and correlation effects in the open 4*f* shells are accounted for using the LDA+U scheme. Nevertheless, limitations of such mean-field scheme to explain excitation spectra are also evident.

MA 26.10 Thu 12:30 HSZ 401

Calculated de Haas-van Alphen frequencies of $NpCoGa_5$ — •Ingo Opahle[1], Saad Elgazzar[1], Vito D.P. Servedio[2], Manuel Richter[1], and Peter M. Oppeneer[3] — [1]IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany — [2]Dip. di Fisica, Univ. di Roma "La Sapienza", 00185 Roma, Italy — [3]Department of Physics, Uppsala University, Box 530, S-751 21 Uppsala, Sweden

The electronic structure and magnetic properties of $NpCoGa_5$ are investigated in the framework of relativistic density functional theory in the local spin density approximation (LSDA) with and without orbital polarization (OP) corrections. A detailed analysis of the Fermi surface is presented. Comparison of the calculated angular dependence of the de Haas-van Alphen frequencies with recent experimental data shows that LSDA reproduces the main features of the Fermi surface topology, while the spin and orbital moments of $NpCoGa_5$ are less well described. The inclusion of OP corrections leads to a very good agreement between calculated and measured de Haas-van Alphen frequencies, but does not yield a significant improvement of the calculated magnetic properties. We predict that $NpCoGa_5$ shows an intrinsic GMR effect at moderate magnetic field.

MA 26.11 Thu 12:45 HSZ 401

Accounting for correlation effects in the calculation of the spin-orbit induced properties of magnetic transition metals — •Stanislav Chadov[1], Jan Minár[1], Hubert Ebert[1], Leonid Pourovskii[2], Michael Katsnelson[2], and Alexander Lichtenstein[3] — [1]Department Chemie und Biochemie, Physikalische Chemie, Universität München, Butenandtstr. 5-13, D-81377 München, Germany — [2]Institute for Molecules and Materials, Radboud University of Nijmegen, NL-6525 ED Nijmegen, The Netherlands — [3]Institut für Theoretische Physik, Universität Hamburg, 20355 Hamburg, Germany

Recently we proposed a charge- and self-energy- self-consistent computational scheme on the basis of the Korringa-Kohn-Rostoker (KKR) multiple scattering theory including many-body effects described by the dynamical mean field theory (DMFT). It was successfully applied to moderately correlated systems, showing the importance to account for the electronic correlations in the calculation of a wide range of their spectroscopic properties (Fano effect, spin-resolved VB-XPS, magneto-optical spectra).

Here we present an extention of the scheme allowing one to consider the influence of electronic correlations on the spin-orbit induced properties by taking into account spin polarization as well as spin-orbit coupling in the many-body solver. The latter is important for systems pocessing both localized and itinerant features as the interplay of relativistic effects and electron-electron correlations makes the calculation of the corresponding electronic properties quite complicated. First results of investigations on 3d transition metals will be presented.

MA 26.12 Thu 13:00 HSZ 401

Electronic structure and Fermi Surfaces of Transuranium* Copmounds UMGa$_5$ ($M=$Pd and Pt)* compounds — •Saad Elgazzar, Ingo Opahle, and Manuel Richter — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

We report a critical analysis of the electronic structures and de Haas-van Alphen (dHvA) quantities of the heavy-fermion UPdGa$_5$ and UPtGa$_5 $. The electronic structures are investigated {\it ab initio} on the basis of full-potential band-structure calculations, adopting the fully relativistic formulations in the framework of the local spin-density approximation (LSDA) with and without orbital polarization (OP) corrections. The calculated calculated dHvA quantities are in good agreement with experimental data for both compounds recently published \cite{Ikeda}

\bibitem{Ikeda} S. Ikeda, {\em et al.}, JPSJ, {\bf 74} (2005) pp.2277-2281.

MA 27 Spin-Dynamics, Magnetization Reversal II

Time: Thursday 10:15–13:00 Room: HSZ 403

MA 27.1 Thu 10:15 HSZ 403

Time-resolved photoelectron emission microscopy after optical ps-excitation — •Klaus Schmalbuch[1], Reza Ghadimi[1], Bernd Beschoten[1], Gernot Güntherodt[1], Jörg Raabe[2], and Christoph Quitmann[2] — [1]II. Physikalisches Institut, RWTH Aachen and Virtual Institute of Spin Electronics VISel, Templergraben 55, 52056 Aachen, Germany — [2]Swiss Light Source, Paul-Scherrer-Institut, 5232 Villigen, Switzerland

In the last years photoelectron emission microscopy (PEEM) has been established as a powerful technique to image magnetic domains in magnetic nano-structures with high spatial resolution (<100 nm).

For studies of ultrafast magnetization dynamics such as precessional switching we have realized a novel time-resolved PEEM setup. A ps-laser pulse either causes an ultrafast excitation of a non-equilibrium carrier population or can act as a heating pulse. The resulting precessional dynamics can be probed by time-resolved PEEM using magnetic circular dichroism. The main experimental achievements are: (1) temporal overlap between the laser pump pulse and the synchrotron probe pulse and (2) spatial overlap of both, controlled by laser-induced 2-photon-photoemission. First time-resolved experiments have been performed on GaAs at room temperature. This method promises to monitor magnetization dynamics in exchange coupled magnetic multilayer systems.

Supported by DFG-SPP 1133 and by HGF

MA 27.2 Thu 10:30 HSZ 403

Ultraslow femtosecond relaxation observed for high excitation power — •Markus Münzenberg, Marija Djordjevic, and Gerrit Eilers — IV. Phys. Inst., University of Göttingen

All-optical pump probe experiments give a unique insight into high nonequilibrium femtosecond timescale. A micromagnetic model using the OOMMF simulation code (NIST) is developed, to explain the significant increase of the relaxation times observed for high pump fluences larger 30 mJ/cm^2. After the restoration of the local spin magnetization, small random few nanometer sized domains are formed with an average net magnetization of zero. If the magnetization below the disturbed region remains unaffected by the pump pulse, the energy is dissipated by the emission of spin waves an decreases the restoration time of the magnetization. The effect is analogous to the increased non local Gilbert damping by the emission of spin waves that was found in earlier investigation of our group in the spot geometry. The investigation and understanding of these effects is of strong importance for the application of thermally-assisted writing in the new generation of hard disc heads.

MA 27.3 Thu 10:45 HSZ 403

Spin-Wave Eigenmodes of Landau-Domain Patterns — •Markus Bolte[1], Guido Meier[1], and Christian Bayer[2] — [1]University of Hamburg, Institute of Applied Physics, Jungiusstr. 11, 20355 Hamburg, Germany — [2]Fachbereich Physik und Schwerpunktprogramm MINAS,Technische Universität Kaiserslautern, Erwin-Schrödinger-Straße 56, 67663 Kaiserslautern, Germany

We present micromagnetic simulations of the spin-wave spectra in Landau-domain patterns. Ultra-short field pulses of various spatial symmetries are used to excite distinct spin-wave eigenmodes. The frequencies as well as the symmetry of the mode patterns depend on the symmetry of the exciting torque. The latter is determined by the symmetries of the field pulse and the magnetic ground state. Landau-domain patterns have collective excitations, i.e., the spin-wave modes cannot be considered for each domain individually. We find transversal modes as well as longitudinal modes as observed experimentally.[1,2] From the mode profiles an effective dispersion relation is deduced which resembles the dispersion relation for infinitely extended thin films.[3]

[1] K. Perzlmaier, et al., Phys. Rev. Lett. 94, 057202 (2005). [2] M. Bolte, G. Meier, and C. Bayer, submitted (2005). [3] B. A. Kalinikos, A. N. Slavin, J. Phys. C 19, 7013 (1986).

MA 27.4 Thu 11:00 HSZ 403

Magnon decay in gapped quantum spin systems — •Oleksiy Kolezhuk and Subir Sachdev — Physics Dept., Harvard University, Cambridge MA 02138, USA

In the O(3) σ-model description of gapped spin systems, $S = 1$ magnons can only decay into *three* lower energy magnons. We show that the symmetry of the quantum spin Hamiltonian often allows decay into *two* magnons, and compute this decay rate in model systems. It is argued that two-magnon decay is present in Haldane gap $S = 1$ spin chains, even though it cannot be induced by any allowed term written in powers and gradients of the σ-model field. We compare our results with recent measurements of Stone *et al.* on a two-dimensional spin system $(C_4H_{12}N_2)Cu_2Cl_6$ (known as PHCC).

MA 27.5 Thu 11:15 HSZ 403

SPIN STATE BLOCKADE AT METAL-INSULATOR PHASE TRANSITION IN LAYERED COBALTITES $RBaCo_2O_{5.5}$ RAMAN STUDIES — •Yurii Pashkevich[1], Vladimir Gnezdilov[2], Peter Lemmens[3], Claudia Ambrosch-Draxl[4], Karina Lamonova[1], Alexander Gusev[1], Kwang-Yong Choi[5], Sergei Barilo[6], Sergei Shiryaev[6], and Georgii Bychkov[6] — [1]A. A. Galkin Donetsk Phystech NASU, 83114 Donetsk, Ukraine — [2]B. I. Verkin Institut for Low Temperature Physics NASU, 61164 Kharkov, Ukraine — [3]Institut für Physik d. Kondensierten Materie, D-38106 Braunschweig, Germany — [4]Institut für Theoretische Physik, Universität Graz, A-8010 Graz, Austria — [5]Institute for Material Research, Tohoku University, Katahira 2-1-1 Sendai 980-8577, Japan — [6]Institute of Physics of Solids & Semiconductors, ASB, 220072 Minsk, Belarus

Using Raman spectroscopy and ab-initio lattice dynamic calculations we uncover the structure of spin states below T_{MI}=350 K in single crystalline $RBaCo_2O_{5.5}$ (R=Gd, Eu). In $GdBaCo_2O_{5.5}$ we observe the G-type of high spin (HS) and intermediate spin (IS) state order of Co-octahedral sites which placed in ac-plane, while pyramidal sites remains in IS states all the way up to 400 K. We show that this type of spin state order strongly suppresses carrier's motion and lead to the anisotropy of resistivity. Below 200 K we observe the gap opening between HS and IS states in XZ-spectra (this gap equals to 55 cm^{-1} at 5 K).

MA 27.6 Thu 11:30 HSZ 403

Spin-wave eigenmodes of an infinite thin film withperiodically modulated exchange bias field — •B. Hillebrands[1], C. Bayer[1], M.P. Kostylev[1], and S.O. Demokritov[2] — [1]Fachbereich Physik and Forschungsschwerpunkt MINAS, TUKaiserslautern, Germany — [2]Institut für AngewandtePhysik, Westfälische Wilhelms-Universität Münster,Germany

We propose a method to modify the spin-wave spectrum of a technologically relevant exchange bias bilayer system. It is based on a periodical suppression of the exchange bias field on the micrometer scale which induces a superlattice in the internal field. This periodic modification can experimentally be realized by focussed ion beam [1]. We will calculate semi-analytically the spin-wave eigenmodes and -frequencies of such a superlattice. The calculation method is based on the Green's function approach and on Bloch's theorem. We identify two different kinds of eigenmodes of this system. The first kind are propagating spin waves which have a band gap at the edge of the Brillouin zone. The second one are localized within the wells of the internal field and are nearly dispersion free. We further show that, by choosing an appropriate periodicity of the superlattice, the band gaps can be introduced at desired frequencies and so this system corresponds to a one-dimensional magnonic crystal. The proposed method might be of real practical interest for applications as it tailors the spin wave frequencies in thin films without a change in the topography. This work was supported by the EC projects ULTRASWITCH and NEXBIAS and by the DFG.

[1] K. Potzger, et al., IEEE Trans. Magn. **41**, 10 (2005).

MA 27.7 Thu 11:45 HSZ 403

Magnetization Dynamics of the Ferrimagnet CoGd near the compensation point — •Michael Binder[1], Alexander Weber[1], Ingo Neudecker[1], Georg Woltersdorf[1], Oleksandr Mosendz[2], Jan-U. Thiele[3], Michael R. Scheinfein[2], and Christian H. Back[1] — [1]Universität Regensburg, Universitätsstr. 31, 93040 Regensburg — [2]Simon Fraser University, 8888 University Drive, V5A 1S6 Burnaby BC, Canada — [3]San Jose Research Center, Hitachi Global Storage Technologies, 650 Harry Road, San Jose, CA 95120

Transition metal (TM)- Rare Earth (RE) - ferrimagnets are interesting systems to study magnetization dynamics. When the antiferromagnetic coupling between the two sublattices is strong, as it is the case for CoGd, there exist two transition temperature points, the compensation temperature T_{comp}, where $M_{Gd} = -M_{Co}$, and the angular momentum compensation temperature T_L, where $(M/\gamma)_{Gd} = (M/\gamma)_{Co}$. These temperatures are sensitive to the concentration. For CoGd the room temperature concentration is about 78% Co. According to a simple mean field model for the coupled sub-lattices, the effective damping parameter α_{eff} and the effective frequency ω increase quickly at T_L. This total response can be measured using ferromagnetic resonance methods (FMR). However, one can also use laser pump/probe experiments which couple predominantly to the TM lattice. We present measurements on various samples. TR-MOKE and FMR were used to address the Co-subsystem and the whole ferromagnetic system. In FMR we find the expected increase of α_{eff} and ω at the compensation point, while TR-MOKE measurements seem to indicate that the rate of energy loss remains nearly constant.

MA 27.8 Thu 12:00 HSZ 403

Phase control of spin wave parametric interaction — •A. Serga[1], M. Kostylev[1], T. Schneider[1], B. Hillebrands[1], and A. Slavin[2] — [1]Fachbereich Physik, TU Kaiserslautern, 67663 Kaiserslautern — [2]Department of Physics, Oakland University, Rochester, MI, USA

Phase sensitive clipping of microwave pulses passed through a parametric non-adiabatic spin wave amplifier driven by pumping pulses of double frequency is discovered. It was known that intensive amplification of the input signal by any spin wave parametric amplifier takes place only for a short time interval immediately after the pumping pulse is switched on. After that, the signal is partially or fully suppressed due to the interaction with thermal spin waves excited by long-acting pumping. It was found that in non-adiabatic amplifier, where the pumping localization length is comparable to the signal carrier wavelength, the level of this suppression can be controlled in a wide range by changing the phase of pumping relative to the phase of the input signal. The phase control is possible because the influence of the parasitic thermal spin waves reveals itself mainly in misphasing between the signal spin wave and the pumping due to local decrease of magnitude of the static magnetization. Brillouin light scattering observation demonstrates that the parasitic waves are generated near the bottom of the spin wave spectrum apparently due to a kinetic instability of parametrically excited spin waves at half the pump frequency.

Financial support by the DFG under Hi380/13 is acknowledged.

MA 27.9 Thu 12:15 HSZ 403

Phase-sensitive Brillouin light scattering spectroscopy — •T. Schneider[1], A. Serga[1], B. Hillebrands[1], and S. Demokritov[2] — [1]Fachbereich Physik, TU Kaiserslautern, 67663 Kaiserslautern — [2]Institut für Angewandte Physik, Westfälische Wilhems-Universität, Münster

We report on the first implementation of phase sensitivity into Brillouin light scattering (BLS) spectroscopy. Combined with a time- and space-resolved BLS setup this allows for access to quantities such as the phase profile and the wave front of spin wave packets and beams. In order

to access phase information, interference between the light inelastically scattered by the spin wave under investigation and a frequency shifted coherent reference beam was used. Designing an optical interferometer setup, mechanical and thermal stability is of paramount importance to yield reliable phase information. We have solved the problem of stability by spatially combining the optical reference and the signal beam along one single axis. To achieve the necessary frequency shift of the reference light, a microwave electro-optical resonance modulator based on a Lithium Niobate single crystal was constructed. As this modulator is driven by the same microwave source that is used for the excitation of the spin waves, coherency between the frequency shifted and the inelastically scattered light guaranteed. The measurements of dipolar dominated spin waves in ferrite films clear demonstrate a phase structure of the spin wave packets. Phase fronts are clearly visible. The measured values of the wavelength corresponds well with the calculated one.

