Dielectric Solids Division
Fachverband Dielektrische Festkörper (DF)

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Overview of Invited Talks and Sessions

(Lecture Rooms H9 and H11; Poster B2)

Plenary Talk of the Dielectric Solids Division

PV VI	Tue	14:00–14:45	H1	**The Thin-Disk Laser - from Physics to Industrial Applications** — •Thomas Graf

Invited Talks

DF 20.1	Thu	9:30–10:10	H11	**Organic Perovskites : Intriguing Magnetic Ferroelectrics** — •Naresh Dalal
DF 20.2	Thu	10:10–10:50	H11	**Ferroelectricity in organic and hybrid organic-inorganic compounds** — •Alessandro Stroppa, Silvia Picozzi
DF 20.3	Thu	11:00–11:40	H11	**Coupling of charge and spin order in organic charge transfer salts** — •Martin Dressel
DF 20.4	Thu	11:40–12:20	H11	**Electrodynamics and ferroelectricity in two-dimensional molecular solids** — •Silvia Tomic, Tomislav Ivek, Marko Pinteric, Matija Culo, Bojana Korin-Hamzic, Martin Dressel

Invited talks of the joint symposium SYTS

See SYTS for the full program of the symposium.

SYTS 1.1	Wed	9:30–10:00	H1	**Transport in Old and New Thermoelectric Materials** — •David Singh
SYTS 1.2	Wed	10:00–10:30	H1	**Binary oxide structures as model systems for thermoelectric transport** — •Peter J. Klar, Christian Heiliger
SYTS 1.3	Wed	10:30–11:00	H1	**Functional oxides films: from single crystals to polycrystalline substrates** — •Wilfrid Prellier
SYTS 1.4	Wed	11:00–11:30	H1	**The Planar Nernst Effect and the Search for Thermal Spin Currents in Ferromagnetic Metals** — •Barry Zink
SYTS 1.5	Wed	11:30–12:00	H1	**Tunneling magneto thermopower in magnetic tunnel junction nanopillars** — Niklas Liebing, Santiago Serrano-Guisan, Patryk Krzysteczko, Karsten Rott, Günter Reiss, Jürgen Langer, Berthold Ocker, •Hans Werner Schumacher

Sessions

DF 1.1–1.3	Mon	9:30–10:30	H11	**Nano- and microstructured dielectrics**
DF 2.1–2.10	Mon	9:30–12:00	H3	**Multiferroics 1 (jointly with MA,DS,KR,TT)**
DF 3.1–3.1	Mon	10:30–10:50	H11	**Dielectric surfaces and interfaces**
DF 4.1–4.3	Mon	15:00–16:00	H11	**Electrical and mechanical properties**
DF 5.1–5.13	Mon	15:00–18:30	H3	**Multiferroics 2 (jointly with MA,DS,KR,TT)**

DF 6.1–6.1	Mon	16:05–16:25	H11	**Nonlinear dielectrics, phase transitions, relaxors**
DF 7.1–7.1	Mon	16:25–16:45	H11	**Ceramics**
DF 8.1–8.2	Mon	16:50–17:30	H11	**Application of dielectric solids**
DF 9.1–9.9	Mon	15:00–17:30	H34	**Glasses and Glass Transition I (joint session with CPP, DY)**
DF 10.1–10.8	Tue	9:30–12:20	H11	**Optical and nonlinear optical properties, photonic**
DF 11.1–11.11	Tue	9:30–12:30	H46	**Glasses II (joint session with CPP, DY)**
DF 12.1–12.85	Tue	10:30–13:30	Poster D	**Poster 1**
DF 13.1–13.1	Tue	14:00–14:45	H1	**PV VI**
DF 14.1–14.5	Wed	9:30–12:00	H1	**Thermoelectric and Spincaloric Transport in Nanostructures**
DF 15.1–15.3	Wed	9:30–10:30	H11	**High- and low-k-dielektrics (joint session with DS)**
DF 16.1–16.5	Wed	10:40–12:20	H11	**Dielectric and ferroelectric thin films**
DF 17.1–17.2	Wed	12:30–13:10	H11	**Glasses III (joint session with CPP, DY)**
DF 18.1–18.3	Wed	12:30–13:30	H9	**Nanostructured oxide thermoelectrics**
DF 19.1–19.23	Wed	15:00–17:30	Poster B2	**Poster 2**
DF 20.1–20.4	Thu	9:30–12:20	H11	**Focus Session: Organic ferroelectrics**
DF 21.1–21.12	Fri	9:30–12:45	H32	**Resistive Switching (jointly with DF, KR, HL)**
DF 22.1–22.82	Fri	10:30–13:30	Poster D	**Poster II**

Jahreshauptversammlung des Fachverbandes Dielektrische Festkörper

Mittwoch 18:00–19:00 H11

- Bericht des Fachverbandsleiters
- Analyse des bisherigen Tagungsverlaufes
- Wahl des neuen Fachverbands-Vorstandes 2013-2016
- Vorschläge für Themen von Symposien, Schwerpunktsitzungen, Plenar- und Hauptvorträgen für die kommenden Jahre
- Verschiedenes

DF 1: Nano- and microstructured dielectrics

Time: Monday 9:30–10:30 Location: H11

DF 1.1 Mon 9:30 H11

Ferroelectric domains at the phase transition in $BaTiO_3$ — •Thorsten Limböck, Akos Hoffmann, and Elisabeth Soergel — Physikalisches Institut, Universität Bonn, Wegelerstrasse 8, 53115 Bonn

The classical example of a perovskite crystal, Barium Titanate ($BaTiO_3$), exhibits several phase transitions, namely from rhombohedral $\xrightarrow{-90^\circ}$ orthorhombic $\xrightarrow{+7^\circ}$ tetragonal $\xrightarrow{+120^\circ}$ cubic. In order to investigate the behavior of the ferroelectric domain patterns at the phase transition occurring at $+7^\circ$ we upgraded our scanning force microscope with a Peltier cooling/heating stage allowing for operation in a temperature range between -80° and $+120^\circ$. Piezoresponse force microscopy (PFM) images, directly mapping the ferroelectric domain configuration, can be acquired either at fixed temperature or, when using a custom-designed script, during temperature ramps linked to the scanning process. We can thereby record the emergence of the domains when cooling down from high temperatures but also the change of the domain patterns across the orthorhombic to tetragonal phase transition.

DF 1.2 Mon 9:50 H11

Properties of ferroelectric domain boundaries investigated with scanning force microscopy — Jakob Frohnhaus, •Akos Hoffmann, and Elisabeth Soergel — Physikalisches Institut, Universität Bonn, Wegelerstrasse 8, 53115 Bonn

In lithium niobate ($LiNbO_3$), the ferroelectric polarization can only occur along the $\pm z$ direction resulting in the well-known 180° domain boundaries ($\downarrow\uparrow$) which are generally used for applications such as periodically poled $LiNbO_3$ is used in nonlinear-optics. The two large faces of a z-cut crystal show the domain pattern as alternating $+z$, $-z$, $+z$, ... areas. Indeed, using a specific thermal treatment, also head-to-head domain boundaries ($\begin{smallmatrix}\downarrow\\\uparrow\end{smallmatrix}$) can be generated. Obviously such a crystal exhibits only two domains, and consequently only one domain boundary, and the two large faces of a z-cut crystal are both $-z$-faces.

Scanning force microscopy (SFM) is known as a very versatile tool for highly resolved imaging not only of the surface itself but also of the materials' properties. It is therefore possible to detect not only the topography but also the surface charge density, the piezoresponse, the conductivity, ... with high lateral resolution. We apply the varieties of SFM for the investigation and modification of these very different domain boundaries.

DF 1.3 Mon 10:10 H11

Nanosecond laser-induced nano-structuring of fused silica — •Pierre Lorenz, Frank Frost, Martin Ehrhardt, and Klaus Zimmer — Leibniz-Institut für Oberflächenmodifizierung e. V., Permoserstraße 15, 04318 Leipzig, Germany

The nano structuring of dielectrics is a big challenge for laser patterning methods. The laser-induced front side etching method using in situ pre-structured metal layers (IPSM-LIFE) allows an easy and fast fabrication of nanostructures into dielectric surfaces. At the IPSM - LIFE process, the irradiation of thin chromium film deposited onto a dielectric substrate with low laser fluences results in the formation of complex metal structures by self-assembly processes. Further laser irradiation of these metal structures with higher or equal laser fluences causes the formation of complex patterns at the surface of the dielectric. The patterns observed after irradiation of chromium-covered fused silica with laser pulses (25 ns, 248 nm) were studied by scanning electron microscopy (SEM) and atomic force microscopy (AFM). The resultant dielectric surface structures was studied dependent on the laser parameter (number of laser pulses, laser fluences) and material parameter (metal layer thickness). Different features like concentric ring patterns, donut-like structures as well as bar patterns were observed. Lateral sizes down to 20 nm can be achieved.

DF 2: Multiferroics 1 (jointly with MA,DS,KR,TT)

Time: Monday 9:30–12:00 Location: H3

DF 2.1 Mon 9:30 H3

Magnetoelectric coupling at the n-doped interface $BaTiO_3/SrTcO_3$ studied from first principles — •Vladislav Borisov[1], Sergey Ostanin[1], and Ingrid Mertig[1,2] — [1]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany — [2]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, D-06099 Halle, Germany

Antiferromagnetically induced magnetoelectric coupling at the interface $BaTiO_3/SrTcO_3$, which combines a robust ferroelectric and a stable antiferromagnetic perovskite, is studied from first principles. For the BaO/TcO_2-terminated interface, the magnetic order may change from G- to C-type antiferromagnetism upon the electric polarization reversal in the ferroelectric side. By inspecting the two-dimensional band structure and orbital occupation of the Tc 4d-states we conclude that the polarization-dependent charge transfer is responsible for a two-dimensional electron gas at the interface between two insulating perovskites. The case of paraelectric $BaTiO_3$ is also discussed in the context of the effect.

DF 2.2 Mon 9:45 H3

Observation of novel multiferroic-like effect in C60-Co nanocomposites — •Masashi Shiraishi[1], Eiiti Tamura[1], Yutaka Sakai[1], Toyokawa Shuhei[1], Eiji Shikoh[1], Vlado Lazarov[2], Atsufumi Hirohata[3], Teruya Shinjo[1], and Yoshishige Suzuki[1] — [1]Graduate School of Engineering Science, Osaka Univ., Japan — [2]Department of Physics, Univ. York, UK — [3]Department of Electronics, Univ. York, UK

A novel magnetoelectric effect is found to appear in a C60-Co nanocomposite. Although Co is well-known as a ferromagnet, its nanoparticles embedded in a C60 matrix can exhibit enhancement of magnetoresistance ratio due to a combination of Coulomb-blockade and higher order co-tunneling [1], and also multiferroic-like behavior [2], i.e., an electric field controls magnetic alignment of the nanoparticles and a magnetic field controls their charged states. This novel effect enables a strong magnetic switching effect for which the on/off ratio is ca. 1e4. Such an effect has been expected to exist and these findings show this magnetoelectric coupling for the first time.

[1] D. Hanataka, M. Shiraishi et al., Phys. Rev. B79, 235402 (2009). [2] Y. Sakai, E. Tamura, M. Shiraishi et al., Adv. Func. Mat. 22, 3845 (2012).

DF 2.3 Mon 10:00 H3

Investigation of magnetic ordering in $Eu_{1-x}Y_xMnO_3$ using full polarization analysis at P09 beamline — •Arvid Skaugen, Dinesh K. Shukla, Helen Walker, Sonia Francoual, and Jörg Strempfer — Deutsches Elektronen-Synchrotron, Harmburg, Germany

Varying multiferroic properties with strong ME coupling have been reported for $Eu_{1-x}Y_xMnO_3$ [1]. The crystal structure of $Eu_{1-x}Y_xMnO_3$ is similar to the one of $TbMnO_3$ with comparable lattice distortions. However, the effect of rare earth magnetism is eliminated since Eu^{3+} ($4f^6$) and Y^{3+} ($4f^0$) ions both are non-magnetic. The compound $Eu_{0.8}Y_{0.2}MnO_3$ first shows a phase transition at T_N = 45K from a paramagnetic to an antiferromagnetic and paraelectric state with a presumably sinusoidal collinear AFM structure, in analogy to $TbMnO_3$. At T_C = 30K the magnetic structure changes to weak ferromagnetism, attributed to a cone-like structure that breaks inversion symmetry and gives rise to ferroelectricity with the polarization along the a-axis.

We have investigated $Eu_{0.8}Y_{0.2}MnO_3$ using resonant x-ray diffraction as function of temperature, magnetic field and incident polarization at beamline P09 at PETRA III. The method of full polarization analysis has been used to investigate the different resonances showing up at the Mn K-edge. From the polarization scans, it is possible to draw conclusions on the complex magnetic order. Preliminary results suggest a helicoidal SDW structure of the Mn moments rather than a

cone-like structure.

[1] J. Hemberger et al., Phys. Rev. B 75, 035118 (2007)

DF 2.4 Mon 10:15 H3

Electrostatic tuning of large-distance sputtered LSMO/PZT heterostructures — •Philipp Moritz Leufke, Ajay Kumar Mishra, Wang Di, Robert Kruk, and Horst Hahn — Institute of Nanotechnology (INT), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

In order to obtain a physical picture and quantitative characteristics of a magnetoelectric coupling at ferromagnetic/ferroelectric interfaces, epitaxial $La_{0.87}Sr_{0.13}MnO_3$/Pb(Zr,Ti)O_3 (LSMO/PZT) heterostructures were deposited by large-distance magnetron sputtering[1,2]. The remarkably high lateral uniformity achieved in such films allowed for a ferroelectric device area of more than 6 mm^2.

This has enabled for the first time *in-situ* SQUID measurements of the magnetic response to the systematically varied remanent ferroelectric polarization. Temperature dependence of the magnetic modulation upon charging and the magnetic response to the ferroelectric stimulation indicates a field-effect dominated coupling mechanism and generally confirms the concept of electrostatic hole (h^+) doping of LSMO.

For small charge modulations at low temperature, a linear tuning coefficient of $\approx 3.6\,\mu_B/h^+$ has been determined. This suggests the activation of an antiferromagnetic coupling, even for very small surface charge densities. Simultaneously a shift in the magnetic transition temperature at higher surface charge concentration indicates the presence of a ferromagnetic phase at the LSMO/PZT interface.

[1] P. M. Leufke *et al.*, *Thin Solid Films* **520**, 5521 (2012).
[2] P. M. Leufke *et al.*, *AIP Advances* **2**, 032184 (2012).

DF 2.5 Mon 10:30 H3

Optimized magnetoelectric interface coupling — •Igor Maznichenko[1], Arthur Ernst[2], and Ingrid Mertig[1,2] — [1]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, D-06099 Halle (Saale), Germany — [2]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle (Saale), Germany

It was shown that magnetoelectric coupling occurs at interfaces between a magnetic and a ferroelectric material. Our idea is to construct heterostructures with a particularly strong magnetoelectric coupling. We concentrate on the optimization of the magnetic layer. We demonstrate that a small magnetic moment at the interface can still transfer the magnetoelectric coupling to a strong ferromagnet and could cause significant response. The idea is supported by numerical simulations within density functional theory using the self-consistent KKR Green function method.

DF 2.6 Mon 10:45 H3

Role of electron correlation of FeO at Fe/ferroelectric oxide/Fe interface for magnetic transport properties — •Andrea Neroni, Daniel Wortmann, Ersoy Sasioglu, Stefan Blügel, and Marjana Ležaić — Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich and JARA, 52425 Jülich, Germany

Fe/ferroelectric oxide/Fe is a nanoferronic tunnel junction with exciting electronic magneto-conductive transport properties. FeO layers at the interface of Fe/oxide/Fe barriers seems to significantly alter these properties as indicated by several experiments. In order to understand the role of electron correlations in FeO at the interface on the tunneling properties of a Fe/$BaTiO_3$/Fe barrier we use an embedded Green-function approach [1] implemented within the framework of the full-potential linearized augmented plane-wave (FLAPW) method `FLEUR` [2]. Conductances are obtained for different oxidation conditions and for different magnetic configurations of the contacts. Strong correlations are taken into account employing the LDA+U approach within the framework of the density functional theory (DFT) with a Hubbard U parameter determined by constrained random phase approximation (cRPA) [3]. Work is supported by Helmholtz Young Investigators Group Program VH-NG-409.

