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Fachgruppe Kristallographie (KR)

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Overview of Invited Talks and Sessions

(lecture rooms HSZ 04 and HSZ 101; Poster P1 and P2)

Invited Talks

KR 7.1	Thu	14:00–14:45	HSZ 101	**Crystallography of Nanowires** — •Julian Stangl, Dominik Kriegner, Christian Panse, Bernhard Mandl, Kimberley A Dick, Mario Keplinger, Johan M Persson, Philippe Caroff, Daniele Ercolani, Lucia Sorba, Friedhelm Bechstedt, Günther Bauer
KR 7.4	Thu	15:30–16:15	HSZ 101	**New Grounds in Materials Science: Complex Metallic Alloys** — •Michael Feuerbacher

Sessions

KR 1.1–1.8	Mon	14:45–17:00	HSZ 04	**Multiferroics I (Joint Session of MA, DF, DS, KR, TT)**
KR 2.1–2.7	Mon	17:00–18:45	HSZ 04	**Multiferroics II (Joint Session of MA, DF, DS, KR, TT)**
KR 3.1–3.1	Tue	10:15–10:45	HSZ 04	**Multiferroics III (Joint Session of MA, DF, DS, KR, TT)**
KR 4.1–4.6	Tue	10:45–12:15	HSZ 04	**Multiferroics IV (Joint Session of MA, DF, DS, KR, TT)**
KR 5.1–5.111	Tue	10:45–13:00	P2	**Poster Multiferroics (Joint Session of MA, DF, DS, KR, TT)**
KR 6.1–6.5	Wed	15:00–17:30	P1	**Poster: Crystallography in Materials Science**
KR 7.1–7.6	Thu	14:00–16:45	HSZ 101	**Crystallography in Materials Science (jointly with DF)**
KR 8	Thu	17:00–18:00	HSZ 101	**Mitgliederversammlung KR**

Annual General Meeting of the Crystallography Division

Donnerstag 17:00–18:00 HSZ 101

- Bericht der Fachgruppenleiterin
- Aktivitäten auf der DPG-Tagung 2012 (Laue-Jahr)
- Verschiedenes

KR 1: Multiferroics I (Joint Session of MA, DF, DS, KR, TT)

Time: Monday 14:45–17:00 Location: HSZ 04

KR 1.1 Mon 14:45 HSZ 04

DFT calculation of $ACrO_3$ perovskites using hybrid functionals — •Martin Schlipf[1], Alessandro Stroppa[2], Silvia Picozzi[2], and Marjana Ležaić[1] — [1]Forschungszentrum Jülich, Peter Grünberg Institut and JARA, Germany — [2]CNR-SPIN, L'Aquila, Italy

Density-functional theory (DFT) is a very powerful tool for understanding the properties of several crystals and molecules. Novel hybrid exchange-correlation functionals, which include a fraction of Hartree-Fock exchange, improved the predictive power of DFT further. In this contribution, we have studied the $ACrO_3$ (A = Ca, Sr, Pb) perovskite compounds by DFT. These materials have recently gained a renewed interest, because they offer a rich phase-space of electronic, magnetic and structural transitions. The origins of several of these transitions are not understood, yet. In $SrCrO_3$ different authors report different electronic (metal/insulator) and magnetic (Pauli paramagnetic/Curie Weiss) configurations. It is not clear yet what is the ground state of this compound. In $PbCrO_3$ theoretical calculations predict a conducting state whereas experimentally a metal is found. We use a multi-code approach and clarify these issues from first-principles.

We gratefully acknowledge the support from HGF Nachwuchsgruppe Programme VH-NG-409.

KR 1.2 Mon 15:00 HSZ 04

Optical properties of $BiCrO_3$ — •Cameliu Himcinschi[1], Ionela Vrejoiu[2], Silvia Bahmann[1], Kannan Vijayanandhini[2], Adreas Talkenberger[1], Christian Röder[1], Dietrich R.T. Zahn[3], Alexei A. Belik[4], and Jens Kortus[1] — [1]TU Bergakademie Freiberg, Institute for Theoretical Physics, D-09596 Freiberg — [2]Max Planck Institute of Microstructure Physics, D-06120 Halle — [3]TU Chemnitz, Semiconductor Physics, D-09107 Chemnitz — [4]International Center for Materials Nanoarchitectonics, National Institute for Materials Science, Tsukuba, Ibaraki 305-0044, Japan

Multiferroic materials that simultaneously show polarization and magnetization ordering are envisaged to play a significant role in developing devices with large magnetoelectric coupling. An interesting candidate for intrinsic multiferroism is $BiCrO_3$ (BCO). In this work, the optical properties of polycrystalline BCO ceramics and epitaxial BCO films deposited on $NdGaO_3$(110) substrates are investigated by Raman spectroscopy and spectroscopic ellipsometry. The spectral changes seen in temperature-dependent Raman measurements correlate well to a structural phase transition from a monoclinic structure (space group *C2/c*) to an orthorhombic structure (space group *Pnma*) at about 420 K. The room temperature dielectric function of a 55 nm thick BCO film deposited on $NdGaO_3$ substrate is determined by analyzing ellipsometry data and exploited to estimate the BCO band-gap. The imaginary part of the dielectric function calculated by means of density functional theory shows good agreement with the experimental one. *This work was supported by the German Research Foundation DFG HI 1534/1-1.*

KR 1.3 Mon 15:15 HSZ 04

Pressure induced phase transitions in $MnTiO_3$: Insights from First Principles calculations — •Carmen Quiroga and Rossitza Pentcheva — Section Crystallography, Dept. of Earth and Environmental Sciences, University of Munich

$MnTiO_3$ crystallizes in the ilmenite structure at ambient conditions and remains stable at least up to 26 GPa [1]. A denser $LiNbO_3$ phase can be quenched from high pressure and high temperature experiments to ambient conditions [2]. Our density functional theory calculations, including an on-site Coulomb repulsion term (LDA/GGA+U), show a transition from the $LiNbO_3$ to the perovskite phase at 2.5 GPa in agreement with experiments [3]. A transition from perovskite to the post-perovskite phase ($CaIrO_3$-type) is predicted at pressures above 50 GPa. Furthermore, the magnetic coupling of the Mn ions and the possibility of spin transitions in the different phases are explored.

Funding by DFG SPP1236 (PE883/8-1) is acknowledged.

[1] X. Wu et al. Geoscience Frontiers, in press (2010).
[2] J. Ko and C.T. Prewitt. Phys. Chem. Minerals **15**, 355 (1988).
[3] N. Ross et al. Phys Chem Minerals **16**, 621 (1989).

KR 1.4 Mon 15:30 HSZ 04

Resonant Soft X-ray Scattering (RSXS) Studies on Multiferroic YMn2O5 — •Sven Partzsch[1], Stuart Wilkins[2], John Hill[2], Enrico Schierle[3], Eugen Weschke[3], Dmitri Souptel[1], Bernd Büchner[1], and Jochen Geck[1] — [1]IFW Dresden — [2]BNL Upton — [3]Helmholz-Zentrum Berlin

Multiferroic RMn_2O_5 (R = Y, rare earth, Bi) displays a complex magnetic behavior with transition into a ferroelctric phase as a function of temperature. The intensity of the magnetic superlattice reflection $(1/2, 0, 1/4)$ displays a strong resonance at the Mn L_{23}-edge, due to the strongly increased magnetic sensitivity close to the absorption edge.

Surprisingly, we also observe that this magnetic peak also displays a strong resonance at the oxygen K-edge. The measured integrated intensity of this reflection at the Mn L_3-edge in the commensurate and incommensurate magnetic phase is essentially unchanged. At the oxygen K-edge, however, a strong drop of the temperature dependent integrated intensity is observed at the corresponding phase transition, which resembles the temperature dependence of the ferroelectric polarization. Therefore RSXS at the different edges might provide more information about the origin of ferroelectricity in these frustrated magnets.

The experimental data together with LSDA+U calculations provide evidence that magnetically driven charge transfer between oxygen and manganese plays an important role for the ferroelectricity in these frustrated magnets.

KR 1.5 Mon 15:45 HSZ 04

Dilatometric studies of the multiferroic $FeTe_2O_5Br$ — •Christian Balz[1], Mariano de Souza[1], Matej Pregelj[2], Helmuth Berger[3], Denis Arčon[2], and Michael Lang[1] — [1]Physikalisches Institut, Goethe-Universität, D-60438 Frankfurt(M), SFB/TR49, Germany — [2]Institute "Jozef Stefan", Jamova 39, 1000 Ljubljana, Slovenia — [3]Institute of Physics of Complex Matter, EPFL, 1015 Lausanne, Switzerland

We report on high-resolution directional dependent thermal expansion measurements of the novel multiferroic system $FeTe_2O_5Br$ [1]. Our results reveal two distinct phase transition anomalies centered at $T_{N1} = 11.0$ K and $T_{N2} = 10.6$ K, which coincide with the transitions observed in other quantities [2]. A rounded minimum in α_c shows that short-range magnetic correlations within the crystal layers start to develop already above T_N. At T_{N1}, the system undergoes a magnetic phase transition into the high-T incommensurate (HT-ICM) phase. Interestingly, at T_{N2}, a second phase transition into the low-T incommensurately modulated (LT-ICM) phase is observed, which is accompanied by a spontaneous electric polarization. When magnetic field is applied, the transition temperatures shift depending on the field orientation. In the case of $B \| b > 4.5$ T, the HT-ICM phase merges into the LT-ICM phase. Despite the pronounced lattice effects observed at T_{N2} at 6 T, the electric polarization is destroyed. The rich low-T magnetic phase diagram of $FeTe_2O_5Br$ will be discussed in details [2].

[1] M. Pregelj *et al.*, Phys. Rev. Lett. **103**, 147202 (2009).
[2] M. Pregelj *et al.*, Phys. Rev. B **82**, 144438 (2010).

KR 1.6 Mon 16:00 HSZ 04

Investigation of multiferroic order in M_3TeO_6 (M=Co, Mn, Ni) by second harmonic generation — •Vera Carolus[1], Thomas Lottermoser[1], Sergey A. Ivanov[2], Matthias Weil[3], Roland Mathieu[4], Matthias Hudl[4], Per Nordblad[4], and Manfred Fiebig[1] — [1]HISKP, University of Bonn, Germany — [2]Department of Inorganic Materials, Karpov' Institute of Physical Chemistry, Vorontsovo pole, 10 105064, Moscow K-64, Russia — [3]Institute of Chemical Technologies and Analytics, Vienna University of Technology, Austria — [4]Department of Engineering Sciences, Uppsala University, Box 534, SE-751 21 Uppsala, Sweden

Orthotellurates with the formula M_3TeO_6 are structurally well characterized and can be divided into six different structure types. According to this, these materials show a wide range of magnetic phases. Recently it was suggested, that in some of the orthotellurates multiferroic order is possible.

Among this are: Co_3TeO_6 (space group C2/c) and Mn_3TeO_6 ($R\bar{3}$) with two magnetic phase transitions as well as Ni_3TeO_6 (R3) with one magnetic phase transition. However, a direct proof of ferroelectricity has not been reported so far.

Here, we investigate the multiferroic order by second harmonic generation (SHG) spectroscopy. For Co_3TeO_6 we measured a intense SHG contribution in the low temperature phase below 18 K, which is a strong evidence for multiferroic order. This interpretation is supported by the observation of complex domain patterns using SHG imaging techniques.

KR 1.7 Mon 16:15 HSZ 04

Optical Spectroscopy on the triangular antiferromagnet $CuCrO_2$ — •Michael Schmidt, Zhe Wang, Franz Mayr, Vladimir Tsurkan, Joachim Deisenhofer, and Alois Loidl — Experimental Physics 5, Center for Electronic Correlations and Magnetism, Institute of physics, Augsburg University, Germany

$CuCrO_2$ belongs to the class of triangular lattice antiferromagnets and shows ferroelectricity below $T_{FE} \approx 24$ K [1] while the spins order in a proper screw [2]. Already a moderate magnetic field of 5.3 T can flop the plane of the spins and the polarization. A microscopic theory [3] explains this by the variation of the spin-orbit coupling with the metal-ligand (d-p) hybridization. Recently, electromagnons (magnetic excitations excited by electric field) have been detected in the related compound $Cu(Fe,Al)O_2$ [4] in the submillimeter range. We report on the optical excitation spectrum of $CuCrO_2$ including phonons, crystal-field excitations and magnon sidebands. The relation of magnon lifetime with the possible formation of Z_2 vortices in this system is discussed.

[1] K. Kimura et al., Phys. Rev. B 78, 140401 (2008)
[2] S. Seki et al., Phys. Rev. Lett. 101, 067204 (2008)
[3] T. Arima J. Phys. Soc. Jap. 76, 073702 (2007)
[4] S. Seki et al., Phys. Rev. Lett. 105, 097207 (2010)

KR 1.8 Mon 16:30 HSZ 04

New design for magnetoelectric switch from first principles — •Michael Fechner[1], Peter Zahn[2], Sergey Ostanin[1], and Ingrid Mertig[1,2] — [1]Max-Planck-Institut für Mikrostrukturphysik Halle, Germany — [2]Fachgruppe Theoretische Physik, Martin-Luther-Universität Halle-Wittenberg

Saving information in a magnetic bit requires at least two stable magnetic states that can be distinguished. In conventional hard disks two opposite directions of the magnetization provide these two states. The magnetic state is changed by an external magnetic field thus writing information, whereas reading is performed by the usage of the GMR effect (giant magnetoresistance) [1]. Based on ab intio material design we propose a new hybrid magnetoelectric that allows this switching of the magnetic states by an applied electric field instead of the magnetic field. The switching in the proposed multilayer system is based on internal electronic couplings without any strain. Thus, it is a promising candidate for application in future magnetoresistive random access memory (MRAM).

[1] Baibich et al., PRL 61, 2472-2475, (1988)

15 min. break

KR 2: Multiferroics II (Joint Session of MA, DF, DS, KR, TT)

Time: Monday 17:00–18:45 Location: HSZ 04

KR 2.1 Mon 17:00 HSZ 04

Tuning magnetism by epitaxial strain in biferroic $Fe_{70}Pd_{30}$ films — •Sandra Weiss[1], Markus Ernst Gruner[2], Jörg Buschbeck[1,3], Ludwig Schultz[1], and Sebastian Fähler[1] — [1]IFW Dresden, Institute for Metallic Materials, P.O. Box 270116, D-01171 Dresden — [2]University of Duisburg-Essen, Theoretical Physics, Lotharstraße 1, D-47048 Duisburg — [3]ECE Department, University of California, Santa Barbara

Due to combination of ferromagnetic and ferroelastic properties magnetic shape memory alloys can be considered as multiferrorics. For the magnetic shape memory alloy Fe-Pd we could demonstrate recently, that strained epitaxial film growth allows a variation of the tetragonal distortion by 27 % [J. Buschbeck et al., PRL 103, 2009, 216101]. Density functional calculations revealed a flat energy landscape along the Bain path, explaining this soft behaviour of $Fe_{70}Pd_{30}$. Here we show that tetragonal distortions up to 43 % are possible. This exceeds the Bain transformation path connecting bcc and fcc structure. $Fe_{70}Pd_{30}$ films are produced by coherent epitaxial growth on MgO substrates covered by different metallic buffer layers. By adjusting the tetragonal distortion intrinsic magnetic properties like Curie temperature, saturation magnetisation and magnetocrystalline anisotropy can be controlled. The relevance of two mechanisms for relaxation of epitaxial strain - misfit dislocations and adaptive martensite - is discussed.

KR 2.2 Mon 17:15 HSZ 04

Strain effect on the magnetic properties of $SrRuO_3$ thin films on ferroelectric PMN-PT substrates — •Andreas Herklotz, Mikko Kataja, Ludwig Schultz, and Kathrin Dörr — IFW Dresden, IMW, Helmholtzstrae 20, 01069 Dresden, Germany

We investigate a two-component multiferroic system consisting of a ferroelectric $0.72PbMg_{1/3}Nb_{2/3}O_3$-$0.28PbTiO_3$ (PMN-PT) substrate and ferromagnetic $SrRuO_3$ (SRO) thin films. The inverse piezoelectric effect of the substrate is used to reversibly vary the strain state of the epitaxial SRO films in order to clarify the strain dependence of the magnetic film properties. Buffer films of $Sr_{1-x}Ba_xTiO_3$ are introduced to vary the as-grown state of the SRO films and to cover a wider range from compressive to tensile strain.

High resolution X-ray diffraction is deployed to structurally characterize the films and to determine Poisson's ratio of SRO, which is not known so far. SQUID magnetometry reveals that the Curie temperature is increasing with tensile strain, but starts to decrease again under high strain. Angular-dependent measurements provide that the easy axis orientation shows a complex dependence on strain and temperature. SQUID measurements on conventional substrates like $SrTiO_3$ and $LaAlO_3$ and electric transport measurements complete the data.

KR 2.3 Mon 17:30 HSZ 04

Strain effect on ferroelectric switching dynamics of epitaxial $PbZr_{0.52}Ti_{0.48}O_3$ films — •Kathrin Dörr[1], Andreas Herklotz[1], Michael Biegalski[2], and Hans Christen[2] — [1]IFW Dresden, IMW, Helmholtzstr.20, Dresden — [2]CNMS, Oak Ridge National Laboratory, TN, USA

Elastic strain is known to change ferroic properties of thin films such as the remanent polarization. Less understood and little measured is the influence of the lattice strain induced by film-substrate mismatch on the switching dynamics. In this work, reversible biaxial strain has been applied to films on piezoelectric substrates for a study of their strain-dependent ferroelectric switching. $PbZr_{0.52}Ti_{0.48}O_3$ (PZT) films have been epitaxially grown by pulsed laser deposition on piezoelectric substrates of $0.72PbMg_{1/3}Nb_{2/3}O_3$-$0.28PbTiO_3(001)$ (PMN-PT) buffered with a $SrRuO_3/SrTiO_3$ double layer. Four-circle x-ray diffraction has been employed to confirm the tetragonal symmetry and to measure the lattice parameters of the films. Measurements of the characteristic ferroelectric switching time at various temperatures and strains show an increase of several percent under compression, revealing a similarly strong strain sensitivity of the switching dynamics as that of the remanent polarization. We attempt to identify the strain dependence of the domain wall velocity.

KR 2.4 Mon 17:45 HSZ 04

Fabrication and multiferroic properties of $BiFeO_3/BiCrO_3$ perovskite heterostructures — •Vijayanandhini Kannan, Florian Johann, Alessio Morelli, Miryam Arredondo, Eckhard Pippel, and Ionela Vrejoiu — Max Planck Institute of Microstructure Physics, Weinberg 2, D-06120 Halle.

Bi-based multiferroic materials have attracted strong research interests due to the presence of sterochemical active $6s^2$ lone pair electrons in Bi^{3+} ions and high ordering temperatures, e.g., $BiMeO_3$ (Me = Fe, Cr, Mn, etc). In the present work, epitaxial films of $BiCrO_3$ and $BiFeO_3$ of different thickness (5 nm to 250 nm) were grown on $SrTiO_3$ (100) using pulsed laser deposition technique. Reciprocal space mapping XRD measurements showed that both $BiFeO_3$ (40 nm) and $BiCrO_3$ films (130 nm) are fully strained, having out-of-plane lattice constants of 4.075 Å, and 3.88 Å, respectively. The transmission electron microscopy (TEM) analysis of $BiCrO_3(130nm)/SrRuO_3(16nm)/SrTiO_3$ films revealed the presence of 45^o and 90^o domains along with the coexistence of three structurally different phases, (i) monoclinic (Space

Group: C2/c) and (ii) orthorhombic (Space Group: Pnma) and (iii) an unknown monoclinic-like structure. $BiCrO_3$ film (160 nm) grown on $NdGaO_3$ (110) showed a coherent interface without any misfit dislocations or structural variants. A systematic approach on understanding the thickness evolution of these defects or strain induced structural variants of $BiCrO_3/SrRuO_3/SrTiO_3$ films is done. Furthermore, the fabrication and multiferroic properties of $BiCrO_3/BiFeO_3$ bilayers and multilayer heterostructures are investigated.

KR 2.5 Mon 18:00 HSZ 04

Microscopic Investigations of the Strain-Mediated Coupling in Magnetoelectric Ni/BaTiO$_3$ — •Robert Streubel[1], Denny Köhler[1], Lukas Eng[1], Rudolf Schäfer[2], Claudia Patschureck[2], Anja Wolter[2], Sebastian Gass[2], Stephan Gepräg[3], and Rudolph Gross[3] — [1]Institute of Applied Physics, Technische Universität Dresden — [2]Leibniz Institute for Solid State and Materials Research Dresden — [3]Walther-Meißner-Institute for Low Temperature Research

Coupling the (anti-)ferromagnetic and ferroelectric phases within magnetoelectrics allows affecting the magnetic properties by electric fields. Magnetoelectric heterostructures thus may be considered as prospective candidates for future nanoscale memory devices. However, since only a few single-phase room temperature magnetoelectrics exist with rather poor permeability values, simple composite materials, e.g. amorphous nickel on barium titanate ($Ni/BaTiO_3$) may be used for this purpose. While the macroscopic characterization by monitoring magnetic hysteresis and other effects has been thoroughly carried out, microscopic investigations elucidating the mechanism of ferroelectric/ferromagnetic coupling are still missing.

We report here on the nanoscale inspection of the $Ni/BaTiO_3$ system by PFM, MFM and MOKE. In addition, the saturation magnetization and magnetic anisotropy were measured by SQUID. Both stress and anisotropy within the amorphous Ni film have been modeled showing an excellent agreement with experimental results.

KR 2.6 Mon 18:15 HSZ 04

Magnetoelectric properties of core-shell CoFe$_2$O$_4$-BaTiO$_3$ composites — •Vladimir Shvartsman[1], Firas Alawneh[2], Morad Etier[1], Shiwam Tiwari[1], and Doru Lupascu[1] — [1]Institut für Materilawissenschaft, Universität Duisburg-Essen — [2]The Hashemite University, Zarqa, Jordan

In recent years there has been growing interest in materials exhibiting the magnetoelectric (ME) effect. A large ME coupling has been achieved in composites, where a magnetostrictive phase is mechanically coupled to a piezoelectric phase. The magnitude of the ME effect in such systems depends on the properties of the phases and the type of connectivity. In particular, in core/shell-type structures, where the magnetostrictive core is surrounded by the piezoelectric shell, a large well-defined interface area should enhance the ME coupling.

We report on results of synthesis and ME characterization of $CoFe_2O_4$ - $BaTiO_3$ composites with the core-shell structure. The ceramic samples were prepared by covering cobalt ferrite nanoparticles by a shell of $BaTiO_3$ using a sol-gel technique. Scanning probe microscopy studies confirm formation of the core-shell structure with a magnetic core and piezoelectric shell. The ME effect was measured using a modified SQUID susceptometer. Though the relatively high conductivity of the samples prevents an efficient poling of the ferroelectric component, the obtained ME coefficients are comparable to those reported for similar systems. Effects of the microstructure and ratio between piezoelectric and magnetostrictive phases on ME performance are analysed.

KR 2.7 Mon 18:30 HSZ 04

Highly ordered multiferroic nanocomposite arrays: Fabrication and Properties — •Xiaoli Lu, Yunseok Kim, Silvana Goetze, Peter Werner, Marin Alexe, and Dietrich Hesse — Max Planck Institute of Microstructure Physics, Weinberg 2, 06120 Halle, Germany

With the resurgence of interest in multiferroics, searching for materials with high coupling coefficient becomes more and more important from both fundamental and practical point of views. We report a new type of artificial nanocomposite, $BaTiO_3/CoFe_2O_4$ (BTO/CFO) heterostructured nanodot arrays. Using a stencil of ultra thin anodic aluminum oxide (AAO) membrane and pulsed laser deposition (PLD), BTO and CFO nanodots were epitaxially grown on top of each other. The size of the nanodots can be easily tuned from 60 to 400 nm. Piezoresponse force microscopy (PFM) and superconducting quantum interference device (SQUID) were used to study the nanocomposite. The local characterization of the piezoresponse and domain structure within single nanodots may shed new light on the strain-mediated magnetoelectric (ME) coupling. The epitaxial interface and reduced clamping from the substrate in this nanocomposite promise a better elastic coupling, which makes it a good prototype for nonvolatile ultrahigh-density memory unit with multi-state data storage capability.