Financial support by the DFG is acknowledged.

MA 27.10 Thu 12:30 HSZ 403

Thermal Switching Behaviour of Superparamagnetic Nanoislands: SP-STM on Fe/W(110) — •Stefan Krause, Luis Berbil-Bautista, Matthias Bode, and Roland Wiesendanger — Institute of Applied Physics, University of Hamburg, Jungiusstraße 11, 20335 Hamburg

Spin-polarized scanning tunneling microscopy (SP-STM) is a well-established tool to reveal the static magnetic structure of surfaces at spatial resolution down to the atomic scale. Recently it has been shown that SP-STM can also be applied to investigate the dynamic switching processes in real time and real space, e.g. the thermal switching behaviour of individual superparamagnetic nanoislands [1]. While the experiments of Ref. [1] were performed only for a very limited temperature range, we have now used a home-built variable-temperature STM for detailed temperature-dependent investigations. This allows a critical examination of the predictions on the temperature-dependence of the switching rate made by the so-called Néel-Brown law. This theory predicts an Arrhenius-like behaviour for nanoparticles which are coherently magnetized even during the switching process.

Our sample consists of in-plane magnetized uniaxial Fe monolayer islands on W(110). For islands with an area of about 20 nm^2 we find a blocking temperature of about 45 K. The high stability of our experimental setup allows the observation of the same islands over a wide temperature range. The experimental data will be discussed in terms of the particle's anisotropy barrier and the attempt frequency.

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

MA 27.11 Thu 12:45 HSZ 403

Dynamic magnetization behavior of nanocrystalline tape wound cores — •Sybille Flohrer[1], Rudolf Schäfer[1], Jeffrey McCord[1], Stefan Roth[1], Giselher Herzer[2], and Ludwig Schultz[1] — [1]IFW Dresden, Institut für Metallische Werkstoffe, 01069 Dresden — [2]Vacuumschmelze GmbH & Co. KG, 63450 Hanau

The so-called excess loss is an important component of dynamic magnetization losses. It originates from localized eddy currents around moving domain walls. Therefore, observation of the dynamic magnetization process together with simultaneous loss measurement provides a useful tool to investigate excess loss. Stroboscopic Kerr-microscopy observations and loss measurements on nanocrystalline $Fe_{73}Cu_1Nb_3Si_{16}B_7$ tape wound cores with different strength and direction of induced anisotropy are presented. In cores with an induced anisotropy along the field direction, the correlation between excess loss, strength of the anisotropy, and measured domain wall velocity on the surface is studied. The relevance of the observed surface magnetization process for the core volume is discussed. Cores with an induced anisotropy transverse to the field direction should ideally show homogeneous magnetization rotation, preventing excess loss. However, besides homogeneous rotation, inhomogeneous rotations, wall displacement processes and domain nucleation are observed in the nanocrystalline cores, being responsible for a significant excess loss.

MA 28 Invited Talks Brune / Moritz

Time: Thursday 14:00–15:00 Room: HSZ 03

Invited Talk MA 28.1 Thu 14:00 HSZ 03

Surprises in the Magnetism of Surface Supported Nanostructures — •Harald Brune — EPFL, CH-1015 Lausanne

We use self-assembly during atomic beam epitaxy to create two-dimensional metallic islands with sizes from a few thousands of atoms down to the single atom limit. We show how the magnetic properties, such as anisotropy energy, spin- and orbital moments, as well as spin-polarization, evolve as function of size. Measurements with Magneto-Optical Kerr Effect (MOKE), X-ray Magnetic Circular Dichroism (XMCD), and STM reveal a giant increase in anisotropy with reduced coordination. As a consequence, the low-coordinated atoms are at the origin of magnetic anisotropy in nanostructures on single crystal surfaces. We present model systems exploring the ultimate density limit of magnetic information storage. They are characterized by uni-axial out-of-plane magnetization, narrow anisotropy distributions, and the absence of dipolar interactions. Spin-polarized STM measurements show up to 850% tunnel magnetoresitance (TMR) and 80% spin-polarization on single domain islands.

Invited Talk MA 28.2 Thu 14:30 HSZ 03

Discrete media made from pre-patterned wafers: a promising route towards ultra high density magnetic recording — •Jerome Moritz, Mohamed Asbahi, Vincent Baltz, Bernard Rodmacq, Jean-Pierre Nozieres, and Bernard Dieny — SPINTEC, URA 2512 CEA/CNRS, Grenoble, France

Patterned media have been proposed as a route to increase the areal density in magnetic storage devices towards 1 Tbit/in2 because they allow circumventing the super-paramagnetic limit, which is expected to appear in conventional media at densities ˜300 GB/in2. Pre-patterned media are prepared by classical lithography or nanoimprinting at the Silicon wafer level, followed by magnetron sputtering of Co/Pt multilayers. A bit binary value (0 or 1) is associated with the orientation of the magnetization carried by each dot. It is also possible to stack several layers with different coercive properties on top of the dots and to obtain 2ˆN stable states (N being the number of layers). An octet could then be coded on only one dot for instance, which leads to a drastic increase in the information density. The recording performances have been studied by using a quasi-static tester equipped with commercial write/read heads. The pulse width of the write field was varied from 1 s down to 1 nanosecond. The possibility of high data transfer rates was demonstrated. The signal to noise ratio of the readback signal is competitive with classical continuous media especially at small bit length. The improvements in nanoimprint lithography make this approach based on pre-patterned wafers promising for future ultrahigh density hard disk drives.

MA 29 Magnetic Thin Films IV

Time: Thursday 15:15–18:15 Room: HSZ 03

MA 29.1 Thu 15:15 HSZ 03

Critical Thickness and Critical Field of magnetic multilayered structures — •Hartmut Hafermann[1] and Mikhail I. Katsnelson[2] — [1]I. Institut für Theoretische Physik, Universität Hamburg, Jungiusstraße 9, 20355 Hamburg — [2]University of Nijmegen, Toernooiveld 1, NL 6525 ED Nijmegen, The Netherlands

For magnetic thin films and multilayers the phase transition from the homogeneous magnetization to the domain structure occurs at a critical thickness. For supercritical films, the phase transition occurs at a critical field applied in the film plane.

By investigating the stability conditions of a linearized Landau-Lifshitz torque equation, we are able to calculate numerically the critical thickness and critcal field for magnetic multilayered structures, consisting of alternating magnetic layers or magnetic and nonmagnetic layers. In addition we obtain information on the spin wave dispersion relation as well as the domain structure and domain period close to the phase transition.

We studied the influence of volume and surface anisotropies as well as interlayer exchange coupling between magnetic and across nonmagnetic spacer layers on the critical thickness and the critical field.

MA 29.2 Thu 15:30 HSZ 03

Magnetic coupling in Gd/Ni-layered films — •Alexander Barth[1], Frank Treubel[1], Jacek Jaworski[2], Marta Marszalek[2], Manfred Albrecht[1], and Günter Schatz[1] — [1]Universität Konstanz, Fachbereich Physik, Konstanz — [2]The H. Niewodniczanski Institute of Nuclear Physics, Krakau

In this study the magnetic interaction of the rare earth metal Gadolinium and the transition metal Nickel was examined. In the first approach the materials were deposited under UHV conditions onto sapphire and silicon nitride substrates. In order to investigate the coupling mechanism of the two layers the Nickel thickness was varied. Then measurements by SQUID and XMCD were used to resolve magnetic properties. The structure was examined by XRD and MEED and the composition during evaporation by AUGER-spectroscopy. Due to the huge size of the Gd-atoms and their thereby low mobility on the substrate surface the layer grows amorphous from the first monolayer on. In order to suppress interdiffusion with the Ni-layer the sample was cooled to -175°C. But still a strong tendency to intermixing could be observed on sapphire but not on the silicon nitride. The system shows a variety of magnetic coupling phenomena between the two layers with a strong temperature dependence due to an amorphous Gd/Ni-alloy forming inbetween.

MA 29.3 Thu 15:45 HSZ 03

Exchange-coupled Sm-Co trilayer systems — •Katrin Häfner, Ajit Patra, Volker Neu, Steffen Oswald, and Ludwig Schultz — IFW Dresden, P.O. Box: 270116, 01171 Dresden, Germany

Exchange-coupled Sm-Co trilayers have been prepared by pulsed laser deposition on Cr buffered MgO(110) substrates at elevated temperature. Soft magnetic layers of Fe and Fe-Co were sandwiched between two hard magnetic Sm-Co layers of 25 nm thickness and their influence on the magnetic properties was investigated. Film architecture, texture and magnetic properties of the films have been investigated by x-ray photo electron spectroscopy, pole figure measurements and vibrating sample magnetometry. The texture investigations show that the Sm-Co/Fe/Sm-Co and Sm-Co/Fe-Co/Sm-Co trilayers grow epitaxially throughout the whole layer stack with the following relationship: Sm-Co(100)[001]|| Fe/Fe-Co(211)[01-1]||Sm-Co(100)[001]||Cr(211)[01-1]||MgO(110)[001]. By varying the soft layer thickness d_s the magnetic behaviour of the trilayer changes from a completely coupled system with high coercivity of 1.5 T for $d_s = 5$ nm to a partially coupled regime with coercivities decreasing down to 0.8 T for d_s= 15 nm. The epitaxial growth of Sm-Co/Fe-Co/Sm-Co trilayers has been observed for the first time and is a very promising approach for fully coupled, remanence enhanced permanent magnet multilayers.

MA 29.4 Thu 16:00 HSZ 03

Coexistence of collinear and non-collinear magnetic domains in an [Er|Tb] superlattice — •Jörg Voigt, Emmanuel Kentzinger, Ullrich Rücker, Amitesh Paul, and Thomas Brückel — Institut für Festkörperforschung, Forschungszentrum Jülich, 52425 Jülich

The off-specular neutron scattering from an [Er|Tb] superlattice reveals the correlation length of co-existing magnetic structures. From wide angle neutron diffraction, the phase diagram has been deduced earlier, showing commensurate und incommensurate correlations in the same temperature range $T < 60$ K [1]. Polarized neutrons allow to distinguish between collinear ferromagnetic correlations and non-collinear helical correlations. We have studied the formation of the different domains as a function of magnetic field, temperature and magneto-thermal history of the sample.

[1] J.Voigt et al.,Europhys. Lett., 65 (4) , pp. 560-566 (2004)

MA 29.5 Thu 16:15 HSZ 03

New magnetic order in Fe/Fe-oxide superlattices — •Th. Diederich[1], R. Röhlsberger[1], S. Stankov[2], and R. Rüffer[2] — [1]Deutsches Elektronen Synchrotron DESY, Notkestr.85, 22607 Hamburg — [2]European Synchrotron Radiation Facility ESRF, B.P. 220, 38042 Grenoble Cedex, France

We have studied the magnetic structure of multilayer systems consisting of Fe and native Fe-oxide. The Fe layers have been produced by magnetron sputtering. Native oxide layers on the Fe were prepared by subsequent dosage of oxygen into the chamber. The samples have been prepared in an UHV system and were analysed in-situ by Nuclear Resonant Scattering (NRS). Ultrathin layers of ^{57}Fe are used to probe the magnetic structure of the Fe and the Fe-oxide layers with very high spatial resolution. Surface oxide layers coupled to the metallic Fe appeared to be nonmagnetic at room temperature. After deposition of another Fe layer one observes a ferromagnetically ordered component in the Fe-oxide layer that increases with growing thickness of the iron capping layer. This results in a relatively high magnetization of these buried oxide layers [1]. In an Fe/^{57}Fe-oxide superlattice we discovered a new type of interlayer coupling that results in superstructure Bragg peaks of the nuclear resonant reflectivity [2]. These observations point to an antiferromagnetically ordered spin arrangement within the lattice of Fe-oxide layers.

[1] G.S.D. Beach et al. Phys. Rev. Lett. 91, 267201 (2003).
[2] Th. Diederich, R. Röhlsberger et al., to be published.

MA 29.6 Thu 16:30 HSZ 03

Effect of hydrogen on the magnetism in Fe/V superlattices — •Arndt Remhof[1], Gregor Nowak[1], Alexei Nefedov[1], Matts Björk[2], Martin Pärnaste[2], Björgvin Hjörvarsson[2], and Hartmut Zabel[1] — [1]Institut für Experimentalphysik / Festkörperphysik, Ruhr-Universität Bochum, Germany — [2]Department of Physics, Uppsala University, Sweden

We report on the increase of the Fe magnetic moment within Fe/V superlattices upon H-uptake. At the Fe/V interface of pristine, ferromagnetically coupled Fe/V superlattices the V atoms acquire a magnetic moment, antiparallel aligned to the Fe moments [1]. Upon hydrogen loading the saturation magnetization was found to increase [2]. We employed element specific X-ray resonant magnetic scattering to investigate the response of the Fe and the V moments separately. An epitaxial [Fe(2ML)/V(16ML)]×30 superlattice was employed, ensuring a high number of V neighbors of each Fe atom. The soft x-ray measurements were carried out using the ALICE diffractometer at BESSY II in Berlin, Germany. The data clearly show a strong increase of the Fe moment upon H-loading. No change of the magnetic asymmetry at the V edge could be recognized. Our measurements confirm nicely the theoretical model by Uzdin et al. [3], predicting an increase of the Fe moment and a stable V moment in H loaded Fe/V superlattices.

This project founded by the DFG under contract no. RE 2203/1-1.

[1] A. Scherz et. al. Phys. Rev. B 68, 140401(R) (2003).
[2] D. Labergerie, et al. J. Magn. Magn. Mater. 225, 373 (2001).
[3] V. Uzdin, et al., Phys. Rev. B 68, 214407 (2003).

MA 29.7 Thu 16:45 HSZ 03

Synthetic metamagnetism: reorientation effects and multidomain states in perpendicular antiferromagnetic superlattices — •U.K. Rössler and A.N. Bogdanov — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

Recently synthesized antiferromagnetically coupled multilayers with strong perpendicular magnetic anisotropy, like [CoPt]/Ru, [CoPt]/NiO, Co/Ir, or Fe/Au, represent a new class of magnetic materials. These synthetic metamagnets are characterized by a cascade of metamagnetic

phase transitions, extended regions of metastable states and complex multidomain structures [1,2]. Within a phenomenological theory, we have classified and analyzed the wide variability of magnetic field-driven reorientation transitions and accompanying multidomain states in these synthetic metamagnets. In contrast to other bulk and nanomagnetic systems, the magnetic states are determined by a close competition between antiferromagnetic interlayer exchange and dipolar couplings. The theory of this phenomenon allows to explain the unusual switching processes and specific transformation of the domain patterns observed in these synthetic metamagnets.

[1] O. Hellwig et al., Nature Mater. 2 (2003) 112. [2] U. K. Rößler, A. N. Bogdanov, JMMM 269 (2004) L287.

MA 29.8 Thu 17:00 HSZ 03

Comparison of sputter-techniques for Co/Pt-multilayer-growth — •H. Stillrich[1], S. Pütter[1], D. Lott[2], R. Frömter[1], A. Schreyer[2], and H.P. Oepen[1] — [1]Institut für Angewandte Physik, Universität Hamburg, Jungiusstr. 11, 20355 Hamburg, Germany — [2]GKSS-Forschungszentrum Geesthacht, Institut für Werkstoffforschung, Max-Planck-Str., 21502 Geesthacht, Germany

Co/Pt-Multilayers are well known to show high perpendicular magnetic anisotropy (PMA) and magneto-optic response. Therefore there has been great interest in this system over the last decades. In general these films are grown either by MBE or by magnetron sputtering.