[1] www.flapw.de
[2] D. Wortmann, H. Ishida, and S. Blügel, PRB **65**, 165103 (2002)
[3] E. Şaşıoğlu, C. Friedrich, and S. Blügel, PRB **83**, 121101(R) (2011)

DF 2.7 Mon 11:00 H3

Multiferroic Aurivillius Phases: the Case of $Bi_5FeTi_3O_{15}$ by *ab initio* — •Yael Birenbaum, Nicola Spaldin, and Claude Ederer — Materials Theory, ETH Zürich, Switzerland

The Aurivillius phases form a family of naturally-layered perovskite-related materials with good ferroelectric properties. $Bi_5FeTi_3O_{15}$ (BFTO) is perhaps the simplest known member of this family that also incorporates magnetic degrees of freedom. Using *ab initio* electronic structure calculations, we establish the ferroelectric and magnetic properties of BFTO. We then discuss a possible site preference of the Fe^{3+} cation, which so far has not been found experimentally, and quantify the magnetic coupling between adjacent Fe cations. In addition, we analyse the different structural distortions, in order to relate BFTO to other members of the Aurivillius phases.

DF 2.8 Mon 11:15 H3

Strain effect on magnetic properties of $La_{0.7}Ca_{0.3}MnO_3$/$SrRuO_3$ Superlattices — •Sujit Das[1,2], Andreas Herklotz[1,2], and Kathrin Doerr[1,2] — [1]IFW Dresden, Postfach 270116, 01171 Dresden, Germany — [2]Institute for Physics, MLU Halle-Wittenberg, 06099 Halle, Germany

Coherent interfaces between magnetic oxides such as $La_{0.7}$ $Sr_{0.3}MnO_3$ and $SrRuO_3$ may induce an intense magnetic coupling [1]. Recent work indicated an impact of elastic strain on the strength and even the sign of the coupling [2]. Superlattices (SL) of $La_{0.7}$ $Ca_{0.3}MnO_3$/$SrRuO_3$ with layer thicknesses below 10 unit cells were grown by pulse laser deposition simultaneously on $SrTiO_3$(001) (STO), $LaAlO_3$(001) (LAO) and piezoelectric 0.72Pb($Mg_{1/3}Nb_{2/3}$)O_3-0.28$PbTiO_3$ (001) (PMN-PT) substrates and structurally characterized by X-ray diffraction (XRD). On LAO, the SL assumes a compressive strain state, i. e. the lattice parameter is larger out-of-plane than in-plane, whereas on PMN-PT it shows a tensile strain state and on STO an intermediate strain value. Magnetization measurements demonstrate a strong antiferromagnetic (AFM) coupling in SLs on STO and LAO substrates which is due to superexchange interaction between Ru and Mn ions. The AFM coupling seems to decrease under tensile strain. The coupling is much weaker on PMN-PT, probably because of higher interface roughness. In order to probe the effect of elastic strain directly, magnetization loops in reversibly controlled strain states have been recorded for SLs on PMN-PT. [1] M. Ziese et al., PRL 104, 167203 (2010), [2] J. W. Seo et al., PRL 105, 167206 (2010) .

DF 2.9 Mon 11:30 H3

Tuning the multiferroic phase of CuO with impurities — •Johan Hellsvik[1], Marcello Balestieri[1], Alessandro Stroppa[2], Anders Bergman[3], Lars Bergqvist[4], Olle Eriksson[3], Silvia Picozzi[2], and José Lorenzana[1] — [1]ISC-CNR, Rome, Italy — [2]CNR-SPIN, L'Aquila, Italy — [3]Uppsala University, Uppsala, Sweden — [4]KTH, Stockholm, Sweden

The discovery that CuO is a multiferroic with a high antiferromagnetic transition temperature of 230 K opened a possible route to room-temperature multiferroicity with a strong magnetoelectric coupling [1]. CuO belongs [2] to a new class of multiferroic materials where the so called 'order by disorder mechanism' [3] plays a crucial role. In this work we study the effect of different impurities on the phase diagram of CuO aiming at engineering the multiferroic properties. Extensive density functional theory (DFT) calculations were performed for a large number of fixed spin configurations in pure CuO and CuO doped with a small fraction of the Cu atoms substituted with the nonmagnetic elements Mg, Zn or Cd, or the magnetic elements Ni or Co. Our computations established that the energy difference between the low-temperature collinear AF1 phase and the intermediate temperature multiferroic AF2 phase decreased monotonously with increasing doping level confirming that impurities favour the multiferroic phase. The magnetic phase diagram has been mapped out in Monte Carlo simulations for classical Heisenberg spins. [1] T. Kimura et al., Nature Mat. 7, 291 (2008); [2] G. Giovannetti et al., Phys. Rev. Lett. 106, 026401 (2011); [3] C. L. Henley, Phys. Rev. Lett. 62, 2056 (1989)

DF 2.10 Mon 11:45 H3

Charge-mediated magnetoelectric coupling in patterned multiferroic heterostructures — •daniele preziosi[1], dietrich hesse[1], marin alexe[1], martin wahler[2], and georg schmidt[2] — [1]Max-Planck-Institut für Mikrostrukturphysik Weinberg 2, 06120 Halle(Saale) Germany — [2]Martin-Luther-Universität Halle-Wittenberg Von-Danckelman-Platz 3, 06120 Halle(Saale) Germany

Several studies on single phase multiferroics demonstrate that the coupling between the ferroelectric and the (ferro)magnetic order parameters tends to be small. Engineering of artificially structured systems could provide a reliable way to improve the MagnetoElectric (ME) coupling. Devices based on charge-mediated ME effect represent a vi-

able alternative. The electric field produced by the polarization of the ferroelectric material can induce, at the interface with an ultrathin strongly correlated magnetic oxide, a change in the magnetization. The ME coupling would be in this case the consequence of the spin-dependent screening of the electric field. Patterned hetero-structures of La1-xSrxMnO3 (LSMO) and PbZr0.2Ti0.8O3 (PZT) have been fabricated. Transport and magnetic measurements show that the switching of the PZT polarization influences significantly the competing electronic ground states of the LSMO, modulating the resistivity as well as the magnetization value.

DF 3: Dielectric surfaces and interfaces

Time: Monday 10:30–10:50 Location: H11

DF 3.1 Mon 10:30 H11

First principles simulation of a moving longitudinal domain wall in $PbTiO_3$ — •Kourosh Rahmanizadeh, Gustav Bihlmayer, and Stefan Blügel — Peter Grünberg Institut (PGI-1) & Institute for Advanced Simulation (IAS-1), Forschungszentrum Jülich and JARA, 52425 Jülich, Germany

In ferroelectrics, the formation of domain walls can compensate the surface charge, release elastic strain and lower the free energy of the crystal. However, 180° head-to-head domain walls are energetically costly due to electrostatic repulsion of charges at the interface. It is possible to reduce the electrostatic energy at the longitudinal domain wall by including electron donors / acceptors.

We carried out density functional theory calculations based on the full-potential linearized augmented planewave (FLAPW) method as implemented in the `FLEUR` code (www.flapw.de) for simulating domain walls in $PbTiO_3$. To stabilize these walls, we introduce effective Ti and O vacancies for accepting and donating electrons.

We modeled the growth of domains with different configurations of the vacancies. For each configuration, the structures were optimized. We also investigated the pinning strength of domain walls in $PbTiO_3$. To this end, we applied external electric fields ranging up to 9×10^7 V/cm to the simulated structures, monitoring the evolution of the total energy.

Financial support of the EU grant NMP3-LA-2010-246102 (IFOX) is gratefully acknowledged.

DF 4: Electrical and mechanical properties

Time: Monday 15:00–16:00 Location: H11

DF 4.1 Mon 15:00 H11

High-pressure crystal structure of $Bi_{12}GeO_{20}$ sillenite — •Leonore Wiehl, Alexandra Friedrich, Eiken Haussühl, Wolfgang Morgenroth, and Björn Winkler — Institut für Geowissenschaften, Goethe-Universität, Frankfurt/Main, Germany

$Bi_{12}GeO_{20}$ crystallizes in the sillenites structure type with the non-centrosymmetric cubic space group $I23$. Sillenites $Bi_{12}MO_{20}$ (M = Si, Ge, Ti) are used in technical applications because of their outstanding electrical and nonlinear optical properties, especially the photorefractive effect. These properties are assumed to be correlated with the stereochemical activity of the $6s^2$ lone electron pair of Bi^{3+}.

The evolution of the $Bi_{12}GeO_{20}$ crystal structure under high pressure was investigated by experiment and theory using single-crystal X-ray diffraction and density functional theory (DFT) calculations. The crystal structure was determined from X-ray intensity data collected at ambient conditions in house and at high pressure with synchrotron radiation at HASYLAB (D3). Pressures up to 21 GPa were generated in diamond anvil cells. DFT calculations were performed up to 50 GPa. The pressure dependence of interatomic distances indicates a reduced eccentricity of the Bi^{3+} coordination at high pressure, but not a collapse of the Bi^{3+} lone electron pair. The results are discussed in comparison with the isotypic Si sillenite [1].

Financial support from the DFG (HA 5137/3-1) and from HASYLAB is gratefully acknowledged. We thank HASYLAB for synchrotron beamtime and Martin Tolkiehn for assistance at D3.

[1] Wiehl L, et al. (2010) J. Phys.: Condens. Matter 22, 505401

DF 4.2 Mon 15:20 H11

Ripening of ZnO nanoparticles - influence of the stabilizing layer — •Torben Schindler, Martin Schmiele, Thaer Kassar, and Tobias Unruh — Lehrstuhl für Kristallographie und Strukturphysik, Friedrich-Alexander Universität Erlangen Nürnberg, Staudtstr. 3, 91058 Erlangen

ZnO semiconductor nanoparticles (NPs) exhibit promising electro-optical properties for applications in e.g. solar cells or light emitting devices due to the quantum size effect. Thus, the preparation of well-defined, stable ZnO-NPs is of high interest and therefore knowledge about the nucleation and growth processes is crucial.

For the synthesis ethanolic solutions of zincacetate and lithiumhydroxide are simply mixed. The nucleation of the NP occurs instantly, while a further ripening of the ZnO-NPs starting from about 2.5 nm as a function of temperature was observed using UV/Vis measurements. The ripening process is further investigated in detail using temperature- and time-dependent small angle x ray scattering (SAXS) measurements. To determine the influence of the stabilizing acetate layer for the particle growth, small angle neutron scattering (SANS) is used and first results will be presented.

DF 4.3 Mon 15:40 H11

Localization Effects in Dielectric Disordered Crystals and Random Materials — Anton Lebedev, Marius Dommermuth, and •Regine Frank — Institut für Theoretsiche Physik, Universität Tübingen

Anderson localization, the counterpart of hyper diffusion, more than ever is of high interest to the semiconductor community. We apply diagrammatic quantum field theory beyond Lippmann-Schwinger equation to derive and explain localization effects in disordered photonic crystals and random media. Mie-Scattering als well as other scatterers are considered and we present self-consistent fit-parameter free 'ab initio' calculations and results.

DF 5: Multiferroics 2 (jointly with MA,DS,KR,TT)

Time: Monday 15:00–18:30 Location: H3

DF 5.1 Mon 15:00 H3

Magnetization control in thin two-phase multiferroic structures via external electric fields — •Alexander Sukhov[1], Paul P. Horley[2], Chenglong Jia[3], 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 — [3]Key Laboratory for Magnetism and Magnetic Materials of the Ministry of Education, Lanzhou University, Lanzhou 730000, China

We present a theoretical study of the coupled magnetization and polarization dynamics in a thin multiferroic junction related to a $BaTiO_3$ (rhombohedral phase) layer in contact with Fe-layer. The dynamical properties are discussed in the context of different interfacial magnetoelectric coupling mechanisms. For the magnetoelectric coupling

induced by the screening of the spin-polarized electrons in Fe we investigate the minimum strength of the coupling constant which is required for the full switching of the magnetization [1]. In the case of a strain-induced magnetoelectric interaction we show an electric field-induced magnetic switching in the plane perpendicular to the magneto-crystalline easy axis while the total magnetization remains stable [2]. In addition, the response of the multiferroic structure to magnetic radio-frequency fields by means of ferromagnetic resonance and dependent on the applied electric field is studied. [1] P.P. Horley, A. Sukhov, C.-L. Jia, E. Martinez, J. Berakdar, Phys. Rev. B **85**, 054401 (2012). [2] C.-L. Jia, A. Sukhov, P.P. Horley, J. Berakdar, Europhys. Lett. **99**, 17004 (2012).

DF 5.2 Mon 15:15 H3

Magnetic field induced charge anisotropy in $CoFe_2O_4/BaTiO_3$ nanocomposite — •Carolin Schmitz-Antoniak[1], Detlef Schmitz[2], Sven Stienen[1], Pavel Borisov[3], Anne Warland[1], Bernhard Krumme[1], Wolfgang Kleemann[1], and Heiko Wende[1] — [1]Fakultät für Physik, Universität Duisburg-Essen, D-47048 Duisburg — [2]Helmholtz-Zentrum Berlin für Materialien und Energie, D-12489 Berlin — [3]Department of Chemistry, University of Liverpool, Liverpool L69 7ZD

The system of $CoFe_2O_4$ nanopillars in a $BaTiO_3$ matrix represents a multiferroic nanocomposite in which strong ferrimagnetism and strong ferroelectricity coexist at room temperature [1]. The magnetostrictive CFO nanopillars and the piezoelectric BTO matrix are coupled by strain so that it is possible to change the electric properties by a magnetic field and the magnetic properties by an electric field. The charge anisotropy of Ti ions is probed by x-ray linear dichroism (XLD) and the magnetisation of Co ions by x-ray magnetic circular dichroism (XMCD) giving the unique possibility to study the effect of the coupling on a microscopic level as a function of magnetic field strength and direction. The occurrence of significant in-plane components of the electric polarisation is discussed. They are due to shear forces acting on the $BaTiO_3$ matrix while taking into account non-diagonal piezoelectricity components.

Funded by DFG (SFB491) and BMBF (05 ES3XBA/5).

[1] H. Zheng et al., Science 303, 661 (2004)

DF 5.3 Mon 15:30 H3

Multiferroic CoFe2O4/ BaTiO3 with core shell structure nanoparticles — •Morad Etier[1], Vladimir V.Shvartsman[1], Yanling Gao[1], Joachim Landers[2], Heiko Wende[2], and Doru C.Lupascu[1] — [1]University of Duisburg-Essen, Institute for Materials Science, Essen, Germany — [2]University of Duisburg-Essen, Faculty of Physics, Duisburg, Germany

Multiferroic materials exhibit ferroelectricity and ferromagnetism simultaneously. Combining piezoelectricity and magnetostriction components in the same composite received more interests in the modern researches. In this work we report synthesis and properties of cobalt iron oxide barium titanate composite with a core shell structure. To synthesize the samples we combine co-precipitation and organosol method. Phases content, microstructure and morphology were studied by x-ray diffraction, SEM and TEM. Multiferroic properties were proved by home-built Sawyer-Tower circuit and SQUID magnetometry. Temperature dependence of magnetic moment was measured in zero field cooling (ZFC) and field cooling (FC) and compared with those cobalt iron oxide nanopowder. The dielectric properties were studied using impedance spectroscopy.