KR 3: Multiferroics III (Joint Session of MA, DF, DS, KR, TT)

Time: Tuesday 10:15–10:45 Location: HSZ 04

Invited Talk KR 3.1 Tue 10:15 HSZ 04

Search for a permanent electric dipole moment of an electron: Multiferroics bring us a step closer — •Marjana Ležaić — Peter Grünberg Institute, Forschungszentrum Jülich, 52425 Jülich, Germany

Although it is conjectured that the Big Bang created equal amounts of matter and antimatter, the Universe that we know consists only of matter. It is not yet clear why the Nature treats matter and antimatter in a different way. One possibility that is being intensively explored lies in the existence of a permanent electric dipole moment (EDM) of an electron. Electron's EDM would violate time-reversal symmetry leading to charge-parity symmetry violation and as a consequence, would act as a source of the matter-antimatter asymmetry. The talk will present a multidisciplinary study [1] including theoretical solid state design, consequent synthesis and characterization of a multiferroic material, $(Eu,Ba)TiO_3$, with characteristics optimized for a search for electron's EDM.

[1] K. Z. Rushchanskii, S. Kamba, V. Goian, P. Vaněk, M. Savinov, J. Prokleška, D. Nuzhnyy, K. Knížek, F. Laufek, S. Eckel, S. K. Lamoreaux, A. O. Sushkov, M. Ležaić and N. A. Spaldin, Nature Mater. **9** 649 (2010).

KR 4: Multiferroics IV (Joint Session of MA, DF, DS, KR, TT)

Time: Tuesday 10:45–12:15 Location: HSZ 04

KR 4.1 Tue 10:45 HSZ 04

Polarization and magnetization dynamics of a field-driven multiferroic structure — •Alexander Sukhov[1], Chenglong Jia[1], Paul P. Horley[2], and Jamal Berakdar[1] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, D-06120 Halle/Saale, Germany — [2]Centro de Investigation en Materiales Avanzados, S.C. (CIMAV), 31109 Chihuahua, Mexico

A multiferroic chain with a linear magnetoelectric coupling induced by electrostatic screening at the ferroelectric/ferromagnet interface [1] is considered. We study theoretically the dynamic ferroelectric and magnetic response to external magnetic and electric fields by utilizing an approach based on coupled Landau-Khalatnikov and finite-temperature Landau-Lifshitz-Gilbert equations. Additionally, we make comparisons with Monte Carlo calculations. It is demonstrated [2] that for material parameters corresponding to $BaTiO_3/Fe$ the polarization and the magnetization are controllable by oscillating external magnetic and electric fields, respectively.

[1] T. Cai, S. Ju, J. Lee, N. Sai, A.A. Demkow, Q. Niu, Z. Li, J. Shi and E. Wang, Phys. Rev. B **80**, 140415(R) (2009). [2] A. Sukhov,

C.L. Jia, P.P. Horley and J. Berakdar, J. Phys.: Condens. Matter **22**, 352201 (2010).

KR 4.2 Tue 11:00 HSZ 04

Rare-earth induced magnetoelectric effect in multiferroic $TbMn_2O_5$ — •Naëmi Leo[1], Dennis Meier[2], Roman V. Pisarev[3], Sang-Wook Cheong[4], and Manfred Fiebig[1] — [1]HISKP, Universität Bonn — [2]UC Berkeley, USA — [3]Ioffe Institute, St. Petersburg — [4]Rutgers University, USA

The presence of magnetic frustration and multi-dimensional magnetic order parameters leads to remarkable effects like magnetically induced ferroelectricity. Such a particularly interesting compound is $TbMn_2O_5$ due to the associated magnetic-field controllable electric polarization. The gigantic magnetoelectric coupling originates in the presence of three independent ferroelectric contributions, which can be separatedly accessed by optical second harmonic generation (SHG). Two of these contributions are related to the manganese Mn^{3+} and Mn^{4+} magnetism. The third one is attributed to the spin arrangement of the Tb^{3+} sublattice which also mediates the intricate field-dependent cross-coupling. We confirm this model by measurements taken on isostructural YMn_2O_5 with non-magnetic Y^{3+} ions.

Also we perform spatially resolved domain topography to show that the magnetic-field induced polarization reversal in $TbMn_2O_5$ does not include domain wall motion but is indeed due to a reversal of only one ferroelectric contribution.

This work was supported by the DFG through SFB 608.

KR 4.3 Tue 11:15 HSZ 04

Three-dimensional distribution of protected ferroelectric vortices in multiferroic hexagonal $YMnO_3$ — Tobias Jungk[1], •Martin Lilienblum[2], Ákos Hoffmann[1], Manfred Fiebig[2], and Elisabeth Soergel[1] — [1]PI, Universität Bonn, Wegelerstraße 8, 53115 Bonn, Germany — [2]HISKP, Universität Bonn, Nussallee 14-16, 53115 Bonn, Germany

Multiferrroics are a rich source for "unusual" forms of ferroelectric order. The spontaneous polarizations is induced by magnetism, charge order, geometric effects, etc., and may lead to novel domain states and functionalities. Here we show by piezoresponse force microscopy that ferroelectric domains in hexagonal multiferroic $YMnO_3$ form vortex-like structures around the direction of polarization. Although one would intuitively associate the sixfold character of the domain vortices to the uniaxial hexagonal structure, sixfold vortices are also present perpendicular to the direction of the spontaneous polarization. We will explain the intriguing topology on the basis of a simple geometric model. In addition, we will show how individual domain vortices are affected by application of an electric field applied along the polarization axis.

KR 4.4 Tue 11:30 HSZ 04

Poling of ferrotoroidic domains in $LiCoPO_4$ with toroidal fields — •Anne S. Zimmermann[1], Jean-Pierre Rivera[2], Hans Schmid[2], and Manfred Fiebig[1] — [1]HISKP, University of Bonn, Germany — [2]Department of Inorganic, Analytical and Applied Chemistry, University of Geneva, Switzerland

Ferrotoroidicity denotes a fourth, space- and time-asymmetric form of ferroic order with a spontaneous uniform alignment of magnetic vortices. Space and time asymmetry also relates ferrotoroidic materials to multiferroics and magnetoelectrics. After ferrotoroidic domains have been observed in $LiCoPO_4$ by second harmonic generation (SHG) experiments [1] controlled manipulation of these ferrotoroidic domains is the next step in demonstrating the ferroic nature of the toroidal state. This can be achieved by a toroidal field, i.e., a field behaving asymmetric under space inversion and time reversal, which can be realized by crossed electric and magnetic fields.

Here we report on the behaviour of ferrotoroidic domains in applied toroidal fields. The ferrotoroidic domain structure in various field experiments was investigated by phase-sensitive SHG. We demonstrate that it is possible to orient and switch the ferrotoroidic domains with an appropriate toroidal field. Furthermore the critical field strengths required to orient the ferrotoroidic domains and the relation of ferrotoroidic poling with magnetoelectric annealing are discussed. - Work supported by the SFB 608.

[1] B. B. Van Aken et. al., Nature 449, 702 (2007)

KR 4.5 Tue 11:45 HSZ 04

Time resolved measurements of the multiferroic switching in MnWO4 — •Max Baum[1], Thomas Finger[1], Jeannis Leist[2], Karin Schmalzl[3], Louis-Pierre Regnault[4], Petra Becker[5], Ladislav Bohatý[5], and Markus Braden[1] — [1]II. Physikalisches Institut, Universität zu Köln — [2]Institut für Physikalische Chemie, Georg-August-Universität Göttingen — [3]Jülich Centre for Neutron Science (JCNS) at ILL, Grenoble — [4]Institut Nanosciences et Cryogénie, CEA-Grenoble — [5]Institut für Kristallographie, Universität zu Köln

Multiferroic materials or compounds with a strong magnetoelectric effect posses a large application potential in data storage techniques. Quite recently, systems with a peculiar spiral magnetic order were shown to directly induce a spontaneous electric polarisation and to exhibit giant magnetoelectric and magnetocapacitance effects, among them MnWO4. Neutron scattering with spherical polarisation analysis gives direct access to the chiral component of the magnetic structure which is directly linked to the electric polarisation and thus may be tunable by an electric field. In MnWO4 it is possible to drive multiferroic hysteresis loops at constant temperature as a function of the electric field. We broadened our investigations in this topic and present time resolved measurements of magnetoelectric switching. We applied stroboscopic techniques in order to investigate how fast the chiral component of the magnetic structure adapts to an instantaneously switched electric field. The time scale of the response is remarkable slow, in the range of 3 - 20 ms.

KR 4.6 Tue 12:00 HSZ 04

Time resolved reversal of spin-spiral domains by an electric field in multiferroic $MnWO_4$ — •Philip Thielen[1], Tim Hoffmann[1], Petra Becker[2], Ladislav Bohatý[2], and Manfred Fiebig[1] — [1]University Bonn, HISKP, Germany — [2]Institut für Kristallographie, Universität zu Köln

The interaction of magnetic and ferroelectric order is intrinsically strong in spin-spiral multiferroics. Here the complex magnetic long range order breaks inversion symmetry and induces a spontaneous electric polarization. The interaction allows for switching of the magnetization by means of an applied electric field and is thus of great interest for possible applications. So far there exists little information on the time scale and dynamics of the actual switching process. Here we report time resolved measurements of the reversal of spin-spiral domains in multiferroic $MnWO_4$ by optical second harmonic generation. Magnetic single-domain states are created by the application of an electric field. By reversing its polarity, a reversal of the magnetic domain state occurs. The time scale of the dynamic switching process is found to be in the ms region. Images of the domain-reversal process are obtained. The dynamic domain pattern differs substantially from that of quasi-statically switched multi domain structures.

KR 5: Poster Multiferroics (Joint Session of MA, DF, DS, KR, TT)

Time: Tuesday 10:45–13:00 Location: P2

KR 5.1 Tue 10:45 P2

XPS investigation of a tetranuclear nickel complex — •Daniel Taubitz[1], Phalguni Chaudhuri[2], Vitaly Pavlishchuk[2], Karsten Kuepper[3], and Manfred Neumann[1] — [1]Department of Physics, University of Osnabrück, Barbarastrasse 7, D-49069 Osnabrück, Germany — [2]Max-Planck-Institut für Strahlenchemie, Stiftstrasse 34-36, D-45470 Mülheim an der Ruhr, Germany — [3]Department of Solid State Physics, University of Ulm, Albert-Einstein-Allee 11, D-89069 Ulm, Germany

Organic transition metal complexes could be potentially useful for the development of new materials in the field of molecular magnetism. In this work we report on the investigation of a tetranuclear $[Ni_4(HL)_3]^{2+}$ compound which was characterised by X-ray photoelectron spectroscopy. A comparison with similar nickel complexes will be discussed. During the X-ray spectroscopic investigation some radiation induced damage was observed and studied in more detail. It turned out that the main damage was a decomposition of the ClO_4^- anions.

KR 5.2 Tue 10:45 P2

Spin-resolved Photoelectron Spectroscopy of Mn_6Cr Single-Molecule-Magnets and of Manganese Compounds as Reference Layers — •Andreas Helmstedt[1], Aaron Gryzia[1], Niklas Dohmeier[1], Norbert Müller[1], Armin Brechling[1], Marc Sacher[1], Ulrich Heinzmann[1], Veronika Hoeke[2], Thorsten Glaser[2], Mikhail Fonin[3], Ulrich Rüdiger[3], and Manfred Neumann[4] — [1]Faculty of Physics, Bielefeld University — [2]Faculty of Chemistry, Bielefeld University — [3]Department of Physics, University of Konstanz — [4]Department of Physics, Osnabrueck University

The properties of the manganese-based single-molecule-magnet (SMM) Mn_6Cr are studied. This molecule exhibits a large spin ground state of S_T=21/2. It contains six manganese centres arranged in two bowl-shaped Mn_3-triplesalen building blocks linked by a hexacyanochromate. The Mn_6Cr complex can be isolated with different counterions which compensate for its triply positive charge. The spin polarization of photoelectrons emitted from the manganese centres in Mn_6Cr SMM after resonant excitation with circularly polarized synchrotron radiation has been measured at selected energies corresponding to the prominent Mn L_3VV and $L_3M_{2,3}V$ Auger peaks. Spin-resolved photoelectron spectra of the reference substances MnO, Mn_2O_3 and Mn(II)acetate recorded after resonant excitation at the Mn-L_3-edge around 640eV are presented as well. The spin polarization value obtained from MnO at room temperature in the paramagnetic state is compared to XMCD measurements of Mn(II)-compounds at 5K and a magnetic field of 5T.

KR 5.3 Tue 10:45 P2

Preparation of Monolayers of Mn_6Cr Single-Molecule-Magnets on different Substrates and characterization by means of nc-AFM — •Aaron Gryzia[1], Armin Brechling[1], Hans Predatsch[1], Ulrich Heinzmann[1], and Thorsten Glaser[2] — [1]Faculty of Physics, Bielefeld University, D-33615 Bielefeld — [2]Faculty of Chemistry, Bielefeld University, D-33615 Bielefeld

The preparation of a highly ordered monolayer of Single-Molecule-Magnets (SMM) is one of the main preconditions for a technical application of these molecules. The adsorption of these SMMs on surfaces is associated with difficulties due to the often low chemical stability of these molecules in the vicinity of a surface.

The used Mn_6Cr-complex [1] has a C_3-symmetry and a spin ground state of $S_t = 21/2$. This complex is a trication and needs therefore counter ions for electrical charge compensation. Tetraphenylborate, lactate and perchlorate came into consideration for this function.

Mn_6Cr-SMMs were prepared on different substrates by a droplet technique in air at room temperature. The samples were characterized by means of an AFM operating in non-contact mode, using tips with cone radii of approx. 2 nm.

An island-like growth was observed on SiO_2- and Si_3N_4-substrates, whereas on HOPG and mica the Mn_6Cr-SMM adsorbates preferred a layer growth. Also an influence of the used counter ions was observed on different substrates. The measured thicknesses of the layers are consistent with the Van der Waals radii of the Mn_6Cr-SMMs.

[1] T. Glaser et al., Angew. Chem., 118, 6179-6183 (2006)

KR 5.4 Tue 10:45 P2

Rare-earths-based single molecule magnets and single chain magnets — •Sabrina Haas[1], Conrad Clauss[1], Sina Zapf[1], Javier Luzon[2], Boris Gorshunov[1,3], Roberta Sessoli[2], Martin Dressel[1], and Lapo Bogani[1] — [1]1. Physikalisches Institut, Universität Stuttgart, Germany — [2]Dipartimento di Chimica e sezione INSTM, Universita degli Studi di Firenze, Italy — [3]Prokhorov Institute of General Physics, Russian Academy of Sciences, Russia

The field of molecular magnetism has allowed the observation of several interesting quantum effects. Much is nowadays known of molecular magnets made of transition metal ions but, when moving to rare-earth building blocks, little can be said, due to the complexity of such systems.

We focus in our study on the monomeric compound $[Dy(hfac)_3NIT(C_6H_4OPh)_2]$ and its one-dimensional counterpart $[Dy(hfac)_3NIT(C_6H_4OPh)]_\infty$. These are among the most complex systems, due to the complete lack of symmetries both in the molecule and in the crystal lattice. We show that $[Dy(hfac)_3NIT(C_6H_4OPh)_2]$ shows slow relaxation of the magnetization and zero-field quantum tunnelling assisted by the nuclear spin. In particular we rely on a combined use of Frequency-domain magnetic resonance spectroscopy with backward wave oscillators and Fourier transform infrared spectroscopy, spanning a frequency range from 4 to 100 cm^{-1}. The results are compared to those obtained from ac susceptibility data and static magnetic measurements. All results are eventually compared with theoretical values obtained by CASSCF calculations.

KR 5.5 Tue 10:45 P2

Real time observation of magnetic nanobead transportation using domain walls in ferromagnetic nanostripes — •Sascha Glathe, Jörg Beinersdorf, Robert Müller, Sandra Julich, Thomas Henkel, Uwe Hübner, and Roland Mattheis — IPHT Jena e.V., Albert-Einstein-Str. 9, 07745 Jena

It was recently proposed that magnetic nanobeads can be trapped [1] and manipulated [2] by means of domain walls (DW) in magnetic nanostripes for biological applications. The bead is pinned in the vicinity of the DW due to the stray field originating from a transverse DW at the surface. We will show the reliable control of magnetic beads (SiO_2 coated $\gamma - Fe_2O_3$ particles) with a diameter of 500-1500 nm by DWs in 200*20 nm^2 Permalloy (Py) nanostripes. The Py layer was deposited by means of a UHV sputter deposition and patterned using e-Beam lithography and Ar-Ion etching. We used not-gate like structures [3] to allow for DW transportation with a rotating magnetic field, whereby the frequency of the rotating field determines the velocity of the DWs. The nanobead movement was detected by means of a dark field microscope with a 14,7 frames/s camera. We will show that the DW velocity is limited by the drag force of the nanobead in the liquid medium. From frequency dependent measurements we could estimate the drag force in dependence on the bead diameter.

[1] P. Vavassori et al., Appl. Phys. Lett., **93**, 203502 (2008)
[2] M. T. Bryan et al., Appl. Phys. Lett., **96**, 192503 (2010)
[3] D. A. Allwood et al., Science, **296**, 2003 (2002)

KR 5.6 Tue 10:45 P2

Structure and electronic properties of magnetic molecules on surfaces — •Philipp Erler[1], Samuel Bouvron[1], Sönke Voss[1], Michael Burgert[2], Ulrich Groth[2], and Mikhail Fonin[1] — [1]Fachbereich Physik, Universität Konstanz, 78457 Konstanz — [2]Fachbereich Chemie, Universität Konstanz, 78457 Konstanz

Molecular-scale spintronic devices are expected to have radically novel properties, with the added benefits of inexpensive fabrication through self-assembly, as well as chemical tunability. Single molecule magnets (SMM) representing mesoscopic systems which show magnetic bistability and rich quantum behavior are particularly interesting for applications in spin-based data storage and quantum-computing technologies.

Here we present a detailed study of structural and electronic properties of various Mn_{12} clusters chemically bound to a metallic surface, which was performed in order to find efficient preparation routes yielding intact clusters. We extensively studied the electronic properties of monolayers of Mn_{12} molecules on surfaces by means of scanning tunneling microscopy and spectroscopy at room temperature as well as by photoelectron spectroscopy. Complementary to the experiments on complex SMM molecules, the electronic properties of paramagnetic Cobalt Phthalocyanine molecules on different metallic surfaces were investigated by means of a cryogenic scanning tunneling microscope. We discuss the features in the local density of states measured at 4 K with and without having applied a high magnetic field.

KR 5.7 Tue 10:45 P2

Study of cobalt cluster films deposited by high-rate cluster source — •Björn Gojdka, Stefan Rehders, Viktor Hrkac, Venkata S.K. Chakravadhanula, Vladimir Zaporojtchenko, Thomas Strunskus, and Franz Faupel — University of Kiel, Institute for Materials Science, Kaiserstraße 2, 24143 Kiel

Ferromagnetic nanoparticles have been investigated intensively in the last decade as their properties open up a vast range of applications. In the last few years dedicated sources have been developed for the fabrication of size-selected nanoclusters, some of which are now even commercially available. However, present systems often suffer from high instrumental complexity and low deposition rates. We designed and built a cluster source with low technical complexity to deposit ferromagnetic nanoparticles with high deposition rates up to 100 nm/min. We present a study of nanocluster films which consist of cobalt nanoparticles with an average size of about 10 nm. Individual clusters and cluster films with a thickness of several hundred nanometers were investigated regarding their magnetic properties and morphology. The magnetic properties of the resulting cluster films can be tuned directly by the operation parameters of the cluster source.

KR 5.8 Tue 10:45 P2

Transition from superparamagnetism to correlated ferromagnetism in Pt capped Co nanoparticles — •Astrid Ebbing[1], Leonardo Agudo[2], Gunther Eggeler[2], and Oleg Petracic[1] — [1]Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, 44780 Bochum — [2]Institut für Werkstoffe, Ruhr-Universität Bochum, 44780 Bochum

In this work we show that by capping Co nanoparticles with small amounts of Pt drastic changes of the magnetic properties can be induced. The magnetic properties were investigated using superconducting quantum interference device (SQUID) magnetometry. We find that for zero and for very small amounts of Pt (nominal thickness t(Pt) < 0.7 nm) the nanoparticles behave superparamagnetic. With increasing t(Pt) the blocking temperature is enhanced from 15 K up to 110 K. However, for values t(Pt) > 1 nm a strongly coupled state is encountered resembling a ferromagnet with T_c values > 300 K.

KR 5.9 Tue 10:45 P2

Temperature dependent magnetorelaxometry: Comparison between theory and experimental data — •Markus Schiffler, Markus Büttner, Frank Schmidl, and Paul Seidel — Friedrich-Schiller-Universität Jena, Institut für Festkörperphysik

For investigation in the properties of magnetic nanoparticles their relaxation behavior can be used. One possibility is to perform temperature dependent magnetorelaxometry (TMRX) measurements. According to the thermal activation of the particles their relaxation behavior is determined by the energy barrier distribution. For such systems there is a theory provided by [1]. The numerical simulations presented there were done with arbitrary chosen simulation parameters. On the other hand there exist extensive data records of fractionated ferrofluids. Therefore the aim of the work presented here is to simulate the energy barrier distribution for the available data. The information used in the investigation is the anisotropy constant and the particle volume concentration. The mean volume of the particles is used for rescaling the obtained energy barriers to a temperature scale comparable with measurement results. Simulations with original volume concentrations are performed and compared with original results. The influence of agglomeration and variation of the particle volume concentration provide a shift of the energy barrier distribution to lower temperatures.

[1] Berkov, D.V., Numerical calculation of the energy barrier distribution in disordered many-particle systems: the path integral method. Journal of Magnetism and Magnetic Materials, 1998. 186(1-2): p. 199-213.

KR 5.10 Tue 10:45 P2

Are spin and orbital contributions to magnetic moments of FePt nanoparticles size-dependent? — •Luyang Han, Ulf Wiedwald, and Paul Ziemann — Institut für Festkörperphysik, Universität Ulm, A.-Einstein-Allee 11, 89069 Ulm, Germany

FePt nanoparticles (NPs) have attracted much interest due to their potential applications as well as its intriguing properties in basic research [1]. For magnetic NPs in general it is often observed that the magnetic properties deviate from the corresponding bulk behavior for diameters well below 10 nm. In this contribution we report on spin and orbital magnetic moments of FePt NPs with diameter of 3-10 nm prepared via reverse micelles [2]. X-ray magnetic circular dichroism (XMCD) reveals an increase of the ratio of orbital and spin magnetic moments after annealing at 700 °C for 30 min correlated with the emerging $L1_0$ phase. For this ratio, however, no significant size-dependence could be found. On the other hand, extended annealing above 700 °C leads to a decreasing ratio of orbital-to-spin moment. Since XMCD is quite surface sensitive, this indicates that besides the $L1_0$ phase formation annealing induced changes of the chemical surface composition may influence orbital-to-spin ratio of magnetic NPs.

[1]S. Sun, *Adv. Mater.*, **18**, 393, (2006)
[2]U. Wiedwald et al., *Beilstein J. Nanotechnol.*, **1**, 24, (2010)

KR 5.11 Tue 10:45 P2

Shift of the blocking temperature of Co nanoparticles by Cr capping — •Melanie Ewerlin[1], Derya Demirbas[1], Leonardo Agudo[2], Gunther Eggeler[2], and Oleg Petracic[1] — [1]Experimentalphysik IV, Ruhr-Universität Bochum, 44780 Bochum — [2]Institute for Materials, Department of Materials Science, Ruhr-Universität Bochum, 44780 Bochum

We have prepared self-assembled Co nanoparticles on Al2O3 buffer layers and studied the effect of capping with various amounts of Cr onto the magnetic properties. Magnetization measurements were performed using superconducting quantum interference device (SQUID) magnetometry and structural characterization using transmission electron microscopy (TEM). The uncapped Co nanoparticles show superparamagnetic behaviour with a blocking temperature of TB=14K. The magnetic properties are strongly influenced by the Cr capping resulting in a decrease of TB for nominal thicknesses of Cr up to 0.15nm. However, for larger values 0.15 nm < tCr <0.4nm the blocking temperature increases again. We suggest that for the first regime the Cr capping layer leads to an enhanced dissipation of magnetization, while the second regime is governed by inter-particle coupling via Cr bridges.

KR 5.12 Tue 10:45 P2

AFM-based method for imaging and magnetic characterization of isolated nanoparticles with nanometer lateral resolution — •Stephan Block and Christiane A. Helm — Institut für Physik, Ernst-Moritz-Arndt Universität, Felix-Hausdorff-Str. 6, D-17489 Greifswald, Germany

We present a new AFM-based method, which allows the simultaneous measurement of magnetic and spatial properties of nm-sized objects (nanoparticles, e.g. colloids or clusters). Thus, it becomes possible to distinguish different materials by their unique magnetism (e.g. superparamagnetism or diamagnetism). Basically, an oscillating magnetic field is applied to the sample and with a magnetic AFM-tip the surface magnetization is probed. Spatial changes of the magnetic flux density affect the vibration amplitude of the tip and thus, (dynamic) magnetic properties of the surface can be determined with high resolution.