In the work presented here ECR-sputtering was used as growth process to guarantee kinetic growth conditions. The films reported in this study show high quality Pt(111)-texture which is crucial for high perpendicular surface anisotropies. The films show PMA for Pt-buffer-layers as thin as 4 nm and Co-layers from 0.4 to 0.7 nm.

We have investigated the magnetic, magneto-optic and structural properties from single Co-layers to Co-multilayers. The magnetic properties are studied by magneto-optic Kerr effect (MOKE) and scanning electron microscopy with polarization analysis (SEMPA). Structural analysis was carried out by x-ray diffraction and reflectometry. The films grown by ECR-sputtering show interface intermixing and the surface anisotropy is reduced compared to MBE or magnetron sputtered films. For comparison we have also grown Co/Pt-films by magnetron sputtering. The influence of the growth technique on film properties is discussed.

MA 29.9 Thu 17:15 HSZ 03

Electrodeposition and magnetic properties of multilayered Fe-Pt films — •Karin Leistner, Heike Schlörb, Sebastian Fähler, and Ludwig Schultz — IFW Dresden

The $L1_0$ FePt phase exhibits a very high magnetocrystalline anisotropy and a high saturation magnetisation. These properties make FePt films suitable for micromagnets in micro electromechanical systems. There, films with thicknesses in the μm range are needed which could be economically produced by electrodeposition. Up to now homogeneous FePt films have been deposited potentiostatically. During post annealing in hydrogen, the $L1_0$ phase is formed and coercivities up to 1.1 T have been achieved [1]. However, oxygen is incorporated into the films during electrodeposition and cannot be fully removed during annealing. Oxide impurities are thus limiting the remanence. Less oxygen is incorporated when depositing the single elements. It has been shown that by alternating the deposition potential, Fe/Pt multilayers with a significantly lower oxygen content can be obtained. Annealing of these multilayers leads to complete intermixing and the formation of the $L1_0$ phase. Coercivities as high as 1 T are obtained.

[1] K. Leistner, H. Schlörb, J. Thomas, M. Weisheit, S. Fähler, L. Schultz, APL 85(16), 3498 (2004)

MA 29.10 Thu 17:30 HSZ 03

On the temperature driven reorientation in Au/Co/Au: the influence of the structure — •E. Holub-Krappe[1], A. Hahlin[2], H. Maletta[1], C. Andersson[2], O. Karis[2], J. Hunter Dunn[3], and D. Arvanitis[2] — [1]Hahn-Meitner-Institut, Berlin, Germany — [2]Department of Physics, Uppsala University, Sweden — [3]MAX-lab, Lund University, Sweden

We present X-ray Magnetic Circular Dichoism (XMCD) results to characterize the Spin Reorientation Transition (SRT) in ex-situ prepared epitaxial Au/Co sandwich structures [1]. The Co thickness is kept 1.9 nm, the Au cap thickness is 2 nm. The temperature is varied between 170 K and 300K. The in-plane response is characterized by element specific hysteresis loops taken in the resonant reflectivity mode. Below 200K only an out-of-plane remanence is stable. At 300K the out-of-plane remanence decreases to zero. Between 200 and 300K both an in- as well as an out-of-plane remanence can be stabilized. A canted magnetization is excluded using angle dependent XMCD. The same values are found for the in- and out-of-plane spin moment. In contrast, the orbital moment exhibits a variation between the in-and out-of-plane phases. In the transition region the in- and out-of-plane remanence correspond to different values of the orbital moment. The SRT has been linked to the strong temperature dependence of the Co/Au interface anisotropy constants. Our results highlight the importance of structural modifications to the temperature induced SRT.

[1] R. Sellmann, H. Fritzsche, H. Maletta et al. Phys. Rev. B 64, 054418 (2001)

MA 29.11 Thu 17:45 HSZ 03

Magnetic domains and spin structure in single-crystalline NiMn/Co bilayers on Cu(001) — •Carsten Tieg[1], Radu Abrudan[1,2], Matthias Bernien[2], Wolfgang Kuch[2], and Jürgen Kirschner[1] — [1]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle — [2]Freie Universität Berlin, Institut für Experimentalphysik, Arnimallee 14, 14195 Berlin

The magnetic domain structure in epitaxial single-crystalline bilayers of antiferromagnetic NiMn and ferromagnetic Co on Cu(001) was studied by photoelectron emission microscopy using the element selective x-ray magnetic circular dichroism as a contrast mechanism. We observed that the Co domain structure changes from a large domain configuration into a small domain configuration as the thickness of the NiMn layer exceeds a critical thickness of 8–10 monolayer (ML) at $T = 300$ K. The occurrence of small domains in the Co layer is attributed to the magnetic phase transition in the NiMn layer from para- to antiferromagnetic (AFM). The spin structure of NiMn deposited on magnetically saturated Co was investigated by x-ray magnetic linear dichroism (XMLD) spectroscopy. A non-vanishing XMLD signal was found at the Mn L_3 absorption edge obtained from a 20 ML NiMn/6 ML Co/Cu(001) sample. This indicates a certain degree of collinearity of the Mn moments in the NiMn layer. The angular dependence of the XMLD signal suggests a non-bulk-like AFM spin structure of NiMn. The XMLD spectra can be explained by a small twist of the bulk AFM spin axes towards the Co magnetisation direction.

MA 29.12 Thu 18:00 HSZ 03

Magnetoelastic waves in multilayered structures — •Zukhra Gareyeva — IMCP,prospect Octyabrya 151, Ufa , Russia

The presented paper reports investigation of dynamic properties of magnetoelastic and elastic waves in confined layered structure representing a system made of magnetostrictive thin films deposited on nonmagnetic substrates. Application area of such structures is wide and encounters sensors and actuators for bulk and microelectromechanical devices, devices for delay lines, angular motion, torque generation, magnetic labels etc. In this article we draw attention to frequencies of vibrations induced by variable magnetic field in composed films-substrate system and peculiarities of their behavior under the change of intrinsic and external parameters. We show dispersion law of composite system differs from the case of thin magnetic film. It reveals in peculiarities of dimensional resonant frequencies behaviour. Results of investigation are expected to be important both from theoretical and practical point of views: to predict behaviour of magnetostrictive systems subjected to magnetic dynamic loads, to determine elastic and magnetoelastic properties of materials from dynamic experiments, to control dimensional resonances frequencies in composite oscillator devices, to contribute to the laminated plate theory.

MA 30 Spin-Electronics II

Time: Thursday 15:15–16:15 Room: HSZ 103

MA 30.1 Thu 15:15 HSZ 103

Spin-resolved photoemission studies at the Fe(001)/MgO interface — •Martina Müller, Frank Matthes, and Claus M. Schneider — Institut für Festkörperforschung, Forschungszentrum Jülich

The epitaxial system Fe(001)/MgO/Fe represents one of the most interesting materials for studying the tunnel magnetoresistance effect (TMR). In order to explain discrepancies between experimental results and theoretical predictions for the height of TMR, our experiments focus on the properties of the interface between Fe(001)/MgO since its electronic structure strongly determines the interfacial coupling. We performed spin-resolved photoemission experiments at the Synchrotron DELTA (Dortmund) studying the Fe (3d) valence bands covered with an ultrathin MgO layer. The samples were produced by molecular beam epitaxy and characterized in-situ by Auger spectroscopy and low energy electron diffraction. The systematic variation of either oxidation and layer thickness of the on-top MgO covering reveals different processes: A spin dependent attenuation of the Fe (3d) minority channel is observed for varying MgO thickness whereas electrons of both spin directions are involved in the change of electronic structure when passing from an oxidic to a more metallic MgO capping layer. The analysis of the Fe spin polarization completes the investigations by uncovering the spin dependent bonding conditions at the Fe(001)/MgO interface.

MA 30.2 Thu 15:30 HSZ 103

Spin-dependent tunneling through antiferromagnets: Mn/Fe(001) — •Peter Bose[1], Jürgen Henk[2], Arthur Ernst[2], Ingrid Mertig[1], and Patrick Bruno[2] — [1]Martin-Luther-Universität, FB Physik, FG Theoretische Physik, 06099 Halle/S., Germany — [2]MPI für Mikrostrukturphysik, Abteilung Theorie, 06120 Halle/S., Germany

The size of the tunnel magnetoresistance (TMR) of a magnetic tunnel junction (MTJ) which includes an antiferromagnet (AFM) film is *a priori* not clear. On one hand, a large TMR can be expected due to the large spin polarization in the leads. On the other hand, the TMR is determined essentially by interface properties, suggesting a small TMR due to the interfaces of the antiferromagnet. Recent spin-resolved scanning tunneling microscopy (SR-STM) experiments [1] proved that the latter is true for layer-wise AFM Mn films on Fe(001) [2], hence stressing the importance of interface properties.

While model calculations corroborate the experimental findings [1], there appears need for sophisticated first-principles tunneling calculations, the latter being reported on in this contribution. The spin-dependent conductance of Fe/Mn/vacuum/Fe MTJs is computed within Landauer-Büttiker theory applying multiple-scattering theory (layer-KKR). By this means, the origin of the experimentally observed TMR is unequivocally determined. Further, the role of surfaces states which provide a contrast mechanism in SR-STM is investigated.

[1] U. Schlickum *et al*, submitted to Phys. Rev. Lett.
[2] A. Ernst, J. Henk, R. K. Thapa, J. Phys.: Cond. Matt. **17** (2005), 3269.

MA 30.3 Thu 15:45 HSZ 103

Large room temperature TMR effect in tunnel junctions based on magnetite — •Andrea Boger, Edwin Menzel, Suleman Qureshi, Daniel Reisinger, Wolfgang Kaiser, Sebastian T. B. Goennenwein, Matthias Opel, and Rudolf Gross — Walther-Meissner-Institut, Bayerische Akademie der Wissenschaften, Walther-Meissner-Str. 8, 85748 Garching

To realize magnetic tunnel junctions with high tunneling magnetoresistance (TMR) at room temperature, the ferromagnet magnetite (Fe_3O_4) is attractive. The Curie temperature T_C is 860 K, and it has been predicted to be a half-metal [1].
To experimentally determine the spin polarization, we have investigated properties of magnetic tunnel junctions (MTJs) with Fe_3O_4 as the bottem electrode, fabricated by pulsed laser deposition. Ni or Co served as counter electrodes, and AlO_x as the tunnel barrier.
The MTJs were patterned in different shapes and areas. Measurements of magnetotransport and dc magnetization were done between 150 K and 350 K. They show ideal switching behavior and match to each other. TMR effects up to 20 % for Fe_3O_4/AlO_x/Co and 11 % for Fe_3O_4/AlO_x/Ni could be reached at 300 K. From this follows a spin polarization of about 44 % for Fe_3O_4. In addition, the temperature and voltage dependence of the TMR has been studied. We also observed a large geometrically enhanced TMR of more than 1000 % at 300 K, which is due to an inhomogeneous current distribution in the MTJs.
This work is supported by the BMBF project 13N8279.
[1] Z. Zhang, and S. Satpathy, Phys. Rev. B **44**, 13319 (1991).

MA 30.4 Thu 16:00 HSZ 103

Tunnel junctions with the Heusler-electrode $Co_2Cr_{0.6}Fe_{0.4}Al$ — •Martin Jourdan, Andres Conca, Christian Herbort, Anna Gerken, and Hermann Adrian — Institut für Physik, Johannes Gutenberg Universität, 55099 Mainz, Germany

Due to the theoretically predicted half-metallicity of the Heusler compound $Co_2Cr_{0.6}Fe_{0.4}Al$ tunneling junctions employing this material as electrodes promise huge magnetoresistance effects. However, the control and understanding of the influence of the interface and tunneling barrier properties on the tunneling magnetoresistance (TMR) poses a challenge. Recently we were able to prepare well ordered (B2 structure) epitaxial thin films of $Co_2Cr_{0.6}Fe_{0.4}Al$ which serve as a base electrode of $Co_2Cr_{0.6}Fe_{0.4}Al$-AlO_x-Co-CoO junctions. The dependence of the TMR-effect on the deposition temperature of the Heusler-electrode and the parameters of barrier preparation is presented. The electrode-barrier interface is characterized by in situ STM and RHEED as well as TEM. The relation between the bulk properties of the $Co_2Cr_{0.6}Fe_{0.4}Al$ electrode and the tunneling magnetoresistance of the junctions is investigated.

MA 31 Magnetic Measuring Techniques

Time: Thursday 16:15–17:00 Room: HSZ 103

MA 31.1 Thu 16:15 HSZ 103

GMI effect and anisotropy in soft magnetically coated wires — •J. Velleuer[1], A.G. Munoz[2], H. Yakabchuk[1], C. Schiefer[1], A. Hackl[1], and E. Kisker[1] — [1]Institut für Angewandte Physik, Heinrich-Heine Universitä Düsseldorf, 40225 Düsseldorf — [2]Dept. of Mat. Sci., LKO, University of Erlangen-Nuremberg, 91058 Erlangen

The impedance of soft magnetic microwires strongly depends on an external magnetic field (GMI). Here, we investigate the GMI effect of Cu wires coated with a soft magnetic layer. The layer thickness and the annealing conditions are varied. Depending on these parameters a GMI effect of up to 1100% was observed.

In order to gain further knowledge about the magnetic anisotropy in these wires -besides the GMI effect- the Procopiu effect was also investigated. The Procopiu effect (also known as the inverse Wiedemann effect) manifests itself in the occurrence of an AC voltage on a solenoid wrapped around the wire, when an AC current is flowing through the wire and an external magnetic field is applied.

MA 31.2 Thu 16:30 HSZ 103

Extracting the intrinsic switching field distribution in perpendicular media: a comparative analysis — •Michael Winklhofer[1,2] and Gergely Zimanyi[1] — [1]Physics Departement, UC Davis, CA, USA — [2]Geophysics Section, LMU, Munich

The quality of recording media depends crucially on the intrinsic (microscopic) switching-field distribution (SFD) of the media particles, which determines both magnetic stability and attainable recording density. We introduce a new method based on the first-order-reversal-curve (FORC) diagram to extract the SFD of perpendicular recording media (PRM). To demonstrate the viability of the method, we micromagnetically simulated FORCs (recoil loops) for PRM with known SFD and compare the extracted SFD with the SFD obtained by means of two different methods that are based on recoil loops, too, which however rely on mean-field approximations and assumptions on the shape of the SFD. The FORC method turns out to be the most accurate algorithm over the technologically relevant range of magnetic quality factors

($Q = 2K/(\mu_0 M_s^2)$), where the other methods overestimate the width of the SFD [1]. Moreover, the FORC method directly renders the shape of the SFD, without having to make *a priori* assumptions on its shape, and allows one to test if and to what degree the underlying assumption model of square hysterons is met.

[1] Winklhofer M., Zimanyi G.T., cond-mat/0509074

MA 31.3 Thu 16:45 HSZ 103

Theoretical contributions to the analysis of XMCD spectra — •Fabian Dörfler[1], Christos Kostoglou[1], Matej Komelj[2], and Manfred Fähnle[1] — [1]MPI Metallforschung, Heisenbergstr. 3, D-70569 Stuttgart — [2]Josef Stefan Institute, Jamova 39, SI-1000 Ljubliana, Slovenia

In the first part of the talk we will discuss under what circumstances the so called ground state moments, introduced by van der Laan [1] for atomic multiplet configurations, can be obtained also for atoms in a solid from the shape of the measured XMCD spectra. Starting from an isolated atom in a very strong crystal field, we will comment on the ground state moment analysis of XMCD spectra in solids suggested by Goering et al. [2].