DF 5.4 Mon 15:45 H3

Strain-induced changes of magnetic anisotropy in epitaxial spinel-type cobalt ferrite films — •Stefania Florina Rus[1,2], Andreas Herklotz[2,4], Iuliu Grozescu[3], and Kathrin Dörr[4] — [1]Politehnica University of Timişoara, 300006 Timişoara, Romania — [2]IFW Dresden, 01171 Dresden, Germany — [3]Institute for Research and Development in Electrochemistry and Condensed Matter, 300224 Timisoara, Romania — [4]Martin-Luther-Universität Halle-Wittenberg, Institute for Physics, 06099 Halle, Germany

We present results on the effect of biaxial strain on the magnetic anisotropy of thin films of the parent compound CoFe2O4 and films with a partial substitution of Co and Fe by Zr and Pt, respectively. The strain states of the epitaxially grown films are controlled twofold: (i) statically by epitaxial misfit strain via an appropriate choice of substrates and buffer layers and (ii) reversibly by strain transfer from piezoelectric $Pb(Mg_{1/3}Nb_{2/3})_{0.72}Ti_{0.28}O_3$ (001) (PMN-PT) substrates. Due to large negative magnetostriction all films show an out-of-plane magnetic easy axis under tensile strain and an in-plane easy axis under compressive strain. Our reversible strain measurements show that the magnetic anisotropy can be efficiently altered by the application of an electric field to the ferroelectric PMN-PT substrates. The effect of substitution with Zr and Pt on the magnetoelectric effect will be discussed. This work is supported by the strategic grant POSDRU ID77265 (2010), co-financed by the European Social Fund, within the Sectoral Operational Programme Human Resources Development 2007-2013. Advising by P. Vlazan is greatly acknowledged.

DF 5.5 Mon 16:00 H3

***Ab initio* study of magneto-phonon interaction in $GaFeO_3$** — •Konstantin Z. Rushchanskii, Stefan Blügel, and Marjana Ležaić — Peter Grünberg Institut, Forschungszentrum Jülich and JARA, 52425 Jülich, Germany

Magnetoelectric (ME) coupling provides a handle for manipulating the magnetization of a material with an electric field, giving a perspective for a new type of non-volatile memory. Unfortunately, materials with ME coupling that is large enough for industrial applications are scarce. Moreover, among the materials which are both ferroelectric and magnetic at room temperature, only $BiFeO_3$ is known. Unfortunately, the ordering of spins in this material is antiferromagnetic (whereas ferro/ferrimagnetic coupling is desired) and the ME coupling is small.

$GaFeO_3$ (GFO) is the first material observed to simultaneously present a strong ME coupling and a resulting magnetization in a single phase. It has the polar structure $Pc2_1n$, which allows disorder in A and B cation sites. By increasing the iron content its Curie temperature can be increased above room temperature [1].

To understand the mechanism of the strong ME coupling in $GaFeO_3$ at the microscopic level, we performed *ab initio* calculations based on density functional theory of the structural properties and magneto-phonon interaction in stoichiometric $GaFeO_3$ compounds in different structures, as well as with different occupancies of the A and B sites.

We acknowledge the support by Helmholtz Young Investigators Group Programme VH-NG-409 and GALIMEO Consortium.

[1] T. Arima *et al.*, Phys. Rev. B **70**, 064426 (2006)

DF 5.6 Mon 16:15 H3

The effect of ion doping on multiferroic $MnWO_4$ — •safa golrokh bahoosh[1,3], julia m. wesselinowa[2], and steffen trimper[3] — [1]Max Planck Institute of Microstructure Physics,Weinberg 2, 06120 Halle, Germany — [2]University of Sofia, Department of Physics,Blvd. J. Bouchier 5, 1164 Sofia, Bulgaria — [3]Institute of Physics, Martin-Luther-University, 06120 Halle, Germany

We have studied the ion doping effects on different transition temperatures in the multiferroic compound $MnWO_4$ based on a microscopic model and within the framework of Green functions technique. It is shown that the exchange interaction constants can be changed due to the different ion doping radii. This leads to reduction of the magnetic phase transition temperature T_N by doping with non-magnetic ions,such as Zn, Mg, whereas T_N is enhanced by doping withtransition metal ions, such as Fe, Co. The different behavior of the temperature T_1 (where up-up-down-down collinear spin structure appears) by Fe and Co doping could be explained taking into account the single-ion anisotropy.

15 min. break

DF 5.7 Mon 16:45 H3

Hybrid improper ferroelectricity in a Multiferroic and Magnetoelectric Metal- Organic Framework — •Alessandro Stroppa[1], Paolo Barone[1], Prashant Jain[2], Manuel Perez-Mato[3], and Silvia Picozzi[1] — [1]CNR-SPIN Via Vetoio, 67100, L'Aquila (Italy) — [2]Los Alamos National Lab, 30 Bikini Atoll Rd Los Alamos, NM 87545-0001 (505) 664-5265 — [3]Departamento de Fisica de la Materia Condensada, Facultad de Ciencia y Tecnologia, UPV/EHU, Bilbao (Spain)

Metal-organic frameworks (MOFs) show increasing promise as candidates for various applications. Of particular interest are MOFs with the perovskite topology showing hydrogen bonding-related multiferroic phenomena. By using state-of-the-art-ab-initio calculations, we show that in [C(NH2)3]Cr(HCOO)3 MOF, interaction between the cooperative antiferro-distortive Jahn-Teller distortions and the C(NH2)3 cations breaks the inversion symmetry through hydrogen-bonding and induces a ferroelectric polarization. Interestingly, the polar behavior arises due to a trilinear coupling between two unstable modes, namely a

Jahn-Teller and a tilting mode, and one stable polar mode. Therefore, this compound represents the first example of hybrid improper ferroelectric in the family of metal-organic compounds. Since rotational modes in perovskite-inorganic compounds usually freeze-in at elevated temperatures (300 K), the trilinear coupling in MOF compounds may provide an interesting route to realize room temperature multiferroic. Last but not least, we show that switching of polarization direction implies the reversal of a large weak ferromagnetic component.

DF 5.8 Mon 17:00 H3

Ferroelectric properties of (Ba,Sr)TiO_3/$La_{0.7}Sr_{0.3}MnO_3$ multilayered thin films — •Markus Michelmann[1], Johannes Aprojanz[1,2], Arseni Buryakov[2], Elena Mishina[2], Markus Jungbauer[1], Sebastian Hühn[1], and Vasily Moshnyaga[1] — [1]I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen — [2]Moscow State Institute of Radioengineering, Electronics and Automation, Prosp. Vernadskogo 78, 119454 Moscow, Russia

$Ba_xSr_{1-x}TiO_3$ (BSTO) epitaxial thin films became feasible for room temperature applications in contrast to the bulk material due to a possibility to enhance the ferroelectric Curie temperature under biaxial compressive strain. Using $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) thin films as metallic electrodes, we have grown highly strained BSTO/LSMO bilayers and LSMO/BSTO/LSMO trilayers on $SrTiO_3$ (100) substrates with BSTO layer thicknesses of 10 - 200 nm by means of metalorganic aerosol deposition. Ferroelectric switching was studied both electrically and by nonlinear optics (second harmonic generation (SHG)). Capacitance-voltage characteristics in a frequency range of $f = 1-10^6$ Hz and PUND measurements prove a ferroelectric hysteretic behavior up to room temperature with a remanent polarization of several $\mu C/cm^2$ and a switching fields in the range of 10−100 kV/cm. This was also supported by the SHG measurements. A detailed study of multiferroic properties will be performed for temperatures, $T = 10-400$ K, and applied magnetic field, $B = 0-9$ T. This work was supported by IFOX of the European Community's 7th Framework Programme.

DF 5.9 Mon 17:15 H3

Epitaxial thin films of the multiferroic double perovskite Bi_2FeCrO_6 — •Vikas Shabadi, Mehran Vafaee, Mehrdad BaghaieYazdi, Aldin Radetinac, Philipp Komissinskiy, and Lambert Alff — Institute of Materials Science, Technische Universität Darmstadt, Germany

Co-existence of magnetism and ferroelectricity was theoretically predicted in the ordered double perovskite Bi_2FeCrO_6 (BFCO) [1]. We report epitaxial BFCO thin films grown by pulsed laser deposition from a 20% Bi-rich ceramic target on single crystal $SrTiO_3$(100) substrates. The degree of the Fe-Cr cation ordering in the BFCO films was calculated based on the X-ray diffraction patterns. The magnetic moments of the BFCO films were measured with a SQUID magnetometer and analyzed as a function of the Fe-Cr ordering. The discrepancies in the previously reported values of the magnetic moment of BFCO [2,3] are most likely connected to the varying degree of the Fe-Cr cation ordering in the samples. In a recent experiment more than 90% spontaneous B-site ordering in a similar Fe-Cr based double perovskite system has been achieved [4]. Anti-site disorder control is a key challenge to design double perovskite multiferroics.

[1]P. Baettig and N. A. Spaldin, Appl. Phys. Lett. **86**, 012505 (2005)
[2]Kim *et al.*, Appl. Phys. Lett. 89, 102902 (2006)
[3]R. Nechache *et al.*, J. Appl. Phys. **105**, 061621 (2009)
[4]S. Chakraverty *et al.*, Phys. Rev. B **84**, 064436 (2011)
The authors acknowledge support from DAAD.

DF 5.10 Mon 17:30 H3

Growth of multiferroic heterostructures — •Sergiu Stratulat, Dietrich Hesse, and Marin Alexe — Max-Planck-Institut für Mikrostrukturphysik, Halle, Germany

Coupling two materials with different order parameters gives great flexibility in engineering multifunctional devices. In achieving the maximum interfacial effects, vertical heterostructures present the maximum potential. Creating well-ordered vertical multiferroic heterostructures is not a trivial task, especially on large areas. We are focusing our attention on the system comprising ferrimagnetic CoFe2O4 and ferroelectric/antiferromagnetic BiFeO3, using pulsed laser deposition as a synthesizing technique. Considering a time-viable process to create the pillar-matrix configuration, we used anodic aluminum oxide masks to pattern the nucleation sites for the cobalt ferrite on previously deposited SrRuO3 bottom electrode on SrTiO3. After removal of the mask, deposition by means of a mixed target leads to ordered arrays of CFO pillars embedded in a BFO matrix. Scanning electron microscopy was employed at every step of the experiments to show the development of the samples, and X-ray diffraction probed the structural parameters. Testing the ferroelectric and magnetic properties locally gives an indication on the coupling influences present in the thin films.

DF 5.11 Mon 17:45 H3

Self-assembled composite multiferroic films in controlled strain states — •Mohsin Rafique[1,2,3,4], Andreas Herklotz[3,4], Er-Jia Guo[3,4], Kathrin Doerr[3,4], and Sadia Manzoor[1,2] — [1]Magnetism Laboratory, COMSATS Institute of Information Technology, Park Road 44000, Islamabad, Pakistan — [2]Center for Micro and Nano Devices (CMND), COMSATS Institute of Information Technology, Park Road 44000, Islamabad, Pakistan — [3]IFW Dresden, Postfach 270116, 01171 Dresden, Germany — [4]Institute for Physics, Martin-Luther-University Halle-Wittenberg, 06099 Halle, Germany

Self-assembled thin-film nanocomposites of piezoelectric and magnetostrictive materials have stimulated increasing research activities because of their potential to exhibit a large magnetoelectric response exploitable in multifunctional devices. Epitaxial thin films of $CoFe_2O_4$ and $BaTiO_3$ (CFO-BTO) composites were grown on $SrTiO_3$ (001) and piezoelectric $Pb(Mg_{1/3}Nb_{2/3})_{0.72}Ti_{0.28}O_3$(001) (PMN-PT) substrates by pulsed laser deposition. Self-assembled nanostructures consisting of spinel nanopillars heteroepitaxially embedded in the ferroelectric perovskite matrix form. X-ray diffraction is utilized to estimate the lattice parameters. The magnetic properties studied by SQUID magnetometry show an out-of-plane easy axis of the CFO nanopillars and a strengthening of the out-of-plane anisotropy with increasing compression along the nanopillar axis. The magnetoelectric coupling in the composite film is revealed at a structural transition of the BTO matrix. Electrically controlled substrate strain of PMN-PT is applied to modify the magnetic anisotropy of the nanopillars.

DF 5.12 Mon 18:00 H3

Low-lying magnetic excitations in the distorted triangular lattice antiferromagnet α-$CaCr_2O_4$ — •Michael Schmidt[1], Zhe Wang[1], Sandor Toth[2], Bella Lake[2], A.T.M.Nazmul Islam[2], Alois Loidl[1], and Joachim Deisenhofer[1] — [1]Experimental Physics V, Center for Electronic Correlations and Magnetism, Institute of Physics, University of Augsburg, D-86135 Augsburg, Germany — [2]Helmholtz-Zentrum Berlin für Materialien und Energie, D-14109 Berlin, Germany

We will discuss our results on α-$CaCr_2O_4$ obtained by FIR and Terahertz spectroscopy. This compound orders below $T_N = 42.6$ K in a proper screw 120° magnetic order, but shows additional low-lying magnetic modes indicative for the vicinity of a more complex magnetic order [1], [2]. Our spectra obtained by FTIR and THz-TD spectroscopy show several optical magnons appearing below the magnetic ordering with anomalous temperature dependence. We will discuss their polarization dependence and a possible magnetoelastic coupling of these modes.

[1] S. Toth *et al.*, Phys. Rev. B 84, 054452 (2011)
[2] S. Toth *et al.*, PRL 109, 127203 (2012)

DF 5.13 Mon 18:15 H3

Multiferroic $Ni_3V_2O_8$ measured in THz range at low temperatures and in high magnetic fields — •Malte Langenbach[1], Tobias Hissen[1], Komalavalli Thirunavukkuarasu[1], Holger Schmitz[1], Iván Cámara Mayorga[2], Rolf Güsten[2], Joachim Hemberger[1], and Markus Grüninger[1] — [1]II. Physikalisches Institut, Universität zu Köln, Köln, Germany; — [2]Max-Planck-Institut für Radioastronomie, Bonn, Germany;

THz spectroscopy in high magnetic fields is an important technique to probe materials with strong magneto-electric coupling. Here, we discuss the Kagomé-staircase compound $Ni_3V_2O_8$. The triangle-based lattice gives rise to a frustration of the short-range antiferromagnetic couplings. This causes a rich variety of magnetic and structural phases at low temperatures.
Below $T_N = 9.8$ K, a incommensurate phase with collinear sinusoidal spin structure is established. This phase is followed by a cycloidal spin structure which is accompanied by the onset of ferroelectricity. Finally, below 3.9 K, the structure changes to a commensurate canted antiferromagnetic phase [1].

We report on elementary excitations in the THz range observed between 2 K and 50 K in fields up to 8 T.

Work supported by the DFG through SFB 608.

[1] G. Lawes et al., Phys. Rev. Lett. **95**, 087205 (2005)

DF 6: Nonlinear dielectrics, phase transitions, relaxors

Time: Monday 16:05–16:25 Location: H11

DF 6.1 Mon 16:05 H11

Damping of longitudinal acoustic phonons in $SrTiO_3$ - coupling to a soft mode and the role of anharmonicity — •Lena Maerten, André Bojahr, Marc Herzog, and Matias Bargheer — Universität Potsdam, Deutschland

$SrTiO_3$ shows a structural phase transition at 110K that is accompanied by the softening of a phonon mode at the zone boundary. This leads to an increased damping of the longitudinal phonons and an abrupt change in sound velocity at T_c. We use time resolved Brillouin scattering experiments to monitor the propagation of longitudinal acoustic phonons in bulk $SrTiO_3$. A metallic transducer film is excited by an infrared pump pulse generating a spectrally broad sound pulse travelling into the $SrTiO_3$ substrate. A broadband probe pulse is scattered from the propagating phonons leading to an oscillating signal in the time domain. We determine the damping and oscillation frequency of these phonons across the phase transition, compare the frequency dependence of the damping with theoretical models and experimental results from other groups. A fluence-dependent series of experiments at different temperatures highlights the important role of anharmonicity, which was observed in room temperature experiments [1].