In the present work, this new technique is applied to (diamagnetic) gold and (superparamagnetic) iron-(II,III)-oxide nanoparticles. It is shown, that the magnetic susceptibility of nanoparticles with lateral resolution of few nanometers can be resolved at least qualitatively. Additionally, the preliminary measurements show that these nanoparticles (with a diameter of less than 20 nm) can be clearly distinguished by this new method. This allows us to unambiguously identify nanoparticles in AFM measurements simply by the nature of their magnetism, which might be a very valuable tool in biochemical or biomedical methods like AFM-based immunolabeling of proteins.

KR 5.13 Tue 10:45 P2

Shape dependant oxidation of cobalt nanoparticles — •Britta Vogel, Katrin Eckstädt, Nadine Mill, Alexander Auge, Jan-Philipp Grote, and Andreas Hütten — Department of Physics, University of Bielefeld, D-33615 Bielefeld, Germany

Cobalt nanoparticles have been prepared as spheres, discs and cubes. Then the decrease of the saturation magnetisation by oxidation was determined with an AGM. The oxidation curves differ with the shape of the nanoparticles. To gain information about the oxidation processes, investigations concerning the surface of the particles were made, which exhibit an interesting connection between the shape and the oxidation behaviour.

KR 5.14 Tue 10:45 P2

Electrical characterization of intermetallic FePt nanoparticles — •Ulrich Wiesenhütter[1], Jochen Grebing[1], Bernd Rellinghaus[2], Jürgen Fassbender[1], and Artur Erbe[1] — [1]Helmholtz-Zentrum Dresden Rossendorf, D-01328 — [2]Leibniz-Institut für Festkörper- und Werkstoffforschung, D-01069

Magnetic nanoparticles have a large potential for applications such as medical diagnosis and therapy, (bio-)sensors or magnetic recording. Conventional techniques, e.g., MFM, electron holography or Lorentz microscopy are only suited to determine magnetical properties of macroscopic particle ensembles. In order to investigate the electrical and magnetic properties of a single, free-standing FePt nanoparticle two nano-sized Au electrodes, that are fabricated by electron beam lithography, are used. The full characterization of the particle is carried out by electron microscopy and by recording current-voltage characteristics. Coulomb-blockade effects, which occur at low temperatures, can be used to determine the size and the magnetic properties of the particles.

KR 5.15 Tue 10:45 P2

Imaging of spin-torque induced magnetization dynamics in lateral spin injector configuration — •Matthias Buhl[1], Kerstin Bernert[1], Sebastian Wintz[1], Tom Henschel[1], Roland Mattheis[2], Jörg Raabe[3], Jochen Grebing[1], Kay Potzger[1], Artur Erbe[1], and Jürgen Fassbender[1] — [1]Helmholtz Zentrum Dresden Rossendorf, Bautzner Landstraße 400, 01328 Dresden, Germany — [2]Institut für Photonische Technologien e.V., Postfach 100239, 07702 Jena, Germany — [3]Swiss Light Source, Paul Scherrer Institut, 5232 Villigen, Switzerland

Electrical transport characteristics of structures consisting of normal metals and ferromagnetic materials depend strongly on the magnetization direction of the ferromagnets. Thus, different spin polarizations can lead to different resistance values of such structures. The absorption of spin polarized electrons in a ferromagnetic material (spin transfer torque) by domain/domain walls leads to magnetization switching or domain wall movement. This can be achieved by driving a current perpendicular to the plane of the ferromagnet (CPP) or in the plane (CIP). In this experiment we investigate the magnetization behavior of ferromagnetic nanopillars located between two lateral spin injectors in the CIP configuration. Using Scanning Transmission X-ray Mircoscopy (STXM) these studies will give more insights in the switching behavior and dynamics. Technological applications can mostly be found in memory structures, where the magnetization can be stored and read out.

KR 5.16 Tue 10:45 P2

Magnetization reversal in dipolarly coupled PdFe nanodot arrays — •Derya Demirbas, Melanie Ewerlin, Frank Brüssing, Oleg Petracic, and Hartmut Zabel — Festkörperphysik, Ruhr-Universität Bochum, 44780 Bochum, Germany

We have studied a 2-dimensional XY macrospin model system by fabricating nanodot arrays from Pd1-xFex with low Fe-concentrations x < 15 % as magnetic material. Pd1-xFex films of 10 nm thickness and various Fe concentrations were deposited by ion beam sputtering and characterized by superconducting quantum interference device (SQUID) magnetometry, magneto-optic Kerr effect (MOKE), atomic force microscopy (AFM) and x-ray diffraction (XRD). For the nanostructuring we used films with x = 11 at% showing a Curie temperature of 230 K. This low Tc ensures that the system can be cooled from a completely paramagnetic state into the macrospin state. We have fabricated circular dots with a diameter of 150 nm on a square lattice with various inter-dot distances. The magnetization reversal of the entire system has been studied using a low-temperature MOKE setup and has been compared to model expectations of a XY system with dipolar interactions.

KR 5.17 Tue 10:45 P2

Competition of dipolar interactions and lateral exchange spring effect in NiFe elements — •Norbert Martin[1], Ingolf Mönch[2], Rudolf Schäfer[2], Ludwig Schultz[2], Jürgen Fassbender[1], and Jeffrey McCord[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstr. 400, 01328 Dresden — [2]Leibniz Institut für Festkörper- und Werkstoffforschung Dresden, Helmholtzstr. 20, 01069 Dresden

Conventional exchange spring systems consist of directly exchange coupled hard and soft magnetic layers. In the presented work, lateral exchange spring structures were prepared by structured ion implantation on patterned samples to investigate the interplay between structuring and additional dipolar fields. The collective magnetization reversal of hard and soft phase is attributed to strong dipolar fields at the element edges that cause a hysteresis behaviour, which is comparable to that of a magnetic homogeneous square element. The exchange spring behaviour, occurring with increasing difference in M_s between the two phases, is related to an increase in effective shape anisotropy in the high M_s stripes. The magnetization reverses through an antiparallel alignment of magnetization of the individual stripes. The resulting lateral domain walls are stabilized by the inter-stripe flux closure. The two-step reversal is modelled by taking the demagnetization and domain wall energy terms into account. This work is funded by the German Science Foundation, project DFG: Mc 9/7

KR 5.18 Tue 10:45 P2

Localized and delocalized modes in magnonic materials of hexagonal structure — •Fabian Garbs[1], Benjamin Lenk[1], Henning Ulrichs[2], and Markus Münzenberg[1] — [1]I. Physikalisches Institut, Georg-August-Universität Göttingen — [2]Institut für Angewandte Physik, Universität Münster

With the time resolved measurement of the magneto-optical Kerr effect (TRMOKE) the spin amplitude is detected until 1 ns after excitation. Dependence of the external magnetic field can be measured in the range of $0 \leq \mu_0 H_{\text{ext}} \leq 150\,\text{mT}$ within an angle of up to 30° out of plane. The 50 to 150 nm thin samples were nanostructured with a focused ion beam (FIB) to lattices of hexagonal or honeycomb symmetry in the micrometer range.

The existence of antidots lead to new modes in micron-sized hexagonal structured thin films of Ni or CoFeB. Due to inhomogeneities in the internal field, localized spin-wave modes in nickel and propagating surface modes in the low damping CoFeB film occur. These modes are investigated for different structural parameters and varying alignments in the external field. In both cases the structural lattice is reflected in the measurements. One finds strong changes for directions of high symmetry. To clarify the influence of the symmetry, simulations have been done to show the internal field distribution.

KR 5.19 Tue 10:45 P2

Micromagnetic analysis of spin wave propagation in nanostructured magnonic crystals — •Florin Ciubotaru, Andrii V. Chumak, Alexander A. Serga, Philipp Pirro, and Burkard Hillebrands — FB Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

Spin wave propagation in nanostructured magnonic crystals (MCs) start to be intensively studied due to its potential technological application for signal processing in spintronic devices. Here we report on micromagnetic simulations [1] of the spin wave transmission in nanosized MCs. Two kinds of Permalloy waveguides with periodically varying width were under consideration: sinusoidal and rectangular profiles [2] of the notches. The band gaps (frequency regions where spin waves are not allowed to propagate) have been clearly observed and studied in the space and frequency domain. It is shown that both the band gap frequency and its depth depend strongly on the probing position inside the MC. It is due to the geometrically induced modulation of the internal magnetization field. Furthermore, the MC transmission characteristics can be changed from multiple rejection bands state to a single-band-state by using the harmonically modulated structure. Support from DFG (grant SE 1771/1) is gratefully acknowledged.

[1] OOMMF open code, M. J. Donahue, and D. G. Porter, Report NISTIR 6376, NIST, Gaithersburg, MD (1999). [2] A.V. Chumak et al. Appl. Phys. Lett. 95, 262508 (2009).

KR 5.20 Tue 10:45 P2

Granular CoCrPt:SiO_2 recording media on assemblies of GaSb nanocones — •David Ball[1], Stephan Günther[2], Monika Fritzsche[1], Gaspare Varvaro[4], Denys Makarov[2,3], Kilian Lenz[1], Jürgen Fassbender[1], and Manfred Albrecht[2] — [1]Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, P.O. Box 510119, 01314 Dresden — [2]Institute of Physics, TU Chemnitz, 09126 Chemnitz — [3]Institute for Integrative Nanosciences, IFW Dresden, P.O. Box 270116, 01069 Dresden — [4]ISM-CNR, Via Salaria km 29.500, C.P. 10-00016 Monterotondo Scalo, Roma, Italy

Investigation of the magnetization reversal in arrays of magnetic nanostructures is relevant for both fundamental understanding as well as application for magnetic data storage. We present a study of the magnetization reversal in granular CoCrPt:SiO_2 recording media with weakly interacting magnetic grains grown onto pre-structured templates fabricated by ion irradiation of GaSb. By tuning the irradiation conditions, assemblies of nanocones of different size and periodicity were prepared. Columnar CoCrPt grains with their c-axis normal to the surface of the cones were formed as evidenced by HR-TEM. The spread of the c-axis of these grains results in a tilted easy magnetization axis with respect to the substrate normal. Investigation of the integral magnetic properties by vector-VSM reveals a decrease of the remanence with increasing cone size. The magnetic domain patterns observed by MFM suggest that the CoCrPt behaves as a single-domain cap structure on the cones. This work is supported by DFG FA 314-7.1 and AL 618-6.

KR 5.21 Tue 10:45 P2

Magnetic microstructure of nanocrystalline Gadolinium: a small-angle neutron scattering study — •Frank Döbrich[1,4], Helmut Eckerlebe[2], Melissa Sharp[2], Joachim Kohlbrecher[3], Rainer Birringer[4], and Andreas Michels[1] — [1]University of Luxembourg, 162A Avenue de la Faïencerie, L-1511 Luxembourg — [2]GKSS Forschungszentrum, D-21502 Geesthacht, Germany — [3]Paul Scherrer Institute, CH-5232 Villigen PSI, Switzerland — [4]Universität des Saarlandes, D-66041 Saarbrücken, Germany

We report on grain-size dependent magnetic small-angle neutron scattering (SANS) experiments on nanocrystalline Gd, which was synthesized using the low-capturing isotope ^{160}Gd. The angular variation of the two-dimensional SANS cross-section at different applied magnetic fields is discussed with a special focus on the rather unusual scattering contribution of the clover-leaf-type found for nanocrystalline Gd at intermediate field values. Additionally we have calculated from experimental data the autocorrelation function of the spin misallignment. This approach allows in particular for the extraction of the field-dependent correlation length of static spin misalignment fluctuations induced by microstructural defects. The data analysis suggests that the grain boundaries constitute a major scource of spin disorder in this material, which may be attributed to local atomic site disorder and modified coupling at internal interfaces.

KR 5.22 Tue 10:45 P2

Magnetoresistance of ferromagnetic materials on self-assembled nanospheres — •Florian Strigl and Elke Scheer — Department of Physics, University of Konstanz, 78475 Konstanz, Germany

Self-assembled spherical particles provide a huge variety of applications. Here we present a study in which they are brought into a linear arrangement by deposition onto a lithographically defined mask. We evaporate ferromagnetic materials of different thickness and composition, e.g. Co/Pd multilayers, onto these chains and contact them electrically with normal or superconducting leads. Co/Pd multilayers show a high magnetic anisotropy perpendicular to their surface [Albrecht]. Due to the limited dimension and the curvature, the multilayer-caps are single-domain and magnetically decoupled, but in electrical contact with each other. It is possible to control the magnetisation of a single cap by a magnetic force microscope (MFM) or of the whole chain by applying an external field while measuring the electrical conductance. Magnetoresistance measurements on 2D arrangements [Kimling] have shown large amplitudes, where the underlying mechanism is proposed to be similar to GMR.

Currently we are investigating the magnetoresistance of pure Co layers with varying thicknesses, the influence of the contacting materials (Au, Al) and characterising the system via MFM measurements.

[Albrecht] Nature Mater. 4 (2005) 203

[Kimling] JAP 107 (2010) 09C506

KR 5.23 Tue 10:45 P2

Morphology Induced Magnetic Anisotropy of Thin Films Deposited on Nanoscale Ripple Substrates — •Michael Körner[1], Maciej Oskar Liedke[1], Kilian Lenz[1], Mukesh Ranjan[1], Monika Fritzsche[1], Stefan Facsko[1], Jürgen Fassbender[1], Ulrich von Hörsten[2], Bernhard Krumme[2], and Heiko Wende[2] — [1]Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf (HZDR), P.O. Box 510119, 01314 Dresden, Germany — [2]Fakultät für Physik und CeNIDE, Universität Duisburg-Essen, 47048 Duisburg, Germany

Magnetic properties of thin films are influenced by the morphology of substrates with periodically modulated patterns on the nanometer scale [1]. These well ordered surface modulations (ripple) can be produced by low energy ion beam erosion and are tuneable over a wide range [2]. Thin magnetic films deposited on these ripple surfaces repeat the surface profiles of these patterns and thus an additional uniaxial magnetic anisotropy is induced. This is shown for thin films of Fe, Co as well as the quasi-Heusler compound Fe_3Si. The magnetic anisotropy is determined by means of angular- as well as frequency-dependent ferromagnetic resonance measurements using a vector network analyzer. We find a strong uniaxial magnetic anisotropy induced by the ripple surface, which is superimposed on the cubic anisotropy in the case of single crystalline films.

This work is supported by DFG grant FA 314/6-1.

[1] M. Körner et al., Phys. Rev. B 80, 214401 (2009).

[2] J. Fassbender et al., New Journal of Physics 11, 125002 (2009).

KR 5.24 Tue 10:45 P2

An experimental approach to a 2-dimensional random resistor network — •Miriam Lange, Philipp Szary, Oleg Petracic, and Hartmut Zabel — Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, D-44780 Bochum, Germany

We present an experimental approach to a 2-dimensional random resistor network using the nanosphere lithography technique. Our samples are prepared by using self-organized polystyrene micro-particles of 500 nm diameter forming a 2-dimensional array of hexagonal order on top of a Si substrate. By means of oxygen plasma etching the diameter of the spheres is reduced in a controlled fashion. In a subsequent metallization step a Permalloy (Py = $Ni_{80}Fe_{20}$) layer with a thickness of 20 nm is deposited with the particle array acting as a shadow mask. After final lift-off the Py pattern remains as an antidot array, where each bridge represents a resistor in a 2-d network. The randomness of the preliminary particle self-organization process is transferred onto the network. Variation of the etching time allows us to fabricate systems of different connection widths. Magnetic and electrical properties have been studied by means of magnetic force microscopy (MFM), magneto-optical Kerr-effect (MOKE), superconducting interference device (SQUID) and magnetoresistance (MR) measurements.

KR 5.25 Tue 10:45 P2

Temperature dependence of stochastic domain-wall depinning in permalloy nanowires — •Clemens Wuth, Peter Lendecke, and Guido Meier — Universität Hamburg, Institut für Angewandte Physik, Jungiusstraße 11, 20355 Hamburg

We investigate the temperature dependence of domain-wall depinning in permalloy nanowires by measuring depinning fields and their corresponding depinning times as a function of bias field. The domain walls are pinned at triangular notches in the nanowires and detected non-invasively by Hall micromagnetometry [1,2]. This technique allows to acquire depinning-field and -time distributions in the temperature range between 5 K and 50 K and thus to determine the stochastics of the domain-wall depinning process. The results are discussed in terms of the Néel-Brown model for thermally activated magnetization reversal [3] and aim for a better understanding of field-induced domain-wall depinning.

[1] P. Lendecke, R. Eiselt, G. Meier, and U. Merkt, J. Appl. Phys. 103, 073909 (2008), [2] P. Lendecke, U. Merkt, and G. Meier, J. Magn. Magn. Mat. 322, 1399 (2010), [3] W. Wernsdorfer, Adv. Chem. Phys. 118, 99 (2001).

KR 5.26 Tue 10:45 P2

Magnetotransport properties of iron microwires grown by local electron beam induced activation — •Fabrizio Porrati[1], Roland Sachser[1], Marie-Madeleine Walz[2], Florian Vollnhals[2], Hans-Peter Steinrück[2], Hubertus Marbach[2], and Michael Huth[1] — [1]Physik. Institut, Goethe-Univ., Frankfurt a. M. — [2]Physikalische Chemie II, Uni Erlangen-Nürnberg, Erlangen

We have grown iron microwires under UHV conditions and we have measured their magnetic and transport properties in a 4-probe geometry. The growth process takes place in two-steps: First, a SiO_2 substrate is locally activated by electron beam irradiation. Second, the molecules of a precursor gas ($Fe(CO)_5$) injected in the UHV chamber decomposes and grows autocatalytically. The growth process can be controlled by tuning the electron beam dose, the dosage of precursor flux and the deposition time. For the transport measurements, the temperature dependence of the longitudinal resistivity (ρ_{xx}) shows a typical metallic behaviour with resistivity at room temperature of about 30 mW cm, i.e. only a factor 3 larger than the bulk value. Furthermore, we have measured isothermal Hall-resistivities in the range between 4.2 K and 260 K. These measurements reveal positive ordinary and anomalous Hall coefficients, which, respectively, decrease and increase by increasing temperature. The relation between anomalous Hall resistivity (ρ_{AH}) and longitudinal resistivity is quadratic, $\rho_{AH} \sim \rho_{xx}^2$, revealing an intrinsic origin of the anomalous Hall effect. Finally, we have measured at low temperature in the transversal geometry a negative magnetoresistance in the order of 0.2%.

KR 5.27 Tue 10:45 P2

Strong enhancement of magnetic anisotropy energy in alloyed nanowires — •Nikolay Negulyaev[1], Larissa Niebergall[1], Lucila Juárez Reyes[2], Jesus Dorantes-Dávila[3], Gustavo Pastor[2], and Valeri Stepanyuk[1] — [1]Max-Planck-Institut für Mikrostrukturphysik, D-06120 Halle, Germany — [2]Institut für Theoretische Physik, Universität Kassel, D-34132 Kassel, Germany — [3]Instituto de Física, Universidad Autónoma de San Luis Potosí, 78000 San Luis Potosí, Mexico

One-dimensional atomic structures (monatomic wires and chains) are believed to be likely candidates for creation of nanostructures with large atomic orbital moments and hence with giant magnetic anisotropy energy (MAE) per atom [1,2]. We investigate the possibility of tuning the MAE of 3d transition metal monowires alloyed with 5d elements (Ir, Pt). Our ab initio studies give clear evidence that in mixed 3d-5d atomic wires MAE is one and even two orders of magnitude more than in pure wires constructed of the corresponding

5d [2] and 3d elements, respectively. Mechanisms responsible for the formation of such a strong MAE are revealed. The interplay between the structure of a monowire and its MAE is demonstrated. The contribution of both types of species (3d and 5d) into the MAE is discussed.

[1] J. Dorantes-Dávila and G. M. Pastor, Phys. Rev. Lett. 81, 208 (1998); Y. Mokrousov et al., Phys. Rev. Lett. 96, 147201 (2006).

[2] A. Smogunov, A. D. Corso, A. Delin, R. Weht, and E. Tosatti, Nat. Nanotechnol. 3, 22 (2008).

KR 5.28 Tue 10:45 P2

Characterization of TMR-based memory cells with elliptically shaped elements — •Ana Ruiz Calaforra, Andres Conca, Britta Leven, and Burkard Hillebrands — FB Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

The optimization of TMR-based memory cells fundamentaly depends on the switching properties of the single storage elements within a cell. In particular, the understanding of the role of the dimension of the TMR-elements is of importance. To study this systematically, a 4×4 memory cell device has been developed, using standard UV-lithography techniques on Si wafers in an industrial environment. It consists of two sets of Cu current lines, which are perpendicularly oriented to each other forming a grid cross structure. On each of the 16 intersections, elliptical elements with the symmetry axis oriented parallel to the current lines are structured. An additional Cu line allows for the resetting of the magnetization of all magnetic elements. Different dimensions for the TMR-elements were tested.

We present a systematic study of the static and dynamic magnetization behavior of the memory cell device for CoFeB elements using a micro-focused time resolved MOKE setup with a spotsize of 400 nm. Experiments using different amplitude and duration (ca. 1 μs) of the applied pulses are presented.

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KR 5.29 Tue 10:45 P2

Influence of the geometrical parameters on the angular dependence of H_C in elliptical microstructures — •Thomas Sebastian, Andrés Conca, Georg Wolf, Thomas Meyer, Britta Leven, and Burkard Hillebrands — FB Physik und Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

Elliptical magnetic microstructures with dimensions of a few micrometers play a crucial role in the design of magnetic field sensors and in data storage applications such as MRAM cells. A systematic study of the influence of the shape anisotropy on the coercive field H_C provides important information for the ability to control the anisotropic switching properties of single elements.

Here, we present measurements on the angular dependence of H_C for elliptical elements with varying size and aspect ratio (AR). The size of the structures ranges from 6 μm to 3 μm with ARs varying from 2 to 5. The measurements were performed with a μMOKE setup equipped with a micro-focused HeNe-laser beam with a spotsize of 1 μm. The elements were structured from 5 nm thick polycrystalline films of NiFe, CoFe and CoFeB using e-beam lithography. A comparison of the influence of the shape anisotropy on the angular dependence of H_C for the three materials and for the different dimensions will be discussed.

Support by the BMBF project MultiMag (VDI-TZ 13N9913), the state of Rhineland-Palatinate and the industrial partner Sensitec GmbH, Mainz is acknowledged. We would like to thank the Nano+Bio Center of the TU Kaiserslautern for sample preparation.

KR 5.30 Tue 10:45 P2

Nanocomposites as a magnetic core in torodial thin film inductors and their integration — Amit Kulkarni[1], Thomas von Hofe[2], Falk Hettstedt[3], Vladimir Zaporojtchenko[1], •Thomas Strunskus[1], Eckhard Quandt[2], Reinhard Knöchel[3], and Franz Faupel[1] — [1]Institute for Material Science, Multicomponent Materials, Faculty of Engineering, University of Kiel, Kaiserstr 2, 24143 Kiel — [2]Institute for Material Science, Inorganic Functional Materials, Faculty of Engineering, University of Kiel, Kaiserstr 2, 24143 Kiel — [3]Institute of Electrical and Information Engineering, Microwave Group, Faculty of Engineering, University of Kiel, Kaiserstr 2, 24143 Kiel

The current advancements in many areas of modern electronics point towards the development and integration of high frequency magnetic components. Use of high permeable magnetic core in the integrated micro-inductors would lead to miniaturization of the geometry and increased inductance provided that, extra losses due to eddy currents are avoided. We have investigated the high frequency permeability of sputter co-deposited CoFe/SiO2 composite films and their integration into torodial micro inductors. High frequency permeability of the composites depends on the metal filling factor and the anisotropy field present. The later can be induced during the fabrication process. Permeabilities of the order of 100 were achieved at 1 GHz for the core material, and it was shown that the preparation technique is compatible with the inductor integration process. The integration process is presently optimized involving the electromagnetic field simulation tool HFSS.

KR 5.31 Tue 10:45 P2

Simulation of atomic deposition between MnAs-clusters — •Andreas Rühl and Christian Heiliger — I. Physikalisches Institut, Justus Liebig University Giessen, D-35392, Germany

We successfully implemented a computational algorithm to calculate and simulate a classical many-body system in a given potential. The considered many-body systems consists of a fixed number of particles, which interact within the boundary conditions suiting the deposition problem at hand. To simulate the condensation of the atoms on a substrate, we included the possibility of cooling down the system by means of a renormalisation of the particles' velocities. So far, the observed results show the equilibration of the system after a certain time, meaning for example, that a random velocity distribution from the start configuration becomes a maxwellian velocity distribution. With the help of the so called radial distribution function we were also able to analyse the system after it has been cooled down to see if the particles arrange in a specific structure.