In the second part of the talk the influence of the mixing of the $2p_{1/2}$ and $2p_{3/2}$ core levels by the crystal field or by the exchange field experienced by the core electrons is discussed, with special emphasis on the system CrO_2.

[1] G. van der Laan, Phys. Rev. B 55, 8086 (1997)
[2] E. Goering et al., Appl. Phys. A 78, 855 (2004)

MA 32 Magnetic Particles / Clusters

Time: Thursday 15:15–18:45 Room: HSZ 401

MA 32.1 Thu 15:15 HSZ 401

The Mackay transition in Fe clusters — •Georg Rollmann, Alfred Hucht, Markus E. Gruner, and Peter Entel — Theoretical Low-Temperature Physics, University of Duisburg-Essen, Lotharstr. 1, Campus 47048 Duisburg, Germany

Icosahedral (Ih) structures are commonly observed in small clusters and even nanoparticles consisting of, e.g., rare-gas or transition-metal atoms. Their particular stability compared to corresponding cuboctahedral (CO), fcc-like packings is often related to their lower surface energy. However, due to the presence of internal strain, they become unfavorable for larger particles, and therefore a crossover from Ih to CO geometries is expected to occur with increasing particle size. Both packings can be transformed into one another via the Mackay transition [1].

We have investigated the potential energy surfaces of Fe clusters with closed atomic shells within density functional theory in the generalized gradient approximation allowing for full relaxation of the atoms. For Fe_{13}, the CO geometry is not stable with respect to a Mackay transformation, resulting in an Ih ground state. However, in the case of Fe_{55}, the lowest-energy isomer found is neither Ih nor CO, but has a CO-like core and an Ih shell. We also find these shell-wise transformed structures to be especially stable for larger Fe particles.

[1] A. Mackay, Acta Crystallogr. **15**, 916 (1962)

MA 32.2 Thu 15:30 HSZ 401

Influence of temperature on the magnetic properties of clusters — •Svetlana Polesya[1], Sven Bornemann[1], Jan Minár[1], Voicu Popescu[1], Ondrej Šipr[2], and Hubert Ebert[1] — [1]LMU München, Dept. Physikalische Chemie, München, Germany — [2]Institute of Physics Acad. of Science, Prague, Czech Republic

We investigate the temperature-dependence of the magnetisation of free Fe clusters and of supported Co clusters on Pt(111) and on Au(111). Electronic and magnetic properties of these systems at T=0 K are calculated ab-initio via a scalar-relativistic multiple-scattering formalism. Exchange coupling parameters are then obtained from zero-temperature results and employed for describing magnetic excitations at finite temperatures within a classical Heisenberg Hamiltonian. In that way, one can interconnect ground-state and finite-temperature properties. The mean magnetisation and magnetic profiles of clusters was evaluated by the Monte Carlo method. We show how the magnetic profiles of clusters change if the temperature is varied and how the dependence of mean cluster magnetisation on the cluster size is influenced by the temperature. In particular it turns out that for small clusters the critical temperature in general does not increase monotonously with the cluster size.

MA 32.3 Thu 15:45 HSZ 401

Magnetic and spectroscopic properties of Ru and Mo clusters deposited on Fe(001) and Ni(001) — •Sven Bornemann[1], Jan Minar[1], Wilfried Wurth[2], and Hubert Ebert[1] — [1]Department Chemie, LMU München — [2]Institut für Experimentalphysik, Universität Hamburg

The fully relativistic spin-polarized KKR method has been used to study the magnetic and spectroscopic properties of small Ru and Mo clusters deposited on Fe(001) as well as Ni(001). For both substrates the results for the XMCD spectra and their connection with the spin- and orbital moments will be discussed on the basis of the so-called sum rules.

In line with recent X-ray absorption experiments a pronounced XMCD signal is found for the $M_{2,3}$-edge of the Ru dimer on Fe(001). However, for a single Ru adatom no XMCD signal is found in the experiment, while theory predicts a dichroic signal and a magnetic moment of 0.84 μ_B for a single Ru adatom on a Fe(001) surface. In order to understand this contradiction with experiment we also simulated a stepped surface and an incorporation of Ru into the substrate. As it will show, this geometrical situations lead to a strong change in the magnetic moment compared to that of an isolated adatom.

MA 32.4 Thu 16:00 HSZ 401

Magnetic spin and orbital moments of mass-filtered Fe nanoparticles deposited on Co/W(110) — •Armin Kleibert[1], Joachim Bansmann[2], and Karl-Heinz Meiwes-Broer[1] — [1]Institut für Physik, Universität Rostock, Universitätsplatz 3, D-18051 Rostock — [2]Abteilung Oberflächenchemie und Katalyse, Universität Ulm, Albert-Einstein-Allee 47, D-89069 Ulm

In this contribution we focus on the magnetic spin and orbital moments of large Fe nanoparticles with diameters between 6-10nm (i.e. 15.000-50.000 atoms per cluster) deposited on ultrathin Co films on W(110). The moments have been obtained from *in situ* measurements of the XMCD (X-ray magnetic circular dichroism) via TEY (total electron yield) and are corrected for self-saturation effects. HRTEM (high resolution transmission electron microscopy) images yield structural and morphological properties of the Fe nanoparticles. The particles show bulk-like magnetic spin moments being nearly independent of the particle size. However, the orbital moments are strongly enhanced when compared to the bulk and exhibit a pronounced increase when reducing the size of the particles. Analysing the data reveals that the enhancement of the orbital moments is most probably not restricted to the surface of the particles. Thus, even the inner parts of the particles may possess properties being different from the bulk. As possible mechanisms we suggest size- and shape-dependent surface strain as well as surface relaxations, both being able to modify the crystal lattice as well as the symmetry. Moreover, we expect a significant influence of the substrate on the properties of the particles.

MA 32.5 Thu 16:15 HSZ 401

Magnetic moments of mass-selected FeCo alloy clusters on Ni(111)/W(110) — •R.K. Gebhardt[1], A. Kleibert[2], J. Bansmann[2,3], F. Bulut[1], K.-H. Meiwes-Broer[2], and M. Getzlaff[1] — [1]Institute of Applied Physics, University of Düsseldorf, Germany — [2]Institute of Physics, University of Rostock, Germany — [3]Institute of Surface Chemistry, University of Ulm, Germany

FeCo-alloys yield the highest magnetic moments of all binary 3d-transition metal alloys, such as $Fe_{50}Co_{50}$ about 2,5 μB (Slater-Pauling-curve). We prepared $Fe_{56}Co_{44}$ clusters (5 - 6 nm diameter) using the arc cluster ion source (ACIS) working in a continuous mode. The clusters were mass-selected by an electrostatic quadrupole deflector and subsequently deposited on Ni(111)/W(110). We present X-ray absorption measurements recorded under different angles. The investigation of the X-ray magnetic circular dichroism (XMCD) allows us to determine element-specifically the magnetic spin- and orbital moments. Measurements of the magnetic moments of larger clusters (7,5 nm diameter) are in a good agreement with the theoretically expected values in the solid [1,2]. Furthermore, the absorption measurements permit an estimation of

the stoichiometry. Comparison of the angle-dependent absorption spectra gives indication of the cluster shape. The relation between size and magnetic properties will be discussed.
[1] J. Bansmann and A. Kleibert, Appl. Phys. A **80** (2005) 957
[2] M. Getzlaff et al., Appl. Phys. A **82** (2006) 95

MA 32.6 Thu 16:30 HSZ 401

Superferromagnetic domains in granular multilayers observed by X-PEEM and transmission x-ray microscopy — •S. Bedanta[1], T. Eimüller[2], P. Fischer[3], W. Kleemann[1], D.- H. Kim[3], E. Amaladass[4], S. Cardoso[5], and P. P. Freitas[5] — [1]Universität Duisburg-Essen, D-47048 Duisburg, Germany — [2]Ruhr-Universität Bochum, D-44780 Bochum, Germany — [3]Lawrence Berkeley National Laboratory, Berkeley CA 94720, USA — [4]Max-Planck-Institut fur Metallforschung, 70569 Stuttgart, Germany — [5]INESC, Rua Alves Redol 9-1, 1000 Lisbon, Portugal

Due to interparticle interactions, a collective superferromagnetic domain state is encountered in non-percolated granular multilayers $[Co_{80}Fe_{20}(t_n)/Al_2O_3(3nm)]_{10}$, where t_n represents the nominal thickness of CoFe [1-3]. Based on x-ray magnetic circular dichroic element-specific contrast, photoemission electron microscopy (X-PEEM) and transmission soft x-ray microscopy (XM-1), both at ALS, Berkeley, proved successful to image superferromagnetic domains at different external applied fields. Stripe domains stretched along the easy in-plane axis, but exhibiting irregular walls and hole-like internal structures ("domains in domains") are revealed by X-PEEM on a sample with t_n = 1.3nm. More compact domains with a few μm in size were imaged by XM-1 on a sample with t_n = 1.6nm. Their growth was recorded during magnetization reversal under near-coercive magnetic fields.
[1] W. Kleemann *et al.*, Phys. Rev. B **63**, 134423 (2001).
[2] X. Chen *et al.*, Phys. Rev. Lett. **89**, 137203 (2002).
[3] S. Bedanta *et al.*, Phys. Rev. B **72**, 024419 (2005).

MA 32.7 Thu 16:45 HSZ 401

Preparation and characterisation of L10-FePt nanoparticles in the gas phase. — •Olga Dmitrieva, Günter Dumpich, Jöchen Kästner, and Mehmet Acet — Experimentalphysik, AG Farle, Universität Duisburg-Essen, 47048 Duisburg

FePt nanoparticles with sizes between 5-10 nm are prepared by inert gas condensation using DC sputtering and subsequent flight-annealing through a furnace set to temperatures in the range 600°C 1200°C. Morphology and structure of the obtained nanoparticles depend on the nucleation pressure and annealing temperature. The process at a nucleation pressure of 0.5 mbar yields multiply twinned icosahedral particles, whereas at 1.0 mbar, polycrystalline nanoparticles are observed. The desired chemically ordered L10-phase with high magneto-crystalline anisotropy in some particles was detected using high resolution transmission electron microscopy (HRTEM). With the addition of nitrogen to the sputtering gas, the formation of the icosahedral structure is suppressed, predominantly single crystalline L10-ordered nanoparticles are formed. To verify the incorporation of nitrogen into the atomic structure, we use electron energy loss spectroscopy (EELS) and X-Ray absorption spectroscopy (XAS). Work supported by DPG (SFB445).

MA 32.8 Thu 17:00 HSZ 401

Enhanced orbital magnetism in oxide-free FePt nanoparticles — •C. Antoniak[1], K. Fauth[2,3], H.-G. Boyen[4], U. Wiedwald[4], F. Wilhelm[5], A. Rogalev[5], M. Spasova[1], J. Lindner[1], M. Acet[1], and M. Farle[1] — [1]Fachbereich Pysik, Universität Duisburg-Essen, Lotharstr. 1, D-47048 Duisburg — [2]MPI für Metallforschung, Heisenbergstr. 3, D-70689 Stuttgart — [3]Experimentelle Physik IV, Universität Würzburg, Am Hubland, D-97074 Würzburg — [4]Abteilung Festkörperphysik, Universität Ulm, Albert-Einstein-Allee 11, D-89069 Ulm — [5]European Synchrotron Radiation Facility, 6 Rue Jules Horowitz, B.P. 220, F-38043 Grenoble

Wet chemically synthesised $Fe_{50}Pt_{50}$ particles with a mean diameter of 6.3 nm deposited on a naturally oxidised Si substrate have been structurally and magnetically characterised. By a soft hydrogen plasma treatment, the oxide shell and the organic ligands surrounding the chemically disordered particles in the as prepared state were removed and pure metallic x-ray absorption and magnetic circular dichroism spectra were measured at both the Fe and Pt $L_{3,2}$ edges. After annealing for 30min at 600°C in a hydrogen atmosphere of 5 Pa, the coercive field increased by a factor of 6. This indicates the formation of the chemically ordered $L1_0$ phase and is accompanied by an enhancement of the orbital magnetic moment at the Fe sites by more than 300%, whereas the magnetic moments at the Pt sites remain largely unchanged.
This work was supported by the BMBF (05 ES3XBA/5), the ESRF, the DFG (SFB 445) and the EU (MRTN-CT-2004-0055667, SyntOrbMag).

MA 32.9 Thu 17:15 HSZ 401

Phase transformation of FePt nanoparticles from fcc to fct as probed by XMCD — •Ulf Wiedwald[1], Birgit Kern[1], Kai Fauth[2], Andreas Klimmer[1], Luyang Han[1], Hans-Gerd Boyen[1], and Paul Ziemann[1] — [1]Abteilung Festkörperphysik, Universität Ulm, Albert-Einstein-Allee 11, 89069 Ulm, Germany — [2]Max-Planck-Institut für Metallforschung, Heisenbergstrasse 3, 70569 Stuttgart, Germany

FePt alloy nanoparticles show huge magnetic anisotropy energy in the chemically ordered $L1_0$ phase. The ordered phase is typically obtained by annealing at 600-800°C starting from fcc, chemically disordered FePt nanoparticles. Nowadays, wet-chemical approaches like the synthesis of ligand-stabilized colloidal particles or the plasma-induced nucleation of metal salt loaded reverse micelles allow the self-organized formation in regular arrays onto various substrates. Hereby, the colloidal approach gives short interparticle spacing of 2-3 nm and the heat treatment at elevated temperatures is likely to form unwanted larger agglomerates of particles. By employing the micellar preparation route, the particle separation can be tuned between 20-100 nm. These larger distances permit us to study the phase transformation towards $L1_0$ ordered particles without any agglomeration, loss of the array quality or magnetostatic coupling between particles. We investigated FePt nanoparticles (4 nm and 9 nm) with spacing of 28 nm and 64 nm by XMCD. The phase transformation is tracked by hysteresis loops at various temperatures. In case of 9 nm particles we observe a coercive field of μ_0H = 0.2 T at 340 K. The magnetic anisotropy rises by more than one order of magnitude due to annealing, while the total magnetic moment remains nearly constant.

MA 32.10 Thu 17:30 HSZ 401

Charge Transfer Controlled Magnetism of FePt Nanoparticles — •Balaji Gopalan[1], Christophe Stroh[1], Keir Foster[1], Christian Lemier[1], Raghavan Viswanath[1], Jörg Weissmüller[1,2], and Stefan Mangold[3] — [1]Institut für Nanotechnologie, Forschungszentrum Karlsruhe GmbH, Hermann-von-Helmholtz-Platz 1, D-76344 Eggenstein-Leopoldshafen, Germany — [2]Fachrichtung Technische Physik, Universität des Saarlandes, 66041 Saarbrücken, Germany — [3]Institut für Synchrotronstrahlung, Forschungszentrum Karlsruhe GmbH, Hermann-von-Helmholtz-Platz 1, D-76344 Eggenstein-Leopoldshafen, Germany

The effect of charge transfer between ligand and nanoparticles on the magnetic properties of monodispersed 2.0 nm FePt nanoparticles is studied. For this purpose, we have synthesized FePt nanoparticles covered by high fatty acid ligand (FePtCL), octadecanethiol (FePtSH), and oleic acid/oleylamine mixture (FePtOAc) as a series and the magnetic properties are compared. The superparamagnetic blocking temperature (T_B) are found to be 14, 11 and 7.5 K for FePtCL, FePtSH and FePtOAC samples respectively. The coercivity (H_c) values measured at 5 K are 3880, 4800 and 4000 Oe for FePtCL, FePtSH, and FePtOAC respectively. These differences suggest that the effective magnetic anisotropy constant (K_{eff}) is different for these samples. XANES Fe K pre-edge values of 7114.6 and 7115.4 eV are observed for FePtCL and FePtSH (reference Fe value is 7112.1 eV) indicating that Fe in 2(+) and 3(+) oxidation states respectively in these samples. A correlation between the observed oxidation states and the magnetic properties will be attempted.