[1] Bojahr et al. Phys. Rev. B 86 (144306) 2012

DF 7: Ceramics

Time: Monday 16:25–16:45 Location: H11

DF 7.1 Mon 16:25 H11

Titanate glass-ceramics for mobile applications in the GHz range — •Hubertus Braun[1,2,3], Martin Letz[2], Martun Hovhannisyan[4], and Hans-Joachim Elmers[1] — [1]Johannes-Gutenberg Universität Mainz — [2]SCHOTT AG, Mainz — [3]Graduate School Materials Science in Mainz — [4]TU Darmstadt

In recent years, the continuous growth in mobile communication technologies operating in the microwave frequency range demands cost-efficient low-loss dielectric materials with sufficiently high permittivity. In the current work, glass-ceramics in the TiO_2-SiO_2-B_2O_3-Al_2O_3 system are developed ($\varepsilon_r \sim$ 16-32, Qf $\approx$ 10.000 GHz, $|\tau_f| <$ 10 ppm/K) which have promising properties as microwave materials and offer a number of advantages in comparison to conventional sinter-ceramics. Materials which are obtained via a true glassy phase are new in this field and are an alternative to sintered ceramics. Glass-ceramics are produced in a two step process: At first, a homogeneous basic glass is casted in a conventional glass production process. Then the glass undergoes a temperature treatment with a defined temperature profile to initiate a controlled partial crystallisation of desired paraelectric phases inside the glassy matrix (Ceramisation). Obtaining materials via a homogeneous glassy phase enables intrinsic pore free materials with comparatively superior surface properties. The effect of solid solution type doping on the dielectric properties and glass stability is investigated and the glass-ceramic materials are analysed concerning suitability for dielectric loaded antenna applications. Comparative measurements with antennas using commercial sinter-ceramics are made.

DF 8: Application of dielectric solids

Time: Monday 16:50–17:30 Location: H11

DF 8.1 Mon 16:50 H11

Influence of dielectric nonlinearities on the storable energy of $BaTiO_3$-capacitors — •Tino Band[1], Sebastian Lemm[1], Mandy Zenkner[2], Martin Diestelhorst[1], Albrecht Rost[3], Horst Beige[1], and Stefan Ebbinghaus[2] — [1]Institute of Physics, Martin-Luther-University Halle-Wittenberg, D-06099 Halle, Germany — [2]Institute of Chemistry, Martin-Luther-University Halle-Wittenberg, D-06099 Halle, Germany — [3]University of Applied Sciences Merseburg, 06217 Merseburg, Germany

The concept of energy storage in a capacitor is of great interest in connection with the energy production based on wind energy or solar energy. According to the commonly used linear relation for the energy density $w_{el} = \frac{1}{2}\varepsilon_0\varepsilon E^2$ of an electric field a capacitor may store the total amount of electric energy $W_{el} = \frac{1}{2}CU^2$. The aim is to find dielectrics with high permittivities ε and high dielectric strength to store large quantities of electric energy without increasing the volume of the capacitor too much. At a first glance ferroelectrics are good candidates because of their relatively high values of small-signal dielectric permittivities ε. But it is well known that they are nonlinear dielectrics. We discuss the influence of dielectric nonlinearities on the amount of storable energy. As will be shown the nonlinear dielectric properties reduce the storable energy in ferroelectric capacitors compared to the estimations of the linear model. We present results of detailed hysteresis measurements and charge-discharge measurements on ceramic $BaTiO_3$-samples to demonstrate the limitations of the linear model.

DF 8.2 Mon 17:10 H11

Loss reduction of dielectrics: CVD diamond — •Theo Scherer — Karlsruhe Institut of Technology KIT; Hermann-von-Helmholtz-Platz 1 ; D-76344 Eggenstein-Leopoldshafen

The high-power long pulse RF loss properties of CVD diamond materials for ECR heating and plasma stabilization in large fusion devices have been measured by established Fabry-Perot methods. The dielectric loss is strongly influenced by the surface chemistry of the diamond. Special surface passivation techniques are investigated due to the reduction of the electrical surface conductivity and therefore of the RF losses.

DF 9: Glasses and Glass Transition I (joint session with CPP, DY)

Time: Monday 15:00–17:30 Location: H34

Invited Talk DF 9.1 Mon 15:00 H34

Intra- and inter-molecular dynamics in glass-forming liquids — •Periklis Papadopoulos[1], Wilhelm Kossack[2], and Friedrich Kremer[2] — [1]Max Planck Institute for Polymer Research, Mainz, Germany — [2]Universität Leipzig, Germany

The intra- and inter-molecular interactions of salol and polystyrene, as low molecular weight and polymeric glass-forming model systems, are studied by Fourier-transform infrared (FTIR) spectroscopy and Broadband Dielectric Spectroscopy (BDS). By analysing the temperature dependencies of specific IR absorption bands it is demonstrated that each molecular moiety in the glass-formers has its own signature in the course of the dynamic glass transition: while some do not show any change at the calorimetric glass transition temperature, others exhibit a pronounced "kink". The effects cannot be attributed solely to microscopic thermal expansion, but instead indicate gradual conformational changes. The ease of application of this approach to a variety of systems in different geometries and external conditions can assist the modelling of glasses and the understanding of the coupling between the glass transition and molecular-level dynamics.

[1] P. Papadopoulos, W. Kossack, and F. Kremer, *Soft Matter*, 2013, **9**, 1600 - 1603

DF 9.2 Mon 15:30 H34

In-situ investigation of vapor-deposited thin films of toluene and ethylbenzene by AC chip-nanocalorimetry — •Mathias Ahrenberg[1], Katie R. Whitaker[2], Yeong-Zen Chua[1], Heiko Huth[1], Mark D. Ediger[2], and Christoph Schick[1] — [1]Institut für Physik, Universität Rostock, Wismarsche Str. 43-45, 18051 Rostock, Germany — [2]Department of Chemistry, University of Wisconsin-Madison, Madison, Wisconsin 53706, USA

Physical vapor deposition can be used to produce thin films with particular material properties. For example extraordinarily stable glasses can be obtained from organic molecules like toluene and ethylbenzene. We have investigated properties like packing efficiency and kinetic stability depending on substrate temperature and deposition rate by in-situ AC chip-nanocalorimetry. We have varied the substrate temperature covering the range from temperatures proven to yield high enthalpy glasses up to temperatures proven to yield low enthalpy glasses. This way the complete evolution of the mentioned stable glass properties is observed. Moreover AC calorimetry offers the possibility for isothermal measurements which enables to follow the transformation of the stable glass to the super-cooled liquid. Transformation experiments give suggestion of the transformation mechanism and its temperature dependence. The data are in agreement with a growth front for the transformation of the stable glass into the supercooled liquid.

DF 9.3 Mon 15:45 H34

Calorimetric glass transition of ultathin films of homopolymers and their blends — •Huajie Yin and Andreas Schönhals — BAM Bundesanstalt für Materialforschung und -prüfung, Unter den Eichen 87, 12205 Berlin, Germany

Glass transition behavior of different ultrathin polymer films (down to around 10 nm) was investigated by specific heat spectroscopy using differential AC calorimetry. For thin homopolymer films like polystyrene (PS) and poly(vinyl methyl ether) (PVME), no thickness dependence of dynamic glass transition temperature was observed down to 10 nm. Furthermore, the width of the glass transition is independent of the film thickness which indicates that the extent of the cooperativity is essentially smaller than 10 nm. For polymer blend thin films in the case of PS/PVME with the weight fraction of 50/50, the dynamic glass transition temperature was found to be decreasing with reducing the film thickness. This phenomenon is explained in terms of surface enrichment of PVME in the polymer blend system where PVME has a lower surface energy than PS. X-ray photoelectron spectroscopy (XPS) was used to probe the surface composition in order to confirm such surface enrichment phenomena.

DF 9.4 Mon 16:00 H34

Molecular dynamics of a discotic liquid crystal studied by Dielectric Relaxation and Specific Heat Spectroscopy — •Christina Krause[1], Huajie Yin[1], Andreas Wurm[2], Christoph Schick[2], and Andreas Schönhals[1] — [1]BAM Federal Institute for Materials Research and Testing, Unter den Eichen 87, D-12205 Berlin — [2]Institute of Physics, University of Rostock, Wismarsche Straße 43-45, D-18051 Rostock

The molecular dynamics of the discotic liquid crystal pyrene-1,3,6,8-tetracarboxylic tetra(2-ethylhexyl)ester is investigated by dielectric relaxation and specific heat spectroscopy. The data from dielectric spectroscopy shows 3 processes: a β-relaxation at low temperatures and an α-relaxation in the temperature range of the mesophases followed by conductivity. In both phases the dielectric α-relaxation is assigned to restricted glassy dynamics. Glassy dynamics is also detected in the plastic crystalline phase by means of specific heat spectroscopy but with a different temperature dependence of the relaxation rates. This is discussed considering the different molecular restrictions of the fluctuations: close to the columns (dielectric spectroscopy) and more in the intercolumnar space (specific heat spectroscopy). In the frame of the fluctuation approach a correlation length of glassy dynamics is calculated to 0.78 nm which correlates well to the core-core distance estimated by X-ray scattering.

DF 9.5 Mon 16:15 H34

Liquid to glass transition in a Wigner glass — •Fabian Westermeier, Michael Sprung, and Gerhard Grübel — HASYLAB, Deutsches Elektronen-Synchrotron, 22607 Hamburg, Germany

One of the interesting problems of disordered systems is the nature of the liquid to glass transition. While the glass transition in molecular glass formers can be typically achieved by cooling down the system, in colloidal systems the glassy state is experimentally accessible by changing the strength of the direct particle interactions.

Colloidal systems can be distinguished by their type of interaction. While so called hard sphere systems interact via a repulsive, short range interaction potential, electrostatically stabilized systems are interacting via a long-range, screened Coulomb potential which depends inter alia on the charge of the particles and the concentration of additional ions in the solvent screening the direct particle interactions. As it is thus possible to tune the direct particle interaction strength of these systems, the glass transition can already occur at much lower volume fractions when compared to the hard sphere case.

We have used X-ray scattering techniques to investigate the glass transition of a charge stabilized system at a constant volume fraction, varying only the strength of the direct particle interactions. While the average structure of the colloidal suspensions shows only minor changes, the dynamics of the system vary strongly as a function of the direct particle interaction strength.

DF 9.6 Mon 16:30 H34

Temporal evolution of structural and dynamical heterogeneities in a metastable colloidal fluid — •Sebastian Golde[1,2], Markus Franke[2], and Hans Joachim Schöpe[2,3] — [1]Graduate School Materials Science in Mainz, Staudinger Weg 9, 55128 Mainz, Germany — [2]Johannes Gutenberg-Universität Mainz, Institut für Physik, Staudinger Weg 7, 55099 Mainz, Germany — [3]MPI für Polymerforschung, Postfach 3148, 55021 Mainz, Germany

An interesting property of the metastable melt is that it exhibits spatial heterogeneous dynamics [1]. The dynamics can be understood as an accumulation of mobile and immobile particles. Recent work suggested that the local structure and dynamics of the metastable melt are correlated to each other [2]. In order to investigate these phenomena we used a hard sphere like colloidal model system. The local dynamics in the metastable colloidal melt were measured with our recently new designed multispeckle correlation spectroscopy setup which performs space- as well as time-resolved dynamic light scattering. The solidification kinetics was measured using an advanced time-resolved laser light Bragg scattering setup. The correlation between the particle dynamics and the solidification kinetics could be quantified by analyzing the temporal evolution of the local particle dynamics, the ensemble averaged dynamic structure factor and the solidification kinetics. Crossing the glass transition point we can show that there is fundamental link between crystallization and vitrification. [1] L. Berthier and G. Biroli, Rev. Modern Physics 83 (2011),[2] T. Kawasaki and H. Tanaka, JCPM 22 (2010)

DF 9.7 Mon 16:45 H34

Multiple reentrant glass transitions in confined hard-sphere glasses — •Suvendu Mandal[1,2], Simon Lang[3], Rolf Schilling[4], Vitalie Botan[4], Martin Oettel[4], Dierk Raabe[1], Thomas Franosch[3], and Fathollah Varnik[1,2] — [1]Max-Planck Institut fur Eisenforschung, Max-Planck Str. 1, 40237 Dusseldorf, Germany — [2]Interdisciplinary Centre for Advanced Materials Simulation (ICAMS), Ruhr-Universitat Bochum, Stiepeler Strasse 129, 44801 Bochum, Germany — [3]Institut fur Theoretische Physik, Friedrich-Alexander-Universitat Erlangen-Nurnberg, Staudtstraße 7, 91058, Erlangen, Germany — [4]Institut fur Physik, Johannes Gutenberg-Universitat Mainz, Staudinger Weg 7, 55099 Mainz, Germany

We perform molecular dynamics simulations for a polydisperse, densely packed hard-sphere fluid confined between two parallel walls [1]. The diffusion coefficient parallel to the walls is observed to vary by orders of magnitudes upon changing the wall separation while keeping the packing fraction fixed. A striking multiple reentrance scenario emerges for the transition from liquid to glass as the wall separation becomes comparable to the particle diameter. The non-monotonic behavior of the phase diagram is rationalized in terms of a numerical solution of a recently developed mode-coupling theory [1,2].

[1] S. Mandal, S. Lang, R. Schilling, V. Botan, M. Oettel, D. Raabe, T. Franosch, and F. Varnik submitted [2] S. Lang, V. Botan, M. Oettel, D. Hajnal, T. Franosch, R. Schilling PRL 105, 125701 (2010).

DF 9.8 Mon 17:00 H34

Shear banding in hard sphere glasses — Segun Ayodele[1], Dierk Raabe[1], Ingo Steinbach[2], and •Fathollah Varnik[1,2] — [1]Max-Planck-Institut für Eisenforschung GmbH, Düsseldorf, Germany — [2]ICAMS, Ruhr Universität Bochum, Germany

When an amorphous solid is exposed to a simple shear such as a planar Couette flow, the flow may become heterogeneous despite the fact that the macroscopic stress is constant across the system [1,2]. However, both in computer simulations [1,3] and experiments [2] the observed velocity profile is unsteady with significant spatio-temporal fluctuations. In this work, we address the question whether a steady shear banded solution may exist. For this purpose, we both perform an analysis of the underlying equations as well as lattice Boltzmann simulations, using as input the constitutive laws obtained from MD simulations [3].

[1] F. Varnik, L. Bocquet, J.-L. Barrat, L. Berthier, Phys. Rev. Lett. 90, 095702 (2003).

[2] R. Besseling, L. Isa, P. Ballesta, G. Petekidis, M.E. Cates, W.C.K. Poon, Phys. Rev. Lett. 105, 268301 (2010).

[3] S. Mandal, M. Gross, D. Raabe, F. Varnik, Phys. Rev. Lett. 108, 098301 (2012).

DF 9.9 Mon 17:15 H34

Re-establishment of the equipartition theorem for small systems in molecular dynamics ensemble — •Nima Hamidi Siboni[1,2], Dierk Raabe[2], and Fathollah Varnik[3] — [1]AICES, RWTH-Aachen, Germany — [2]Max-Planck-Institut für Eisenforschung, Düsseldorf, Germany — [3]ICAMS, Ruhr-Universität Bochum, Germany.

It has been reported recently that, in molecular dynamics (MD) simulations, periodic boundary condition leads to a violation of the equipartition theorem for systems containing particles with different masses [Shirts et al, J. Chem. Phys. **125** 164102 (2006)]. This effect is associated with the finite number of particles in MD simulations. Here, we propose a modification to MD simulation, which removes this problem. Our method is based on imposing Gaussian random fluctuations on the system's center of mass velocity. Using the analogy to a system exchanging momenta with impenetrable walls, we work out an analytical expression for the rate at which fluctuations are added to the system. The restoration of the equipartition is then demonstrated for small systems both at equilibrium as well as beyond equilibrium in the linear response regime.

DF 10: Optical and nonlinear optical properties, photonic

Time: Tuesday 9:30–12:20 Location: H11

DF 10.1 Tue 9:30 H11

Transient gratings based on small polarons in nominally undoped, thermally reduced $LiNbO_3$ — •Hauke Bruening[1], Holger Badorreck[1], Kay-Michael Voit[1], Volker Dieckmann[1], Gabor Corradi[2], Christoph Merschjann[3], and Mirco Imlau[1] — [1]Department of Physics, University of Osnabrück, Germany — [2]Wigner Research Centre for Physics, Budapest, Hungary — [3]Helmholtz-Zentrum für Materialien und Energie, Berlin, Germany

We studied a new type of hologram recording in nominally undoped, thermally reduced $LiNbO_3$ by means of single intense ns-laser pulses ($\lambda = 532$ nm) yielding short-lived volume phase-gratings with high diffraction efficiencies η. The gratings are probed in the blue-green spectral range ($\lambda = 488$ nm) [1] and the NIR spectral range ($\lambda = 785$ nm) [2]. They show unique features like a stretched-exponential relaxation behavior with a lifetime in the ms-range at room temperature, an accelerated decay with increased temperature and a pronounced dependence of η on the orientation of the grating vector with respect to the polar c-axis. These properties can be explained comprehensively by taking an optically generated, spatial modulated density of small polarons into account. Therefor, this new recording mechanism is of particular interest for the field of nonlinear and ultrafast photonics because of the fast small polaron generation on the fs-scale.