KR 5.32 Tue 10:45 P2

Néel walls in magnetic hybrid structures — Mohammed Abdul Basith[1], Stephen McVitie[1], •Thomas Strache[2], Monika Fritzsche[2], Arndt Mücklich[2], Jeffrey McCord[2], and Jürgen Fassbender[2] — [1]Department of Physics and Astronomy, University of Glasgow, G12 8QQ, United Kingdom — [2]Institut für Ionenstrahlphysik und Materialforschung, Helmholtz-Zentrum Dresden - Rossendorf, PF 510119, 01314 Dresden, Germany

Néel walls in soft magnetic NiFe/NiFeGa hybrid stripe structures surrounded by a NiFe film are studied by Lorentz microscopy. Upon downscaling the stripe structure size from 1000 nm to 200 nm a transition from a discrete domain pattern to an effective magnetic medium is observed for external magnetic field reversal experiments. This transition is associated with a vanishing ability of hosting neighboring high angle domain walls between adjacent stripes for stripes widths smaller than 500 nm. Furthermore domain walls constricted inside the stripes are characterized concerning the connection between domain wall witdh and domain wall angle. These results are compared with unconstricted domain walls in the surrounding film, theoretical predictions and with micromagnetic simulations.

KR 5.33 Tue 10:45 P2

Magnetisation reversal of individual α-Fe nanowires embeded in carbon nanotubes studied by submicron Hall magnetometry — •Kamil Lipert[1,2], Stefan Bahr[1], Franziska Wolny[1], Paola Atkinson[1], Uhland Weissker[1], Thomas Mühl[1], Oliver G. Schmidt[1], Bernd Büchner[1], and Rüdiger Klingeler[2] — [1]Leibniz Institute for Solid State and Materials Research IFW, 01069 Dresden, Germany — [2]Kirchhoff Institute for Physics, INF 227, D-69120 Heidelberg, Germany

We present the fabrication and characterization of a submicron Hall magnetometer which is based on a n-doped GaAs/AlGaAs heterostructure forming a two dimensional electron gas (2DEG). The device is designed for investigating the magnetic properties of individual nanomagnets. Here, we have studied the magnetisation switching and its dependence on temperature (6K<T<70K) and angle between applied magnetic field and tube axis for two single crystalline Fe nanowires with different diameters $d_1 = 26$ nm and $d_2 = 17$ nm coated with carbon shells. For the thicker Fe-nanowire, the data imply a noncoherent character of the magnetisation reversal. In contrast, for the wire with $d_2 = 17$ nm the nucleation fields increase for fields parallel to the wires axis. This observation resembles the Stoner-Wohlfarth model for rotation of magnetisation in unison, even though the nanowire diameter exceeds the critical diameter of coherent rotation ($d_0 = 12$ nm). In both cases, the temperature dependence of nucleation fields implies that magnetisation switching is a localized process which in case 1 is initiated by curling.

KR 5.34 Tue 10:45 P2

Preparation of domain walls in Co/Pt multilayer wires — •Judith Kimling[1], Andreas Vogel[1], André Kobs[1], Lars Bocklage[1], Sebastian Wintz[2], Jürgen Fassbender[2], Mi-Young Im[3], Peter Fischer[3], Ulrich Merkt[1], Hans Peter Oepen[1], and Guido Meier[1] — [1]Institute of Applied Physics and Microstructure Research Center Hamburg, University of Hamburg, Germany — [2]Institute of Ion-Beam Physics and Materials Research, Helmholtz-Zentrum Dresden - Rossendorf, Dresden, Germany — [3]Center for X-ray Optics, Lawrence Berkeley National Laboratory, Berkeley, USA

Current-induced domain wall motion for studies of spin momentum transfer requires the reliable preparation of domain walls. Since high current densities can alter or destroy the structures investigated, weak pinning potentials and reliable depinning of domain walls at low current densities are desirable. A prerequisite for the preparation of a domain wall at such pinning sites is that the domain wall nucleates at a field smaller than the field required to depin the domain wall. We suggest methods to tune the nucleation field of lithographically patterned Co/Pt multilayer wires. An up to fourfold reduction of the nucleation field could be achieved through altering the lateral shape of the wires or by depositing iron stripes on top. Furthermore we explored the applicability of geometric constrictions and ion implantation for the creation of pinning sites. The magnetization reversal in the structures was imaged by transmission X-ray microscopy.

Financial support by the DFG via SFB 668 and GrK 1286 as well as by BES Mat Sci&Eng Div at DOE is gratefully acknowledged.

KR 5.35 Tue 10:45 P2

Preparation of domain walls in cylindrical nanowires — •Judith Kimling[1], Stephan Martens[1], Kristina Pitzschel[1], Tim Böhnert[1], Michael Martens[1], Peter Lendecke[1], Lars Bocklage[1], Victor Vega[2], Florian Kronast[3], Ulrich Merkt[1], Kornelius Nielsch[1], and Guido Meier[1] — [1]Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung Hamburg, Universität Hamburg, Germany — [2]Departamento de Física, Universidad de Oviedo, Asturias, Spain — [3]Helmholtz-Zentrum Berlin für Materialien und Energie, BESSY, Germany

Electrodeposition of ferromagnetic materials in self-organized nanopores of an alumina membrane provides the unique ability to process ultrathin wires of complex shape and with reproducible properties [1]. For both fundamental research and technological applications it is of interest to understand the nucleation, propagation and pinning of domain walls in such nanostructures. We synthesized nickel and permalloy nanowires with diameters between 30 nm and 300 nm and aspect ratios up to 1000. The magnetization reversal of single wires was studied by magnetic force microscopy, magnetoresistance measurements, magneto-optical Kerr-effect and X-ray photoemission electron microscopy in straight wires, in bent wires, and in wires with diameter modulations serving as tailored pinning sites.

[1] K. Nielsch et al., Handbook of Magnetism and Adv. Magnet. Mat., Vol. 4, John Wiley and Sons, Ltd., Chichester, 2007.

Financial support by the DFG via SFB 668, GrK 1286, and SPP 1165 is gratefully acknowledged.

KR 5.36 Tue 10:45 P2

Ion-beam induced magnetic nanostructures in Fe/Cu(100) — •Sameena Shah Zaman, Hinnerk Ossmer, Jakub Jonner, Zbyněk Novotný, Andreas Buchsbaum, Ondrej Krapek, Petr Dvorak, Michael Schmid, and Peter Varga — TU Wien, Institut für Angewandte Physik, Wien, Austria.

We demonstrate fabrication of nanoscale magnetic patterns by ion irradiation. For this purpose, we have grown face-centered cubic (fcc) 8-ML and 22-ML thick Fe films on a Cu(100) single crystal; the latter ones stabilized by CO. A structural transformation of these films from the paramagnetic fcc to the ferromagnetic bcc phase can be induced by Ar^+ ion irradiation [1]. Scanning tunneling microscopy images show the nucleation of bcc crystallites, which grow with increasing Ar^+ ion dose and eventually result in complete transformation of the film to bcc. Surface magneto-optic Kerr effect measurements confirm the transformation of the Fe film from paramagnetic to ferromagnetic with an in-plane easy axis. We also demonstrate the transformation of films coated with Au to protect them from oxidation at ambient conditions. Nano-patterning was conducted on these films via a SiN mask having 80-nm-diameter holes.

[1] S. Shah-Zaman et al., Phys. Rev. B 82, 235401 (2010).

KR 5.37 Tue 10:45 P2

Correlation between lancet domains and misorientation in FeSi sheets with Goss texture — •Jörg Fankhänel, Felix Kurth, Konrad Güth, Ludwig Schultz, and Rudolf Schäfer — IFW Dresden, Institute for Metallic Materials, P.O. Box 270116, D-01171 Dresden, Germany

For transformer cores, mostly Iron-Silicon-sheets with Goss texture are used. For ideal grain orientation, one of the easy <100> crystal axis is aligned along the rolling direction, while the other two are at angles of 45° with respect to the rolling direction. The magnetic performance strongly depends on the misorientation angle, i.e. the angle between the near-surface easy axis and the sheet surface. Earlier work [1] has shown that this angle correlates with the density of lancet domains, a supplement domain structure that is observed for surfaces with small misorientation and which is formed to minimize the magnetic stray-field energy. In this work we want to verify this correlation and determine the experimental conditions for a reliable determination of the misorientation angle from the lancet domain density. To achieve this we directly measured the misorientation angle by means of EBSD (electron backscatter diffraction) and cross correlate them to the lancet pattern (observed by Kerr microscopy) by application of an external magnetic field at a small angle with respect to the rolling direction. Thus the quantification of misorientation and texture degree in Goss sheets by means of Kerr microscopy is an easy to implement and fast alternative to expensive methods like EBSD or x-ray analysis.

[1] N. Bär, A. Hubert, W. Jillek , J. Magn. Magn. Mat. 6, 242 (1977)

KR 5.38 Tue 10:45 P2

Normal and anomalous Hall effect in $NbFe_2$ — •Sven Friedemann[1], Manuel Brando[2], William J Duncan[3], Andreas Neubauer[4], Christian Pfleiderer[4], and Malte Grosche[1] — [1]University of Cambridge, Cavendish Laboratory, JJ Thomson Avenue, CB3 0HE Cambridge, United Kingdom — [2]Max Planck Institute for Chemical Physics of Solids, Nöthnitzer Strasse 40, 01187 Dresden, Germany — [3]Department of Physics, Royal Holloway, University of London, Egham TW20 0EX, United Kingdom — [4]Physik Department E21, Technische Universität München, James-Franck-Strasse, D-85748 Garching, Germany

The intermetallic system $NbFe_2$ exhibits ferromagnetic and antiferromagnetic order, which can be suppressed by slight changes to the composition within the $Nb_{1-y}Fe_{2+y}$ homogeneity range, thus accessing a quantum critical point (QCP). In proximity to its QCP $NbFe_2$ exhibits non-Fermi-liquid behavior, which makes this material the first clear candidate for a three dimensional ferromagnetic QCP within the transition metals. We present Hall effect measurements on two selected samples of the $Nb_{1-y}Fe_{2+y}$ solution series. The data are analyzed in terms of anomalous and normal contributions to the Hall voltage. The normal contribution is expected to give insight into the electronic structure whereas the anomalous contributions may help to clarify the yet unresolved magnetic properties close to the QCP.

KR 5.39 Tue 10:45 P2

Scaling study on magnetic ordering transition and specific heat in the cubic helimagnet FeGe — •Andrey A. Leonov[1], Michael Baenitz[2], Walter Schnelle[2], Marcus Schmidt[2], Ulrich K. Rössler[1], and Heribert Wilhelm[3] — [1]IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany — [2]MPI CPfS, Noethnitzer Str. 40, 01187 Dresden — [3]Diamond Light Source Ltd., Chilton, Didcot, OX11 0DE, United Kingdom

The magnetic phase transition of the cubic helimagnet FeGe at the ferromagnetic-paramagnetic transition have been analyzed from a scaling study on dc magnetization data by extrapolation from high applied fields. The critical properties have been calculated for a hypothetical homogeneously magnetized state, as FeGe is a helimagnet in the zero-field state. The exponents β for spontaneous magnetization, γ for the initial susceptibility above T_C, and δ for the critical magnetization isotherm at T_C have been obtained from modified Arrott plots and by the Kouvel-Fisher method. The analysis indicates a conventional magnetic phase transition with critical exponents similar to those expected for an isotropic magnet belonging to the Heisenberg universality class. Deviations from the ferromagnetic ordering are discernible at low applied fields for $T < T_C$ owing to the onset of chiral twisting and the inception of helimagnetic order. The specific heat data display only a small region near T_C where scaling applies and reliable determination of the related exponent α is not possible. The anomalous specific heat closer to T_C indicates a first-order phase transition.

KR 5.40 Tue 10:45 P2

New Resonant Inelastic X-ray Scattering and Coherent X-ray Scattering station at UE49-SGM, BESSY II — •Justine Schlappa, Peter Bischoff, Stefan Eisebitt, Frank Eggenstein, Alexander Föhlisch, Rolf Follath, Jan Geilhufe, Christian Günther, Christian Jung, Tino Noll, Bastian Pfau, Jan-Simon Schmidt, Fred Senf, Carsten Tieg, Kerstin Tietz, and Thomas Zeschke — BESSY II, Helmholtz Zentrum Berlin, Germany

Soft x-ray scattering techniques are powerful probes for the understanding of nano- and atomic-scale phenomena, including magnetism, atomic motion and electronic structure [1-3]. New beamline UE49-SGM and experimental stations are currently under construction, dedicated to the techniques of resonant inelastic x-ray scattering (RIXS) and coherent x-ray scattering (CXS). This facility will have the unique possibility to combine high-resolution spatial information studies with high-resolution chemicaly- and atomically-selective spectroscopy studies for a broad range of applications.

[1] S. Eisebitt, et al., Nature 204, 885 (2004), [2] J. Schlappa et al., Phys. Rev. Lett 103, 047401 (2009), [3] F. Hennies, et al. Phys. Rev. Lett 104, 193002 (2010).

KR 5.41 Tue 10:45 P2

Ferromagnetic resonance in Heusler thin films using broadband microwave transmission spectroscopy — •Diana Geiger[1], Marc Scheffler[1], Martin Dressel[1], and Martin Jourdan[2] — [1]1. Physikalisches Institut, Universität Stuttgart, Germany — [2]Institut für Physik, Johannes-Gutenberg-Universität Mainz, Germany

Heusler compounds with a chemical structure X_2YZ are very promising candidates for applications in spintronics because some of them are ferromagnets with a perfect spin polarization of the electrons at the Fermi level. In order to utilize these qualities it is crucial to understand the magnetic properties of these materials. $Co_2Cr_{0.6}Fe_{0.4}Al$ (CCFA) is a ferromagnetic Heusler material with a Curie temperature of 700 to 800K, which makes it well suitable for magnetoelectronic devices. With ferromagnetic resonance studies, magnetization and magnetic moments of ferromagnets can be probed.

We performed broadband microwave stripline transmission measurements on CCFA Heusler samples in variable magnetic field of 0 to 160 mT at temperatures from 100K to 300K. The covered frequency range is 45 MHz to 12 GHz. We employ a stripline geometry where our CCFA thin film serves as ground plane, separated from a copper meandered inner conductor by teflon sheets. With this experimental approach we were able to detect and identify the ferromagnetic resonance in a broad frequency range. We will present both the field and temperature dependence of the ferromagnetic resonance.

KR 5.42 Tue 10:45 P2

***T*-matrix approach for electron-magnon interactions in ferromagnetic materials** — •Mathias C. Müller, Christoph Friedrich, Ersoy Sasioglu, and Stefan Blügel — Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich and JARA, 52425 Jülich, Germany

First-principles calculations of the quasiparticle energies and lifetimes in real materials have been performed mainly within the GW approximation (GWA). The GWA has been shown to yield accurate quasiparticle band structures for weakly to moderately correlated systems, whereas it is expected to fail in describing short-range interactions in strongly correlated systems. The scattering between electrons and magnons that takes place in systems with localized d and f orbitals plays an important role in transport and thermodynamic properties of magnetic materials. These scattering phenomena are not accounted for in the GWA. In order to improve the theoretical description of magnetic materials we go beyond the GWA and take higher-order terms into account. We present a formalism that combines the electron-electron scattering described by GWA and the electron-magnon scattering in a unified way. The magnons are calculated with the T-matrix, which describes multiple scattering of electron-hole pairs with different spin. Our implementation is based on the all-electron full-potential linearized augmented-plane-wave (FLAPW) method [1]. As a first step, we calculate the magnon spectra of elementary ferromagnets.

[1] E. Şaşıoğlu, A. Schindlmayr, Ch. Friedrich, F. Freimuth, and S. Blügel, Phys. Rev. B **81**, 054434 (2010).

KR 5.43 Tue 10:45 P2

Magnetic properties of $Fe_{90}Sc_{10}$ nanoglass — •Ralf Witte[1,2], Jixiang Fang[2], Mohammad Ghafari[2], Robert Kruk[2], Richard A. Brand[2], Horst Hahn[2], and Herbert Gleiter[2] — [1]Technische Universität Darmstadt, Gemeinschaftslabor Nanomaterialien, Petersenstr. 23, D-64287 Darmstadt, Germany — [2]Karlsruher Institut für Technologie, Institut für Nanotechnologie, D-76344 Eggenstein-Leopoldshafen Germany

We report on our work on magnetic properties and their correlation with local structure in Fe-Sc nanoglasses. Samples were synthesized with a nominal composition of $Fe_{90}Sc_{10}$ in an inert-gas condensation (IGC) process. X-ray diffraction, Mössbauer spectroscopy as well as magnetometric characterization methods were applied to characterize the samples. Magnetometric measurements revealed a significant change of magnetic properties in the Fe rich compound marked by an increase of the Curie point to temperatures well above 300 K, which is much higher than the transition temperature in regular metallic glasses of similar composition. The maximum magnetic hyperfine field obtained from low temperature Mössbauer spectroscopy was about 37.5 T, which is much more than observed in bcc-Fe. This newly identified ferromagnetic phase is attributed to the modified short-range-order in the interfaces of adjacent amorphous nanoparticles.

KR 5.44 Tue 10:45 P2

Finite-size effects on the magnetoelectric response of field-driven ferroelectric/ferromagnetic chains — Chenglong Jia[1], •Alexander Sukhov[1,2], Paul P. Horley[3], and Jamal Berakdar[1] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, D-06120 Halle/Saale, Germany — [2]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle/Saale, Germany — [3]Centro de Investigation en Materiales Avanzados, S.C. (CIMAV), 31109 Chihuahua, Mexico

We study theoretically the coupled multiferroic dynamics of one-dimensional ferroelectric/ferromagnet chains with different lengths driven by harmonic magnetic and electric fields. We performed Monte-Carlo simulations and calculations based on the coupled finite-temperature Landau-Lifshitz-Gilbert and Landau-Khalatnikov equations showing that the magnetization and the polarization of thin hetero-structures can be reversed by external electric and magnetic fields, respectively.

KR 5.45 Tue 10:45 P2

Magnetoelectric response of feld-driven composite multiferroics — Chenglong Jia[1], •Alexander Sukhov[1,2], and Jamal Berakdar[1] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, D-06120 Halle/Saale, Germany — [2]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle/Saale, Germany

We study theoretically the electric or magnetic feld-induced dynamical response of a multiferroic material and trace the footprints of the magnetoelectric (ME) coupling in this response. Several scenarios of ME couplings are considered: (*i*) strain-mediated, (*ii*) charge-mediated, (*iii*) and exchange-bias mediated multiferroic oxide composite structures. By utilizing the kinetic Monte-Carlo simulations [1], it is demonstrated that the magnetization and the polarization of the heterostructures are controllable by external electric and magnetic felds, respectively. [1] A. Sukhov, C.L. Jia, P.P. Horley and J. Berakdar, J. Phys.:Condens. Matter **22**, 352201 (2010).

KR 5.46 Tue 10:45 P2

Coupling Effects between Lattice dynamics and Magnetism in $GdMnO_3$ studied by optical spectroscopy — Sven Issing[1], Michael Schmidt[2], Franz Mayr[2], Joachim Deisenhofer[2], Alois Loidl[2], Alexander A. Mukhin[3], Andrei Pimenov[4], and •Jean Geurts[1] — [1]Experimentelle Physik III, Universität Würzburg, Germany — [2]Experimentelle Physik V, Universität Augsburg, Germany — [3]General Physics Institute of the Russian Academy of Sciences, Moscow, Russia — [4]Institut für Festkörperphysik, Technische Universität Wien, Austria

We present detailed optical reflectivity FT-IR investigations of the temperature dependence of the infrared active phonons in the multiferroic manganite $GdMnO_3$ from T = 300K down to T = 5K. $GdMnO_3$ is in the focus of interest due to its intimately coupled orbital, lattice and spin degrees of freedom and the resulting multiferroism. Our results clearly show two different coupling effects shifting the phonon frequencies at the onset of the magnetically ordered phases: Spin-Phonon Coupling (SPC) and Electromagnon-Phonon Coupling (EMPC). SPC is caused by a modulation of the magnetic exchange by a movement of the O^{2-} ions within the MnO_2 plane. Thus, it is most strongly pronounced for phonons consisting mainly of distortive modes of the MnO_6 octahedra within this plane. We observed a softening of the phonon frequencies by $\Delta\omega \approx -(1-2)\%$. EMPC on the other side manifests itself as a strong hardening of the phonon frequency ($\Delta\omega \approx +3\%$) for the $B_{3u}(1)$ mode, which is mainly a Gd^{3+} and Mn^{3+} displacement. It is clearly connected with the appearance of the Electromagnon.

KR 5.47 Tue 10:45 P2

Response of hexagonal multiferroic *R*MnO3 (*R*=Y, Yb, Ho, Er) to magnetic and electric fields — •Sebastian Manz, Tim Günter, Thomas Lottermoser, and Manfred Fiebig — HISKP, University of Bonn, Germany

Contradictory reports on the electric and magnetic properties of the multiferroic hexagonal $RMnO_3$ compounds and their behavior in electric and magnetic fields are found in literature. Examples are the magnetic structure itself, critical field values for the magnetic phase transition, or the electric coercive field and saturation polarization values. These uncertainties further lead to controversial discussions of the magnetoelectric effects to be expected in the $RMnO_3$ system.

Here, we report on a systematical analysis of the response of hexagonal multiferroic $RMnO_3$ to magnetic and electric fields by linear and nonlinear optical techniques and pyroelectric current measurements. The response of samples grown from the flux at different dates and floating-zone samples are compared. We find that the magnetic hysteresis curve can display ferromagnetic, induced ferromagnetic, and ferrimagnetic behavior. Furthermore, we demonstrate that flux-grown samples can no longer be fully polarized at temperatures < 260 K and, due to sample leakage, not at all in the majority of floating-zone samples. We discuss the consequences for electric-field poling experiments reported in the literature.

KR 5.48 Tue 10:45 P2

Nonlinear Spectroscopy and Domain Imaging in the High-temperature Multiferroic CuO — Tim Hoffmann[1], Kenta Kimura[2], •Tsuyoshi Kimura[2], and Manfred Fiebig[1] — [1]University Bonn, HISKP, Germany — [2]Osaka University, Japan

Compounds in which the ferroelectric polarization is directly induced by the magnetic structure (joint-order parameter multiferroics) are of special interest because of their intrinsically strong magnetoelectric coupling. In the majority of these systems this effect occurs at temperatures < 50 K. However, in CuO ferroelectricity is induced by a spiral magnetic order at ≈ 230 K. This proves that joint-order-parameter multiferroicity is not limited to the low-temperature regime and renders CuO an important subject of research on the search for large magnetoelectric effects at near-ambient temperatures.

We performed a full characterization of the compound by polarization-dependent optical second harmonic generation spectroscopy. By temperature dependent measurements we could identify the SHG tensor components coupling to the multiferroic state and obtain the temperature dependence of the ferroelectric polarization and the magenetic order parameter, respectively. The gigantic efficiency of the observed SHG signal points to a substantial electronic (instead of ionic) contribution to the ferroelectric polarization. Furthermore we investigated the multiferroic domain structure by spatially resolved SHG and found that in zero-field-cooled samples the domain size is on the order of 0.1-1 μm.

KR 5.49 Tue 10:45 P2

Spin-Phonon Excitations in Multiferroics — •Safa Golrokh Bahoosh[1], Steffen Trimper[2], and Julia Wesselinowa[3] — [1]Max Planck Institute of Microstructure Physics,Halle,Germany — [2]Institute of Physics, Martin-Luther-University,Halle,Germany — [3]University of Sofia, Department of Physics,Sofia,Bulgaria

The influence of phonons on multiferroic systems are studied using a Green's function technique. The calculations are performed on the basis of considering nearest and the next nearest neighbor interaction in the Heisenberg model which favors the occurrence of helical structures in the magnetic system. The ferroelectric subsystem is characterized by the Ising model in a transverse field and is described by pseudo-spin-operators. Taking into account anharmonic phonon couplings, spin-phonon interaction as well as pseudo-spin-phonon-interaction we calculate the temperature dependent spectrum of the coupled system. The elementary excitations determine the macroscopic properties of the system like the magnetization and the polarization. The results are compared with experimental observations.

KR 5.50 Tue 10:45 P2

Nonlinear optical spectroscopy on magnetoelectric and multiferroic pyroxenes $LiFeSi_2O_6$ and $NaFeSi_2O_6$ — •Adrian Volz[1], Naëmi Leo[1], Petra Becker[2], Ladislav Bohatý[2], and Manfred Fiebig[1] — [1]HISKP, Universität Bonn — [2]Institut für Kristallographie, Universität zu Köln

There has been a growing interest in the class of pyroxenes $AMSi_2O_6$ (A alkali metal, M transition metal) with multifunctional properties such as multiferroicity or magnetic-field controllable electric polarization. In particular the close relation between toroidal moment and the observed cross-coupling of magnetic and electric properties are discussed for multiferroic $NaFeSi_2O_6$ and magnetoelectric $LiFeSi_2O_6$.