MA 32.11 Thu 17:45 HSZ 401

Synthesis of magnetic nanoparticles with pronounced shape anisotropy and characterization via small angle X-ray scattering (SAXS) — •Frank Döbrich, Andreas Michels, Andreas Tschöpe, and Rainer Birringer — Universität des Saarlandes, Technische Physik, Geb. D2 2, 66041 Saarbrücken, Germany

Ferrofluids (FF) are stable colloidal suspensions of magnetic particles in a nonmagnetic carrier fluid. This fact renders a FF sensitive to an external magnetic field, which leads to a coupling of magnetic and rheological properties. For instance, it is expected that a dispersion of highly anisometric particles such as rods or chains reveals a large enhancement (compared to spherical particles) of the magnetoviscous effect, i.e. the increase of the FF's viscosity due to an externally applied magnetic field. This contribution reports on the synthesis of a highly anisometric FF

containing stable chains of iron nanoparticles and on the microstructural characterization by means of transmission electron microscopy (TEM) and small angle X-ray scattering (SAXS). The SAXS measurements develop a pronounced anisotropy of the scattering pattern as a function of increasing external magnetic field. Evaluation of the radially averaged SAXS curves in terms of basic scattering functions is discussed.

MA 32.12 Thu 18:00 HSZ 401

Magnetoviscous behaviour of nanorod ferrofluids — •Dörte Junk, Christian Lang, Andreas Tschöpe, and Rainer Birringer — Universität des Saarlandes, 66123 Saarbrücken, Germany

We prepare shape-anisotropic iron particles in a magnetic-field-assisted forced flux aerosol reactor. On their way downstream the particles are coated with oleic acid and dispersed in a carrier fluid. As in conventional ferrofluids these rod-like particles behave as Brownian particles. Their morphology has been characterized by TEM and ac susceptibility measurements in a dc bias field. We find an average aspect ratio lying between 10 and 15; we will call such a complex fluid nanorod ferrofluid (nrod FF). The magnetoviscous effect of the nrod FF has been studied using a squeeze flow viscometer (piezoelectric axial vibrator) in the presence of a homogenous magnetic field. The comparison with conventional FF reveals a giant magnetoviscous effect.

MA 32.13 Thu 18:15 HSZ 401

Characterization of magnetic nanoparticles by combining magnetization, magnetorelaxometry, ac susceptibility and microscopic measurements — •Frank Ludwig, Erik Heim, and Meinhard Schilling — TU Braunschweig, Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, Hans-Sommer-Str. 66, D-38106 Braunschweig, GERMANY

The MAgnetic Relaxation ImmunoAssay (MARIA) uses superparamagnetic nanoparticles as markers and is based on the different relaxation times and behaviour of bound and unbound magnetic nanoparticles (MNPs). A crucial point is that MARIA relies on the availability of functionalized MNPs with a proper size and narrow size distribution. We have investigated various commercially available Fe$_{3}$O$_{4}$ MNP samples with organic shell, either diluted in water or immobilized by freeze-drying, combining static M(H) curves, magnetorelaxometry (MRX), ac susceptibility as well as TEM and AFM measurements. Whereas the microscopic data reveal rather local information on size and shape of MNPs, the magnetic measurements provide integral information on their size and size distribution as well as on magnetic properties, such as anisotropy constant, saturation magnetization and Néel and Brownian relaxation times. Especially MRX using fluxgates is shown to provide more information on MNP properties than SQUID MRX since it allows one to record the whole magnetization and relaxation process of MNPs.

Financial support by the DFG via SFB 578 is acknowledged.

MA 32.14 Thu 18:30 HSZ 401

Investigation of biological research issues with superparamagnetic nanoparticles by differential fluxgate magnetorelaxometry — •Erik Heim, Kai Pöhlig, Frank Ludwig, and Meinhard Schilling — TU Braunschweig, Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, Hans-Sommer-Str. 66, D-38106 Braunschweig, GERMANY

A promising bioanalytical application of superparamagnetic iron oxid nanoparticles (SPIOs) is the Magnetic Relaxation ImmunoAssay (MARIA). Commonly SPIOs are used as a contrast agent in magnetic resonance imaging. In MARIA biological targets are specifically marked with SPIOs. Here the relaxation signal of magnetized SPIOs is measured. Magnetic nanoparticles have the advantages of being non-toxic, that they can be used in opaque medium and that they are suitable for homogeneous assays at the same time. For MARIA the ideal SPIOs are monodisperse with a core diameter of 20 nm. So far commercially available SPIOs are not optimized for MARIA. Therefore we fractionize and functionalize these ferrofluids. As a model system to study binding kinetics we use SPIOs functionalized with streptavidin and biotinilated binding partners.

Financial support by the DFG via SFB578 is acknowledged.

MA 33 Spin-Dynamics, Magnetization Reversal III

Time: Thursday 15:15–18:30 Room: HSZ 403

MA 33.1 Thu 15:15 HSZ 403

Current-induced microwave excitations of nanomagnets made of single-crystalline iron — •Ronald Lehndorff, Henning Dassow, Reinert Schreiber, Daniel E. Bürgler, and Claus M. Schneider — Institut für Festkörperforschung, Foschungszentrum Jülich GmbH, D-52425 Jülich, Germany

The magnetization dynamics of nanomagnets under the influence of a spin-polarized current is of great interest since Slonczewski and Berger predicted the possibilities of magnetization switching and steady precessions in 1996 [1, 2].

We study the magnetization dynamics of nanomagnets made of epitaxial Fe with diameters of 100 nm to 200 nm and thicknesses of 2 nm relative to an extended Fe layer of 10 nm thickness that is magnetically hardened by interlayer exchange coupling over Cr to a 14 nm Fe layer.

We measure magnetoresistance and resistance versus current to characterize our samples. The switching behavior shows clear four-fold in-plane crystalline anisotropy of the Fe layers. Varying the field direction relative to the crystalline axes can assist the current-induced switching process.

We detect microwave signals due to steady large angle precessions of the magnetization and study the dependence on current, magnetic field and field angle relative to the crystalline axes.

[1] J.C. Slonczewski, J. Magn. Magn. Mater. **159**, L1 (1996)
[2] L. Berger, Phys. Rev. B **54**, 9353 (1996)

MA 33.2 Thu 15:30 HSZ 403

Magnetization switching by spin transfer torque in magnetic nanostructures — •Nicolas Müsgens[1], Georg Richter[1], Barbaros Özyilmaz[1,2], Michael Fraune[1], Matthias Hawraneck[1], Bernd Beschoten[1], Matthias Bückins[3], Joachim Mayer[3], and Gernot Güntherodt[1] — [1]II. Phyikalisches Institut , RWTH Aachen, and Virtual Institut of Spin Electronics (ViSel), Templergraben 55, 52056 Aachen, Germany — [2]Department of Physiks, Columbia University, New York, NY 10027, USA — [3]Gemeinschaftslabor für Elektronenmikroskopie, RWTH Aachen, 52056 Aachen, Germany

The transfer of a torque of spin-polarized currents onto macroscopic magnetizations has been investigated in confined magnetic nanostructures. Nanostencil masks are used to define the device dimensions (sub 100 nm2) prior to the deposition of the thin Co/Cu/Co stack with perpendicular current. The masks consist of a focused-ion-beam (FIB) milled nano-aperture in a top metal layer on top of an insulator and an underlying pre-patterned bottom electrode. The insulator causes an undercut by its selective wet etching. The approach is demonstrated by spin transfer torque-induced magnetization dynamics, giving rise to a giant magneto-resistance effect of 0.3 % at room temperature.

Supported by DFG-SPP 1133 and by HGF.

MA 33.3 Thu 15:45 HSZ 403

Probing the Electron and Spin Dynamics of 3d-transition Elements in Real-Time — •Bernd Heitkamp, L. Heyne, H. A. Dürr, and W. Eberhardt — BESSY, Berlin, Germany

We report on pump-probe experiments investigating the physical properties of 3d transition elements. An intensive fs laser pump pulse is used to heat the electron system, which triggers a fast quenching of the magnetic moments. Observing the energy distribution of the hot electron and spin subsystem on a fs time scale after excitation gives a deep insight into the interplay of electron relaxation, spin-orbit coupling and spin-lattice relaxation. Time-resolution of the experiment is given by a fs-laser system. The photoelectron emission microscope (PEEM) allows to investigate structures with a spatial resolution well below one micrometer. Measuring the time-of-flight of the emitted photoelectrons by means of a delayline detector determines the energy resolution. In addition sensitivity to the photoelectron spin is given by SPLEED-detector. Experiments on Nickel and Cobalt show a demagnetization below one picosend while the electron subsystem is still not thermalized. Both the demagnetization and the relaxation are strongly affected by the dielectric response of the nanoscale structures.

MA 33.4 Thu 16:00 HSZ 403

Decrease of entropy in magnetic particles — •H.J. Elmers[1], A. Krasyuk[1], F. Wegelin[1], S.A. Nepijko[1], A. Conca[1], G. Schönhense[1], M. Bolte[2], and C.M. Schneider[3] — [1]Johannes Gutenberg-Universität Mainz, Institut für Physik, Staudingerweg 7, D-55099 Mainz — [2]Universität Hamburg, Institut für Angewandte Physik, Jungiusstrasse 11, D-20355 Mainz — [3]Forschungszentrum Jülich GmbH, Institut für Festkörperforschung IFF-6, D-52425 Jülich

In a closed system entropy maximization tends to decrease order. An open system with a constant throughput of energy, however, allows for an increase of local order. Exciting micron-sized permalloy particles with an oscillating external field we found an example for this phenomenon. The external oscillating field is the energy source while the internal damping plays the role of the sink. In a rectangular platelet (16 μm×32 μm×10 nm) the equilibrium magnetization state is formed by a symmetric flux-closure domain pattern comprising two equally-sized domains separated by a 180 degree domain wall. The external oscillating field is applied off-resonance along the short side of the platelet, thus exciting a precessional motion of the magnetization. The system reacts by increasing one magnetic domain at the expense of the others. The final state has uniform magnetization and is thus completely ordered. The basic mechanism, revealed by both stroboscopic imaging with time-resolved photoelectron emission microscopy and computer simulation, is the decrease of the resonance frequency in the larger domain. This leads to larger energy dissipation in the system, allowing increasing order with increasing entropy.

MA 33.5 Thu 16:15 HSZ 403

Nanosecond magnetization dynamics with pulsed high fields in microcoils — •Martin Weisheit[1,2], Marlio Bonfim[1], Vitoria Barthem[1], Sebastian Fähler[2], and Dominique Givord[1] — [1]Laboratoire Louis Neél, CNRS Grenoble, 25 av. des Martyrs, F-38042 Grenoble Cedex 9, France — [2]Institute for Metallic Materials, IFW Dresden, Helmholtzstr. 20, D-01069 Dresden, Germany

In order to study the switching of highly anisotropic magnetic materials, which can have coercivities of a few T, pulsed magnetic fields may be employed. Very high fields of up to 50 T can be generated by short current pulses in microcoils [1]. Coils with inner diameters of 50 μm are used, for which pulse energies below 1 J are sufficient, allowing for very compact and fast designs. Since field rise times are of the order of 1 T/ns, the dynamics of magnetization behavior become apparent. This is demonstrated by polar Kerr effect measurements on FePt thin films, where the observed coercivity is drastically increased compared to $H_{\mathrm{c,static}} = 5.6$ T as measured by VSM [2]. Simulations of the magnetization response to the external field pulse, using a no-precession approximation of the Landau-Lifshitz-Gilbert equation, compare well with the pulsed field measurements.

[1] M. Bonfim, K. Mackay, S. Pizzini, M.-L. Arnou, A. Fontaine, G. Ghiringhelli, S. Pascarelli, and T. Neisius, J. Appl. Phys. **87** (2000) 5974
[2] M. Weisheit, L. Schultz, and S. Fähler, J. Appl. Phys. **95** (2004) 7489

MA 33.6 Thu 16:30 HSZ 403

Bloch line generation in cross-tie walls by fast magnetic field pulses — •Andreas Neudert, Jeffrey McCord, Rudolf Schäfer, and Ludwig Schultz — IFW Dresden, Postfach 270116, 01171 Dresden

In ferromagnetic films with an intermediate thickness of 30 to 90 nm cross-tie walls are observed. They consist of a sequence of circular and cross Bloch lines (also called vortex and antivortex) that are connected by 90° Neel walls. Additional 90° Neel walls emerge from the cross Bloch lines and form the "legs"of the cross-tie wall. We investigated the influence of a pulsed magnetic field (amplitude 400 A/m, width 1.2 ns) applied perpendicular to the wall plane onto a constrained cross-tie wall in a 80 μm x 160 μm permalloy rectangle of 50 nm thickness. The equilibrium cross-tie spacing of about 15 μm is reached after demagnetizing the sample with a magnetic ac-field. By applying the pulsed magnetic field with a repetition rate of 23 MHz additional Bloch lines are created and the cross-tie spacing decreases to about 5 μm. This Bloch line generation is not triggered by the repetition rate of the pulsed magnetic field as shown by using a low repetition rate pulse train of 0.2 Hz but by the fast rise time of the field pulses. A comparison with micromagnetic calculations will be given.

MA 33.7 Thu 16:45 HSZ 403

Ultrafast Demagnetization of Ferromagnetic Films Probed by XMCD — •Christian Stamm, Cosmin Lupulescu, Hermann Dürr, and Wolfgang Eberhardt — BESSY, Albert-Einstein-Str. 15, 12489 Berlin, Germany

We investigate the dynamic response of magnetic thin films subjected to high-intensity fs laser pulses. Using the X-ray magnetic circular dichroism (XMCD) we observe the evolution of the magnetization as a function of time delay between laser pump and X-ray probe pulse. This technique complementary to the magneto-optic Kerr effect, allows us to separately determine spin and orbital moments by a sum rule calculation. Our goal is to get new insight into the process of fs demagnetization, especially concerning the conservation of the total angular momentum.

The experiments were performed at the BESSY Synchrotron source using gated detection of single X-ray bunches following a pump pulse from a synchronized fs laser. During normal operation, the X-ray pulse length is ˜50 ps. To further improve the time resolution we also used the "low-alpha" mode of the Synchrotron reducing the pulse length down to 5 ps.

We find that a Ni thin film with in-plane magnetization and a CoPd multilayer with perpendicular anisotropy both can be demagnetized in less than 10 ps. Additionally, X-ray dichroism spectra are recorded at different time delays, allowing the determination of spin and orbital moments of the excited film. The use of fs X-ray pulses from the slicing source currently under commissioning at BESSY will further increase the time resolution of our experiments to the fs regime.

MA 33.8 Thu 17:00 HSZ 403

Magnetization dynamics triggered by photo-conductive switches — •Matthäus Pietz[1], A. Parge[1], M. Djordjevic[1], A. Förster[2], and M. Münzenberg[1] — [1]IV. Phys. Inst. Universität Göttingen — [2]Inst. für Schichten und Grenzflächen (ISG1) Forschungszentrum Jülich

Ultrafast photoconductive switches, based on metal-semiconductor-metal contact pads using low temperature grown GaAs as a semiconductor, deliver the fastest current pulses on a chip so far. Using fs pulses from a Ti:Sapphire laser for the excitation of the carriers, current pulses of a few picoseconds in length are generated. The pulses are characterised with autocorrelation technique. We demonstrate that using amplified laser pulses of 1 μJ energy we are able to create current pulses with an amplitude of 1 Ampere and 3 ps length. The field pulse can be used to trigger the magnetization dynamics in a magnetic nanostructure. Therefore, magnetic structures on a strip line with the help of e-beam lithography are prepared, with the aim to explore magnetic Eigen mode oscillations and extrinsic as well as intrinsic damping parameters in a pump-probe experiment with ps time resolution.