*Financial support by the DFG (IM37/5 and INST190/137-1) and DAAD (50445542) is gratefully acknowledged.

[1] H. Bruening et al., Optics Express 20, 13326 (2012)

[2] M. Imlau et al., Optics Express 19, 15322 (2011)

DF 10.2 Tue 9:50 H11

Lithiumniobat und Lithiumtantalat unter Beschuss: Die Auswirkungen von hochenergetischen Alphas und ihren leichteren Kollegen — •Niels L. Raeth, Johannes Goetze, Konrad Peithmann und Karl Maier — Helmholtz-Institut für Strahlen- und Kernphysik, Universität Bonn

Der künstliche Kristall Lithiumniobat ($LiNbO_3$) ist für viele Anwendungsfälle der nichtlinearen Optik sehr gut geeignet. Mittels Durchstrahlung hochenergetischer, leichter Ionen können entscheidende Materialparameter wie Brechungsindex, Leitfähigkeit oder das Verhalten ferroelektrischer Domänen gezielt beeinflusst werden. Begleitet wird dies jedoch von einer eher störenden nuklearen Aktivierung. Auch für das kristallographisch isomorphe Material Lithumtantalat ($LiTaO_3$) lassen sich ähnliche Modifikationen nach Ionenbeschuss nachweisen.

Wir präsentieren Unterschiede und Gemeinsamkeiten der gemessenen Effekte in beiden Kristallen für alle vier leichten Projektile (^{4}He, ^{3}He, ^{2}D, ^{1}H). Anschließend interpretieren wir die Ergebnisse zur weiteren Erklärung der ablaufenden Prozesse, sowie in Hinblick auf eine Optimierung für Anwendungen.

DF 10.3 Tue 10:10 H11

Three-dimensional ferroelectric domain mapping in lithium niobate — •Thomas Kämpfe[1], Mathias Schröder[1], Philipp Reichenbach[1], Alexander Haussmann[1], Theo Woike[2], and Lukas M. Eng[1] — [1]Institute of Applied Photophysics, Technical University Dresden, 01062 Dresden — [2]Institute of Structural Physics, Technical University Dresden, 01062 Dresden

Ferroelectric domain walls (DWs) are an elegant new approach towards nanoelectric circuitry, as they intrinsically exhibit DW conduction within an insulating volume. The DW conductivity in Mg:$LiNbO_3$ single crystals depends on the inclination [1], which is related to the poling conditions and doping concentration, effectively altering the wall pinning. For three-dimensional investigations of conductive DWs, we apply Cerenkov second-harmonic generation (CSHG) with adjustable fundamental wavelength in a range of 800 – 990 nm. This technique enables the noninvasive DW characterization throughout the whole crystals. Here, we report that conductive DWs have constant inclination throughout the whole crystal. The extracted inclination angles are in agreement with surface-sensitive PFM measurements in [1]. Besides this, the visualization of topological defects, e.g. the merging of two domains within the crystal or domains being completely embedded within the bulk, are shown.

[1] M. Schröder et al., Adv. Funct. Mater., 22: 3936–3944 (2012)

DF 10.4 Tue 10:30 H11

Linear and nonlinear optical properties of congruent LiNbO3

— •Arthur Riefer, Simone Sanna, and Wolf Gero Schmidt — Theoretische Physik, Universität Paderborn, Warburger Str. 100, 33100 Paderborn, Germany

Lithium niobate (LN) is one of the most important ferroelectric materials and the most important optical material. Recently, the linear [1,2,3] and nonlinear [3,4] optical properties of highly ordered stoichiometric LN have been investigated theoretically. However, the technologically relevant material is the congruently melting LN (CLN), containing up to 6% empty Li sites. In this work, we have investigated the linear and the nonlinear optical properties of congruent LN from first-principles. Thereby CLN is simulated both within the established Li and the Nb site vacancy models [5]. Our approach allows us to calculate the dielectric function as well as the second harmonic generation spectra within the independent particle approximation. The influence of the intrinsic defects on the optical and electronic properties of LN is discussed. The results are compared with experimental measurements [6].

[1] W. G. Schmidt *et al.*, Phys. Rev. B **77**, 035106 (2008)
[2] C. Thierfelder *et al.*, phys. stat. sol. (c) **7**, 362 (2010)
[3] A. Riefer *et al.*, IEEE Trans. on Ultrasonics, Ferroelectrics and Frequency Control **59**, 1929 (2012).
[4] S. Cabuk, Central European Journal of Physics **10**, 239 (2012)
[5] T. Volk *et al.*, *Lithium Niobate*, Berlin Springer, 2008
[6] D.A. Roberts, IEEE J. of Quantum Electronics **28**, 2057 (1992)

10 min. break

DF 10.5 Tue 11:00 H11

Near-field optical microscopy of femtosecond laser reshaped silver nanoparticles in dielectric matrix — •Moritz Beleites[1], Christian Matyssek[2,3], Hans-Helmuth Blaschek[4], and Gerhard Seifert[1] — [1]Zentrum für Innovationskompetenz SiLinano, Martin-Luther-Universität Halle-Wittenberg, Karl-Freiherr-von-Fritsch-Str. 3, D-06120 Halle (Saale) — [2]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, D-06099 Halle (Saale) — [3]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle (Saale) — [4]Fraunhofer-Institut für Werkstoffmechanik IWM Halle, Walter-Hülse-Str. 1, D-06120 Halle (Saale), Germany

Near-field scanning optical microscopy (NSOM) and microscope spectrometry have been utilized to detect and evaluate shape transformation of individual silver nanoparticles embedded in a thin dielectric layer (40 nm Al_2O_3). Shape modification was previously executed by femtosecond laser irradiation of samples containing spherical nanoparticles. The NSOM measurements were performed with several optical wavelengths of unpolarized and linearly polarized light on different regions of the samples containing spherical and transformed nanoparticles. We were able to unambiguously identify reshaped, spheroidal nanoparticles by polarization dependent switching of the NSOM contrast at individual particles. In combination with microsope spectrometry, this allows analyzing orientation and aspect ratio of single metal nanoparticles.

DF 10.6 Tue 11:20 H11

Hopping transport in crystalline insulators and semiconductors: the effects of site-correlation and trap saturation in 1, 2 and 3 dimensions — •Christoph Merschjann — Helmholtz-Zentrum-Berlin für Materialien und Energie

Hopping transport of particles and quasiparticles (e.g., electrons, small polarons, or excitons) in otherwise perfectly crystalline insulators and semiconductors is often (vaguely) mentioned in possible explanations for experimental findings in optical and electrical spectroscopy.
Typical problems include transient absorption and luminescence measurements in bulk crystals and lower dimensional systems like monolayers or polymer strands.

A random-walk approach is applied to address the effects of site-correlation (e.g. after excitation out of traps) and trap-saturation (e.g. due to recombination of electrons and holes after band-band excitation). It is found that both effects lead to characteristic deviations from Debye-like monoexponential relaxation and give means to deduce the dimensionality of the investigated problem from spectroscopic measurements.

DF 10.7 Tue 11:40 H11

Phase matching for efficient nonlinear frequency generation in hybrid Si/Chalcogenide glass slot waveguides — Peter W. Nolte, Christian Bohley, and •Joerg Schilling — ZIK SiLinano, Martin-Luther-University Halle-Wittenberg, Germany

To circumvent the limitation of strong two photon absorption in nonlinear silicon photonics, hybrid photonic structures have to be used, in which silicon is combined with other materials.

We theoretically investigated the situation for degenerate four wave mixing in silicon slot waveguides which are infiltrated by a chalcogenide glass (e.g. As_2S_3) promising efficient frequency generation within the vicinity of the pump wavelength.

Varying waveguide height, width and slot width we optimized the waveguide cross section to achieve a maximum effective mode area and modes which are well confined to the slot resulting in a figure of merit of 1.3. Furthermore a new phase matching scheme for degenerate four wave mixing in these waveguides was investigated by introducing a periodic index variation along the waveguide. This leads to a photonic band gap and strong band bending in its vicinity allowing the desired group velocity dispersion (GVD) of zero. The usable bandwith is above 40nm for waveguide lengths up to 5mm. With this scheme the phase matching condition can be independently fulfilled from the wave guide cross section and the GVD = 0 condition can be easily tuned to the wavelength of interest allowing a flexible design of the hybrid photonic components.

DF 10.8 Tue 12:00 H11

Room-Temperature Lasing from Tamm Plasmon-Polaritons in an Organic Microcavity — •Andreas Mischok[1], Robert Brückner[1], Reinhard Scholz[1], Vadim G. Lyssenko[1], Markas Sudzius[1], Susanne I. Hintschich[1], Alexander A. Zakhidov[2], Hartmut Fröb[1], and Karl Leo[1] — [1]Institut für Angewandte Photophysik, George-Bähr-Str. 1, 01062 Dresden — [2]Fraunhofer COMEDD, Maria-Reiche-Str. 2, 01109 Dresden

Organic solid state lasers combine a tunable emission spectrum and room-temperature operation with a comparably easy fabrication. In order to drive such devices electrically, high current densities must be transported, calling for highly conductive - and highly absorptive - metal electrodes.

In this work, we report stimulated emission in an organic-dielectric surface emitting microcavity with an embedded continuous silver layer of 40nm thickness, under non-resonant optical excitation. Despite the absorption introduced by the silver, the quality factor of the sample and the gain provided by the Alq3:DCM Host:Guest emitter system suffice to reach lasing from Tamm plasmon-polariton states. Knowledgeable design of the cavity multilayer stack minimizes the metal-induced absorption via a shift of the resonant cavity mode. Above the laser threshold, the excitation intensity can be increased at least 20 times without damage to the device. These results pave the way to an electrical contacting of the emitter and are essential for the future realisation of an electrically driven organic solid state laser.

DF 11: Glasses II (joint session with CPP, DY)

Time: Tuesday 9:30–12:30 Location: H46

DF 11.1 Tue 9:30 H46

Towards reliable structural information of multicomponent glass systems — •Christoph Scherer[1,2], Friederike Schmid[1], and Martin Letz[2] — [1]Johannes Gutenberg-Universität, Mainz, Deutschland — [2]Schott AG, Mainz, Deutschland

Glasses have a huge range of applications, however, they are still theoretically not well understood. Also experimental access to the structure of glasses is limited. This motivates the study of glass systems by means of computer simulations.

In this work, a set of glass structures is generated on the computer by equilibrating a system of a few hundred atoms at high temperature, well above the glass transition temperature, with a classical molecular dynamics simulation (MD). Afterwards the system is cooled down to 0 K and structurally relaxed to the next (local) minimum by means of a quantum mechanical density functional (DFT) calculation. The glass properties before and after the structural relaxation are compared to

experimental results. Especially, the phonon density of states is of interest, as it provides access to thermodynamical quantities.

This sets the basis for the next steps: The force fields for the MD simulation are generated by means of a structural fitting procedure. Here, the force field parameters are fitted in a way that the structure, namely the radial distribution function, of a short MD run at high temperature matches as closely as possible that one of a short DFT run at the same temperature. The dependence of the fitting accuracy of the classical force field on the final glass structure and glass properties is examined.

DF 11.2 Tue 9:45 H46

On the behavior of supercooled liquid water in Confinements formed by frozen water molecules: a molecular dynamics simulation study — •Felix Klameth and Michael Vogel — Institut für Festkörperphysik, TU Darmstadt, 64289 Darmstadt

Molecular dynamics simulations are performed to study the influence of an amorphous ice confinement on liquid water. Investigating water in confinement is believed to reveal information unaccessible for bulk water due to crystallization. Therefore, there are numerous studies on confined water, which claim, e.g., existence of a second critical point associated with a liquid-liquid phase transition in the supercooled regime [1]. However, transfer of information from confined water to bulk water is not straightforward because introducing walls changes the static properties of water due to specific interactions at the interfaces. To avoid this drawback, we use a neutral confinement comprised of immobilized water molecules. We compare static and dynamical properties found in pores with different radii to that of bulk water. The static characteristics, like the tetragonal order parameter, are not changed even near the pore wall. On the contrary, the dynamics inside the pore are dramatically influenced. We find a tremendous increase of the structural relaxation time of liquid water when approaching the pore wall. Thus, we observe a strong change of the local dynamics, which is neither accompanied by a variation of the local structure nor caused by specific wall-liquid interactions. Possible origins for this effect are discussed. [1] P. Kumar et al, PRL (2006), 97, 177802

DF 11.3 Tue 10:00 H46

Deuteron-NMR investigation on the dynamics of supercooled, confined water — •Matthias Sattig and Michael Vogel — TU Darmstadt, Institut für Festkörperphysik

The dynamical behaviour of water in the regime of the supercooled liquid is a topic of large interest. In particular, the existence of a fragile-to-strong transition (FST) at T=225K related to the transition between two distinct phases of liquid water is controversially discussed [1]. Due to crystallization the temperature range proposed for the FST is hardly accessible in bulk water. Therefore, we confine heavy water to narrow pores in the mesoporous sillicate MCM-41. This suppresses the freezing of a substantial fraction of water, enabling direct investigation of the interesting temperatures. Deuteron-NMR methods are utilised to determain the rotational correlation times τ of water on time scales from ns up to s. The spin-lattice-relaxation time T_1 exhibits a typical minimum at about T=230K. Above this minimum the correlation times follow a Vogel-Fulcher-Tammann law. Below the minimum, two relaxation processes could be observed. The low-temperature processes show a different temperature dependence, where the curves τ(T) of all processes intersect at about T=230K. A comparison with literature data [2] from neutron scattering and dielectric spectroscopy gives rise to the idea that the observed crossover is due to this intersection of processes rather than to a FST. To test this idea studies on water confined to MCM-41 with different pore sizes and fillings are in progress.

[1] Mishima; Nature, Vol. 396, 329(1998) [2] Hedström; EPJST 141, 53(2007)

DF 11.4 Tue 10:15 H46

Modelling the relaxation of glass-forming systems at low temperatures: a potential energy approach — •Andreas Heuer and Christian Rehwald — Institute for Physical Chemistry, Corrensstr. 28/30, D-48149 Münster

Based on finite-size effects of a model glass-forming system we have introduced a model which allows one to express the dynamics of a macroscopic glass-former in terms of coupled subunits of temperature-independent size and temperature-dependent coupling constant [1]. The results are obtained from computer simulations on a binary mixture Lennard-Jones model, interpreted in terms of the underlying potential energy landscape. The model is denoted coupled landscape model (CLM).

After a short review of the CLM we present key predictions of this approach for temperatures far below the range accessible by computer simulations. In particular we present results for the violation of the Stokes-Einstein relation (connecting diffusivity and structural relaxation) and the validity of the time-temperature superposition. Finally, the CLM is compared with other models presently discussed for the explanation of the glass-transition phenomena.