Here we characterize the pyroxene compounds $LiFeSi_2O_6$ and $NaFeSi_2O_6$ by optical second harmonic generation (SHG). SHG is particularly sensitive to the subtle symmetry issues distinguishing between the magnetoelectric and the multiferroic properties of the pyroxenes. We observe gigantic SHG effeciency which indicates electronic (i.e. non-ionic) contributions to the magnetically induced spontaneous polarization. By SHG spectroscopy we seperate signals of crystallographic, magnetic and electric origin which allows us to investigate the interaction between the corresponding sublattices. The influence of externally applied fields is discussed.

This work is supported by the DFG through SFB 608.

KR 5.51 Tue 10:45 P2

Magneto-electric coupling in $NdFe_3(BO_3)_4$ studied by resonant x-ray scattering — •J. E. Hamann-Borrero[1], S. Partzsch[1], S. Valencia[2], R. Feyerherm[2], C. Mazzoli[3], J. Herrero-Martin[3], C. Hess[1], A. Vasiliev[4], L. Bezmaternykh[5], B. Büchner[1], and J. Geck[1] — [1]IFW Dresden, 01171 Dresden — [2]Helmholtz Zentrum Berlin. Albert Einstein Str. 15 12489 Berlin — [3]ESRF, Boite Postale 220, 38043 Grenoble, France — [4]Faculty of Physics, Moscow State University, Russia. — [5]Kirensky Institute of Physics, Russian Academy of Sciences, Krasnoyarsk, Russia.

Resonant x-ray magnetic scattering (RXS) experiments on $NdFe_3(BO_3)_4$ were performed at the Nd $L_{2,3}$ and Fe K edges in order to determine its magnetic structure as a function of temperature (T) as well as applied magnetic (**B**) and electric (**E**) fields. Results of the T dependent measurements show that the magnetic structure changes from a commensurate collinear structure to an incommensurate spin helix structure. Moreover, the analysis of the resonant intensities shows that the T dependence of the magnetic order is different for the Nd and for the Fe sublattice. A mean field analysis implies that the magnetization of the Nd sublattice is induced by the Fe magnetization. When a **B** field is applied along the a-direction, the spin helix is destroyed and a collinear structure is formed where the moments align perpendicular to **B**. Since the critical **B** at which the spin helix is destroyed is the same at which the magnetic induced electric polarization is maximum. This shows that the spin helix is not the origin of the electric polarization in $NdFe_3(BO_3)_4$.

KR 5.52 Tue 10:45 P2

Magnetic field induced polarization in the Ba3NbFe3Si2O14 crystal with a chiral spin structure — •Matthias Hudl[1,2], Yusuke Tokunaga[3], Yasujiro Taguchi[1], Roland Mathieu[2], and Yoshinori Tokura[1,3,4] — [1]RIKEN, Adv. Sci. Inst., CERG and CMRG, Wako, Saitama, 3510198 Japan — [2]Uppsala University, Dept. Engn. Sci., SE-75121 Uppsala, Sweden — [3]ERATO JST, Multiferroics Project, Tokyo 1138656, Japan — [4]University of Tokyo, Dept. Appl. Phys., Tokyo 1138656, Japan

Single crystals of langasite Ba3NbFe3Si2O14 with a chiral magnetic structure have been synthesized by floating zone method. In this system, the magnetic ions (Fe3+) are arranged in the ab-plane forming planar triangular lattices of triangle units. Below T = 27 K, three spins within a single triangle order uniformly in a 120° spin structure in the ab-plane. This structure is helically modulated from plane to plane along the c-axis. The complex magnetic structure suggests magnetic-field-induced electrical polarization and magnetoelectric effects. We have investigated the magnetic and magnetoelectric properties of the single crystals by magnetization and electrical polarization measurements. While no polarization is induced along the c-axis of the structure for any orientation of the magnetic field, we have observed a field-induced electric polarization along the a-axis direction for applied magnetic fields in the ab-plane up to 14 T. *** M. H. and R. M. thank the Anna Maria Lundin-, Hans Werthén- and Göran Gustafsson Foundation for support. This work was in part supported by JSPS,

FIRST program on "Quantum Science on Strong Correlation".

KR 5.53 Tue 10:45 P2

Magnetic Resonance and Magnetization Measurements of Multiferroic $Eu_xBa_{1-x}TiO_3$ — •Nataliya Georgieva[1], Andreas Pöppl[1], Rolf Böttcher[1], Marko Bertmer[1], Jürgen Haase[1], and Alex Sushkov[2] — [1]Faculty of Physics and Earth Sciences, University of Leipzig, Germany — [2]Department, Yale University, New Haven, Connecticut, USA

We are investigating multiferroic $Eu_xBa_{1-x}TiO_3$ with different Eu^{2+} concentrations (x = 1, 0.75, 0.5, 0.25) using magnetic resonance spectroscopy (EPR and NMR) and magnetization measurements.

The ceramics samples exhibit different magnetic and electric properties depending on their Eu^{2+} concentration. SQUID magnetization measurements have revealed Curie-Weiss behavior of all samples and magnetic ordering at low temperatures.

The X- and Q-band EPR spectra show strongly dipole-broadened and exchange-coupled Eu^{2+} signals. Temperature dependent line broadening effects are observed and differ for various Eu^{2+} concentrations.

Preliminary ^{137}Ba NMR spectra were recorded using frequency stepped Hahn Echo experiments. The line width of the central ^{137}Ba nuclear quadrupole transition shows a striking dependence on the Eu^{2+} concentration.

KR 5.54 Tue 10:45 P2

Magnetic structure of multiferroic $GdMnO_3$ explored by Resonant Soft X-ray Scattering — •Enrico Schierle[1], Victor Soltwisch[1], Detlef Schmitz[1], Andrey Malyuk[2], Fabiano Yokaichiya[2], Dimitri N. Argyriou[2], and Eugen Weschke[1] — [1]Helmholtz-Zentrum Berlin für Materialien und Energie, Albert-Einstein-Straße 15, 12489 Berlin, Germany — [2]Helmholtz-Zentrum Berlin für Materialien und Energie, Hahn-Meitner-Platz 1, 14109 Berlin, Germany

In the orthorombic $ReMnO_3$s (Re=Gd, Dy, Tb), ferroelectric polarization is induced by complex magnetic structures resulting in a strong coupling of the two ordering phenomena [1]. While the multiferroic properties are dominated by the cycloidal structure of Mn moments as established by neutron diffraction [2], there is growing evidence for a decisive role of ordering of the Re-4f moments as well. This has been highlighted by x-ray diffraction studies as a complementary tool [3,4]. Particularly, resonant soft x-ray scattering (RSXS) is well suited to study details on the magnetic structure in an element-specific way [4]. We studied the magnetic ordering of the Gd-4f spins of $GdMnO_3$ in detail by RSXS, shedding new light on the possible mechanisms of multiferroicity. The experiment was performed using a very recently commissioned diffractometer for RSXS built at HZB.

[1] Kimura et al., Nature **426**, 55-58 (2003)
[2] Kenzelmann et al., PRL **95**, 087206 (2005)
[3] Prokhnenko et al., PRL **98**, 057206 (2007)
[4] Schierle et al., PRL **105**, 167207 (2010)

KR 5.55 Tue 10:45 P2

Resonant Soft X-ray Scattering (RSXS) Studies on Multiferroic YMn2O5 with six circle diffractometer and CCD-camera — •Sven Partzsch[1], Stuart Wilkins[2], John Hill[2], Enrico Schierle[3], Eugen Weschke[3], Dmitri Souptel[1], Bernd Büchner[1], and Jochen Geck[1] — [1]IFW Dresden — [2]BNL Upton — [3]Helmholz-Zentrum Berlin

RMn_2O_5 (R = Y, rare earth, Bi) are multiferroics there RSXS at the magnetic modulation vector $(1/2, 0, 1/4)$ provide additional information to neutrons. By tuning the energy to the Mn L- and O K-edges, respectively, the experiment becomes element selective. To see which scattering is proportional to the electric polarization the integrated intensity is important. For this we performed experiments at X1A2 (Tardis), NSLS, BNL, Upton, New York, USA. Four moving motors in six circle geometry and a CCD-camera provided the integrated intensity and all widths in three principal directions with one scan (set of images). Thus this technique is practical to study strongly correlated electron systems.

KR 5.56 Tue 10:45 P2

Multiferroics: Magnetic Structures & Excitations — •Simon Holbein[1], Max Baum[1], Thomas Finger[1], Navid Qureshi[1], Jeannis Leist[3], Götz Eckold[3], Petra Becker[2], Ladislav Bohatý[2], and Markus Braden[1] — [1]II. Physikalisches Insittut, Universität zu Köln — [2]Institut für Kristallographie, Universität zu Köln — [3]Institut für Physikalische Chemie, Georg-August-Universität Göttingen

Multiferroics possess a large application potential in data storage techniques. Quite recently, systems with a peculiar spiral magnetic order were shown to directly induce a spontaneous electric polarisation and to exhibit giant magnetoelectric and magnetocapacitance effects, among them MnWO4, TbMnO3 and the pyroxenes (Na/Li)FeSi2O6.

We already presented time resolved measurements of magnetoelectric switching in MnWO4. Stroboscopic techniques were applied in order to investigate how fast the magnetic chirality adapts to an instantaneously switched electric field. Recently we arranged a new set-up to investigate the corresponding behaviour of the electric polarisation at such electric fields.

Our results on the magnetic structure of NaFeSi2O6 reveal that the moments arrange in a helical spiral. Therefore the Dzyaloshinski-Moriya interaction is not explaining the development of electrical polarisation (a cycloidal spiral would be needed for this). We extended our investigations on electric field driven switching of magnetic chirality to NaFeSi2O6.

Furthermore we discuss the electromagnon - collective spin-phonon excitations - in DyMnO3.

KR 5.57 Tue 10:45 P2

Competing Ferri- and Antiferromagnetic Phases in Geometrical Frustrated $LuFe_2O_4$ — •Joost de Groot[1], Karin Schmalzl[1], Andrew Christianson[2], Mark Lumsden[2], Karol Marty[2], Shilpa Adiga[2], Stephen Nagler[2], Werner Schweika[1], Zahra Yamani[3], and Manuel Angst[1] — [1]IFF, JARA-FIT, Forschungszentrum Jülich GmbH, Jülich, Germany — [2]Oak Ridge National Laboratory, Oak Ridge, USA — [3]Canadian Neutron Beam Center, Chalk River, Canada

$LuFe_2O_4$ is proposed to be a multiferroic material [1], with a novel mechanism for ferroelectricity, based on Fe2+/Fe3+ charge order (CO). Frustration leads to near degeneracy between ferro- and antiferroelectric CO, with antiferroelectric long range order established below T_{CO} ∼320K [2]. Clarifying the magnetic long range order below T_N ∼240K [3] and the transition to a glassy state at T_{LT} ∼170K is as important as elucidating the origin of (anti)ferroelectricity.

We will present a detailed study of the magnetic field - temperature phase diagram, which features an antiferromagnetic and a ferrimagnetic phase and for low temperatures a phase separation. We demonstrate that nearly degenerate ferrimagnetic and antiferromagnetic instabilities at T_N are the key to the remarkably rich phase diagram. These bear a striking resemblance to nearly degenerate antiferro- and ferroelectric CO instabilities at T_{CO}[2].

[1]N. Ikeda *et al.*, Nature **436** 1136 (2005); [2]M. Angst *et al.*, Phys. Rev. Lett. **101** 227601 (2008); [3]A. D. Christianson *et al.*, Phys. Rev. Lett. **100** 107601 (2008).

KR 5.58 Tue 10:45 P2

Synthesis optimization of Possible Relaxor Ferroelectric Magnetite crystals — •Shilpa Adiga, Jörg Persson, and Manuel Angst — IFF, JARA-FIT, Forschungszentrum Jülich GmbH, Jülich, Germany

The 120 K Verwey-transition [1] in magnetite Fe_3O_4 is the classical example for charge ordering. Despite of the decades of research, the complex low-temperature structure and even the existence of $Fe^{2+/3+}$ charge order is still unresolved. Early experimental studies and recent theoretical calculations on magnetite support ferroelectricity (FE) due to charge ordering. If confirmed, FE, and thus multiferroicity from charge order in classical magnetite would be significant. Recently, Schrettle *et al* [2] observed signatures of relaxor FE in dielectric spectroscopy measurements. Specific diffuse scattering would be expected in such a case. Unambiguous proof of (relaxor) FE may be obtained by detailed scattering experiments. The sensitivity of the Verwey transition depends on sample quality (oxygen stoichiometry) [3]. The best way to obtain high-quality crystals is the direct synthesis in an appropriate CO/CO_2 flow [4]. We first investigated appropriate ratios of CO/CO_2 at high temperature on polycrystalline samples, characterized primarily by thermo-remanent magnetization and specific heat. The use of the results for the crystal growth by floating zone method and the physical properties of the grown crystals will be presented.

[1] E.J.W.Verwey, Nature **144** 327 (1939). [2] F. Schrettle *et al.*, arXive:1007.3613. [3] P. Shepherd *et al.*, Phys. Rev. B. **43** 8461 (1991). [4] R.Aragon *et al.*, J. crystal growth,. **61** 221 (1983).

KR 5.59 Tue 10:45 P2

DFT modeling of point defects in strontium titanate — •Ider

Ronneberger, Matthias Zschornak, and Sibylle Gemming — Institut für Ionenstrahlphysik und Materialforschung, Helmholtz-Zentrum Dresden-Rossendorf (HZDR), D-01314 Dresden, Germany

Multiferroics, which simultaneously exhibit at least 2 ferroic properties, are considered as novel materials with promising technological applications, e.g. as sensor or switching element. A possible candidate for such materials is strontium titanate, doped with magnetic point defects. In our research we studied 2 x 2 x 2 supercells of strontium titanate defect structures with DFT. As defects we considered the substitution of Ti by the transition metals Fe, Mn and V as single impurities and in combination with oxygen vacancies. From the electron density calculations we derive structural deformations, charge transfer and magnetic properties. Stability is discussed in terms of formation energies of the defects.

KR 5.60 Tue 10:45 P2

Raman spectroscopic investigations of epitaxial $BiCrO_3$ thin films on different substrates — •Andreas Talkenberger[1], Kannan Vijayanandhini[2], Christian Röder[1], David Rafaja[3], Miryam Arredondo[2], Ionela Vrejoiu[2], and Cameliu Himcinschi[1] — [1]TU Bergakademie Freiberg, Institute of Theoretical Physics, D-09596 Freiberg, Germany — [2]Max Planck Institute of Microstructure Physics, Weinberg 2, D-06120 Halle, Germany — [3]TU Bergakademie Freiberg, Institute of Materials Science, D-09596 Freiberg, Germany

Multiferroic epitaxial thin films are of strong research interest due to their properties and potential applications for example in memory devices. In this work epitaxial $BiCrO_3$ (BCO) thin films deposited by pulsed laser deposition on $SrTiO_3$ (100), $(LaAlO_3)_{0.3}$-$(Sr_2AlTaO_6)_{0.7}$ (100) and $NdGaO_3$(110) substrates were investigated by Raman spectroscopy. The Raman spectra were measured from 87 K to room temperature using the 532 nm emission line of a Nd:YAG laser for excitation. The epitaxial relation between films and substrates was verified by analyzing high resolution transmission electron microscopy images, electron diffraction patterns, and polarization dependent Raman spectra considering that BCO crystallizes in the C2/c space group. The shift of phonon modes at room temperature indicates different strains in the BCO films grown on the three substrates. The optical phonon shift of the epitaxially strained BCO films was related to the strain determined from high resolution XRD measurements.

This work is supported by the German Research Foundation DFG HI 1534/1-1.

KR 5.61 Tue 10:45 P2

Structural and magnetic characterization of spinel films prepared by MAD — •Simon Slapka, Vasile Mosneaga, and Konrad Samwer — 1. Physikalisches Institut, Universität Göttingen

Spinels are known for a long time as magnetic materials, the oldest one (Fe3O4) used by the chinese as a compass. Spinels with multiferroic properties have been found (CoCr2O4).

In the case of manganese-doped spinel films spins are arrangend on an triangular lattice. The antiferromagnetic coupling causes magnetic frustration.

Unexpected dielectric properties have been found in thin films of Zn0.25Mn0.75Al2O4. The present study is adressed to the connection between spin frustration, magnetic properties and these unexpected dieletric properties.

KR 5.62 Tue 10:45 P2

Tuning the ferroelectric properties of $BiFeO_3$ thin films with mechanical stress — •Martin Hoffmann, Oliver Mieth, and Lukas M. Eng — Institut für Angewandte Photophysik, Technische Universität Dresden, D-01062 Dresden

In thin film physics, the crystallographic structure of the deposited film is strongly influenced by the substrate induced strain caused by the lattice mismatch between substrate and film. This leads to the fact that the properties of thin films and surfaces can differ dramatically from the corresponding bulk values.

In the present study, the ferroelectric properties of multiferroic $BiFeO_3$ thin films on $SrTiO_3$ under compressive and tensile stress were investigated via piezoresponse force microscopy (PFM). The systematic substrate bending allows us to record the strain dependent domain distribution and the local switching behavior on the nanometer lengthscale. We quantify these effects through monitoring the coercive field and the imprint as a function of applied stress; in fact, we observe that strain effects can be significantly enhanced or even fully compensated in BFO/STO thin films allowing the BFO film to become tunable in its ferroic properties.

KR 5.63 Tue 10:45 P2

Magnetic domain structure evolution in NiMnGa magnetic shape memory alloy — •Andreas Neudert and Jeffrey McCord — Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Bautzner Landstr. 400, 01328 Dresden

We have investigated the magnetic domain structure evolution due to twin boundary motion in single crystalline NiMnGa (10M) magnetic shape memory samples. Due to the high mobility of the twin boundaries they can be moved by applying a magnetic field or mechanical stress. In general, the equilibrium domain width in magnetic samples depends on the interplay of demagnetization and anisotropy energy. Depending on the orientation of the easy axis within a magnetic sample different equilibrium widths can be found. We investigated the magnetic domain structure using optical polarization microscopy and magnetic indicator film technique. We found that the qualitative domain structure depends on whether the sample was subjected to magnetic fields or mechanical stresses. In both cases the twin boundary is moved and therefore the orientation of the magnetic easy axis is changing. During the field induced motion the variants are partially saturated, whereas during the stress induced motion the net magnetization in the variants is unchanged. This results in a completely different remagnetization process and magnetic domain structure. Using domain theory the equilibrium domain width can be calculated and is compared with the experimental values. We greatly acknowledge support by DFG priority program SPP 1239.

KR 5.64 Tue 10:45 P2

Local epitaxial growth of magnetic shape memory films Ni2MnGa on MgO-buffered CMOS substrates — •Yuansu Luo, Xueyuan Zhang, and Konrad Samwer — I. Phys. Institut, Universität Göttingen, Friedrich-Hund Platz 1, 37077 Göttingen

Local epitaxial films Ni2MnGa were prepared on MgO-buffered CMOS substrates for possible integration of microsensors. The MgO buffer layers were reactively sputtered at 350-700°C, exhibiting a perfect [100] orientation perpendicular to the substrate and accordingly a preference of [010] and [001] orientations parallel to the substrate. No significant difference was found of MgO buffer layers on Si and SiO2. Similar texture behaviours were measured in austenitic Ni2MnGa films and indicate the local epitaxial growth on MgO buffer. The surface of martensitic films reveals thus twin boundaries in two preferred directions perpendicular to each other. The magnetic transition at TC of about 375K was observed relatively sharp, but the martensitic phase transformation (TM ~320K) slightly broad compared to overall epitaxial films prepared on MgO substrates. Two-dimensional (2D) grain growth and thus a smooth surface are typical characters for the local epitaxial films on the MgO buffer, rather than rough 3D grain films prepared directly on SiO2 substrates. (Supported by BMBF-project 13N10061 MSM-Sens)

KR 5.65 Tue 10:45 P2

Investigation of single-crystalline magnetic shape memory alloys: Ni-Mn-X (X = In, Ga, Sb) — •Christian Schöppner[1], Santa Pile[1], Ivan Titov[1], Detlef Spoddig[1], Ralf Meckienstock[1], Mehmet Acet[1], Michael Farle[1], Jian Liu[2], Nils Scheerbaum[2], Sandra Weiss[2], and Oliver Gutfleisch[2] — [1]Universität Duisburg-Essen, Fakultät für Physik, AG Farle, 47057 Duisburg, Germany — [2]IFW Dresden, Institue for Metallic Materials, P.O. Bos 270116, 01171 Dresden

Ni-Mn-based magnetic shape memory alloys are promising active materials for actuators and sensors, since they provide huge field-induced strains up to 10% due to magnetic field-induced structural reorientation or magnetic field-induced phase transformation. For a deeper understanding of these effects, the magnetic-structural properties of Ni-Mn-X (X= In, Sb, Ga) magnetic shape memory alloys are investigated on single-crystalline samples in the μm-range by electron-backscatter-diffraction (EBSD), magnetization analysis and ferromagnetic-resonance (FMR). Temperature and angular dependent FMR measurements on single-crystalline samples provide the possibility to determine crystalline anisotropy constants in certain crystallographic planes in austenite and martensite states and can be put into context with M(H)-data measured in the temperature range $5 \leq T \leq 400K$.

Work supported by the Deutsche Forschungsgemeinschaft (SPP1239)

KR 5.66 Tue 10:45 P2

Microstructure of free-standing Ni2MnGa films — •Richard Hausmanns, Tobias Eichhorn, and Gerhard Jakob — Institut für Physik, Johannes Gutenberg-Universität Mainz, Deutschland

One of the interesting properties of the Heusler compound Ni2MnGa is the presence of the magnetic shape memory effect with a maximum length change of 10%. Thin, single crystalline films of this material thus are interesting for miniaturized sensor and actuator applications. The here investigated samples are prepared by dc-magnetron sputter deposition on heated MgO(100) substrates with a Cr buffer layer. The films can be released from the substrate by selective chemical etching of the Cr layer. The complex crystal structure before and after releasing the film is studied by x-ray diffraction in 4-circle geometry. Thereby different orthorhombic variants and modulation (7M/14M) are identified. The crystal structure appears to be unaffected by the removal of the buffer layer.

The presence of steps in the hysteresis loops, measured on free-standing films, indicates that magnetically induced reorientation of variants can occur. To prove that the variant distribution is studied by x-ray diffraction with applied magnetic field.

KR 5.67 Tue 10:45 P2

Structural and magnetic properties of tetragonal Heusler compounds Mn2-xFe1+xGa (x=0.2-1) — •Teuta Gasi, Jürgen Winterlik, and Claudia Felser — Institute of Inorganic and Analytical Chemistry, Johannes Gutenberg-University, Mainz, Germany

The subject of this brief report are the structural and magnetic properties of tetragonal Heusler compounds Mn2- xFe1+xGa (x=0.2-1). These materials play an important role because of their multifunctional application in STT-MRAM technology, STO etc. A series of samples were successfully synthesized by arc-melting and characterized. The crystal structure was determined at RT by XRD and the magnetic measurements were done using SQUID magnetometer in the temperature range 2K-800K. STT-MRAM requires high Tc, low Gilbert damping constant, low magnetic moment. The magnetic measurements show that all these materials show high Tc above 600 K and diverse magnetic hardness. We have found that a compound Fe2MnGa demonstrates the shape-memory effect.

KR 5.68 Tue 10:45 P2

Electronic structure of the austenitic and martensitic phase of Ni_2MnGa . — •Aleksej Laptev[1], Philipp Leicht[1], Mikhail Fonin[1], Martin Weser[2], Hendrik Vita[2], Yuriy Dedkov[2], S. W. D'Souza[3], and Sudipta Roy Barman[3] — [1]Fachbereich Physik, Universität Konstanz, 78457 Konstanz — [2]Fritz-Haber-Institut der Max-Planck-Gesellschaft, 14195 Berlin — [3]UGC-DAE Consortium for Scientific Research, 452001 Indore, India

Recently Ni_2MnGa and related alloys have attracted strong scientific interest due to a reported magnetic field induced strain of up to 10 % in the low temperature martensitic phase. The occurrence of the structural martensitic phase transition is reported to be closely related to the electronic structure of this material. Especially strong Fermi-surface nesting was proposed for this material [1,2]. Here we report the investigation of the electronic structure of a $Ni_2MnGa(001)$ single crystal with angle resolved photoemission (ARPES). The sample was also studied by means of STM and revealed a well-ordered and reconstruction-free surface. ARPES measurements were performed in both austenitic and martensitic state. The obtained Fermi-surface and band structures of both phases were compared with currently existing electronic structure calculations [1,2]. At this preliminary point of our analysis good agreement between theory and experiment is found.