MA 33.9 Thu 17:15 HSZ 403

Intrinsic and non-local Gilbert Damping parameter in all optical pump-probe experiments — •Marija Djordjevic[1], J. Walowski[1], G. Eilers[1], M. Münzenberg[1], and J.S. Moodera[2] — [1]IV. Physikalisches Institut, Universität Göttingen — [2]Francis Bitter Magnet Laboratory, MIT, Cambridge, USA

With the time resolution inherent using femtosecond laser pulses in all optical pump-probe experiments, the basic time constants of magnetic precessional modes, as well as the energy dissipation processes determining the Gilbert damping, can be studied. Our focus is to explore the underlying damping mechanisms and how they can be controlled. The non-local Gilbert damping due to evanescent spin currents can be studied at double layers (FM/NM), in which the thickness of the FM layer is varied. The precession moment emits a dynamic spin current that is subsequently damped in a material with a strong spin-orbit coupling. An enhancement in the Gilbert damping parameter for Ni/Pd and Ni/Cr double layers which is inversely proportional to the thickness of the Ni layer is observed. The frequency dependence of damping parameter for Ni/Cr films monitors presence of two-magnon scattering processes. The non-local damping for different Ni/NM double layers is found not to simply scale with the spin-orbit coupling constant. Increased roughness as well as the (non)compatibility of the DOS at E_F of Ni and NM, have to be included to model the damping. It will be of special interest to connect the elementary relaxation mechanisms to the origin of non-local Gilbert damping, as it is seen on the LLG timescale.

MA 33.10 Thu 17:30 HSZ 403

Magnetization dynamics in all optical pump-probe experiments — •Marija Djordjevic[1], J. Walowski[1], A. Parge[1], M. Münzenberg[1], and J.S. Moodera[2] — [1]IV. Physikalisches Institut, Universität Göttingen — [2]Francis Bitter Magnet Laboratory, MIT; Cambridge, USA

The study of magnetization dynamics on the femtosecond timescale is an important task for the implementation of future spintronics. In all optical pump-probe experiments the Ti:Sapphire laser pulses amplified with a regenerative amplifier (RegA 9000, 1 μJ pulse energy) are used to demagnetize a 50 nm Ni film and to follow the magnetization relaxation with 80 fs time resolution. Magnetization precession is triggered with a laser induced change in the anisotropy field. The demagnetization rate is controlled with the pump laser fluence. Different precession modes are observed in the range from 1.5 GHz up to 13 GHz. In the time-resolved spectrum an incoherent magnon background, a coherent homogeneous precession mode and a standing spin wave mode are observed. All those contributions are strongly dependent on the amplitude and the orientation of the external field as well as on the pump laser fluence. The corresponding Gilbert damping parameter is found to be dependent on the precession mode, taking values from $\alpha = 0.05$ for very low up to $\alpha = 0.25$ for highly damped modes. The parameter changes with the variation of the field angle, the field strength and the height of the excitation amplitudes. This indicates mode dependent energy dissipation and mode conversion mechanisms.

MA 33.11 Thu 17:45 HSZ 403

Femtosecond Spin-Dependent electron Dynamics in Co thin films — •Mirko Cinchetti, Marina Sánchez Albaneda, Oleksiy Andreyev, Jan-Peter Wüstenberg, Michael Bauer, and Martin Aeschlimann — University of Kaiserslautern, Physics Department, Erwin Schroedinger-Str. 46, 67663 Kaiserslautern, Germany

Using the energy-, spin- and time-resolved two-photon photoemission technique, we have been able to follow the ultrafast spin-dependent electron dynamics in an epitaxially grown Co thin film. We observe that the time evolution of the spin polarization of unoccupied intermediate states (lying between the Fermi and the vacuum level) shows remarkable differences in dependence of the energy of the unoccupied state itself. In particular, for high intermediate states energies we find an increase of the polarization within the first 50 fs, which is due to the lifetime difference between spin-up and spin-down electrons. On the other hand, at low energies we find a modification of this behavior up to 700 fs. This is mainly due to secondary electrons which are scattered into the intermediate state, leading to refilling of the state itself. Within these 700 fs we can distinguish between a spin-selective region (with almost no spin-flips) and a spin-flip region, where a dramatic drop in the polarization is observed. The reasons for this behavior are discussed.

MA 33.12 Thu 18:00 HSZ 403

Ultrafast demagnetization dynamics of ferromagnetic materials — •Tobias Roth, Dorothea Hoffmann, and Martin Aeschlimann — Fachbereich Physik, TU Kaiserslautern, Erwin-Schrödinger Str.46, 67663 Kaiserslautern

The response of the magnetization to an ultrashort femtosecond laser pulse has been investigated by different techniques in the last decade but it still remains a highly controversial topic with respect to the involved microscopic processes. Up to now most of the investigations were based on ultrathin samples like Ni or CoPt3 with a low Curie temperature. The availability of very intense laser pulses delivered from a multipass amplifier system of 1 kHz repetition rate provides the experimental precondition to do time resolved measurements on Co, the material with the highest Curie point among the 3d transition metals. We apply the longitudinal MOKE in a bi-chromatic pump-probe technique to obtain a time resolved response of the magnetic system. By choosing a different wavelength for the pump and probe the well known "bleaching", an optical effect - caused by a change in the occupation number in a highly non equilibrium state - can be suppressed; therefore we have access to the pure magnetization. Our results exhibit a distinct demagnetization effect of around 50 % which is reached 750 fs after the pump pulse has impinged on the sample.

MA 33.13 Thu 18:15 HSZ 403

Magnetization dynamics in rare-earth orthoferrites — •Carmine Antonio Perroni, Ansgar Liebsch, Andreas Bringer, and Simon Woodford — Institute of Solid State Research (IFF), Research Center Juelich, Juelich 52428, Germany

Recently an ultrafast non-thermal control of magnetization has become feasible in canted antiferromagnets through instantaneous photomagnetic pulses [A.V. Kimel et al., Nature 435, 655 (2005)]. In this experiment circularly polarized femtosecond laser pulses set up a strong magnetic field through the inverse Faraday effect exciting non-thermally the spin dynamics of dysprosium orthoferrites. A theoretical study of magnetization dynamics is performed by using a model for orthoferrites based on a general form of free energy and by solving coupled sublattice Landau-Lifshitz-Gilbert equations. Due to the inverse Faraday effect and the non-thermal excitation, the effect of the laser is simulated analyzing the effect of magnetic field Gaussian pulses on time scales of the order of hundred femtoseconds. As a result, the magnetization oscillates around the initial equilibrium position with amplitudes in agreement with experiment. The simulations are pursued considering the effect of the temperature and of the field pulse along the x-axis in order to excite a different mode as obtained in the experiment. Finally the consequences of a double pump and of a large number of pulses on the magnetization dynamics are analyzed.

MA 34 Invited Talk Mioara Mandea

Time: Friday 10:15–10:45 Room: HSZ 03

Invited Talk MA 34.1 Fri 10:15 HSZ 03

The Earths magnetic field during the new satellite era — •Mioara Mandea — GFZ-Potsdam, Telegrafenberg, Haus F, 14473 Potsdam

Due to the instability of its generating process, the geodynamo, reversals of the predominant dipolar magnetic field component, as well as relatively short periods of very weak total fields occur at irregular intervals. Currently, the geomagnetic field strength decreases quite rapidly, with certain regional areas where a drop of 20% over the last 40 years has been detected. The dipolar part has dropped by more than 10% within the past 150 years. This is an order of magnitude faster than its natural decay time, a reflection of the growth of patches of reverse flux at the core-mantle boundary. Moreover, the velocity of the north magnetic pole has reached some 40 km/year in 2001, the highest velocity measured so far over the 20th and 21st centuries. Recently, important changes in the field have been documented in the South Atlantic region, where the expanding South Atlantic Anomaly has serious implications for low-Earth orbit satellite operations. In order to understand this recent behaviour of the Earths magnetic field, new high-quality measurements are needed. Likely, three new magnetic satellites have recently been launched in low-Earth orbits: Oersted, CHAMP and SAC-C. The high quality data provided by these satellites has allowed to generate field and secular variation models of much higher resolution than previously possible. An overview of the new results of the Earth's magnetic field measurements from space will be given, including the first order spatial and temporal characteristics, and interpretations, from the lithospheric structure to the core flow. A list of problems will be discussed, while satellite experiments to address these challenges will be presented.

MA 35 Magnetic Thin Films V

Time: Friday 10:45–12:45 Room: HSZ 03

MA 35.1 Fri 10:45 HSZ 03

Mode-of-growth dependent interface contribution to magneto-optical response from ultrathin Co films grown on (001), (110) and (111) surfaces of Pd — •Marek Przybylski, Miroslav Nyvlt, Yisheng Shi, Feng Luo, Jan Zukrowski, Jochen Barthel, and Jürgen Kirschner — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany

We have grown ultra-thin epitaxial Co films on three low-index surfaces of Pd. Their magnetic properties studied by magneto-optical Kerr effect are correlated with surface morphology analyzed by scanning tunneling microscopy. A perpendicular magnetic anisotropy in the films appeared after exposure to residual gas atmosphere at low temperature, after coverage with an Au overlayer, or after annealing at 370 K and above. Reversed polar Kerr rotation loops with respect to those of thicker Co films were observed for 1 and 2 ML-thick films. This is due to a negative contribution from the Co/Pd interface dominating over the positive contribution from the non-interface part of the Co film. Reversed loops are not seen when the Co films grow in a three-dimensional mode. This indicates a clear correspondence between the mode of growth and the magneto-optical response. Near the film thickness where the Kerr rotation changes sign a remarkable temperature behavior is observed which is discussed as superposition of two different magneto-optical contributions. The results qualitatively agree with the available ab-initio band-structure calculations for Co/Pd multilayer structures with variable thickness of the Co layers.

MA 35.2 Fri 11:00 HSZ 03

The relevance of dipolar coupling for the stability of ferromagnetism in ultrathin films — •Roland Meier, Frank Bensch, Wolfgang Kipferl, Joseph Biberger, Dieter Weiss, and Günther Bayreuther — Institut für Experimentelle und Angewandte Physik, Universitätsstraße 31, 93040 Regensburg

It has been rigorously shown by Mermin and Wagner [1] that ferromagnetic order cannot exist in two-dimensional systems at any temperature $T > 0$ provided the magnetic interactions are short-range and isotropic. However, it is empirically known that even single atomic layers can have a Curie temperature above 200 K. These contradictory facts are reconciled if we note that real ferromagnetic films are never free from magnetic anisotropy and are subject to long-range dipolar interaction. In order to investigate the relevance of dipolar interactions, the Curie temperature Tc was measured for ultrathin Fe(001) films (about 3 atomic layers) epitaxially grown on GaAs(001) and in arrays of sub-micrometer circular dots and parallel stripes prepared by electron beam lithography and ion etching. It is found that Tc decreases drastically with decreasing thickness, with decreasing dot diameter and with increasing dot separation. A quantitative analysis of the results provides convincing evidence that indeed the long-range dipolar coupling strongly enhances the stability of ferromagnetic order against thermal spin excitations in ultrathin epitaxial films magnetized in the film plane.

[1] N.D. Mermin and H. Wagner, Phys. Rev. Lett. 17 (1966) 1133

MA 35.3 Fri 11:15 HSZ 03

Correlation of Structure and Magnetism in pulsed laser deposited Co/Pd(001) — •Holger L. Meyerheim, M. Przybylski, Y. Shi, and J. Kirschner — MPI f. Mikrostrukturphysik, Weinberg 2, 06120 Halle

The study of growth, structure and magnetism of ultra-thin Co-films on Pd(001) is of considerable interest due to the possible technological applications of CoPd-alloys for magnetic storage device applications involving perpendicular magnetic anisotropy (PMA). Using surface x-ray diffraction (SXRD), scanning tunneling microscopy and magneto-optic Kerr effect (MOKE) measurements we have investigated the correlation of structure and magnetism in Co-films deposited on Pd(001) by using pulsed laser deposition (PLD).

Up to a coverage of about 3 monolayers (ML, 1ˆML=1.32x10$ˆ{15}$ atoms/cm$ˆ{2}$)Co grows in a layer-by-layer mode on Pd(001) forming disordered fct-CoPd-alloy layers. Based on MOKE experiments, as deposited samples do not exhibit PMA. Sample annealing at 600K induces PMA for Co-coverages up to about 5 ML. PMA is directly correlated with structural ordering characterized by the formation of the L1_{0} (CuAu)-structure with alternating Pd-and Co-layers.

The results are discussed in the context of current theories relating structural ordering with PMA.

MA 35.4 Fri 11:30 HSZ 03

Temperature and thickness dependence of magnetic parameters in uncapped Fe monolayers on {4×6}GaAs(001) — •Kh Zakeri, Th Kebe, J Lindner, and M Farle — Fachbereich Physik, Experimentalphysik-AG Farle,Universität Duisburg-Essen, Lotharstr. 1, 47048 Duisburg, Germany.

Epitaxial 3-20 monolayers of Fe have been grown by molecular beam epitaxy on 4×6 surface reconstructed GaAs(001) at room temperature. Both, the temperature and thickness dependence of the magnetic anisotropy and of the magnetization were determined by means of *in situ* Ferromagnetic Resonance (FMR) and *in situ* SQUID magnetometry in ultrahigh vacuum (UHV). The measured anisotropy contributions were quantitatively explained by using a magneto-elastic model considering the magneto-elastic coupling constants of the iron films on GaAs(001). The magnetization M (T$\longrightarrow$0 K) is found to be reduced for d<7 ML. The cubic anisotropy contribution become very small for d = 5 ML , and we find that the independently measured second-order, out-of-plane uniaxial anisotropy $K_{2\perp}$(T) and the magnetization M(T) obey the Callen-Callen power law $K_{2\perp}(T)/K_{2\perp}(0) \propto (M(T)/M(0))^{\Gamma}$ with $\Gamma = 2.9 \pm 0.2$. The extrapolation of the temperature dependence (40-400 K) of the volume ($K^{v}_{2\perp}$) and the surface/interface ($K^{s,\mathrm{eff}}_{2\perp}$) contributions to T$\longrightarrow$0K yields $K^{s,\mathrm{eff}}_{2\perp}(T \longrightarrow 0) = 1.26 \pm 0.1 \times 10^{-3}$ J/m^2 (649 ± 51.5 μeV/atom) and $K^{v}_{2\perp}(T \longrightarrow 0) = 4 \pm 9 \times 10^4$ J/m^3(3± 6.7 μeV/atom) which can be compared to *ab initio* band structural calculations. Supported by DFG, SFB 491 TPA9.

MA 35.5 Fri 11:45 HSZ 03

The effect of oxygen adsorption on the magnetization of Fe monolayers on (4×6) GaAs(001) — •Th. Kebe, Kh. Zakeri, J. Lindner, and M. Farle — Universität Duisburg-Essen

The absolute remanent magnetization of uncapped Fe monolayers grown on GaAs(100) [1] which have been exposed to oxygen doses up to 25000 Langmuir (pressures between 1×10^{-8} to 1×10^{-5} mbar) at RT were measured by *in situ* scanning SQUID magnetometry in UHV. The magnetization and the effect of the oxygen exposure could be monitored with sub monolayer sensitivity. The Fe films exhibit a thickness dependent surface roughness due to a Volmer-Weber growth which is largest for thinner layers. We find that 8 ML Fe still exhibit a ferromagnetic signal after 25000 Langmuir dosage, while the remanent magnetization disappears in a 5 ML Fe film at about 400 Langmuir already. The Fe oxide phase has been identified as Fe_20_3 using Auger spectroscopy. Low temperature (T=40K) oxygen adsorption showed that the oxide formation of a 8 ML Fe film could be totally suppressed after chemisorption of a surface oxygen layer. Supported by DFG, Sfb 491.