[1] C. Rehwald, O. Rubner, A. Heuer, Phys. Rev. Lett. 105, 117801 (2010)

[2] C. Rehwald, A. Heuer, Phys. Rev. E 86, 051504 (2012)

DF 11.5 Tue 10:30 H46

Microrheology on supercooled liquids in terms of a Potential Energy Landscape approach — •Carsten Friedrich Erich Schroer and Andreas Heuer — Westfälische Wilhelms-Universität Münster, Münster, Germany

We perform MD simulations of a binary Lennard-Jones mixture where an external force is applied on a single tracer particle. The dynamics of the tracer particle includes several interesting features like non-linear mobilities and anomalous diffusion parallel to the force direction. Our main focus relies in the investigation of the underlying Potential Energy Landscape (PEL), especially in the energetic minima the system explores during its time evolution. Equally to equilibrium systems a coarse graining of these minima to mesoscopic regions allows the description of the system dynamics in terms of a continuous time random walk (CTRW). Extending the concept of the CTRW towards stationary non-equilibrium systems turns out to be an efficient tool for the understanding of non-equilibrium dynamics. First, the approach contains a decomposition between linear and non-linear effects, thus enables a detailed study of the transition between these dynamical regimes. Second, it allows the quantitative understanding of the anomalous diffusion of the tracer particle. Third, for the first time a connection between the non-Gaussian parameter α_2 in equilibrium and superdiffusivity in non-equilibrium can be established. With the help of the underlying PEL, important information can be gained about the dynamics, e.g. about the onset of non-linear effects. The non-linear regime can be discussed in terms of a rejuvenation scenario.

15 min. break.

DF 11.6 Tue 11:00 H46

Simulation of Aging in SiO2: Single Particle Jump Analysis — •Katharina Vollmayr-Lee[1], Robin Bjorkquist[2], and Landon Chambers[3] — [1]Bucknell University, USA — [2]Cornell University, USA — [3]Texas A&M, USA

Using molecular dynamics computer simulations, we study the aging dynamics of amorphous SiO2. Starting from fully equilibrated configurations at high temperatures the system is quenched to temperatures which are below Tc. We then observe the resulting microscopic dynamics as a function of the waiting time tw, the time elapsed since the temperature quench. We use single particle trajectories to identify "jumps" when the particle's average position changes over a short time interval significantly compared to its fluctuations. We find that the only tw-dependent microscopic quantity is the number of jumping particles per unit time. Similar to previous studies for fragile glass formers, we show here for the strong glass former SiO2 that neither the distribution of jump lengths nor the distribution of times spent in the cage are tw-dependent. We therefore find a surprising similarity of the jump dynamics of fragile and strong glass formers.

DF 11.7 Tue 11:15 H46

Excess free energy of supercooled liquids at disordered walls — •Ronald Benjamin and Jürgen Horbach — Institut für Theoretische Physik II - Soft Matter, Heinrich-Heine-Universität Düsseldorf

We perform NVT molecular dynamics simulations of a supercooled liquid confined between identical walls of two types. In the first case flat structureless walls, represented by an external field are considered. In the second case we consider disordered walls consisting of the same supercooled liquid frozen into an amorphous configuration. Using a thermodynamic integration scheme [R.Benjamin and J. Horbach, J. Chem. Phys. **137**, 044707 (2012)] we are able to obtain the excess free energy of the supercooled liquid with respect to both kinds of walls. While a positive excess free energy (of the order of $10k_BT/\sigma^2$) is obtained with respect to a flat structureless wall, the excess free energy between the supercooled liquid and the frozen disordered walls

turns out to be negative ($\approx -0.5 k_B T/\sigma^2$) even though the potential energy of the supercooled liquid in presence of the disordered walls is the same as that of the bulk. This shows the purely entropic contribution to the excess free energy of the supercooled liquid in presence of the disordered walls. The existence of a negative excess free energy also shows that the thermodynamic properties of such a confined supercooled liquid is not identical to that of the bulk.

DF 11.8 Tue 11:30 H46

Multiple reentrant glass transitions of soft spheres at high densities — •Michael Schmiedeberg — Institut für Theoretische Physik 2: Weiche Materie, Heinrich-Heine-Universität Düsseldorf, 40204 Düsseldorf, Germany

We study the dynamics of soft spheres by using Molecular Dynamics simulations. The relaxation time varies non-monotonically as a function of density at constant temperature (cf. [1,2]). We determine and study the jamming phase diagrams that indeed show multiple reentrant glass transitions if temperature and density are used as control parameters. However, if we switch to a new formulation of the jamming phase diagrams [3], where temperature over pressure and pressure are employed as control parameters, no non-monotonic behavior can be observed.

[1] L. Berthier, A.J. Moreno, and G. Szamel, Phys. Rev. E 82, 060501(R) (2010).
[2] M. Pica Ciamarra and P. Sollich, arXiv:1209.3334.
[3] T.K. Haxton, M. Schmiedeberg, and A.J. Liu, Phys. Rev. E 83, 031503 (2011).

DF 11.9 Tue 11:45 H46

Exact Nonlinear Response in the driven lattice Lorentz gas — •Sebastian Leitmann and Thomas Franosch — Institut für Theoretische Physik, Universität Erlangen-Nürnberg, Staudtstraße 7, 91058, Erlangen, Germany

We determine the nonlinear time-dependent response of a tracer on a lattice with randomly distributed hard obstacles as a force is switched on. The calculation is exact to first order in the obstacle density and holds for arbitrarily large forces. In particular, we show that the nonlinear mobility in the stationary state becomes non-analytic in the driving force. Furthermore we demonstrate that the stationary velocity is approached exponentially fast for any finite values of the force, in striking contrast to the power-law relaxation predicted within linear response. We discuss the range of validity of our analytic results by comparison to Monte Carlo simulations.

DF 11.10 Tue 12:00 H46

From beta-relaxation to alpha-decay: Atomistic picture from molecular dynamics simulations for glass-forming Ni0.5Zr0.5 melt — •Helmar Teichler — Inst. Materialphysik, Univ Göttingen

In glass-forming melts the decay of structural fluctuation shows the well known transition from beta-relaxation (von-Schweidler law with exponent b) to alpha-decay (KWW law with exponent beta). Here we present results from molecular dynamics simulations for a metallic glass forming Ni0.5Zr0.5 model aimed at giving an understanding of this transition on the atomistic scale. At the considered temperature below mode coupling Tc, the dynamics of the system can be interpreted by residence of the particles in their neighbour cages and escape from the cages as rare processes. Our analysis yields that the fraction of residing particles is characterized by a hierarchical law in time, with von-Schweidler b explicitly related to the exponent of this law. In the alpha-decay regime the stretching exponent reflects, in addition, floating of the cages due to strain effects of escaped particles. Accordingly, the change from beta-relaxation to alpha-decay indicates the transition from low to large fraction of escaped particles.

DF 11.11 Tue 12:15 H46

Interaction between tunnelling systems in glasses — •Gudrun Fickenscher[1], Christian Schötz[1], Paul Fassl[1], Alexander Archer[1], Alexander Burin[2], Manfred von Schickfus[1], Andreas Fleischmann[1], and Christian Enss[1] — [1]Kirchhoff-Institut für Physik, Universität Heidelberg — [2]Tulane University, New Orleans, USA

The low-temperature properties of glasses are governed by tunnelling systems as described in the well-established standard tunnelling model. Interactions between tunnelling systems and phonons lead to energy relaxation. In addition, the interaction between individual tunnelling systems, as predicted by spectral diffusion theory, causes phase decoherence phenomena. To study these interaction processes we have measured the decay of different types of polarization echoes in the standard glass BK7 with respect to the delay time at temperatures between 7.5mK and 70mK. The decay of 2- and 3-pulse echoes is strongly influenced by spectral diffusion. In the case of 3-pulse echoes we expect, in addition, a significant contribution to the decay by energy relaxation processes. On comparing the measured data to numerical calculations we find that the decay of the echo amplitude is slower than predicted by the standard theory at all temperatures. This leads us to the assumption, that there exists a small subspace of tunnelling systems which interact very little with phonons due to a very small coupling constant. Including this subspace in the calculations we can accurately fit the data for all echo types and temperatures with one consistent set of parameters.

DF 12: Poster 1

Topological Insulators, Multiferroics, Spin Structures and Magnetic Phase Transitions, Spin Excitations and Spin Torque, Magnetic Nanoparticles and Clusters,Magnetic Materials (Heusler, Semiconductors, Half-Metals, Oxides, Shape Memory), Magnetic Imaging and Scattering Methods,Bio- and Molecular Magnetism

Time: Tuesday 10:30–13:30 Location: Poster D

DF 12.1 Tue 10:30 Poster D

Following Photo-Induced Strains in Multiferroic $BiFeO_3$ Using Ultrafast X-Ray Diffraction — •Daniel Schick[1], Marc Herzog[1], Haidan Wen[2], Peter Gaal[3], and Matias Bargheer[1] — [1]Institut für Physik & Astronomie, Universität Potsdam, Karl-Liebknecht-Str. 24-25, 14476 Potsdam, Germany — [2]X-ray Science Division, Argonne National Laboratory, Argonne, Illinois 60439, USA — [3]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Wilhelm-Conrad-Röntgen Campus, BESSY II, Albert-Einstein-Str. 15, 12489 Berlin, Germany

$BiFeO_3$ had a deep impact in the field of multiferroics, since it is magnetic and ferroelectric at room temperature, opening a wide field of applications, e.g. for spintronics and memory devices which can be addressed magnetically and electrically. Furthermore, it is highly desirable to photo-control the polarization and magnetization in $BiFeO_3$ directly by ultrafast optical excitation. Here we use femtosecond laser pulses with a photon-energy of 3.1eV (λ = 400nm) to excite a 40nm $BiFeO_3$ thin film above its band gap of 2.8eV. Ultrafast X-Ray Diffraction (UXRD) at a laser-driven Plasma X-Ray Source (PXS) is applied to follow the subsequent lattice dynamics on a sub-picosecond timescale. We observe a fast evolution of the photo-induced strains in the excited $BiFeO_3$ within 10ps. We compare these UXRD results with broadband all-optical experiments to get a deeper understanding of the origin of these strains in $BiFeO_3$ induced by the interband excitation.

DF 12.2 Tue 10:30 Poster D

Magnetic and dielectric properties of doped magnetite - multiferroicity? — •Eugen Ruff[1], Florian Schrettle[1], Stephan Krohns[1], Peter Lunkenheimer[1], Victor A.M. Brabers[2], and Alois Loidl[1] — [1]Experimental Physics V, University of Augsburg, 86135 Augsburg, Germany — [2]Department of Physics, Eindhoven University of Technology, 5600 MB Eindhoven, Netherlands

We investigate pure and Al-doped magnetite (single-crystals) using magnetometry, specific heat measurements, and broadband dielectric spectroscopy to analyze the magnetic properties at the Verwey transition and to check for its ferroelectric properties. At low magnetic fields the magnetic moment of magnetite shows an interesting anomaly at

the Verwey transition. One can speculate, that this is due to magnetic softening, which is verified by magnetization measurements around the Verwey temperature. For an Al-content $x < 0.3$ ($Fe_{3-x}Al_xO_4$) the anomaly shifts to lower temperatures with increasing x and for $x \geq 0.03$ it is suppressed. The results of dielectric spectroscopy and specific heat measurements confirm this behavior. At low temperatures, the dielectric properties of the low doped samples are consistent with relaxor ferroelectricity as evidenced by Schrettle et al. [PRB 83, 195109 (2011)] for the undoped material. We found the detected relaxorlike peak to be strongly influenced by doping. The analysis of the temperature dependent relaxation time reveals a freezing of polar dynamics, which becomes faster with higher doping level.

DF 12.3 Tue 10:30 Poster D

magnetic and topological properties of edge states in the multi-band superconductor Sr_2RuO_4 — •Yoshiki Imai[1], Katsunori Wakabayashi[2], and Manfred Sigrist[3] — [1]Department of Physics, Saitama University, Japan — [2]WPI-MANA, NIMS, Japan — [3]Theoretical Physics, ETH-Zurich, Switzerland

Motivated by spin-triplet superconductor Sr_2RuO_4, the magnetic and topological properties of the edge states are investigated by means of the ribbon-shaped model with three Fermi surfaces as electronlike, holelike and two-dimensional ones, which correspond to the α-β bands and γ band of Sr_2RuO_4 in the two-dimensional bulk system. While there exists a full quasiparticle excitation gap, the gapless edge states appear in the ribbon system, in which these edge states are topologically protected and produce the spin and charge currents. While spin current results from the spin-orbit interaction, the charge current appears even without the external magnetic field and originates from the time-reversal symmetry breaking in chiral p-wave superconducting condensate. The effect of the repulsive interaction gives rise to the spin-polarization near the edges due to the Stoner mechanism. The magnetization from the currents couples correlation-induced magnetism through the spin-orbit interaction, so that the orientation of both magnetization is uniquely determined. The net spontaneous magnetic field from the edge current is strongly reduced due to the compensation of magnetic fields induced by correlation effect. This obtained result may explain the negative result from the experimental searches for chiral edge currents.

DF 12.4 Tue 10:30 Poster D

***Ab initio* description of topological insulators** — •Christian Franz, Michael Czerner, and Christian Heiliger — I. Physikalisches Institut, Justus Liebig University, Giessen, Germany

In this contribution we investigate 3D topological insulators (TI) using ab initio methods. These materials are insulating as bulk material but have a conducting surface state bridging the band gap, which is protected by time reversal symmetry. Prominent examples of 3D-TIs are BiSb alloys and Bi_2Se_3. In addition to being protected against (non-magnetic) impurities and other perturbations, the spin of these surface states is locked to their momentum. Therefore, backscattering is suppressed for this states, creating a two dimensional electron gas with high mobility. This inspired many proposed application.

We analyze the band structure of TIs. Since the spin-orbit interaction which creates a band inversion is crucial in TIs we will use a fully relativistic description. This is compared to a result without spin-orbit interaction to identify the band inversion. The appearance of the surface state is demonstrated using half-infinite boundary conditions. Alloys are described using the coherent potential approximation. This is the first step towards an *ab initio* description of transport in TIs.

DF 12.5 Tue 10:30 Poster D

A scanning tunneling spectroscopy investigation of the Bi_2Te_3 surface — •Thomas Bathon, Paolo Sessi, Lydia El-Kareh, and Matthias Bode — Physikalisches Institut, Experimentelle Physik II, Universität Würzburg,

We present a combined scanning tunneling microscopy (STM) and spectroscopy (STS) characterization of the structural and electronic properties of the topological insulator Bi_2Te_3. By interpreting the bias-dependent topographical evolution of defects we can show that they make samples n-doped. With the help of Fourier-transformed dI/dU maps we study scattering processes around defects and reveal that backscattering is forbidden for topological surface states. Based on bias-dependent measurements we determine the energy dispersion relation, the position of the Dirac point, and the carrier velocity. We also show that, by moving away from the Dirac point, the linear dispersion relation—which is typical for massless Dirac fermions—does not hold anymore. Instead, strong warping effects can be detected.