This work was supported by the BMBF-Project MSM-Sens 13N10062.

[1] O. I. Velikokhatnyi and I. I. Naumov, *Phys. Solid State* **41**, 617-623, (1999)

[2] C. Bungaro et al., *Phys. Rev. B* **68**, 134104 (2003)

KR 5.69 Tue 10:45 P2

Designing Heusler systems with martensitic transformations — •Ivan Titov, Mehmet Acet, and Eberhard Wassermann — Experimetalphysik, Universität Duisburg-Essen, 47048 Duisburg

The search for magnetic shape memory alloys as alternatives to the prototype Ni-Mn-Ga alloys system has provided further understanding of magnetic-field-induced effects in a variety of Ni-Mn-based martensitic Heusler alloys. Such alloys exhibit substantial antiferromagnetic exchange just below the martensitic transformation temperature, and this is thought to affect twin-boundary motion adversely since it can lead to pinning effects. We aim to find new Heusler materials that undergo martensitic transformations and, at the same time, are essentially free of antiferromagnetic exchange, or the exchange is sufficiently weak, so that twin-boundary motion is not hindered. These conditions primarily demand the alloy compositions to be Mn-free. Mn is the source of antiferromagnetic exchange, particularly at Mn-rich off-stoichiometric compositions. We present studies on the structural and magnetic properties of Co-Cr-Ga, Ni-(FeCr)-Ga, and Co-Ni-Fe-Ga and present an overview of their phase diagrams in relation to martensitic transformations.

KR 5.70 Tue 10:45 P2

Role of oxygen holes and charge-dispropotionation in transition-metal compounds,$Cs_2Au_2Cl_6$ — •Alexey Ushakov[1], Sergey Streltsov[1,2,3], and Daniil Khomskii[1] — [1]II Physikalisches Institut, Universität zu Köln, Zülpicher Str. 77, D-50937 Köln Germany — [2]Institute of Metal Physics, S. Kovalevskoy Str. 18, 620041 Ekaterinburg GSP-170, Russia — [3]Ural Federal University, Mira Str. 19, 620002 Ekaterinburg, Russia

The systems with mixed-valence (MV) state of magnetic ions and/or with spontaneous charge disproportionation attract at the moment big attention. Typical such system is perovskite gold chloride $Cs_2Au_2Cl_6$. At ambient pressure it is an insulator with tetragonal crystal structure $I4/mmm$. There appears in this phase a spontaneous charge segregation of Au into $Au^{1+}(d^{10})$ and $Au^{3+}(d^8)$, ordered in checkerboard fashion. Under the pressure this valence disproportion vanishes, and at about 11.3 GPa, this systems becomes a metal with equivalent Au (single-valent(SV) state).

In this work we perform the ab-initio band structure calculations of $Cs_2Au_2O_6$. The main aim of our research is to determine the factors, which promote the charge disproportionation in this and similar systems, and the possible role of ligand (here Cl) holes in the formation of such state and its change under pressure.

KR 5.71 Tue 10:45 P2

Electronic structure of transition metal nanoclusters — •Ingo Opahle — Institut für Theoretische Physik, Universität Frankfurt, 60438 Frankfurt/Main, Germany

The electronic structure of small to intermediate sized transition metal clusters (Au, Pt and their binary alloys with Cu and Co) is calculated within the framework of density functional theory. Global optimization of the ground state structure is performed with a recently developed genetic algorithm. Details of the implementation of the genetic algorithm and its performance will be discussed. The transition to bulk like behaviour of the clusters and their electronic and magnetic properties (including magnetic anisotropy) will be discussed.

KR 5.72 Tue 10:45 P2

About the 3ω method - the question current source or voltage source, plus application for field-dependent thermal conductivity measurements — •Johannes Kimling, Johannes Gooth, and Kornelius Nielsch — Institute of Applied Physics, University of Hamburg, Germany

The 3ω method is a standard method for thermal conductivity measurements. Researchers employ current-driven and voltage-driven setups, with or without common-mode subtraction for detecting the third harmonic component of the measurement signal. Nevertheless, there is a lack of clarity for which voltage-driven setups one has to consider a correction factor, as the formalism assumes an ideal current source at 1ω. In this work we show that for voltage-driven setups using common-mode subtraction, the application of a correction factor would be incorrect. On the other hand, for 3ω setups that use simple voltage-driven series circuits without common-mode subtraction a correction factor has to be considered. We employed the 3ω method to perform field-dependent thermal conductivity measurements on individual electrochemically synthesized nickel wires with diameters between 150 nm and 350 nm. Such structures exhibit anisotropic magnetoresistance. The field-dependent 3ω measurement allows observing the thermal analog: the anisotropic magnetothermal resistance. Measuring both effects simultaneously reveals spin-dependent changes in the Lorenz-number. Application to magnetic multilayer nanowires will allow studying the giant magnetothermal resistance in the cross-plane direction.

KR 5.73 Tue 10:45 P2

Formation and evolution of domain patterns and topological defects in antiferromagnetically coupled perpendicu-

larly magnetized multilayers — •Nikolai Kiselev[1], Volker Neu[1], Ulrike Wolff[1], Cristina Bran[2], Olav Hellwig[3], Alex Bogdanov[1], and Ulrich Rössler[1] — [1]IFW Dresden, Germany — [2]Uppsala University, Sweden — [3]Hitachi GST, San Jose, USA

Ground states in magnetic multilayers with strong perpendicular anisotropy and antiferromagnetic (AF) interlayer exchange coupling (IEC) as [Co/Pt(Pd)]/Ru or [Co/Pt]/NiO are (i) multidomain states with ferromagnetic (FM) arrangement of magnetization through the whole multilayer and (ii) the homogeneous state with AF arrangement in adjacent layers [1]. Within the homogeneous AF state, there are different types of defects which exist as a metastable state. These defects are composed of irregular networks of isolated 180-degree domain walls in FM layers which are coupled via interlayers and stabilized by the competition between IEC and magnetostatic interaction. We distinguish sharp domain wall, ferroband and tiger tail (TT) defects [2]. Theoretical analysis using micromagnetic domain models shows that TT patterns cannot be stabilized by the interplay between magnetostatic and IEC energies only, but can be stabilized by domain wall pinning. We present a theoretical and experimental study of nucleation and evolution of these defects in magnetic fields in [Co/Pt]/Ru multilayers.

[1] N. S. Kiselev, et al., Appl. Phys. Lett. 93, 162502 (2008); [2] N. S. Kiselev, et al., J. Magn. Magn. Mater. 322, 1340-1342 (2010);

KR 5.74 Tue 10:45 P2

Micromagnetic model for exchange coupled $SmCo_5$/Fe/$SmCo_5$-trilayers — •Martin Kopte, Simon Sawatzki, Marietta Seifert, Ludwig Schultz, and Volker Neu — IFW Dresden, Germany

The enhancement of remanence and energy density in exchange coupled hard/soft magnets has reached a new record value of $300\,kJ/m^3$ in recently prepared epitaxial $SmCo_5$/Fe/$SmCo_5$-trilayers. A micromagnetic model has been adapted to such a trilayer system, which simulates the full hysteresis in a one-dimensional spin chain approach and the effect of the intermediate Fe-layer thickness d_{Fe} has been evaluated. The simulations have been carried out using the programs OOMMF and MicroMagus, after carefully checking the input parameters for stable solutions. Calculated hysteresis curves are in very good agreement with the experimental results, and reproduce the characteristic decay of nucleation field and coercive field with increasing d_{Fe}. A modification of the model to include gradual changes of the intrinsic magnetic parameters at the interface (mimicking the effect of a diffusion profile as a result of the deposition process) has consequences on the qualitative agreement between model and experiment.

KR 5.75 Tue 10:45 P2

Strayfield landscape supported self-assembling submonolayers of phthalocyanines — •Florian Ahrend[1], Ulrich Glebe[1], Tobias Weidner[2], Ulrich Siemeling[1], and Arno Ehresmann[1] — [1]University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel — [2]Department of Bioengineering, University of Washington, Seattle

Ion bombardment induced magnetic patterning (IBMP) modifies exchange bias layer systems into defined artificial domain patterns of different shape and size. These can be used to control the self-assembly of certain organic compounds into well ordered sub-monolayers. In this experiment topographically flat samples with a magnetic stripe pattern of a periodicity of 10 or 20 micrometer are used. A head-to-head/tail-to-tail magnetization was chosen, so that at each border of adjacent domains strong magnetic strayfields occur above the sample surface. The used organic molecules are derivatives of phthalocyanines, which possess a permanent magnetic moment and should be sensitive to external magnetic strayfields. Because of the planar shape of the phthalocyanines and their aromatic structure, they have the capacity to build self-assembled monolayers. In our case we want to inhibit a developing of a complete monolayer and want to navigate the molecules to chosen areas (i.e. on the domain walls or the domains themselves). To identify the possible alignment of the molecules along the borders of the magnetic domains several techniques were used. For example spectroscopic techniques like scanning ToF-SIMS, NEXAFS and XPEEM.

KR 5.76 Tue 10:45 P2

Investigation of the exchange coupling between Co nanoparticles and a Co/NiMn exchange bias system — •Benjamin Riedmüller, Balati Kuerbanjiang, and Ulrich Herr — Institut für Mikro- und Nanomaterialien, Universität Ulm

In this work, the exchange coupling of Co nanoparticles deposited on a layered Co/NiMn exchange bias system is studied. First the Co/NiMn stack was deposited on a 10 nm thick Ru layer by DC magnetron sputtering. All samples were covered by a 4 nm thick Ta layer to prevent oxidation. For transforming NiMn from the paramagnetic fcc phase to the antiferromagnetic fct phase the samples were annealed in vacuum conditions for 10 min at 360 °C with an external magnetic field of +3 kOe. Different thicknesses of NiMn and Co were used to optimize the interface coupling strength. For 66 nm NiMn a coupling strength of $J_{ex} = 0.3\, mJ/m^2$ was found as a maximum value. Spherical Co nanoparticles of 20 nm in diameter were prepared by Inert Gas Condensation technique. After deposition of the Co nanoparticles on top of the Co/NiMn stack a drastic reduction of the exchange bias field was observed. This effect depends on the particle coverage of the samples. Following the Meiklejohn-Bean description of the exchange bias effect this can be interpreted as a local increase of the film thickness due to exchange coupling between the the nanoparticles and the Co film.

KR 5.77 Tue 10:45 P2

Hochfeld-Magnetokraftmikroskopie und Transporteigenschaften eines epitaktischen Fe3O4/MgO-Films im hohen Magnetfeld — •Ivo Knittel[1], Uwe Hartmann[1], Gala Simon[2], Julia Orna[2] und Luis Morellon[2] — [1]Fachrichtung Experimentalphysik, Universität des Saarlandes, 66123 Saarbrücken — [2]Instituto de Nanociencia de Aragón (INA) and Instituto de Ciencia de Materiales de Aragón (ICMA), Departamento de Física de la Materia Condensada, Universidad de Zaragoza-CSIC, Zaragoza 50009, Spanien

Epitaktische Magnetitfilme unterscheiden sich in ihren magnetischen und ihren Magnetotransporteigenschaften stark vom Volumenmaterial. Selbst in Feldern von mehreren Tesla wird die Sättigungsmagnetisierung nicht erreicht, und u. a. erhöhter Magnetowiderstand und erhöhter außerordentlicher Hall-Effekt werden beobachtet. Als Ursache gilt ein Netzwerk antiferromagnetisch koppelnder Antiphasengrenzen (AF-APG). 40 nm Fe3O4 Filme auf MgO wurden durch pulsed laser deposition (PLD) mit einem 248 nm KrF Excimer Laser hergestellt. Die Struktur wurde mittels Röntgendiffraktometrie, und Transmissionselektronenmikroskopie überprüft. Ein scharfer Verweyübergang deutet auf eine reine Magnetitphase hin.

Die magnetische Struktur wird mit mittels Magnetokraftmikroskopie bis zu Feldern von 1.95 T abgebildet. Die remanente magnetische Struktur ist irregulär, im Feld reduziert sich der magnetische Kontrast gleichmäßig. Im Gegenfeld magnetisiert sich die Struktur bei Feldern um 100mT vollständig um. Modelle auf der Basis von AF-APG werden diskutiert.

KR 5.78 Tue 10:45 P2

Layer resolved magneto-optical Kerr effect magnetometry and domain studies of polycrystalline interlayer exchange coupled NiFe-Ru-Co films — •Thomas Strache and Jeffrey McCord — Institut für Ionenstrahlphysik und Materialforschung, Helmholtz-Zentrum Dresden - Rossendorf, PF 510119, 01314 Dresden, Germany

The magnetization reversal of interlayer exchange coupled NiFe-Ru-Co thin films is studied as a function of coupling strength and ratio of saturation magnetization values of both ferromagnetic layers. These quantities are changed by means of homogeneous ion irradiation, resulting in an interfacial mixing and depth selective doping in the sandwich structures. Both parameters can be varied separately by the choice of the ion species and the ion acceleration energy. In order to characterize the individual reversal mechanisms, layer resolved magnetometry and domain imaging are performed. The layer selectivity is obtained by making use of the phase differences of the Kerr signals, originating from different depths in the samples.

KR 5.79 Tue 10:45 P2

Quantitative magnetic soft X-ray spectroscopy of buried layers in reflection mode — •Patrick Audehm[1], Sebastian Macke[1], Sebastian Brück[2], Gisela Schütz[1], and Eberhard Goering[1] — [1]Max Planck Institute for Metals Research, Heisenbergstrasse 3, 70569 Stuttgart, Germany — [2]University of Würzburg, Experimental Physics, IV Am Hubland, D-97074 Würzburg, Germany

The combination of spectral information obtained with x-ray magnetic circular dichroism (XMCD) and X-ray resonant magnetic reflectometry (XRMR) gives the possibility to measure small magnetic moments and its arrangement especially at the interfaces. Utilizing well established XMCD based sum rules enables the element specific determination of absolute spin and orbital moments, even for a small amount of uncompensated magnetic moments in exchange bias (EB) systems. The measurement of the energy dependent reflection with constant momentum transfer (qz) gives XMCD like spectra. The advantage of this method is the simplified interference condition, because reflection is only affected by the energy dependent absorption and not by the momentum transfer. Using our advanced simulation tool ReMagX for analysis, i.e. fit of the data, it is possible to identify the magnetic spectroscopic nature for both, the rotatable and the pinned magnetic moments at the interface. As an example, we show const qz results of a widely studied EB-system, of polycrystalline iron (Fe)-manganese as an antiferromagnet and cobalt as a ferromagnet. The information for Fe obtained also in resonant reflection at the L3 edge at a very thin layer of uncompensated moment's right below the interface.

KR 5.80 Tue 10:45 P2

Effect of spin structure transition in IrMn on the CoPd\ IrMn perpendicular exchange biased system. — •Muhammad Bilal Janjua and Gernot Güntherodt — II. Physikalisches Institut A, RWTH Aachen University, Aachen, Germany

The exchange bias (EB) phenomenon is studied in MBE grown Pd(10 nm)\CoPd(x=8,16,30 nm)\IrMn(15 nm)\Pd(4 nm) samples, which exhibit a perpendicular anisotropy of Co22Pd78. These samples are field cooled along the out-of-plane direction and hysteresis loops are measured along both the out-of-plane and in-plane directions. It is observed that there is a transition temperature where the out-of-plane EB becomes greater than the in-plane EB. This behavior of EB is an evidence of the change in the spin structure of the given system, which is also revealed by the magnetization versus temperature measurements of the exchange biased and of the sole IrMn samples. It is found that with increasing temperature there is a spin structure transition in Ir25Mn75 (15nm) related to the 2Q to 3Q transition in the bulk, which is responsible for the increase in out-of-plane EB. A vertical shift in the hysteresis loop is also observed in these exchange biased samples at low temperatures (T<50 K).

KR 5.81 Tue 10:45 P2

Exchange bias due to surface-stabilized spin glass in $Co_{33}Fe_{67}$-$CoFe_2O_4$ core-shell nanoparticles — •Syed Rizwan Ali[1], Ghulam Hassnain Jaffari[2], Syed Khurshid Hasanain[3], Gernot Güntherodt[1], and Syed Ismat Shah[2] — [1]Physikalisches Institut (IIA), RWTH Aachen University, Aachen 52056, Germany — [2]Department of Physics and Astronomy, University of Delaware, Newark, Delaware 19716, USA — [3]Department of Physics, Quaid-i-Azam University, Islamabad 45320, Pakistan

We investigate the magnetic and exchange bias (EB) properties of $Co_{33}Fe_{67}CoFe_2O_4$ (core-shell) nanoparticles [1]. Both dc magnetization and ac susceptibility measurements indicate the onset of a spin glass (SG) like transition at the freezing temperature of T_F=175 K. The SG transition is also supported by the field dependence of T_F following the well known Almeida-Thouless line, i.e. T_F~$H^{2/3}$. Moreover, the particles exhibit a large EB field, H_{EB}=1357 Oe arising from the core-shell (ferromagnetic-SG) coupling. The unusually high T_F and large EB effects are attributed to several factors including the thickness of the amorphous oxide shell and large values of the exchange and anisotropy constants associated with the $CoFe_2O_4$ shell.

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KR 5.82 Tue 10:45 P2

Ultrafast all-optical switching of magnetic domains using circular polarized laser light — •Alexander Hassdenteufel, Daniel Steil, Sabine Alebrand, Mirko Cinchetti, and Martin Aeschlimann — Department of Physics and Research Center OPTIMAS, University of Kaiserslautern, Germany

Magnetic switching is typically a continuous process that can be described as a damped precession of the magnetization in an external magnetic field. This process takes typically up to 1 ns. Recently it has been shown that it is possible to achieve magnetic switching within 100 fs [1,2]. This process is induced by circularly polarized ultrashort laser pulses, where the direction of this opto-magnetic switching is determined only by the helicity of light. In this contribution, the femtosecond laser-induced reversal mechanism of GdFeCo thin films is investigated by static Faraday measurements. In particular, we studied the dependence of the writing threshold by using a delayed pump-pump geometry where one of the pump pulses is linearly and the second circularly polarized. The obtained results allow to explain all optical switching as a collaborative process induced by pulse helicity and pulse fluence. The fluence dependency leads to a thermal effect. This means there is an ultrafast decrease of the sample magnetization, which is a condition for the following *pure* optical magnetic switching process induced by circularly polarized light. This work was supported by the European project UltraMagnetron (NMP3-SL-2008-214469).

[1] Kimel, A. V. et. al. Nature 435, 2005, 655-657
[2] Stanciu, PRL 99, 047601 (2007)

KR 5.83 Tue 10:45 P2

Temperature dependent propagating spin-wave spectroscopy on permalloy thin films — •Thomas Schwarze, Florian Brandl, Rupert Huber, Sebastian Neusser, Georg Dürr, and Dirk Grundler — Lehrstuhl für Physik funktionaler Schichtsysteme, Technische Universität München, Physik Department, James-Franck-Straße 1, D-85747 Garching b. München, Germany

The study of spin wave propagation in thin films is of great interest, both, fundamentally as well as technologically [1]. In order to get a deeper understanding of the underlying physics we apply broadband all-electrical spin-wave spectroscopy [2] to a thin permalloy film and address temperatures ranging from 4 to 400 K. The external magnetic field of up to 2.5 T is applied perpendicular to the film. We present a thorough study of the temperature dependent variation of the resonance field and frequency, the resonance linewidth, the Gilbert damping α, and group velocities. For each of the relevant parameters a distinct temperature dependence is found and will be discussed. We acknowledge financial support through the European Community*s Seventh Framework Programme (FP7/2007-2013) under Grant Agreement no. 228673 MAGNONICS and the excellence cluster *Nanosystems Initiative Munich*. [1] S. Neusser and D. Grundler, Adv. Materials 21, 2927 (2009) [2] S. Neusser et al., Phys. Rev. Lett. 105, 067208 (2010)

KR 5.84 Tue 10:45 P2

Spin dynamics in phase space — Yuri Kalmykov[1], •Bernard Mulligan[2], Serguey Titov[3], and William Coffey[4] — [1]Laboratoire de Mathématiques, Physique et Systèmes, Université de Perpignan, 52, Avenue de Paul Alduy, 66860 Perpignan Cedex, France. — [2]Dresden — [3]Institute of Radio Engineering and Electronics, Russian Acad. Sci., Vvedenskii Square 1, Fryazino 141190, Russia. — [4]Department of Electronic and Electrical Engineering, Trinity College, Dublin 2, Ireland.

The dynamics of a quantum spin is presented in the representation (phase) space of polar and azimuthal angles via a master equation for the quasiprobability distribution of spin orientations, allowing the averages of quantum mechanical spin operators to be calculated just as the classical case from the Weyl Symbol of the operator. The phase space master equation (see for e.g. [1,2]) has essentially the same form as the classical Fokker-Planck equation, allowing existing solution methods (matrix continued fractions, integral relaxation times, etc.) to be used. For illustration [1], the time behavior of the longitudinal component of the magnetization and its characteristic relaxation times are evaluated for a uniaxial paramagnet of arbitrary spin S in an external constant magnetic field applied along the axis of symmetry. In the large spin limit, the quantum solutions reduce to those of the Fokker-Planck equation for a classical uniaxial superparamagnet. For linear response, the results entirely agree with existing solutions.

1. Kalmykov et al., J. Stat. Phys., 141, 589 (2010).
2. Kalmykov et al., Phys. Rev. B 81, 094432 (2010).

KR 5.85 Tue 10:45 P2

Magneto-dynamic properties of CoFeB thin film elements: The role of magnetic domain walls — Claudia Patschureck[1], •Jeffrey McCord[2], Rudolf Schäfer[1], Kilian Lenz[2], Roland Mattheis[3], and Ludwig Schultz[1,4] — [1]Insitute for Solid State and Materials Research IFW Dresden, Germany — [2]Insitute of Ion Beam Physics and Materials Research, Forschungszentrum Dresden-Rossendorf, Dresden, Germany — [3]Institute for photonic technologies (IPHT), Jena, Germany — [4]Dresden University of Technology, Dresden, Germany

Understanding the role of the magnetic domain structure on the magneto-dynamic properties of patterned thin film structures is crucial for the optimization of high frequency devices, e.g. recording heads, integrated inductors and filters. We show that a controllable domain design offers the advantage of tuning the ferromagnetic zero and low field resonance frequency.

Therefore we studied the dynamic response of closure domain structures in patterned amorphous Co40Fe40B20 stripe arrays with varying domain wall density using pulsed inductive microwave magnetometry. We show that the domain resonance frequency increases significantly the more neighboured crosstie walls interact with each other. A qualitative concept of dynamic magnetic charges is discussed as the origin of such a resonance frequency increase. The dynamic charge concept also allows the explanation of a pronounced resonance frequency increase in concertina domain structures that develop in lens shaped elements.

KR 5.86 Tue 10:45 P2

Linear and nonlinear collective modes in coupled-discs magnetic microstructures — •Henning Ulrichs[1], Vladislav E. Demidov[1], Alexey V. Ognev[2], Maxim E. Stebliy[2], Ludmila A. Chebotkevich[2], Alexander S. Samardak[2], and Sergej O. Demokritov[1] — [1]Institut für angewandte Physik, Universität Münster, Corrensttraße 2-4, 48149 Münster, Germany — [2]Laboratory of Thin Film Technologies, Far Eastern National University, Sukhanova street 8, 690950 Vladivostok, Russia

We have studied experimentally collective spin-wave modes in microscopic magnetic structures constituted by three coupled Permalloy discs, magnetized in-plane. By using phase-sensitive Brillouin light scattering spectroscopy we were able to clearly identify and investigate different types of the collective modes. In particular, we show that the studied systems support two fundamental modes characterized by in-phase and out-of-phase magnetization oscillations in neighboring discs. The in-phase mode demonstrates a maximum amplitude for the disc located in the center of the structure. Increasing the power of the excitation signal, the difference in the amplitudes in the neighboring discs tends to disappear. This behavior can be understood by assuming a nonlinear generation of higher-order spatial spin-wave harmonics. We will also discuss the role of magnetic bridges connecting individual discs. Our results show that the main characteristics of the modes are practically independent of the static field and the geometry of bridges, but are significantly affected by the nonlinearity.

KR 5.87 Tue 10:45 P2

Reliable nucleation of isolated antivortices in taylored ferromagnetic microstructures — •Matthias F.A. Pues, Michael Martens, Thomas Kamionka, and Guido Meier — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Germany

Magnetic antivortices are topological singularities in ferromagnetic thin-film microstructures. They can be distinguished from their counterparts, the vortices, by a negative winding number. In combination, both are common in so-called cross-tie walls.

The isolation of a single antivortex is challenging [1]. We designed particularly shaped elements that facilitate a reliable nucleation and a stabilization of a single antivortex. This is shown by measurements of the anisotropic magnetoresistance (AMR) and magnetic force microscopy (MFM). The process of the nucleation can be understood by means of micromagnetic simulations.