[1] Kh. Zakeri et al., J. Magn. Magn. Mater. in press

MA 35.6 Fri 12:00 HSZ 03

Interface tuning of magnetic interactions of the Fe monolayer on 5*d* metal substrates — •Paolo Ferriani[1], Ilja Turek[2], Stefan Heinze[1], Gustav Bihlmayer[3], and Stefan Bluegel[3] — [1]Institute of Applied Physics and Microstructure Research Center, University of Hamburg, Hamburg, Germany — [2]Institute of Physics of Materials, Academy of Sciences of the Czech Republic, Brno, Czech Republic — [3]Institute für Festkörperforschung, Forschungszentrum Jülich, Jülich, Germany

Magnetic systems play a central role in today's information technology. Stabilising a magnetic state is essential for possible applications of a material. The capability of controlling the magnetic order of a specific material would be of great advantage in this respect, but it remains a challenge. Low-dimensional systems offer new possibilities to tune the magnetic interactions. Recently, it has been proved that an antiferromagnetic structure can be stabilised for a monolayer of Fe, the prototypical ferromagnetic material, by growing it on the W(001) surface [1].

In this work, we deal with the interface tuning of the exchange interaction as a way to control the magnetic order. Based on density functional theory calculations, we show how the magnetic state of an Fe monolayer can be selected by a proper choice of the substrate composition. We demonstrate that the magnetism of an Fe monolayer on W(001) depends on the substrate *d*-band filling. By alloying the W substrate with Ta,

the neighboring element of W, it is thus possible to tune the exchange interaction in the overlayer and stabilise novel magnetic states.
[1] A. Kubetzka *et al.*, Phys. Rev. Lett. 94, 087204 (2005)

MA 35.7 Fri 12:15 HSZ 03

Novel magnetic structure in the Fe monolayer on Ir(111) — •Kirsten von Bergmann[1], Stefan Heinze[1], Matthias Bode[1], Elena Y. Vedmedenko[1], Gustav Bihlmayer[2], Stefan Blügel[2], and Roland Wiesendanger[1] — [1]Institute of Applied Physics, University of Hamburg, Germany — [2]Institut für Festkörperforschung, Forschungszentrum Jülich, Germany

The magnetic properties of thin films have been in the focus of recent research. Up to now only two different magnetic ground states of homoatomic monolayers have been found experimentally: while the ferromagnetic state is accessible by various surface sensitive techniques it is much more challenging to prove antiferromagnetic order such as the $c(2 \times 2)$-antiferromagnetic state [1,2].

Using spin-polarized scanning tunneling microscopy we have observed a much more complex magnetic structure in the pseudomorphic Fe monolayer on Ir(111). The two-dimensional magnetic unit cell is of nanometer-size and the shape is nearly square with one diagonal along a close-packed row of the hexagonal atom arrangement. This symmetry relation gives rise to three rotational domains, all of which are observed experimentally. First-principles calculations verify that the magnetic state proposed on the basis of the experimental data is indeed lower in energy than the ferromagnetic state and indicate that the unusual magnetic structure is induced by the strong Fe-Ir hybridization.

[1] S. Heinze *et al.*, Science **288**, 1805 (2000).
[2] A. Kubetzka *et al.*, Phys. Rev. Lett. **94**, 087204 (2005).

MA 35.8 Fri 12:30 HSZ 03

Thickness-dependent domain structure of ferromagnetic Dy(0001)/W(110) studied by spin-polarized STM — •Luis Berbil-Bautista, Stefan Krause, Matthias Bode, and Roland Wiesendanger — Institute of Applied Physics, University of Hamburg, Jungiusstraße 11, Hamburg

Below the Curie temperature $T_C = 85$ K bulk dysprosium (Dy) is ferromagnetic with an easy direction along the $\langle 2\bar{1}\bar{1}0 \rangle$ directions, i.e. within basal (0001) planes. In this contribution we present a spin-polarized scanning tunneling microscopy (SP-STM) study on the growth and magnetic domain structure of flat epitaxial Dy films on W(110). At low thickness (coverage $\Theta \leq 10$ ML) patches with two different stackings can be found on the W(110) surface which exhibit a diameter of about 100 nm and which are separated by grain boundaries. With increasing thickness these grain boundaries become unstable and transform into double screw dislocations. Spin-resolved data reveal that the domain size and shape is strongly affected by both the thickness and the amount and type of defects on the Dy surface.

MA 36 Magnetic Coupling Phenomena / Exchange-Bias

Time: Friday 10:45–13:00 Room: HSZ 401

MA 36.1 Fri 10:45 HSZ 401

Probing electronic and magnetic properties of epitaxial Fe/CoO bilayers by X-Ray absorption spectroscopy — •R. Abrudan[1,2], W. Kuch[1], M. Bernien[1], J. Miguel[1], C. Tieg[2], and J. Kirschner[2] — [1]Freie Universität Berlin, Institut für Experimentalphysik, Arnimallee 14, D–14195 Berlin, Germany — [2]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D–06120 Halle, Germany

We investigated the magnetic coupling between a ferromagnet and an antiferromagnet using epitaxial single-crystalline Fe/CoO bilayers on Ag(001).

The CoO films exhibit (1x1) LEED patterns similar to the clean Ag(001) substrate. The vertical interlayer spacing of the CoO films, estimated from a kinematic analysis of LEED IV curves, is slightly expanded along the film normal. Magnetic measurements using the magneto-optical Kerr effect (MOKE) show a characteristic increase of the coercive field when the system is cooled down from room temperature.

X-ray absorption spectroscopy at BESSY was employed to probe the magnetic and electronic properties with elemental selectivity. Spectra taken from bilayers with different amounts of deposited Fe do not show any indication for the formation of Fe oxide at the Fe/CoO interface. X-ray magnetic circular dichroism (XMCD) measurements exhibit a small induced ferromagnetic signal at the Co $L_{2,3}$ absorption edge. X-ray linear dichroism (XLD) spectra show a pronounced structural linear dichroism that can be attributed to the vertical expansion of the CoO layer. The angular dependence of the XLD signal was used to separate the magnetic and structural contributions.

MA 36.2 Fri 11:00 HSZ 401

Asymmetry and time dependent effects in IrMn exchange biased bilayers — •Christine Hamann[1], Jeffrey McCord[1], Dieter Elefant[1], Rudolf Schäfer[1], Ludwig Schultz[1], and Roland Mattheis[2] — [1]Leibniz Institute for Solid State an Materials Research Dresden, Helmholtzstraße 20, 01069 Dresden — [2]Institute for Physical High Technology Jena, Albert - Einstein - Str. 9, 07745 Jena

Measurements by inductive and spatially resolved magnetooptical magnetometry revealed an asymmetric magnetization reversal of both $Co_{90}Fe_{10}(20nm)$ and $Ni_{81}Fe_{19}(20nm)/Ir_{23}Mn_{77}$ bilayers. For varying $Ir_{23}Mn_{77}$ thicknesses (2.5-10nm) different extents of misalignment of the effective easy magnetization axis have been detected. The misalignment of the effective easy axis strongly influences the hysteresis shape and thereby the asymmetry. In addition, a corresponding asymmetry in domain nuclation and formation is found. Moreover, a major influence on the asymmetry results from irreversible and time dependent switching processes by the antiferromagnet. Measurements by means of magnetooptical and alternating gradient magnetometry (AGM) have been performed to investigate that particular contribution in more detail. The results show that both the degree of asymmetry and the effective exchange bias field can be modified by a static magnetic field as well as the measuring frequency. This observed training effect is dicussed in terms of irreversible contributions of the antiferromagnet in the sense of a rotatable anisotropy.

MA 36.3 Fri 11:15 HSZ 401

Dilution and grain size effect on ferromagnetic/antiferromagnetic exchange biased bilayers with low anisotropy — •Marian Fecioru-Morariu[1], Cristian Papusoi[2], Jan Hauch[1], and Gernot Güntherodt[1] — [1]II. Physikalisches Institut, RWTH Aachen, Huyskensweg, 52074 Aachen, Germany — [2]MINT Center, 205 Bevill Building, Box 870209, University of Alabama, Tuscaloosa, AL 35487, USA

The effect of inserting nonmagnetic substitutional defects (dilution) in antiferromagnets (AFMs) was tested in high anisotropy AFMs, such as CoO, in Co/CoO exchange biased bilayers [1]. We have extended this study to low anisotropy AFMs, such as FeMn, in which the effects of the substitutional, nonmagnetic Cu defects on the exchange bias (EB) are tested. In addition, by using different Cu buffer layer thicknesses, we are able to test the effect of different AFM grain sizes on the EB and blocking temperature. By using Cu-diluted NiFe/FeMn exchange biased bilayers we have observed a maximum of the exchange bias field as a function of the Cu dilution. At the same time the blocking temperature decreases. In order to clarify the reason for decreasing the blocking temperature we have measured the thermoremanent magnetization (TRM) of the AFM itself. By means of a time quantified Monte-Carlo simulation on the basis of a Heisenberg model, we are able to describe all the above experimental observations of the EB field, blocking temperature and coercive field.

1. J.Keller, P.Miltenyi, B.Beschoten, G.Guntherodt, U.Nowak and K.D.Usadel, Phys. Rev. B 66, 014431 (2002)

MA 36.4 Fri 11:30 HSZ 401

Fundamental Aspects of the Exchange Bias Effect — •Florin Radu[1] and Hartmut Zabel[2] — [1]BESSY GmbH, Albert-Einstein-Str. 15, 12489 Berlin, Germany — [2]Department of Physics, Ruhr-University Bochum, D-44780 Bochum, Germany

We have reconsidered the Meiklejohn and Bean for the exchange bias effect and we have extended it to account for the coercivity enhancement observed in almost all F/AF systems. The essential modification is that the anisotropy of the AF layer is not sharp at the interface, but it decreases from a maximum inside of the AF layer to zero inside of the F layer. Such an interface layer should have properties different from either the AF and F layer. We have assumed it to be a spin glass-like layer.

The reduced AF anisotropy at the F/AF interface leads to a dramatic change of the EB field as function of the magnetic state of the F/AF interface described by a conversion factor. The model based on this concept is able to reproduce the peak of the EB field at the critical thickness and/or critical anisotropy of the AF layer. Furthermore, the training effect can be qualitatively reproduced assuming a progressively increasing magnetic disorder at the interface.

MA 36.5 Fri 11:45 HSZ 401

Spatially Resolved Magnetic Reversal in an Exchange Bias System — •Kai Schlage[1], Torsten Klein[1], Eberhard Burkel[1], and Ralf Röhlsberger[2] — [1]Universität Rostock, August-Bebel-Str. 55, 18055 Rostock — [2]HASYLAB @ DESY, Notkestr. 85, 22607 Hamburg

We present the coupling behaviour of a novel exchange bias system during the reversal of the ferromagnet. Our system consists of a Fe-layer on an antiferromagnetically coupled Fe/Cr-superlattice. This layer system was deposited on a hardmagnetic FePt-layer which pins the first Fe-layer of the superlattice to induce a unidirectional magnetic anisotropy into the AFM. MOKE-hysteresis loops show exchange-bias like effects like shifted and asymmetric swithing behaviour of the FM. We use nuclear resonant forward scattering (NRS) of synchrotron radiation to visualize the magnetic reversal of isotopic 57Fe sensor layers which are placed in the center of the FM and in the AFM near the interface in two identical exchange bias systems. We detected the magnetic moment orientation in the FM and AFM during the magnetic reversal of the FM and got information about the mechanism which is responsible for the asymmetric switching behaviour in this novel exchange bias system. Due to a special detection procedure we can discriminate reversal processes of coherent rotation and domain wall motion.

MA 36.6 Fri 12:00 HSZ 401

Neutron reflectivity studies on lattice-matched, ordered FePt3 based antiferromagnetic/ferromagnetic films — •Dieter Lott[1], P. Mani[2], G. Mankey[2], F. Klose[3], M. Wolf[4], and A. Schreyer[1] — [1]GKSS research center, Geesthacht, Germany — [2]MINT Center, The University of Alabama, Tuscaloosa, AL, USA — [3]Spallation Neutron Source, Oak Ridge National Laboratory,Oak Ridge, TN, USA — [4]ILL, Grenoble, France

Lattice-matched antiferromagnetic(AF)/ferromagnetic(F) films offer an ideal layered system to study exchange bias. Epitaxial films of $FePt_3$ exhibit an AF ordering with a spin wave vector $Q_A = (\frac{1}{2}, \frac{1}{2}, 0)$ and a Néel temperature of $T_N = 160$ K. $CoPt_3$ is chosen as the ferromagnet since it has the same $L1_2$ crystal structure as $FePt_3$ and nearly the same lattice constant, and it can be grown with an in-plane easy axis. X-ray diffraction shows that the peak widths of the rocking curves for $FePt_3$ films grown on Al_2O_3 and MgO are very different indicating that the samples grown on Al_2O_3 have larger grains and a smaller mosaic spread. On the other side, results from vibration sample magnetometry reveal that only the sample grown on MgO shows a significant exchange bias effect. AF films with fewer defects and strain-free interfaces yield a lower exchange bias. Polarized neutron reflectivity was carried on a $CoPt_3/FePt_3$ multilayer grown on MgO to probe the layer-specific magnetizations owing to the significant difference in the neutron scattering length density between Fe and Co and elucidate the magnetic switching behavior in this system for different temperatures and magnetic fields.

MA 36.7 Fri 12:15 HSZ 401

Temperature dependent effects of interlayer exchange coupling in rare earth trilayers — •M. Wietstruk, K.M. Döbrich, J.E. Prieto, O. Krupin, F. Heigl, G. Kaindl, and K. Starke — Freie Universität Berlin, Fachbereich Physik

We investigated the thickness and temperature dependence of the interlayer exchange coupling (IEC) in Tb/Y/Gd-Trilayers. Using wedge samples with Y-spacer layer thicknesses between 5 and 35Å, we recorded hysteresis loops by x-ray magneto-optical Kerr effect (XMOKE) at the Gd M_5 edge. By scanning along the wedge, we could measure about 1.5 oscillation periods of the coupling strength on each sample.

In this all-rare-earth-metal system, we find that the phase of the oscillatory coupling shifts with temperature. In particular, for a fixed spacer layer thickness of 15Å, the coupling changes reversibly between ferromagnetic and antiferromagnetic, when changing the temperature between 20K and 120K.

We compare the experimental findings with simple model calculations in the quantum-well-state picture with free-electron reflectivities. Additionally, we present QWS calculations for this system using theoretical valence band dispersions of bulk Tb, Y, and Gd.

MA 36.8 Fri 12:30 HSZ 401

Magnetic Properties of partly oxidized Ni Nanoparticles — •U. Kreibig[1], V. Schneider[1], A. Reinholdt[1], T. Weirich[2], A. Tillmanns[3], H. Krenn[4], K. Rumpf[4], and P. Granitzer[4] — [1]I.Institute of Physics (IA) RWTH Aachen University D-52056 Aachen, Germany — [2]Gemeinschaftslabor fuer Elektronenmikroskopie RWTH Aachen University D-52056 Aachen, Germany — [3]II.Institute of Physics (IIA) RWTH Aachen University D-52056 Aachen, Germany — [4]Institute of Experimental Physics Karl-Franzens-University A-8010 Graz, Austria

Ni nanoparticles (mean diameters 5 to 10 nm) were produced by our high efficiency laser evaporation source LUCAS. They were deposited and stepwise oxidized in UHV. Electron microscopic analysis proved the formation of oxide shells around a Ni core. Magnetization was measured by SQUID in the temperature range 5 to 400 K. Alternatively two kinds of hysteris loops were observed in different samples: 1) A single, uniform loop which is strongly shifted by exchange bias. 2) A double hysteresis, consisting of a superposition of two loops, without any exchange bias shift. A qualitative explanation will be given, based upon the magnetic properties of the Ni-oxide shell which deviates from a perfect antiferromagnet. The strength of the remaining anisotropy field of the shell probably depends on the structural and chemical details of the core-shell interface. Within the investigated temperature range no hint of superparamagnetism was observed.