DF 12.6 Tue 10:30 Poster D

Influence of substrate imposed strain on epitaxially grown $BiFeO_3$ thin films investigated by Raman spectroscopy — •Andreas Talkenberger[1], Cameliu Himcinschi[1], Florian Johann[2], Ionela Vrejoiu[2], and Jens Kortus[1] — [1]TU Freiberg, Inst. of Theor. Physics, Leipziger Str. 23, D-09596 Freiberg — [2]Max Planck Inst. of Microstr. Physics, Weinberg 2, D-06120 Halle

$BiFeO_3$ (BFO) is an interesting candidate for multiferroic applications. Therefore a deep understanding of the material properties and the fabrication of high quality epitaxial thin films is necessary. In this work we investigated epitaxially grown BFO thin films fabricated by pulsed laser deposition on $SmScO_3$ (110), $GdScO_3$ (110) and $DyScO_3$ (110) substrates by means of Raman spectroscopy. The BFO films on $DyScO_3$ were synthesized with 71° and 109° stripe domain patterns[1,2]. The Raman spectra were recorded using the 532 nm emission line of a frequency doubled Nd:YAG laser as well as the 442 nm emission line of a He-Cd laser. The wave number shift of the phonon modes at 171 and 220 cm^{-1} correlates to the epitaxial strains in the BFO films grown on the different substrates. Further, we found an anomalous behaviour of the phonon mode at 140 cm^{-1}. While the modes at 171 and 220 cm^{-1} are redshifted with increasing tensile strain, the mode at 140 cm^{-1} is blueshifted. A similar anomalous effect was observed previously in $BiCrO_3$ films for the phonon mode at 180 cm^{-1}. This work is supported by the German Research Foundation DFG HI 1534/1-1 and SFB762. [1] F.Johann, Phys. Rev. B 84, 094105 (2011), [2] F.Johann, Phys. Status Solidi B 249, 2278 (2012)

DF 12.7 Tue 10:30 Poster D

Localized magnetoelectric effect in $BaTiO_3$/Hexaferrite composite ceramics — •Harsh Trivedi[1], Vladimir Shvartsman[1], Doru Lupascu[1], Rob Pullar[2], and Andrei Kholkin[2] — [1]Institute für Materialwissenschaft, Universität Duisburg-Essen, Essen Germany — [2]CICECO, University of Aveiro, Aveiro, Portugal

Due to its novel technological implications, the magnetoelectric(ME) effect has led to a bright prospectus for materials that show a direct or indirect coupling between the magnetic and electric order parameters. Owing to scarcity of intrinsic multiferroics, the strain mediated composite systems are a promising approach towards realizing an increased magnetoelectric coupling in bulk materials. The present state of the art in these materials demand concerted efforts toward a better understanding of microscopic mechanisms in the coupling phenomena. Since bulk ME measurements suffer inherent drawbacks concerned with electrical poling, in this work we have studied localized ME effect using scanning probe microscopy(SPM) techniques like Magnetic Force Microscopy(MFM) and Piezoresponse Force Microscopy(PFM) of bulk ME composite ceramics with a homogeneous distribution of piezoelectric($BaTiO_3$) and ferrite($BaFe_{12}O_{19}$/$SrFe_{12}O_{19}$) phases. MFM shows a clear restructuring of juxtaposed magnetic domains indicating motion of the domain walls under the effect of applied electric field. Also we observed the effect of magnetic field on the localized hysteresis behavior of constituent $BaTiO_3$ phase. The observed ME coupling is attributed to strain induced changes taking place

DF 12.8 Tue 10:30 Poster D

Electrically induced magnetic transition at the LSMO/BTO interface — •Markus Schmitz[1], Alexander Weber[1], Daniel Schumacher[2], Paul Zakalek[1], and Thomas Brückel[1] — [1]Jülich Centre for Neutron Science JCNS und Peter Grünberg Institut PGI, Forschungszentrum Jülich GmbH, Germany — [2]Deutsches Elektronen Synchrotron DESY, Hamburg, Germany

The magnetoelectric coupling is one of the most fascinating and active research areas today. The control of the magnetism due to an applied electric field may lead to new device concepts. First principles calculations of $La_{(1-x)}Sr_xMnO_3$/$BaTiO_3$(001) interfaces show magnetic reconstructions due to the change of the polarization of BTO by applying an external electric field [1]. The different electron densities influence the equilibrium between super- and double-exchange favoring a ferromagnetic or an antiferromagnetic order at the interface for the two different orientations of the polarization. Here we report on LSMO/BTO, grown with an Oxide Molecular Beam Epitaxy system. The epitaxial layer-by-layer growth was confirmed by in-situ RHEED analysis and the crystalloine quality of the surface was investigated by LEED and Atomic Force Microscopy. The structural characterization was carried out by X-ray reflectometry and X-ray diffraction. The macroscopic magnetic properties were determined by MOKE and

SQUID magnetometry.

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DF 12.9 Tue 10:30 Poster D

Mechanisms of Multiferroicity of $GdMnO_3$ explored by Resonant Soft X-Ray Scattering in High Magnetic Fields — •Enrico Schierle[1], Victor Soltwisch[1], Christoph Trabant[1,2], Alex Frano[1,3], Sven Landsgesell[1], Fabiano Yokaichiya[1,4], Detlef Schmitz[1], Andrej Maljuk[1,5], Christian Schüssler-Langeheine[1], Ralf Feyerherm[1], Dimitri Argyriou[1,6], and Eugen Weschke[1] — [1]Helmholtz-Zentrum Berlin, Germany — [2]Universität zu Köln, Germany — [3]MPI-FKF Stuttgart, Germany — [4]Laboratrio Nacional de Luz Sincrotron, Campinas-SP, Brasil — [5]IFW, Dresden, Germany — [6]ESS, Lund, Sweden

Several orthorhombic $REMnO_3$ oxides show strongly coupled ferroelectric (FE) and magnetic order, with FE polarization induced by Mn-spin cycloids[1,2]. There is now growing evidence for a decisive role of ordering of the RE-4f moments as well[3-5]. $GdMnO_3$ seems to be the prime candidate for multiferroicity connected with magnetic RE order[4]. We employed Resonant Soft X-Ray Scattering to explore the magnetic Gd-4f and Mn-3d spin order and its coupling to ferroelectricity. While the prominent features can be already observed in the Zero-field FE phase, detailed knowledge could be derived by studying the magnetic field stabilized FE phase using the High-Field-Diffractometer operated at the UE46-PGM-1 beam line at BESSY II.

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DF 12.10 Tue 10:30 Poster D

Nonlinear optical probing in $(Ba,Sr)TiO_3/La_{0.7}Sr_{0.3}MnO_3$ multilayers — •Johannes Aprojanz[1,2], Arseni Buryakov[2], Elena Mishina[2], Markus Michelmann[1], and Vasily Moshnyaga[1] — [1]I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen — [2]Moscow State Institute of Radioengineering, Electronics and Automation, Prosp. Vernadskogo 78, 119454 Moscow, Russia

Ferroelectric oxides stand out due to their excellent nonlinear optical properties and strong electro-optic effect, which offer promising applications as electro-optical modulators. Second harmonic generation (SHG) as a nonlinear optical probe is a powerful tool for studying ferroelectric switching, since it gives direct insight into the domain state in the material. In this work, we report on SHG measurements on $Ba_xSr_{1-x}TiO_3/La_{0.7}Sr_{0.3}MnO_3$ (BSTO/LSMO), $x = 0.15-0.5$, multilayers grown on $SrTiO_3$ substrates by means of metalorganic aerosol deposition (MAD). The voltage characteristics of SHG-signal prove ferroelectric hysteretic behavior at room temperature with switching fields in the range of 100 kV/cm. A detailed study of ferroelectric properties will be given as a function of magnetic field, $B = 0 - 1$ T.

This work was supported by IFOX of the European Community's 7th Framework Programme.

DF 12.11 Tue 10:30 Poster D

Anisotropy study of the magnetoelectric properties of $LiFeSi_2O_6$ — •Matthias Ackermann[1], Petra Becker[1], Ladislav Bohatý[1], and Thomas Lorenz[2] — [1]Institut für Kristallographie, Universität zu Köln — [2]II. Physikalisches Institut, Universität zu Köln

$LiFeSi_2O_6$ belongs to the class of pyroxenes with the general formula AMT_2O_6 (A=mono- or divalent metal, M=di- or trivalent metal, T=tetra- or trivalent metal). The members of this class are well known for their multiferroic/linear magnetoelectric properties. [1] The structure of $LiFeSi_2O_6$ consists of one-dimensional zig-zag chains of edge-sharing $[FeO_6]$ octahedra running along the crystallographic c-axis. Within the (110) and $(\bar{1}10)$ planes these chains are connected by chains of $[SiO_4]$ tetrahedra. At 230 K the compound undergoes a structural phase transition with a change in space group symmetry from $C2/c$ to $P2_1/c$. [3] Below the magnetic ordering temperature $T_C \sim 18$ K $LiFeSi_2O_6$ belongs to the magnetic space group $P2_1/c'$ [2] and shows the linear magnetoelectric effect. In this contribution we present a detailed investigation of the linear magnetoelectric properties and their anisotropy of this compound.

This work was supported by the DFG through SFB 608.

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DF 12.12 Tue 10:30 Poster D

Coupling effects at the interface of nanostructured $BiFeO_3/La_{0.7}Sr_{0.3}MnO_3$ und epitaxial strain — •Christian Mix[1,2], Simone Finizio[1,2], Robert Reeve[1], Pascal Krauscheid[1], Frank Demuth[1], Christian Engel[1], Mathias Kläui[1], and Gerhard Jakob[1] — [1]Institute of Physics, Universität Mainz — [2]Graduate school of excellence MAINZ, Mainz

$BiFeO_3$ (BFO) is one of the few room temperature multiferroics, possessing antiferromagnetic and ferroelectric order [1, 2]. Imaging the domain structure with respect to the interface of artificial multiferroics is of increasing interest to understand the nature of magnetoelectric and exchange coupling at the interface [3].

Here, we report on heteroepitaxial growth of $BiFeO_3$ thin films under different levels of epitaxial strain and buffered by LSMO of varying thickness. Piezo force microscopy (PFM) and reciprocal space maps are utilized to investigate the influence of epitaxial strain on crystal structure and ferroelectric domain structure. In addition, scanning electron microscopy with spin polarization analysis (SEMPA) and x-ray magnetic circular and linear diachroism (XMCD, XMLD) photo emission microscopy (PEEM) are used to investigate the ferromagnetic and antiferromagnetic domain structure in BFO/LSMO bilayer structures.

Financial support by Stiftung Innovation für Rheinland-Pfalz (Project 961-386261/944) is gratefully acknowledged.

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DF 12.13 Tue 10:30 Poster D

Understanding the phase sequence of Fe-Pd alloys from first principles — •Markus Ernst Gruner[1], Sandra Kauffmann-Weiss[2], Sven Hamann[3], Peter Entel[1], Sebastian Fähler[2], and Alfred Ludwig[3] — [1]Faculty of Physics and CeNIDE, University of Duisburg-Essen, 47048 Duisburg — [2]IFW Dresden, P.O. Box 270116, 01171 Dresden — [3]Institute of Materials, Ruhr-Universität Bochum, 44801 Bochum

Just as the prototypical Ni-Mn-Ga Heusler system also the disordered face centered $Fe_{70}Pd_{30}$ alloy shows large magnetic field induced strains in a slightly tetragonal fct martensite. Recent experiments achieved epitaxial growth of $Fe_{70}Pd_{30}$ thin films with $c/a = 1.09$, thus extending the classical Bain path beyond the fcc end [PRL 107, 206105 (2011)]. The combination of XRD spectroscopy and DFT modelling reveals that this process is related to an alternative relaxation mechanism, which leads to a nanotwinned pattern constructed from fct building blocks. The extremely low formation energy of the fct twins results in a finely twinned superstructure in the simulation cell along [110], which corresponds to the experimentally observed soft transversal acoustic phonon in this direction. This is also a central feature of the Ni-Mn-Ga magnetic shape-memory Heusler compound and allows us to interpret the fct phase analogously as a metastable adaptive martensite, where the increasing twin defect energy at larger distortions prevents the relaxation to the bcc ground state. The close interrelation between electronic and structural properties can be exploited to tailor the phase sequence in magnetic shape-memory ternary alloys.

DF 12.14 Tue 10:30 Poster D

High-field magnetization and magnetoelasticity of single crystalline $HoFe_5Al_7$ — •S. Yasin[1], A.V. Andreev[2], D. Gorbunov[2], Y. Skourski[1], S. Zherlitsyn[1], and J. Wosnitza[1] — [1]Dresden High Magnetic Field Laboratory, Helmholtz-Zentrum Dresden-Rossendorf, 01314 Dresden, Germany — [2]Institute of Physics ASCR, Na Slovance 2, 18221 Prague 8, The Czech Republic

Magnetization and ultrasound measurements have been performed in pulsed magnetic fields up to 60 T on a ferrimagnetic $HoFe_5Al_7$ single crystal (Curie temperature $T_C = 213$ K, compensation point $T_{comp} = 65$ K) with tetragonal crystal structure of $ThMn_{12}$ type. The compound poses an "easy-plane" magnetic anisotropy with the easy magnetization direction along the [110] axis and spontaneous magnetic moment $M_s = 2\ \mu_B$/f.u. at $T = 2$ K. For the magnetic field applied along this direction two field-induced magnetic transitions of first-order are observed. The presence of both transitions is accompanied by sharp anomalies in the acoustic properties. The temperature dependences of the critical fields as well as the shape of the acoustic anomalies suggest a different nature of the above magnetic transitions. The magnetoelastic study has been supplemented with magnetization measurements under hydrostatic pressure. T_C decreases with a rate dT_C/dp = -10

K/GPa, whereas T_{comp} increases with dT_{comp}/dp = 3.5 K/GPa. We discuss our results in relation to the exchange interactions of the Ho-Fe sublatices. *Part of this work was supported by EuroMagNET under the EU contract No. 228043.

DF 12.15 Tue 10:30 Poster D

First-principles study of the magnetic phases of bcc and fcc Fe — •David Reith[1], Pedro Bedolla[2], Raimund Podloucky[1], Peter Mohn[2], Tobias C. Kerscher[3], Sascha B. Maisel[3], and Stefan Müller[3] — [1]Universität Wien — [2]TU Wien — [3]TU Hamburg-Harburg

The cluster expansion (CE) technique in combination with Monte-Carlo simulations [1] is applied for deriving temperature and magnetic field dependent stabilities of the magnetic phases of bcc and fcc Fe. The input structures as calculated by VASP [2,3] provide the total energies of the spin configurations as needed for the CE. In addition to the standard spin-polarized configurations utilized for fcc Fe, the magnetic structures for bcc Fe also includes non-collinear orientations in order to model spin fluctuations. The magnetic field for the MC simulation is implemented in terms of a chemical potential. (Supported by FWF.)

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DF 12.16 Tue 10:30 Poster D

The Strong Disorder Renormalisation Group and Tensor Network Methods — •Andrew Goldsborough and Rudolf Römer — Department of Physics and Centre for Scientific Computing, The University of Warwick, Coventry, United Kingdom

We have developed a tensor network method of performing the numerical strong disorder renormalisation group (SDRG) approach [1] on the random 1D spin-1/2 Heisenberg model. We use matrix product operators (MPOs) as a means of describing the Hamiltonian. The coarse-graining is achieved by concentrating on the interaction with the largest energy gap and calculating the lowest eigenvectors of the two-site hamiltonian. This unitary operator can then be contracted with the two-site MPO to create a new one site MPO. The idea can be interpreted as a multi-level coarse-graining of the Hamiltonian or as a multi-level tensor network state with the form of a binary tree tensor network (TTN). This realisation enables us to use the methods of TTNs and MERAs (multi-scale entanglement renormalisation ansatz) to gain more control over the system. We will show first results and compare the performance all methods.

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DF 12.17 Tue 10:30 Poster D

Magnetic Order and Magnon Dispersion Relation in Ultrathin Fe and FePd Alloy Films Grown on Pd(100) — •Huajun Qin, Tzu-Hung Chuang, Yu Zhang, Khalil Zakeri Lori, and Jürgen Kirschner — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany

Ultrathin Fe films with thicknesses of one and two atomic layers were grown on Pd(100) substrate at room temperature. Spin-polarized electron energy loss spectroscopy (SPEELS) has been utilized to measure the magnon dispersion relation. The results are compared to the ones of a chemically disordered FePd alloy film, with a thickness of two atomic layers, prepared by mild annealing of an Fe monolayer on Pd(100) surface at the temperature of 400 K [1]. All SPEELS measurements are performed at T=13 K. It is found that the magnon energies in the 2 ML FePd alloy film are considerably higher than the ones in the Fe monolayer, but are comparable to the ones in the 2 ML Fe film. This observation may be attributed to the enhanced Pd magnetic moment in the FePd alloy film and the role of interlayer exchange coupling. Our dynamic measurements predict that the alloy films shall have a higher Curie temperature than the Fe monolayer, in good agreement with our static measurements obtained by means of magneto-optical Kerr effect.