Since antivortices behave like two-dimensional oscillators, the simultanious generation of multiple antivortices opens new opportunities for the analysis of antivortex dynamics [2], e.g. through ferromagnetic resonance measurements (FMR).

[1] K. Shigeto et al., Appl. Phys. Lett. 80, 4190 (2002)
[2] T. Kamionka et al., Phys. Rev. Lett. 105, 137204 (2010)

KR 5.88 Tue 10:45 P2

The Jülich TRACX-PEEM at BESSY II: a state-of-the-art user-facility for time-resolved magnetism research. — •Florian Nickel, Ingo Krug, Alexander Kaiser, Daniel Gottlob, Stefan Cramm, and Claus M. Schneider — Forschungszentrum Jülich, Institut für Festkörperforschung IFF-9, and JARA-FIT, 52425 Jülich, Germany

Time-resolved X-PEEM is a well-established technique for magnetisation dynamic research. To exploit the capabilities of the latest instrument generation, we built up a state-of-the-art PEEM endstation at the soft x-ray Beamline UE56/1-SGM at BESSY in 2010. This microscope, being based on a design by R. Tromp and custom-built by SPECS GmbH, is the first commercially available device incorporating a tetrode mirror corrector. Key advantages of the aberration-correction are ultimate spatial resolution as well as dramatically improved transmission up to an order of magnitude in respect to uncorrected instruments. This makes the endstation ideally suited for signal-starved experiments such as time-resolved magnetization studies in a stroboscopic arrangement. Here we present the capabilities of our time-resolved, aberration-corrected x-PEEM (TRACX-PEEM) facility. We will present the performance of our gated MCP Detector in the BESSY hybrid-bunch filling-pattern showing that the isolated single-bunch can clearly be selected. This represents an important step for future pump-probe experiments.

KR 5.89 Tue 10:45 P2

Limitations of the macro-spin model for magnetic nanoparticles — •Mohammad Sayad, Daniel Guetersloh, and Michael Potthoff — I. Institut für Theoretische Physik, Universität Hamburg, Jungiusstraße 9, 20355 Hamburg

Magnetization reversal of a magnetic nanoparticle or of a molecular magnet is often described by means of a macro-spin model assuming a strong exchange coupling between the individual spins. This model, however, is a phenomenological construct. Here we discuss the strict microscopic derivation of the macro-spin model in the limit of weak anisotropy. In addition the limitations of the model are worked out by studying linear chains as well as two- and three-dimensional clusters of ferromagnetically exchange-coupled Heisenberg quantum spins with single-site or coupling anisotropy. Magnetization profiles, correlation functions, excitation gaps and the tunneling barrier are computed by exact diagonalization and the Lanczos method for spin-S systems as a function of the system size L, the anisotropy strength and the system geometry. In the case of the classical Heisenberg model, we determine the transition between different reversal mechanisms as a function of system size, system geometry and applied external magnetic field.

KR 5.90 Tue 10:45 P2

Element-selective magneto-optics at the M absorption edge of Fe and Ni using laser generated ultrafast extreme ultraviolet light — •Dennis Lvovsky[1], Patrik Grychtol[1], Moritz Plötzing[1], Roman Adam[1], Claus M. Schneider[1], Chan La-O-Vorakiat[2], Stefan Mathias[2], Henry C. Kapteyn[2], Margaret M. Murnane[2], and Martin Aeschlimann[3] — [1]Institute of Solid State Research, IFF-9, Research Center Jülich, 52425, Jülich, Germany — [2]Department of Physics and JILA, University of Colorado, Boulder, Colorado 80309-0440, USA — [3]University of Kaiserslautern and Research Center OPTIMAS, 66606, Kaiserslautern, Germany

Extreme ultraviolet (XUV) light can be nowadays generated not only by a synchrotron but also by laser based ultrafast sources exploiting the high harmonics generation of the fundamental wavelength. Pulses in the femto-second range with photon energies up to one hundred eV enable time-resolved, element-selective measurements at the atomic absorption edges. We present transversal magneto-optical Kerr effect measurements at the M absorption edge of Ni (around 67 eV) and Fe (around 54 eV). Our results show the potential for investigating the element-selective ultrafast magnetization dynamics.

KR 5.91 Tue 10:45 P2

Spin Wave Propagation in Micron and Submicron $Ni_{80}Fe_{20}$ Stripes — •Hans Bauer, Georg Woltersdorf, and Christian Back — Universität Regensburg, 93043 Regensburg, Germany

The wavelength of propagating spin waves has often been determined in thin ferromagnetic films and more recently in structured $Ni_{80}Fe_{20}$ films [1][2]. Thin stripes are of particular interest for micron-sized spin wave devices as they serve as the building blocks for spin wave wave guides in future spin logic devices and spin wave Mach-Zender interferometers. For realization of such devices with only a few micron in size, the knowledge of the damping length of propagating spin waves within the structure is essential.

We used a TR-MOKE setup with 250 nm spatial resolution to study propagating magnetostatic spinwaves in micron and submicron wide $Ni_{80}Fe_{20}$ stripes. As the MOKE signal is proportional to the amplitude of the dynamic magnetization the wavelength and the damping length can both be directly determined at the same time. The results are compared to analytical calculations taking the excitation profile into account as well as with micromagnetic simulations.

[1] V. E. Demidov et al., Phys. Rev. B 77, 064406 (2008)
[2] S. Neusser et al., Phys. Rev. Lett. 105, 067208 (2010)

KR 5.92 Tue 10:45 P2

Scanning Kerr Microscopy - Spinwave Propagation in Ferromagnetic Nanostructures — •Kim Martens, Sebastian Mansfeld, Felix Balhorn, Jesco Topp, Wolfgang Hansen, Detlef Heitmann, and Stefan Mendach — Institute for Applied Physics, University of Hamburg, Germany

We use a scanning Kerr microscope for the time resolved mapping of spin waves in thin Permalloy films. In my poster I will introduce the concept and functionality of time resolved scanning Kerr microscopy. Additionally, I will present our recent experiments on spin-wave propagation and damping in patterned permalloy films.

We gratefully acknowledge financial support by the DFG via SFB668.

KR 5.93 Tue 10:45 P2

Magnetization dynamics described via a thermal mechanism — •Martin Lüttich[1], Jakob Walowski[1], Andreas Mann[1], Markus Münzenberg[1], Unai Atxitia[2], and Oksana Chubykalo-Fesenko[2] — [1]I. Physikalisches Institut, Universität Göttingen — [2]Instituto de Ciencia de Materiales de Madrid

Magnetization dynamics of polycrystalline nickel films with thicknesses of 2, 5, 10, 15, 20 and 40 nm is measured using the all-optical pump-probe technique. The theoretical description of the microscopic processes in these dynamics has the challenge and complexity of the parallel treatment of photons, electrons, phonons and magnetic correlation of the system. Additionally different length and time scales are involved.

We access these processes via a thermal model derived from the Landau-Lifshitz-Bloch equation. Within this approach it is assumed that the excited state is a statistical ensemble of many spin excitations. First the electron temperature is extracted via a 2 Temperature model from reflectivity measurements, and later used to model the magnetization dynamics. Because of the strong electron-spin coupling in transition metals, we find that the magnetisation dynamics is defined by the electron temperature but is slowed down with respect to the electron temperature due to the slowing down of the longitudinal relaxation defined by the exchange interactions. We discuss the effects for thinest Ni layers below 10 nm where the demagnetization deviates from the simple scaling for fluence and thickness.

KR 5.94 Tue 10:45 P2

Spin-Wave Excitations in Three-Dimensional Rolled-Up Permalloy Structures — •Felix Balhorn, Simon Jeni, Sebastian Mansfeld, Cornelius Bausch, Jesco Topp, Wolfgang Hansen, Detlef Heitmann, and Stefan Mendach — Institut für Angewandte Physik Hamburg, Jungiusstr. 11, 20355 Hamburg

The ability to fabricate geometrically well-defined three-dimensional nanoscrolls utilizing a self-organization process [1] gives rise to transforming any planar structure into a cylindric geometry. After rolling up permalloy (Py) structures, the spin dynamics in these systems are investigated by means of broadband microwave absorption spectroscopy.

Rolled-up Py films show several resonances which exist over a broad field range when magnetized along the rolling axis. These resonances are due to the interference of collective spin waves running in azimuthal direction [2]. In transversally magnetized samples the resonances disappear above a certain magnetic field, which is attributed to geometric anisotropy. Here, we present measurements on rolled-up Py films in transversal magnetization geometry and present a model based on the analytic spin wave dispersion relation for rectangular elements given in [3]. The model used in [2] is refined and applied on rolled-up Py stripes, i.e. small ring elements.

Financial support by the SFB668, GrK 1286, and the Cluster of Excellence Nanospintronics is acknowledged.

[1] V. Y. Prinz et al., Physica E **6**, 828 (2000); [2] F. Balhorn et al., PRL **104**, 037205 (2010); [3] K. Y. Guslienko et al., PhysRevB **68**, 024422 (2003)

KR 5.95 Tue 10:45 P2

Mechanically tunable Spin Wave Resonances in Rolled-Up Permalloy Tubes — •Cornelius Bausch, Felix Balhorn, Simon Jeni, Sebastian Mansfeld, Wolfgang Hansen, Detlef Heitmann, and Stefan Mendach — Institut für Angewandte Physik, Jungiusstr. 11, 20355 Hamburg

The different lattice constants of two epitaxially grown semiconductors cause strain which can be used to fabricate rolled-up mictrotubes [1]. A thin Permalloy layer can be deposited on the strained semiconductor layers before rolling up to obtain a rolled-up Permalloy tube (RUPT)[2]. Spin-wave excitations in these RUPTs have recently been investigated using broadband microwave absorption spectroscopy [2, 3]. Several resonance modes showing different magnetic field dispersions with respect to the magnetic configuration have been observed.

We built a micromechanical squeezer consisting of a small sub-millimeter photo resist block on a polyethylene terephthalate/glass substrate manipulated with a piezo stack. We found that the spin-wave mode spectrum of RUPTs can be modified by mechanically deforming the RUPTs with this squeezer. The modes shift in frequency and eventually disappear. We present possible interpretations for this behavior.

We acknowledge financial support by the SFB668, Grk 1286 and the Cluster of Excellence Nanospintronics.

[1] V. Y. Prinz et al., Physica E 6, 828 (2000); [2] S. Mendach et al., Appl. Phys. Lett. 93, 262501 (2008); [3] Balhorn et al., Phys. Rev. Lett. 204, 037205 (2010)

KR 5.96 Tue 10:45 P2

Mode symmetry breaking of propagating spin waves — •Peter Clausen, Helmut Schultheiss, Björn Obry, Sebastian Schäfer, Katrin Vogt, Georg Wolf, and Burkhard Hillebrands — Fachbereich Physik and Forschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

For the realization of spin-wave logic and spintronics, the understanding of spin-wave propagation in two-dimensional waveguides is essential. We investigate the influence of a double bend on the two-dimensional spin-wave transport in a $Ni_{81}Fe_{19}$-waveguide using space-resolved Brillouin light scattering microscopy.

The observed spin-wave intensity distribution is significantly influenced by the double-bend structure and two quite different regimes can be observed. In front of the bend, the spin-wave intensity measured across the width of the waveguide is symmetric whereas it shows a clear asymmetric pattern behind the double bend. We propose a transition from interfering spin-wave width modes of first and third order, which are originally exited by the antenna, to the superposition of the first and second width mode generated by the lateral symmetry break of the spin-wave waveguide.

Financial support by the Carl-Zeiss-Stiftung, the Graduiertenkolleg 792 and Graduate School of Excellence "MAterials Science IN MainZ" is gratefully acknowledged. The authors thank the Nano+Bio Center of the Technische Universität Kaiserslautern, P. A. Beck and P. Pirro for sample preparation.

KR 5.97 Tue 10:45 P2

Determination of inertial mass of pulsed field-driven domain walls in GMR nanostripes — •Bjoern Burkhardt, Sascha Glathe, and Roland Mattheis — IPHT Jena e.V., Albert-Einstein-Str. 9, 07745 Jena

Domain walls (DW) can be described as quasiparticles with typical mechanic characteristics, e.g. an effective mass. For field driven DW motion one can assume a linear dependence between the DW velocity and field-pulse length for short pulse length (t $\approx$ 1 ns) and small fields (H $< H_w$, Walker field), which is confirmed by the 1D-Modell by Slonczewski [1]. In this regime the DW is uniformly accelerated until the equilibrium state and thus the maximum velocity for the applied field is reached. Using this regime and assuming a driving force derived from the magnetostatic potential, one can deduce an effective mass of the DW. We have measured domain wall velocities for short field pulses in thin and narrow nanostripes (w = 500nm, l = 45 μm) using the giant magnetoresistance effect between a sense layer (NiFe - 20nm thick) and a reference layer (CoFe - part of an AAF/AF-combination). The magnetic field is generated by short current pulses in a coplanar waveguide crossing the GMR nanostripe. We determined the effective mass of a DW (m $\approx 10^{-23}$kg) which is in good quantitative agreement with theory [2].

[1] A. Malozemo and J. Slonczewski, Magnetic Domain Walls in Bubble Materials (Academic Press, New York, 1979).

[2] J.-Y. Lee, S. Choi, S.-K. Kim, J. Magn., **11**, 74 (2006)

KR 5.98 Tue 10:45 P2

Spin wave resonances in ferromagnetic thin films prepared via atomic layer deposition — •Rupert Huber[1], Paul Berberich[1], Thomas Schwarze[1], Thomas Rapp[1], Julien Bachmann[2], Kornelius Nielsch[2], and Dirk Grundler[1] — [1]Lehrstuhl für Physik funktionaler Schichtsysteme, Physik Department E10, Technische Universität München,85748 Garching, Germany — [2]Institut für Angewandte Physik und Mikrostrukturzentrum, Universität Hamburg,20355 Hamburg, Germany

On the way to artificially designed three-dimensional magnetic devices atomic layer deposition (ALD) is a promising thin-film deposition technique. We have produced different ferromagnetic thin films by ALD based on the oxidation of $FeCp_2$ and $NiCp_2$ using ozone [Ref. 1] Afterwards the iron and nickel oxide, respectively, is reduced inside the ALD reactor by H_2 at 400 °C. We have studied the quasistatic and

dynamic properties via the magneto-optical Kerr effect and broadband spin-wave spectroscopy, respectively. In the latter case we mount the thin film on top of a coplanar waveguide with an inner conductor exhibiting a width of 20 μm. Using a vector network analyzer we measure spin wave resonances. They depend characteristically on an applied magnetic field. We thank Sebastian Neusser for experimental help in the initial stage of the experiment. We acknowledge financial support through the European Community*s Seventh Framework Programme (FP7/2007-2013) under Grant Agreement no. 228673 MAGNONICS.
Ref. 1: J. Bachmann et al., JAP, 2009, 105, 07B521

KR 5.99 Tue 10:45 P2

Spin waves in antidot lattices on suspended membranes — •Florian Brandl, Rupert Huber, Sebastian Neusser, Georg Dürr, and Dirk Grundler — Lehrstuhl für Physik funktionaler Schichtsysteme, Technische Universität München, Physik Department, James-Franck-Straße 1, D-85747 Garching b. München, Germany

We have developed a new fabrication method for antidot (AD) lattices using electron beam lithography. This method is based on a photonic crystal consisting of a periodic array of nanoholes etched into a freestanding Si membrane. The membrane is covered subsequently with thermally evaporated $Ni_{80}Fe_{20}$. Using all-electrical spin wave spectroscopy [1] we perform measurements on samples with different lattice constant and hole diameter. Applying an external magnetic field B of up to 100 mT in the plane of the AD lattices we find a series of resonant modes which depend characteristically on B. We perform micromagnetic simulations to analyze the AD modes in detail. We acknowledge financial support through the German excellence cluster "Nanosystems Initiative Munich" and the European Community's Seventh Framework Programme (FP7/2007-2013) under Grant Agreement no. 228673 MAGNONICS.

[1] S. Neusser et al., Phys. Rev. Lett. 105, 067208 (2010).

KR 5.100 Tue 10:45 P2

Dynamics of bubble domains in perpendicular anisotropy dots — C. Moutafis[1,2], A. Bisig[1,2], J. Rhensius[1,2,3], F. Büttner[1,6], •P. Wohlhüter[1,4], T. Thomson[5], G. Heldt[3], L. Heyderman[3], M. Weigand[6], S. Eisebitt[7], and M. Kläui[1,2] — [1]SwissFEL, PSI, CH — [2]Laboratory for Nanomagnetism & Spin Dynamics, EPFL, CH — [3]Laboratory for Micro- & Nanotechnology, PSI, CH — [4]Fachbereich Physik, Universität Konstanz — [5]University of Manchester, UK — [6]MAXYMUS, BESSY, Berlin — [7]Institut für Optik und Atomare Physik, TU Berlin

We study the dynamical response of magnetic bubbles in nanoscale dots with perpendicular anisotropy. Magnetic bubble domains in such dots have been predicted to exhibit rich dynamics dominated by their Skyrmion number N, which reflects their underlying spin structure [1,2]. Specifically, the gyrotropic motion of the symmetric, N=1, bubble (analogous to the gyrotropic mode of the magnetic vortex) was calculated recently for the first time [2]. Here, we attempt to show the bubble's response to external excitations. By using soft X-ray holography we image the magnetic states in CoPd dots of varying geometry and we also identify a bubble in certain diameter for a range of magnetic fields. Furthermore, we use Scanning X-ray Transmission Microscopy to image CoPt dots excited by various field pulses. We image the movement/shift of the bubble between different pinning sites in a dot. In addition, we calculate additional characteristic eigenmodes of the basic N=1 bubble. References: [1] Moutafis et al. Phys.Rev.B vol. 76, 104426 (2007) [2] Moutafis et al. Phys.Rev.B vol. 79, 224429 (2009)

KR 5.101 Tue 10:45 P2

Magnetizatio Dynamic In FeRh Compound — •Federico Pressacco[1] and Simon Mariager[2] — [1]Universität Regensburg, Regensburg, Deutschland — [2]Paul Scherrer Institute, Villigen, Switzerland

FeRh compounds show a first order phase transition from an Anti Ferromagnetic (AFM) to a Ferromagnetic (FM) phase after heating above room temperature. At temperature lower than 395 K the Fe ions are antiferromagnetically coupled while the Rh ions show no magnetic moment. At higher temperature Fe becomes ferromagnetically coupled and also Rh carries a magnetic moment. This phase transition in accompanied by a lattice expansion of about 1%.This features make FeRh a suitable system for investigation of the interplay between electrons, spins and phonons (lattice). We performed laser pump-probe experiments to investigate the magnetization dynamic via Time Resolved Magneto Optical Kerr Effect (TR-MOKE). The impulsive laser heating induce the phase transition and the magnetization is probed with a delayed laser pulse. The onset of the ferromagnetic phase is still under debate. Is the phase transition driven by the lattice expansion? Laser pump-X ray probe experiment where performed to follow the lattice expansion during the onset of the ferromagnetic phase. From the comparison of the data collected in the experiments one can decouple the phonon contribution to the signal and establish if the structural change induces the phase transition.

KR 5.102 Tue 10:45 P2

Ultrafast demagnetization dynamics of thin Fe/W(110) films: comparison of time and spin-resolved photoemission with time resolved magneto-optic experiments — Alexander Weber[1,2], Federico Pressacco[1], Stefan Günther[1], •Eduardo Mancini[1], and Christian Back[1] — [1]Physics Department, Universität Regensburg, 93040 Regensburg, Germany — [2]Institut für Festkörperforschung, Forschungszentrum Jülich, 52425 Jülich, Germany

We use two complementary experimental approaches to probe ultrafast magnetization dynamics. Using a 1.55 eV pump laser pulse we demagnetize 7 monolayer (ML) thin Fe films epitaxially grown on W(110). We probe the temporal evolution of the magnetization using time-resolved magneto-optical Kerr effect (TR-MOKE) at a probe photon energy of 3.1 eV. In addition we use time- and spin- resolved photoemission (TR-SPES) to probe the evolution of the spin polarization of the film (probe photon energy 5.9 eV). With TR-MOKE for all the observed quenching the demagnetization times have the same value (within the error bars) equal to the expected cross-correlation of the pump and probe pulses (about 250 fs). However TR-SPES measurements show demagnetization times limited by the cross-correlation (about 320 fs) only for quenching below 33%. Indeed, for greater quenching we find a significant increase in the demagnetization times to about 500 fs. We explain this behavior as a clear indication of the bandstructure importance in the demagnetization process.

KR 5.103 Tue 10:45 P2

Towards an understanding of longitudinal x-ray-detected ferromagnetic resonance — •Katharina Ollefs[1], Andreas Ney[1], Ralf Meckenstock[1], Detlef Spoddig[1], Christoph Hassel[1], Christian Schöppner[1], Verena Ney[1], Fabrice Wilhelm[2], Andrei Rogalev[2], Frithjof Nolting[3], Carolin Antoniak[4], Heiko Wende[4], and Michael Farle[1] — [1]Fakultät für Physik - AG Farle, Universität Duisburg-Essen, 47057 Duisburg, Germany — [2]ESRF, 38043 Grenoble Cedex, France — [3]SLS, 5232 Villigen PSI, Switzerland — [4]Fakultät für Physik - AG Wende, Universität Duisburg-Essen, 47057 Duisburg, Germany

We present a novel experimental setup for x-ray detected ferromagnetic resonance (XDFMR), which allows the simultaneous separation of three different detection channels after x-ray and microwave absorption: A) the conventional FMR detection by microwave absorption; B) x-ray detected lattice response due to the resonant microwave absorption, C) measurement of the high frequency susceptibility based on the x-ray magnetic circular dichroism (XMCD) effect.

The mechanisms for the different absorption signals detected at resonance will be discussed.

The microwave frequency can be tuned from 4-18 GHz allowing a detailed analysis of spin relaxation mechanisms and an element-specific investigation of the dynamic magnetic properties.

Supported by ESRF, SLS, BESSY and DFG, Heisenberg Programm, SFB 491.

KR 5.104 Tue 10:45 P2

Ultrafast, Element-Specific, Demagnetization Dynamics Probed using Coherent High Harmonic Beams — •Steffen Eich[1], Stefan Mathias[1,2], Chan La-O-Vorakiat[2], Patrik Grychtol[3], Roman Adam[3], Mark Siemens[2], Justin M. Shaw[4], Hans Nembach[4], Timm Rohwer[5], Claus M. Schneider[3], Tom Silva[4], Martin Aeschlimann[1], Margaret M. Murnane[2], and Henry C. Kapteyn[2] — [1]Department of Physics and Resarch Center OPTIMAS, University of Kaiserslautern, Germany — [2]JILA, University of Colorado and NIST, Boulder, Co, USA — [3]Institute of Solid State Research, IFF-9, FZ Jülich, Germany — [4]Electromagnetics Division, NIST, Boulder, Co, USA — [5]Institut für Experimentelle und Angewandte Physik, Christian-Albrechts-Universität zu Kiel, Germany

Element-specific magnetization dynamics on nanometer length and femtosecond time scales is a topic of intense interest. Ultrafast, coherent, table-top, x-ray sources based on high-harmonic upconversion of femtosecond lasers provide a new tool to study how magnets work at the shortest time and length scales, with element specificity [1]. Here, we use this new experimental capability to extract element-specific demagnetization dynamics and hysteresis loops of Fe and Ni in Permalloy.

[1] La-o-vorakiat et al., PRL 103, 257402 (2009)

KR 5.105 Tue 10:45 P2

Detection of ferromagnetic resonance by optical reflectance — •Marc Möller[1], Ralf Meckenstock[2], and Josef Pelzl[1] — [1]Institute of Experimental Physics, Ruhr-University Bochum, Bochum, Germany — [2]Experimental Physics, University Duisburg-Essen, Duisburg, Germany

The absorption of microwave radiation by ferromagnetic resonance (FMR) of a magnetic sample results in heat being dissipated inside the sample. This mechanism can be utilized to generate thermal waves by amplitude modulation of the microwave radiation. These thermal waves periodically modify the temperature dependent properties of the sample like the optical reflectance. Here we present results of the detection of FMR in the optical reflectance at the sample surface. A 10 to 100 nm thin, epitaxial Fe film is mounted inside a microwave cavity and a focused laser beam is reflected off its surface, such that the FMR spectrum can be recorded and be compared to FMR spectra measured using the magneto-optical Kerr effect (MOKE). The dependence of the reflectance changes on the frequency of the microwave amplitude modulation are used to investigate thermal properties of the film and the film/substrate interface, including the thermal contact resistance.