MA 36.9 Fri 12:45 HSZ 401

Magnetic Multilayer Systems on Nanospheres: Experiments and Simulations — •T. C. Ulbrich[1], I. Guhr[1], S. van Dijken[2], T. Eimüller[3], P. Fischer[4], and M. Albrecht[1] — [1]University of Konstanz, Department of Physics, 78457 Konstanz, Germany — [2]SFI Trinity Nanoscience Laboratory, Physics Department, Trinity College, Dublin 2, Ireland — [3]Ruhr-Universitaet Bochum, Department of Experimantal Phyics, NB4/130, 44780 Bochum, Germany — [4]LBNL/CXRO, MS 2-400, Berkeley, CA 94720 U.S.A

We report on a combination of a topographic pattern formed of self-assembled polystyrene particles with sizes as small as 50 nm and film deposition. Using Co/Pt multilayer films, the so formed nanocaps on top of a sphere are monodisperse, reveal a uniform magnetic anisotropy and are magnetically exchange isolated. The film thickness varies and so do the magnetic properties most notable the magneto-crystalline anisotropy across the cap [1]. For Co/Pt multilayer film deposition, the anisotropy direction depends on the Co layer thickness, thus, changing the orientation from parallel to perpendicular to the particle surface below a critical thickness. Therefore, systems with a spin reorientation transition across the cap can be created. Moreover, by combining bilayers consiting of Co/Pt multilayers and MnPt or FeNi layers on the particle array, coupling effects such as exchange bias or exchange spring coupling can be investigated. First results will be presented and compared to micromagnetic simulations. This project is funded by the DFG through the SFB 513 and the Emmy-Noether program at the University of Konstanz.

[1] M. Albrecht et al., Nature Materials 4, 203 (2005).

MA 37 Molecular Magnetism

Time: Friday 10:45–13:15 Room: HSZ 403

MA 37.1 Fri 10:45 HSZ 403

Exploring molecular magnetism by first-principles density-functional-theory calculations — •Jens Kortus — Theoretische Physik, TU Bergakademie Freiberg

Magnetism at the molecular scale holds great promises for future applications in information storage. However, before any applications we have to understand the relevant processes which are governed by the laws of quantum mechanics in detail. The magnetic properties at this length scale are determined by exchange interactions and spin-orbit interaction. The exchange interaction will determine the magnetic ground state of the molecule. The spin-orbit coupling is responsible for the magnetic anisotropy, which is one of the key properties of a single molecule magnet. First-principles density functional theory (DFT) calculations offer an insight in the electronic structure and molecular orbitals and allows for the calculation of exchange interaction and spin-orbit coupling.

We will compare our theoretical results to experimental ones for magnetic anisotropies. For many systems the agreement is very good, however there are also cases were DFT underestimates the magnetic anisotropy by a factor of two. Other possible application of DFT to molecular systems include the calculation of STM spectra, which can be directly compared to experiment allowing for a check of the calculated charge densities.

MA 37.2 Fri 11:00 HSZ 403

Frequency Domain Magnetic Resonance Spectroscopy in Molecular Magnetism — •Joris van Slageren — 1. Physikalisches Institut, Universität Stuttgart

In recent years, we have developed an advanced magnetic resonance technique called frequency-domain magnetic resonance spectroscopy (FDMRS) and applied it to the study of a number of phenomena in molecular magnetism. We are interested in the magnetic anisotropy of molecular magnets especially in the form of zero-field splitting of the ground state multiplet. We have shown that FDMRS is a very efficient and accurate method to determine the parameters that describe the magnetic anisotropy. Our aim is to understand the physical origin of the zero-field splitting in exchange coupled clusters, and the role played by the single ion anisotropy and the mixing of spin multiplets. In addition, we have become interested in the (especially dipolar) interaction between single molecule magnets in the crystal and its influence on the magnetic relaxation. To this end we have studied the magnetic resonance lineshape in frozen solutions of single-molecule magnets. Our ability to vary frequency and field independently allows us to perform more sophisticated experiments. For example, we have shown that we can investigate quantum tunneling of the magnetization. Finally we have shown that single molecule magnets can function as efficient Faraday rotators of the radiation polarization in the terahertz frequency range.

MA 37.3 Fri 11:15 HSZ 403

A ^{23}Na-NMR study of the ferric wheel system Na@Fe$_6$ (tea)$_6$ — •Lars Schnelzer, Roland Leppin, and Bernd Pilawa — Physikalisches Institut, Universität Karlsruhe (TH), D-76131 Karlsruhe

The hexanuclear iron(III) complex Na@Fe$_6$(tea)$_6$ consists of a ring of six Fe(III) ions which are coupled by organic ligands and centred by a ^{23}Na-alkali atom. The dynamic properties of Na@Fe$_6$(tea)$_6$ have been studied by ^{1}H and ^{23}Na NMR measurements at 52 MHz. The temperature dependence of the ^{1}H T_1 rate reveals a peak at 30 K which is a characteristic feature of the ferric wheel systems whereas the ^{23}Na NMR T_1 rate measurements increases linearly with temperature indicating a purely quadrupolar relaxation of the nuclear spin. In order to study the influence of the electronic spin system on the NMR properties of the ^{23}Na nucleus, the magnetic field and temperature dependence of the T_1 rate has been measured on a polycrystalline sample. The field dependence shows the strong enhancement of the T_1 rate due to the level crossing between the S=0 groundstate and the first excited S=1 state in the field range between $B_\parallel$ ∼11 T and $B_\perp$ ∼13 T, proving the influence of the Fe(III) spin on the ^{23}Na nucleus. In contrast to the measurements at 52 MHz, the temperature dependence of T_1 at 79.5 MHz is characterized by a strong increase up to T ∼30 K and a broad maximum, resembling the ^{1}H measurements of ${T_1}^{-1}$ on the Fe$_6$(tea)$_6$ system, when the magnetic field is oriented parallel to the molecular symmetry axis.

MA 37.4 Fri 11:30 HSZ 403

Magnetic Anisotropy Energies of Metal-Benzene Sandwiches — •Nicolae Atodiresei[1], Yuriy Mokrousov[2], Gustav Bihlmayer[1], and Stefan Blügel[1] — [1]Institut für Festkörperforschung, Forschungszentrum Jülich, D-52425 Jülich, Germany — [2]Institute of Applied Physics and Microstructure Research Center, University of Hamburg, 20355 Hamburg, Germany

Molecular magnets moved to the frontier of research as ideal candidates for the smallest possible magnets. We performed *ab initio* calculations for one-dimensional (1D) magnetic organometallic sandwiches, M_nBz_m ($Bz = C_6H_6$; $M = V, Nb, Ta$) and infinite wires within the framework of the density functional theory (DFT) in the generalized gradient approximation (GGA) using the full-potential linearized augmented plane-wave method for 1D-systems [1,2]. We found that all the M_nBz_m molecules and the infinite wires are magnetic. By including the spin-orbit coupling in the total energy calculations we considered the two possible symmetry-determined directions of the magnetization in the molecules and wires: along the z-axis (z) and radial, parallel to the plane of the benzenes (r). The magnetic anisotropy energy (MAE) describes the energy difference between them. We conclude that by replacing the V atoms with heavier metals such as Nb and Ta, leads to a stronger spin-orbit interaction with larger MAE's. The $(NbBz)_\infty$ wire shows a ballistic anisotropic magnetoresistance (BAMR)[3] effect. [1] Y. Mokrousov et al. PRB 72 (2005);[2] http://www.flapw.de; [3] J. Velev et al. PRL 94 (2005)

MA 37.5 Fri 11:45 HSZ 403

Spin-dependent transport through half-metallic organometallic wires — •V. Maslyuk[1], A. Bagrets[1,2], T. Bredow[3], M. Brandbyge[4], and I. Mertig[1] — [1]Martin-Luther-Universit\"at Halle-Wittenberg, Fachbereich Physik, Germany — [2]Institut f\"ur Nanotechnologie, Forschungszentrum Karlsruhe, Germany — [3]Institut f\"ur Theoretische Chemie, Universit\"at Hannover, Germany — [4]Department of Micro and Nanotechnology, Technical University of Denmark, Denmark

During the last years, molecular magnets have been attracting enormous attention, since they are candidates for future applications in high-density information storage and quantum computers. Here, we present a first class of magnetic one-dimensional organometallic systems which show half-metallic behaviour and can be synthesized [1]. These systems are Met-C$_6$H$_6$ multi-decker clusters, with Met=V, Mn and Co [2]. Theoretical investigations of the transport properties of such organometallic wires are presented. The conductance and the electronic structure of the molecular wires were calculated by means of a LCAO method based on density functional theory combined with non-equilibrium Greens functions [3]. A detailed analysis of electronic, magnetic and transport properties is given. A large spin-polarization of the electron current is predicted. Furthermore, the influence of the small molecules, H$_2$, N$_2$, O$_2$ and CO, on the transport properties of organometallic wires is discussed.

[1] K.Miyajima, \textit{et al.},Eur.Phys.J.D {\bf 34},177(2005) [2] V.V.Maslyuk, \textit{et al.},[cond-mat/0510144]. [3] M.Brandbyge, \textit{et al.}, PRB {\bf 65}, 165401(2002).

MA 37.6 Fri 12:00 HSZ 403

Field-dependent magnetic paramaters in {Ni$_4$Mo$_{12}$} — •Mirko Brüger and Jürgen Schnack — Universität Osnabrück, Fachbereich Physik, Barbarastr. 7, D-49069 Osnabrück

$Mo^{V}_{12}O_{30}(\mu_2-OH)_{10}H_2\{Ni^{II}(H_2O)_3\}_4$ is a magnetic molecule which on first glance looks rather unspectacular since it comprises four Ni ions which are placed at the vertices of an almost ideal tetrahedron and connected by oxygen bridges. Thus one would expect that the magnetic energy levels are reasonably well described by an isotropic Heisenberg model with antiferromagnetic coupling. Preliminary experimental results, obtained by our experimental collaborators in Ames (USA) and Okayama (Japan), show a low-temperature magnetization curve (M vs. B) with increasing step size. The magnetization curve shows two equal steps at low fields and two larger steps of similar size at high fields, which are rounded of anisotropy. Even including biquadratic exchange and Dzyaloshinsnskii-Moriya interaction we were unable to describe the low-temperature magnetization curve. Furthermore low-field susceptibil-

ity and magneto-optical experiments of our collaborators in Ames and Knoxville (USA) portend small changes in the structure of the molecule with applied magnetic field.

MA 37.7 Fri 12:15 HSZ 403

AC-susceptibility measurements of spinclusters in high magnetic fields — •Roland Leppin and Bernd Pilawa — Physikalisches Institut, Universität Karlsruhe (TH)

The $Fe_2(hpdta)_1$, $Fe_4(hpdta)_2$ and $Fe_6(hpdta)_3$ clusters denote systems of antiferromagnetically coupled magnetic ions with s=5/2, which are surrounded by organic ligands. Of these spin systems the static magnetic susceptibility and exchange coupling constants are known, but no ESR signal can be detected to gain access to the electronic level structure. However, spin dynamics are still accessible via levelcrossing experiments with high field ac-susceptibility measurements.

Therefore an experimental setup has been developed to measure ac-susceptibility in a dc-magnetic field from 0 to 20T. Initial zero field measurements of a Mn_7 cluster support the expected paramagnetic blocking temperature behaviour. For the (hpdta)-systems it is expected to measure a peak in the ac-susceptibility, when the dc-field passes an electronic levelcrossing between the lowest energy level and the next higher excited state, causing a step-like increase in magnetization.

MA 37.8 Fri 12:30 HSZ 403

Tuning the magnetic ground state of a novel tetranuclear Nickel(II) molecular complex by high magnetic fields — •C. Golze[1,2], A. Alfonsov[1], R. Klingeler[1,3], B. Büchner[1], V. Kataev[1], C. Mennerich[2], H.-H. Klauss[2], M. Goiran[3], J.M. Broto[3], H. Rakoto[3], S. Demeshko[4], G. Leibeling[4], and F. Meyer[4] — [1]IFW Dresden, Germany — [2]TU Braunschweig, Germany — [3]LNCMP Toulouse, France — [4]University Göttingen, Germany

Electron spin resonance and magnetization data in magnetic fields up to 50 T of a novel multicenter magnetic molecular complex $[(L)2Ni_4(N_3)(O_2C\,Ada)_4](Cl\,O_4)$ are reported. In this compound, four Ni spins each $S = 1$ are coupled in a single molecule via the central μ_4-azide bridge which provides paths for magnetic exchange. A complex ESR spectrum comprising four resonance modes has been observed. Analysis of the frequency and temperature dependence of the ESR signals yields the relevant parameters of the spin Hamiltonian, in particular the single ion anisotropy gap and the g factor, which enables the calculation of the complex energy spectrum of the spin states in a magnetic field. The experimental results give compelling evidence for tuning the ground state of the molecule by magnetic field from a nonmagnetic state at small fields to a magnetic one in strong fields owing to the spin level crossing at a field of $\approx$ 25 T.

MA 37.9 Fri 12:45 HSZ 403

Magnetic and optical properties of oxamato bridged Cu(II) complexes — •Björn Bräuer[1], Tobias Rüffer[2], Dietrich R. T. Zahn[1], and Georgeta Salvan[1] — [1]Technische Universität Chemnitz, Institut für Physik, Reichenhainer Str. 70, D-09107 Chemnitz — [2]Technische Universität Chemnitz, Institut für Chemie, Straße der Nationen 62, D-09107 Chemnitz

Coordination complexes allow the step-wise incorporation of an extended number of transition metal ions. Bis-oxamato type transition metal complexes are prominent representatives of such systems and are used for the synthesis of trimetallic complexes. The magnetic coupling constant of such molecules and their spin density were determined using Superconducting Quantum Interference Device (SQUID) and Electron Paramagnetic Resonance measurements on powder. These molecules were also deposited as thin films on silicon using spin-coating. Variable Angle Spectroscopic Ellipsometry (VASE), Raman and IR spectroscopy studies showed that the molecular structure is preserved during the deposition process and that the films exhibit a preferential molecular orientation.

MA 37.10 Fri 13:00 HSZ 403

Quantum Tunneling of the Magnetization in Lanthanide Double-Decker Complexes — •H. Rupp[1], B. Barbara[2], P. Müller[1], S. Brink[3], O. Fuhr[3], and M. Ruben[3] — [1]Physikalisches Institut III, Universität Erlangen, Germany — [2]Laboratoire de Magnétisme Louis Néel, CRNS, Grenoble, France — [3]Institut für Nanotechnologie, Forschungszentrum Karlsruhe, Germany

Magnetization hysteresis of dysprosium double-decker single crystals was observed below 4K. For the first time a larger blocking temperature than for Mn acetate was found. The very large anisotropy of rare-earth ions has two opposing effects on the barrier height for reversal of the magnetization: The strong axial anisotropy results in a very large ligand-field splitting, whereas the large transversal anisotropy shortcuts the barrier. The observed steps in the hysteresis are due to quantum tunneling of the magnetization. We interpret these steps and related features in terms of intermolecular exchange, dipole-dipole and hyperfine interactions.