KR 5.106 Tue 10:45 P2

Vortex coupling in magnetic multilayer elements — •Sebastian Wintz[1], Aleksandar Puzic[2], Thomas Strache[1], Christopher Bunce[1], Michael Körner[1], Tommy Schoenherr[1], Andreas Neubert[1], Jeffrey McCord[1], Ingolf Moench[3], Roland Mattheis[4], Jörg Raabe[2], Christoph Quitmann[2], Artur Erbe[1], and Jürgen Fassbender[1] — [1]Helmholtz-Zentrum Dresden Rossendorf, 01314 Dresden, Germany — [2]Paul Scherrer Institut 5232 Villigen, Switzerland — [3]Leibniz-Institut für Werkstoff- und Festkörperforschung, 01069 Dresden, Germany — [4]Institut für Photonische Technologien, 07702 Jena, Germany

Spin vortices have attracted much attention due to their chiral nature and the variety of dynamic phenomena associated with them. In this contribution we present experimental findings on vortex coupling in trilayer elements, where two ferromagnetic layers are separated by a nonmagnetic spacer. For such systems the relative configurations of the in-plane flux senses (circulations) as well as the core orientations (polarities) of layered vortices are identified by means of scanning transmission x-ray microscopy (STXM). The dominant coupling mechanisms here are the magneto-dipolar interaction and interlayer exchange coupling (IEC). Remarkably, a modification of the IEC, which can be induced by noble gas ion irradiation, allows to specifically set the circulation configuration of a layered vortex pair to be either antiferromagnetic or ferromagnetic. In addition, time-resolved measurements of the response of interlayer coupled vortices to an excitation by sinusoidal magnetic fields will be shown.

KR 5.107 Tue 10:45 P2

Micromagnetic simulations of depinning process of the magnetic domain wall by propagating spin waves on a magnetic thin film — •June-Seo Kim[1], Luis Lopez-Diaz[2], Eduardo Martinez[2], Jungbum Yoon[3], Chun-Yeol You[3], and Mathias Kläui[1] — [1]Fachbereich Physik, Universität Konstanz, Universitätsstr. 10, D-78457 Konstanz, Germany — [2]Universidad de Salamanca, Plaza de la Merced s/n, E-37008, Salamanca, Spain — [3]Department of Physics, Inha University, Incheon 402-751, Republic of Korea

The recent discovery that a propagating spin-wave moves domain wall has created a new possibility to manipulate magnetization [1]. This is now the subject of extensive research motivated not only by its fundamental interest but also by promising applications for novel spintronic devices. First we calculate the domain wall motion by propagating spin waves (SWs) on a magnetic nanowire by using the objected oriented micromagnetic framework (OOMMF) code [2]. We calculate the depinning fields of the trapped head-to-head transverse walls due to notch by propagating SWs and applied fields along the nanowire. The depinning fields depend on the frequency and amplitude of SWs. To understand the optimization frequencies to depin the DWs, we calculate the dispersion relation by using Fast Fourier Transformation (FFT) method. This work is supported by the EU-RTNs SPINSWITCH (MRTN-CT-2006-035327). [1] Dong-Soo Han et al., Appl. Rhys. Letts. 94, 112502 (2009). [2] OOMMF User's Guide, Version 1.0, M. J. Donahue and D. G. Porter, National Institute of Standard and Technology, Gaithersburg, MD, 1999, http://math.nist.gov/oommf

KR 5.108 Tue 10:45 P2

Micromagnetic simulations of depinning process of the magnetic domain wall by propagating spin waves on a magnetic thin film — •June-Seo Kim[1], Luis Lopez-Diaz[2], Eduardo Martinez[2], Jungbum Yoon[3], Chun-Yeol You[3], and Mathias Kläui[1,4] — [1]Fachbereich Physik, Universität Konstanz, Universitätsstr. 10, D-78457 Konstanz, Germany — [2]Universidad de Salamanca, Plaza de la Merced s/n, E-37008, Salamanca, Spain — [3]Department of Physics, Inha University, Incheon 402-751, Republic of Korea — [4]SwissFEL, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland & Laboratory for Nanomagnetism and Spin Dynamics, Ecole Polytechnique Fédérale de Lausanne (EPFL), 1015 Lausanne, Switzerland

The recent discovery that a propagating spin-wave moves a domain wall has created a new possibility to manipulate magnetization [1]. First we calculate the domain wall motion by propagating spin waves (SWs) on a magnetic nanowire by using the objected oriented micromagnetic framework (OOMMF) code. We calculate the depinning fields of the trapped head-to-head transverse walls due to notch by propagating SWs and applied fields along the nanowire. The depinning fields depend on the frequency and amplitude of SWs. To understand the optimization frequencies to depin the DWs, we calculate the dispersion relation by using Fast Fourier Transformation (FFT) method. This work is supported by the EU-RTNs SPINSWITCH (MRTN-CT-2006-035327). [1] Dong-Soo Han et al., Appl. Phys. Letts. 94, 112502 (2009).

KR 5.109 Tue 10:45 P2

Skyrmion textures in cubic helimagnets with competing cubic and exchange anisotropies — •Filipp N. Rybakov[1,2], Andrey A. Leonov[1], Anna B. Butenko[1], Alexei N. Bogdanov[1], and Ulrich K. Rössler[1] — [1]IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany — [2]Institute of Metal Physics, UD of the RAS, 620990, Ekaterinburg, Russia

In non-centrosymmetric chiral magnets, *isotropic* Dzyaloshinskii-Moriya interactions destabilize the homogeneous magnetic structure and induce long-range 1-dimensional (spirals) and 2-dimensional (Skyrmions) chiral modulations of the magnetization with sense of rotation fixed by the sign of Dzyaloshinskii the constant D and period by the twisting length, D/A (A is the exchange stiffness) [1]. In this contribution we show that small *anisotropic* forces as cubic anisotropy and anisotropic exchange determine the propagation directions of spirals and axes of Skyrmions along certain crystal directions and stabilize Skyrmion textures in a broad range of magnetic fields. The equilibrium parameters of Skyrmions, helices, and cycloids are determined as functions of a bias magnetic field and the values of competing anisotropic interactions. The results demonstrate that a plethora of different precursor phenomena, modulated mesophases, and reorientation transitions may arise in cubic helimagnets near magnetic ordering depending on very weak magnetic couplings.

[1] U. K. Rößler et al., J. Phys., in press; arXiv:1009.4849v1 (2010); A.B. Butenko et al., Phys. Rev. B **80**, 134410 (2009).

KR 5.110 Tue 10:45 P2

Simulation of magnetic nanoparticles for hyperthermia therapy — •Christian Haase and Ulrich Nowak — University of Konstanz, 78457 Konstanz

Systems of single domain magnetic nanoparticles are investigated in view of their aplication to magnetic particle hyperthermia therapy, where under application of an ac magnetic field these particles dissipate heat and thus can be used for cancer treatment. This is done via a numerical integration of the Landau-Lifshitz-Gilbert equation including Langevin dynamics.

For an analytical description of such a system one has to consider a relaxation model based on Browns Fokker-Planck equation [1]. The heating characteristics then can be described by linear response theory for particles in the superparamagnetic size range or a Stoner Wohlfarth model type theory for bigger particles[2,3].

We compare these approaches to our numerical calculations with special emphasis on the influence of dipolar interactions which are neglected in both analytical theories. Furthermore we discuss our results in the effort to maximise the specific loss power for acceptable fields and frequencies.

[1]W. F. Brown, Jr., Phys. Rev. **130**, 1677 (1963). [2] R. Hergt et al, Nanotechnology **21**, 015706 (2010). [3] N. A. Usov and Y. B. Grebenshchikov, J. Appl. Phys. **106**, 023917 (2009).

KR 5.111 Tue 10:45 P2

Domain Structures and Hysteresis Loops in Coupled Permalloy Rectangles — •Jonas Jelli, Kristof M. Lebecki, and Ulrich Nowak — Department of Physics, University of Constance, Germany

Arrays of 2 μm x 1 μm x 20 nm Permalloy thin film elements of rectangular shape with varying interelement separation between the long edges are investigated by micromagnetic simulation. Applying one dimensional periodic boundary conditions [1], the influence of the rectangle's magnetostatic interactions on the domain structures and the shape of hysteresis loops is studied. By analyzing the angular distribution of the magnetization it is found that the coupled elements show a flux-closure Landau state whose large domains increasingly split up into two distinct domains the smaller the spacing between the rectangles is chosen. This is in good agreement with experiments in which this tendency is also observed [2]. Besides, magnetisation hysteresis loops indicate a change in the coercive field of the rectangles depending on their spacing and whether the external field is applied in the direction of periodicity or perpendicularly.

[1] K. M. Lebecki et al, J. Phys. D 41, 175005 (2008)
[2] S. Hankemeier et al, Phys. Rev. Lett. 103, 147204 (2009)

KR 6: Poster: Crystallography in Materials Science

Time: Wednesday 15:00–17:30 Location: P1

KR 6.1 Wed 15:00 P1

Investigation of the Mosaicity of Real Crystals — •Anne Kathrin Hüsecken, Oleg Schmidt, and Ullrich Pietsch — Fakultät Physik, Universität Siegen, Walter-Flex-Str. 3, 57068 Siegen (Germany)

Extinction is the weakening of the diffracted X-ray intensity due to multiple scattering in the crystal. Perfect crystals scatter according to the dynamical theory, but no real crystal is perfect. Ideal imperfect crystals scatter according to the kinematical theory. In most cases, the measured intensities of real crystals are in between both cases and an extinction correction is needed to fulfil the kinematic approach. Most experimentalists use extinction as black box. Present theories dealing with extinction correction start with a finite perfect crystal, then go to an ideal mosaic crystal and at last generalize the theory to a real crystal. These approaches are based on a lot of approximations which are not verified by the experiment. Our approach is to verify the validity of one of the other present extinction theories by independent diffraction experiments with high resolution. The probe system used in the measurements was $Li_2SO_4 \cdot H_2O$. The shape of each Bragg reflection was measured by ω- and ω-2θ-scans. From the FWHMs of these scans of X-ray reflections measured very precisely one can determine the size and the misorientation of the mosaic blocks and also the lattice strain. With these parameters one can experimentally derive the validity of approaches made by certain extinction theories.

KR 6.2 Wed 15:00 P1

Modeling of Defects in Silicon Nitride — •Torsten Weissbach, Steve Schmerler, and Jens Kortus — Institut für Theoretische Physik, TU Bergakademie Freiberg, 09596 Freiberg

Si_3N_4 and Oxynitrides play an important role in todays flash memory technology because of their ability to trap charge and retain it for long time. The long-time trapping occurs in deep centers, electronic states within the large bandgap of the basic materials, which are caused by local impurities and defects. In memory chips, these materials are contained in very thin layers which are assumed to be amorphous. DFT methods are frequently applied to model defects within these materials, but have to be carried out on periodic structure models. One approach is to create large supercells with a nearly amorphous arrangement of atoms. In this case, the crystal structure is strongly disturbed, and local defects are not evident. In another method, defects are modeled by manipulating single atoms in a large supercell of bulk-structure material. Here, we show complex defect models obtained by relocation of several atoms in bulk Si_3N_4, and compare their properties to simpler models as a N vacancy or an O substitutional.

The financial support of the Cluster of Excellence "Structure Design of Novel High-Performance Materials via Atomic Design and Defect Engineering (ADDE)" through the European Union and the Ministry of Science and Art of Saxony (SMWK) is gratefully acknowledged.

KR 6.3 Wed 15:00 P1

Polarization dependent Diffraction Anomalous Fine Structure studies of TiO_2. — •Carsten Richter[1,2], Matthias Zschornak[1], Dmitri Novikov[2], Hartmut Stöcker[1], and Dirk C. Meyer[1] — [1]Institute of Experimental Physics, TU Bergakademie Freiberg, Germany — [2]Hamburger Synchrotronstrahlungslabor HASYLAB at DESY, Germany

Diffraction Anomalous Fine Structure (DAFS) is, like X-Ray Absorption Fine Structure (XAFS), a method suitable to study the local electronic structure of a certain type of atoms in the crystal. In contrast to absorption spectroscopy atoms of the same type but different crystallographic sites can be distinguished, due to the combination of spectroscopy and diffraction. Near an absorption edge, the atomic scattering factor becomes dependent of the polarization and direction of the incident and the reflected beam. Reflection conditions based on the crystal's symmetry can be used to eliminate polarization or direction independent parts. This and the variation of the polarization with respect to the crystal allows a closer insight into the types of electronic transitions involved in the scattering process.

Here we present a detailed DAFS study of rutile single crystals with different densities of oxygen vacancies including measurements and modeling of the energy and polarization dependence of the scattered intensity. Recent results of its separation into the 2 polarization states using a polarization analyzer are included. The measurements have been carried out for rutile reflections 001 and 111 at beam lines C, E2 and W1 of the HASYLAB at DESY.

KR 6.4 Wed 15:00 P1

X-ray diffractometry of magnetic (Ga,Mn)As epitaxial layers — •Vaclav Holy[1], Xavier Marti[1], Lukas Horak[1], Vit Novak[2], and Tobias Schuelli[3] — [1]Department of Condensed Matter Physics, Faculty of Mathematics and Physics, Charles University in Prague, Ke Karlovu 5, 121 16 Prague, Czech Republic — [2]Insititute of Physics, Academy of Sciences of the Czech Republic, Cukrovarnicka 10, 162 00 Prague, Czech Republic — [3]ESRF, BP220, 38043 Grenoble, France

The magnetic Mn ions in (Ga,Mn)As epitaxial layers can be found in substitutional and two types of interstitial positions, however only the magnetic moments of the substitutional Mn ions can be ferromagnetically ordered, and the Mn interstitials are detrimental for the ordering. The determination of the density of Mn ions in different lattice positions is therefore an important task. We have determined the densities of Mn substitutional and interstitial ions in (Ga,Mn)As by high-resolution x-ray diffractometry both using a single wavelength, and by measuring the dependence of the diffracted intensity on the photon energy around the MnK absorption edge (anomalous diffraction). In the former method, the dependence of the lattice parameter of the (Ga,Mn)As alloy on the Mn densities must be known a-priori. The latter approach does not use the value of the lattice parameter, however it can be realized only by means of synchrotron radiation. We have used both methods for the study of the kinetics of out-diffusion of Mn interstitials from (Ga,Mn)As layers during post-growth annealing.

KR 6.5 Wed 15:00 P1

Oxygen nonstoichiometry of tetragonal La2-xSrxCuO4-δ (x = 0.15 - 1.2) and in situ XPS studies at elevated temperatures — •Daria Mikhailova[1], Vladimir Alyoshin[2], Steffen Oswald[1], and Helmut Ehrenberg[1] — [1]IFW Dresden, Helmholtzstr. 20 01069 Dresden, Deutschland — [2]Moskauer Staatliche Lomonossov Universität, Vorobyovy Gory, 119992, Moscow, Russia

The peculiarities of oxygen nonstoichiometry (δ) in tetragonal La2-xSrxCuO4-δ solid solution with x(Sr) = 0.15 - 1.2 were studied by XRD, NPD, in situ high-temperature XPS and chemical analysis. Temperature dependences of oxygen nonstoichiometry, $\delta = \delta(T)$, were obtained for different Sr-contents at 1 bar O2. Two types of charge compensation during replacement of lanthanum by strontium are discussed: an increase of the average copper oxidation state or a formation of oxygen vacancies. The average copper oxidation state V(Cu) exhibits a maximum of 2.32 at x(Sr)=0.6, while δ increases with x(Sr). Oxygen vacancies are unambiguously located on the 4c site ({CuO2}-plane) for compositions with different strontium contents, which electronic state is described by the O2p core electron peak at about 531 eV. Thermal stability of the solid solution in vacuum is associated with the extraction of practically the entire oxygen from CuO2-layers and the formation of Cu+ at least in the surface-near region. The higher average copper oxidation state after synthesis in the Sr-rich phases in comparison with the Sr-poor compositions prevents oxygen removal and the formation of Cu+ and, therefore, stabilizes the structure during heating in vacuum.

KR 7: Crystallography in Materials Science (jointly with DF)

Time: Thursday 14:00–16:45 Location: HSZ 101

Invited Talk KR 7.1 Thu 14:00 HSZ 101

Crystallography of Nanowires — •Julian Stangl[1], Dominik Kriegner[1], Christian Panse[2], Bernhard Mandl[1,3], Kimberley A Dick[3], Mario Keplinger[1], Johan M Persson[4], Philippe Caroff[3,5], Daniele Ercolani[6], Lucia Sorba[6], Friedhelm Bechstedt[2], and Günther Bauer[1] — [1]Johannes Kepler University Linz, Austria — [2]Friedrich-Schiller-Universität Jena, Germany — [3]Lund University, Sweden — [4]Technical University of Denmark — [5]IEMN, UMR CNRS, France — [6]Scuola Normale Superiore Pisa, Italy

Semiconductor nanowires are interesting not only from physical and technological viewpoints, but also in a crystallographic sense. While most III-V semiconductors, except nitrides, crystallize exclusively in the cubic zinc-blende lattice in bulk or epitaxial layers, in nanowires very often hexagonal modifications such as wurtzite, but also the more complex 4H structure are observed. The wires grow mainly along the cubic <111> directions, where those lattice structures on first sight differ only by the stacking sequence of bilayers, changing from fcc to hcp. Detailed x-ray diffraction investigations for InAs and InSb nanowires reveal, however, that beside the stacking sequence also the atomic distances change, so that the unit cells deform compared what would be expected from a simple change of stacking. Comparisons to density functional theory calculations are in excellent agreement with the experimental data, and the combination of x-ray diffraction and theoretical calculations allow explaining the reason for the observed changes in atomic distances.

KR 7.2 Thu 14:45 HSZ 101

The Crystal structure of InAs nanorods grown onto Si[111] substrate — •Anton Davydok[1], Andreas Biermanns[1], Steffen Breuer[2], Manos Dimakis[2], Lutz Geelhaar[2], and Ullrich Pietsch[1] — [1]Festkörperphysik, Universität Siegen, Walter-Flex-Str. 3,57072, Siegen, Germany — [2]Paul-Drude-Institut für Festkörperelektronik, Hausvogteiplatz 5-7,10117 Berlin, Germany

Nanowires are of particular interest due to the ability to synthesize heterostructures in the nanometer range. It was found that nearly any AIIIBV semiconductor material can be grown as NWs onto another AIIIBV or group IV [111] substrate independent from lattice mismatch. We presented an X-ray characterization of InAs NRs on Si [111] grown by assist free MBE method. Lattice mismatch of this materials is 11%. For study of strain realizing we concentrated our research on initial stages of growth process investigating samples set with different growth time. Using synchrotron radiation we have performed experiments in symmetrical and asymmetrical out-of plane scattering geometry and grazing-incidence diffraction. Combining the results we were able to characterize the transition between silicon silicon substrate and InAs NWs. We find in-plane lattice mismatch of -0.18% close to the interface compared to InAs bulk material. With help of microfocus setup we are able measure structural paramters of single NWs to determine the strain accomodation as function of NW size. In particular using asymmetric wurzite-sensitive reflections under coherent beam illumination we could quantify the number of stacking faults. In the talk we present details of the analysis and first simulation results.

KR 7.3 Thu 15:00 HSZ 101

X-ray characterization of Au-free grown GaAs nanowires on Si — •Andreas Biermanns[1], Steffen Breuer[2], Anton Davydok[1], Lutz Geelhaar[2], and Ullrich Pietsch[1] — [1]Universität Siegen, Festkörperphysik, Germany — [2]Paul-Drude-Institut für Festkörperelektronik, Berlin, Germany

Semiconductor nanowires (NW) are of particular interest due to the ability to synthesize single-crystalline 1D epitaxial structures and heterostructures in the nanometer range. However, many details of the growth mechanism are not well understood. In this contribution we present a x-ray diffraction study of the early stage of Au-free GaAs nanowire growth on Si(111)-substrates with native oxide using the nano-focus setup available at the ID1 beamline of ESRF. The GaAs NWs were grown by molecular beam epitaxy (MBE), and their formation was induced by Ga droplets. Using a nanometer-sized x-ray beam, size and lattice parameters of individual wires were measured separately. Using asymmetric x-ray diffraction on particular zinc-blende (ZB) and wurtzite (W) sensitive reflections, we show that under the used conditions the NW growth starts with predominantly WZ phases and continues mainly in ZB phase. In addition we can show that the WZ segments of the NWs exhibit a different vertical lattice parameter compared to the zinc-blende segments. A combination of x-ray diffraction from single wires and grazing incidence diffraction shows that the base of the NW is compressively strained along the inplane direction. This strain is released within 20nm from the substrate-interface.

15 min. break

Invited Talk KR 7.4 Thu 15:30 HSZ 101

New Grounds in Materials Science: Complex Metallic Alloys — •Michael Feuerbacher — Institut fuer Festkoerperforschung, Forschungszentrum Juelich GmbH, 52425 Juelich, Germany.

Complex metallic alloys (CMAs) represent a class of materials increasingly receiving scientific attention. These materials possess characteristic structural features substantially deviating from those of simple metals. They have large lattice constants and, correspondingly, a high number of atoms per unit cell, ranging from some ten to some thousands. Their local order is dominated by icosahedral-symmetric atom coordination in the form of concentric cluster shells. These characteristic structural features are at the origin of novel physical properties.

Due to the crucial structure-property relations, transmission electron microscopy is an inevitable tool for the understanding of the physical properties of CMAs. We will present structural characterizations of various CMA materials by state-of-the-art techniques, such as aberration-corrected transmission electron microscopy and high-angle annular dark field scanning transmission electron microscopy. We will review recent experimental investigations of the physical properties of CMAs, and discuss these in the light of the particular cluster substructure. Basic scientific phenomena will be addressed, such as novel structural defects and deformation mechanisms, as well as application related issues, for example the use of CMAs as catalysts, as thermoelectric materials, and for digital data storage.

KR 7.5 Thu 16:15 HSZ 101

Local electronic structure of Ruddlesden-Popper films - a combined DFT and ELNES study — Thomas Riedl[1,2], Thomas Gemming[2], Torsten Weissbach[3,4], Gotthard Seifert[4], Emanuel Gutmann[5], Matthias Zschornak[6,7], Dirk C. Meyer[5,6], and •Sibylle Gemming[7] — [1]Werkstoffwissenschaft, TU Dresden, D-01062 Dresden — [2]IFW Dresden, PF 270116, D-01171 Dresden — [3]Theo. Physik, TU-BA Freiberg, D-09596 Freiberg — [4]Phys. Chemie, TU Dresden, D-01062 Dresden — [5]Strukturphysik, TU Dresden, D-01062 Dresden — [6]Exp. Physik, TU BA Freiberg, D-09596 Freiberg — [7]HZ Dresden-Rossendorf, PF 510119, D-01314 Dresden

Ternary oxides with the composition $AO(ABO_3)_n$, the Ruddlesden-Popper (RP) phases, and derived quaternary phases are versatile materials with complex structure-property relationships; due to their unusual conductivity properties such RP phases have attracted recent interest as materials for solid-oxide fuel cells or as thermoelectric. The present study focuses on the parent phases with A = Sr and B = Ti. Electron energy-loss near-edge fine structures of the $SrO(SrTiO_3)_{n=1}$ Ruddlesden-Popper system and of the reference compounds $SrTiO_3$ and SrO are analyzed by comparison with calculations. The fine structures of sol-gel-grown RP films have been experimentally recorded. All-electron density-functional calculations indicate that the appearance and shape of the experimental O-K and Ti-$L_{2,3}$ fine structure features result from the crystallography-dependent electronic structure of the investigated oxides, which - already without further modification - display technologically interesting dielectric and lattice properties.

KR 7.6 Thu 16:30 HSZ 101

Modeling the environment-controlled morphology changes of adsorbed two-component nanoparticles — •Sibylle Gemming[1], Gintautas Abrasonis[1], and Matthias Krause[1,2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, PF 510119, D-01314 Dresden, Germany. — [2]Institut für Festkörperphysik, Technische Universität Dresden, 01062 Dresden, Germany.

The morphology and the local composition of binary nano-particles from two immiscible components are driven by the local interactions at the different interfaces within the material system. Especially in small nano-particles, atoms at interfaces cover a large part of the total amount of atoms. Therefore, the interface energetics crucially influences the relative stabilities of different possible atom arrangements both at the surface of the particles and at the interface with the support. Such a complex system can be mapped to a two-component phase-field model with a set of complex boundary conditions at the interfaces of the particle with the support and with the surrounding atmosphere. Numerical simulations have been performed to describe the morphology evolution of such particles in dependence on the external physical conditions. The results rationalize recent observations on the structural changes of oxide-supported bimetallic nano-particles cycled in oxidizing and reducing atmospheres. Funding via the ECEMP project D1 (EU-EFRE) is gratefully acknowledged.

KR 8: Mitgliederversammlung KR

Time: Thursday 17:00–18:00 Location: HSZ 101

Mitgliederversammlung FG Kristallographie