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DF 12.18 Tue 10:30 Poster D

Depinning of magnetic domain walls using pure spin currents — •Nils Motzko[1], Björn Burkhardt[1], Piotr Laczkowski[2], Laurent Vila[2], and Mathias Kläui[1] — [1]Institut für Physik, Johannes Gutenberg Universität Mainz — [2]Laboratoire Nanostructure et Magnetisme, CEA/INAC, 38054, Grenoble, France

The controlled motion of magnetic domain walls (DWs) is a vital component of various spintronic devices and memory applications, however, conventional methods of DW manipulation via fields or charge currents suffer from limitations due to their scalability or due to Joule heating. An alternative approach is to employ pure spin currents, for example in non-local spin valve (NLSV) configurations. In our measurements the NLSV consists of two permalloy halfrings which are connected via a non-magnetic copper conduit, a geometry which permits the precise positioning of DWs. Here, we analyze the influence of a pulsed spin current on the depinning field of a DW and we observe pure spin current induced depinning without any external field at a charge current density of $0.5*10^{12}$ A/m^2 and a corresponding spin current density of $6.7*10^9$ A/m^2. The calculated efficiency ($1.1*10^{-12}$ T/(A/m^2)) is more than 100 times higher than for current induced DW motion (CIDM) (M. Laufenberg et. al., Phys. Rev. Lett. 97, 046602 (2006)). This is attributed to the fact that in our measurements the pure spin current acts as a torque completely perpendicularly to the DW magnetization due to the NLSV design maximizing the acting torque.

DF 12.19 Tue 10:30 Poster D

Control of magnetization dynamics by pure spin currents — •Henning Ulrichs[1], Vladislav Demidov[1], Sergej Demokritov[1], and Sergei Urazhdin[2] — [1]University of Muenster, Corrensstrasse 2-4, 48149 Muenster, Germany — [2]Emory University, Atlanta, GA 30322, USA

Recent experiments have shown that pure spin currents can be used to realize efficient control of magnetization dynamics, opening new possibilities for implementation of high-frequency spintronic devices. Here, we review our experimental studies [1-4] on this subject using micro-focus Brillouin light scattering spectroscopy.

We demonstrate that pure spin currents can be utilized for wide-range control of the effective magnetic damping in micrometer-sized structures. In particular, we achieved a reduction of the damping coefficient significantly below values typical for the used magnetic material. This effect can be utilized for stimulation and electric control of nonlinear dynamic phenomena such as parametric spin-wave instability. In addition, we study the effect of pure spin currents on thermal magnetic fluctuations and show that they can be controllably enhanced or suppressed. Finally, we demonstrate excitation of coherent single-mode auto-oscillations in devices where the local injection of pure spin currents results in a complete compensation of damping.

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DF 12.20 Tue 10:30 Poster D

Spin-transfer torque in Fe/MgO/Fe-MTJs with perpendicular magnetic anisotropy — •Jia Zhang, Michael Crezner, and Christian Heiliger — I. Physikalisches Institut, Justus Liebig University, Giessen, Germany

Recently, it was shown that MgO based magnetic tunnel junctions (MTJs) with ultrathin CoFe magnetic electrodes can have perpendicular magnetic anisotropy (PMA) and a low current for current driven switching[1]. In this work, the perpendicular anisotropy and spin-transfer torque in Fe/MgO/Fe-MTJs with ultrathin magnetic Fe layers in the presence of spin-orbital coupling are investigated by full relativistic Korringa-Kohn-Rostoker (KKR) first-principles calculations[2]. First, the critical thickness of Fe with perpendicular anisotropy is determined by calculating the magnetic crystal anisotropy and the shape anisotropy. Second, the bias voltage and angular dependence of spin-transfer torques is calculated. It is found that spin-orbital coupling have three significant effects on the spin-transfer torque: (1) The PMA contributes a new out-plane pseudo-torque in addition to the interlayer exchange coupling torque. (2) The spin-orbital coupling greatly change the magnitude of the spin-transfer torque. (3) The tunneling anisotropy leads to a strong angular dependence of spin-transfer torque.

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DF 12.21 Tue 10:30 Poster D

A theoretical analysis of the spin dynamics of magnetic adatoms traced by pump-probe scanning tunneling spec-

troscopy — •Michael Schüler, Yaroslav Pavlyukh, and Jamal Berakdar — Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, Heinrich-Damerow-Straße 4, 06120 Halle

The inelastic tunneling spectroscopy (IETS) provides a very suitable tool for the detailed analysis of the magnetic properties of adatoms and molecules. Furthermore, the inelastic scanning tunneling microscopy (STM) using a spin-polarized tip also allows for manipulating the spin configuration and for tracing the nanosecond spin dynamics of the magnetic adsorbates in a pump-probe manner. Based on a non-perbutative model, we theoretically investigate the excitation mechanism of the sample spin, its dependence on the anisotropic environmentand demonstrate how the relaxation dynamics can be monitored with the help of the tunnelling current. The predictions of a simple analytical model support our numerical findings and reveal the underlying physics. We also compare our results to recent experiments.

DF 12.22 Tue 10:30 Poster D

Current-induced spinwave doppler shift evidenced by time-resolved kerr microscopy — Jean-Yves Chauleau, Hans Bauer, •Helmut Koerner, Mirkow Ribow, Georg Woltersdorf, and Christian Back — Physics Departement, Universität Regensburg, universitätsstrasse 31, 93040 Regensburg, Germany

Action of spin-polarized electric currents on magnetic textures is now well established both from experimental and theoretical viewpoints. These effects are known as spin-transfer torques (STT). In the case of continuous magnetic distributions, current-induced domain wall (DW) dynamics is a recurrent system of investigation. However, DWs are fairly complicated magnetic structures whose dynamics is consequence of a subtle combination of damping, spin-drift velocity and non-adiabatic parameter. An alternative to domain walls dynamics has been reported by Vlaminck and Bailleul. The current-induced shift of spinwave resonances (spinwave Doppler shift) has been experimentally evidenced using an inductive approach.

In this study, we demonstrate the ability of time-resolved scanning Kerr microscopy (TRMOKE) to investigate the spin-transfer torque effects on propagating spin waves in Permalloy stripes. This approach allows not only the measurement of the full waves spectrum but also a direct imaging of the different modes present in the stripe. Wavevector, damping length and group velocity are directly measured experimentally. This is of utmost importance in order to accurately obtain the spin drift velocity, essential root of any evaluation and study of the non-adiabatic parameter.

DF 12.23 Tue 10:30 Poster D

All-electrical spin-wave spectroscopy on skyrmions in MnSi — •Ioannis Stasinopoulos[1], Thomas Schwarze[1], Andreas Bauer[2], Helmuth Berger[3], Johannes Waizner[4], Markus Garst[4], Christian Pfleiderer[2], Achim Rosch[4], and Dirk Grundler[1,5] — [1]Physik-Department E10, TU München, Garching, Germany — [2]Physik-Department, FG Magnetische Materialien, TU München, Garching, Germany — [3]EPFL, Institut de physique de la matiere complexe, Lausanne, Switzerland — [4]Institute for Theoretical Physics, Univ. Köln, Köln, Germany — [5]STI, EPFL, Lausanne, Switzerland

Skyrmions are topologically stable spin textures with the spins pointing in all directions wrapping up a sphere. The resulting core spins point in opposite direction compared to the outside ones. The recently discovered skyrmion phase (so-called A phase) is formed in a specific magnetic field-temperature (H-T) region of chiral helimagnets, such as MnSi, where skyrmions crystallize at about $T = 28\,\mathrm{K}$ and $\mu_0 H = 200\,\mathrm{mT}$ in a hexagonal lattice with a typical lattice constant of 18 nm. Our group uses an all-electrical microwave spectroscopy setup based on a vector analyzer and lithographically fabricated coplanar waveguides to excite and simultaneously probe the skyrmion states in MnSi. An out-of plane static magnetic field in combination with a He flow cryostat is used to define the skyrmion phase conditions. The observed resonances lie in the low GHz regime. Financial support by the DFG via TRR80 and NIM is acknowledged.

DF 12.24 Tue 10:30 Poster D

Magnetic and electric excitations of helices and Skyrmions in chiral magnets — •Johannes Waizner[1], Markus Garst[1], Achim Rosch[1], Ioannis Stasinopoulos[2], Thomas Schwarze[2], Andreas Bauer[3], Helmuth Berger[4], Christian Pfleiderer[3], and Dirk Grundler[2,5] — [1]Institute for Theoretical Physics, Univ. Köln, Köln, Germany — [2]Physik Department, E10, TU München, Garching, Germany — [3]Physik Department, FG Magnetische Materialien, TU München, Garching, Germany — [4]EPFL, Institut de physique de la matiere complexe, Lausanne, Swizerland — [5]STI, EPFL, Lausanne, Swizerland

An oscillating magnetic field induces precession in a ferromagnet resulting in a ferromagnetic resonance (FMR) that is described by the Kittel formula for a homogeneous magnetisation. We extend the theory of FMR to the case of chiral magnets, i.e., ferromagnets with a Dzyaloshinkii-Moriya interaction, taking into account the effect of demagnetisation fields. In the so-called conical phase, we find two magnetic modes whose weights depend on the polarisation of the driving magnetic field. In the Skyrmion lattice phase, several magnetic modes exist; we find that the mode with the largest weight has a smaller resonance frequency than the ones of the conical phase. As the Skyrmions carry polarisation in insulating chiral magnets, the modes can also be excited electrically. We compare our findings to recent experimental results.

DF 12.25 Tue 10:30 Poster D

Ac spin Hall effect in FMR spin pumping — •Dahai Wei, Martin Obstbaum, Markus Härtinger, Georg Woltersdorf, and Christian Back — Institut für Experimentelle und Angewandte Physik, Universität Regensburg,Regensburg, Germany

The spin Hall effect (SHE), which converts charge current into or from a spin current, has been intensively studied in order to understand its basic mechanism. Furthermore, different materials are investigated in the search for larger spin Hall angles needed for more efficient spin-charge conversions on the basis of dc spin and charge currents. In addition to searching for materials with larger SH angles, ac spin currents, which can be two orders of magnitude larger than the dc ones in spin pumping, may be very promising [1].

We studied both the ac and the dc SHE of Pt/Py bilayers by the ferromagnetic resonance (FMR) based spin pumping technique. The spin currents pumped into the Pt layer have both dc, and a much larger ac component which has not been measured up to now. The ac voltages generated by the ac spin Hall effect was directly picked up at the same frequency of the spin pumping.

[1]Hujun Jiao & Gerrit E. W. Bauer, AC Voltage Generation by Spin Pumping and Inverse Spin Hall Effect. arXiv:1210.0724.

DF 12.26 Tue 10:30 Poster D

Current-induced domain wall motion at low current densities in La0.7Sr0.3MnO3 nanostructures imaged with high resolution x-ray magnetic microscopy — S. Finizio[1], M. Foerster[1], C. A. F. Vaz[1,2], F. Büttner[1,2,5], M. Mawass[1], •R. Lo Conte[1], T. Miyawaki[3], A. Bisig[2], L. Méchin[4], F. Nolting[6], and M. Kläui[1] — [1]JGU, Mainz, Germany — [2]SwissFEL, PSI, Villigen PSI, Switzerland — [3]University of Nagoya, Nagoya, Japan — [4]GREYC, UMR 6072, CNRS-ENSICAEN-UCBN, Caen Cedex, France — [5]TU Berlin, Berlin, Germany — [6]SLS, PSI, Villigen PSI, Switzerland

The effect of current pulses on the magnetization of nanometric La0.7Sr0.3MnO3 (LSMO)-half-rings has been investigated by high resolution x-ray magnetic microscopy. The potential high spin polarization and low room temperature saturation magnetization of LSMO make it a promising candidate for spin-torque-based technology applications. Here we investigate Current-Induced Domain Wall Motion (CIDWM) in LSMO nanostructures at low current densities (1-5x10 GA/m2). Their magnetic configuration was imaged by X-ray Magnetic Circular Dichroism - Photoemission Electron Microscopy (XMCD-PEEM). We observe mainly an initial single vortex wall and DW transformations, annihilation and nucleation after current injection due to the low Curie temperature (Tc ~ 340K) of our nanostructures. Low velocity (~0.5mm/s)DW displacements have been observed and interesting information on the energetics of the DW configurations has been obtained. While low current densities allow to move walls, the low Tc of LSMO limits the application for a CIDWM-based technology.

DF 12.27 Tue 10:30 Poster D

3D soft x-ray imaging of magnetite coated microballoons for theranostic applications — •Andreas Späth[1], Hanno Dietrich[1], Birgit Graf-Zeiler[1], Gaio Paradossi[2], and Rainer H. Fink[1] — [1]Friedrich-Alexander Universität Erlangen-Nürnberg, Physical Chemistry II and ICMM, Erlangen, Germany — [2]Università di Roma Tor Vergata, Dipartimento di Scienze e Tecnologie Chimiche, Rome, Italy

Poly(vinylalcohol) stabilized microballoons (diameter 4 - 10 microns) are promising hybrid systems for various applications in theranostics. Their surface can easily be functionalized chemically, and they can

be filled with a large variety of therapeutic gases, thus providing very good contrast agents in ultrasound imaging. By embedding superparamagnetic iron oxide nanoparticles (SPIONs) into the polymer shell magnetic field guidance and even a magnetothermally triggered drug release from these micro containers is possible. This could be a highly valuable progress in selective destruction of tumor cells with highly active pharmazeuticals.

Within this contribution we will clarify the shell morphology and SPION distribution in various batches of magnetically functionalized PVA microballoons by transmission soft x-ray microspectroscopy (TXM) and TEM and extend these investigations to third dimension by reconstructions of TXM focal series and x-ray holography. X-ray magnetic dicroism (XMCD) and SQUID measurements were applied for a basic magnetic characterization of the particles.

DF 12.28 Tue 10:30 Poster D

Measurement of magnetic moment distribution of ferrofluids with single nanoparticle resolution using atomic force microscopy — •Stephan Block[1] and Christiane A. Helm[2] — [1]ZIK HIKE, Fleischmannstr. 42 - 44, D-17475 Greifswald, Germany — [2]Institut für Physik, Ernst-Moritz-Arndt Universität, Felix-Hausdorff-Str. 6, D-17487 Greifswald, Germany

An atomic force microscopy (AFM) method is presented, which allows the simultaneous measurement of magnetic and geometric properties of nm-sized objects (nanoparticles, e.g. colloids or clusters). An oscillating magnetic field is applied to the sample and the surface magnetization is probed using a magnetic AFM-tip. 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 a lateral resolution of few nanometers. The principles of the experimental setup and the data analysis are outlined. It is shown that the resolution is sufficiently high to resolve magnetic moments of single superparamagnetic maghemite nanoparticles (diameter > 4 nm). The approach is applied to determine the distribution of magnetic moments in different ferrofluids on a single particle level.

DF 12.29 Tue 10:30 Poster D

Granular GMR effects in systems with organic matrix — •Judith Meyer, Markus Schäfers, Thomas Rempel, and Andreas Hütten — Bielefeld University, Universitätsstr.25, 33615 Bielefeld

The giant magnetoresistance effect (GMR effect) was found in magnetic multilayer systems [1,2] and was later also reported within granular systems by several research groups who had embedded magnetic particles in a metallic matrix [3,4]. In contrast to previous granular layered systems, we have incorporated Co nanoparticles in a conductive nonmagnetic biogel. Transport measurements carried out using a 4-point-probe measurement at room temperature revealed GMR effects of more than 60 percent. AC transport measurements were found to improve the long-term stability of the effect amplitude. Regarding future applications, the possibility of printing gel will allow for the development of granular gel-GMR sensors more rapid and less expensive in fabrication compared to conventional devices. The large effect amplitudes will ensure high sensor sensitivity and the mechanical flexibility of the matrix might additionally open up new fields of application.

DF 12.30 Tue 10:30 Poster D

Individual and collective ferromagnetic resonance of 43 nm Fe/Fe_xO_y core/shell-nanocubes — •Alexandra Terwey, Ralf Meckenstock, Detelf Spoddig, Christian Schöppner, Marina Spasova, and Michael Farle — AG Farle, Experimentalphysik, Universität Duisburg Essen, Germany

Here we determine the magnetization, anisotropy and linewidth of 43 nm Iron/Ironoxide core/shell nanocubes, from a statistical distribution in solution over small agglomerates to single particles on a substrate. The nanocubes, surrounded by an organic matrix of ligands were produced according to a modified recipe of Kim et al. [1]. For the ferromagnetic resonance (FMR) a new technique with a microcavity set up has been used. This technique allows to investigate different configurations of particle arrangements and thereby to study in detail the effects of dipolar coupling. The microcavity FMR has a resolution of 10^6 spins [2]. The number of particles was continuously reduced until only single particles remained in the microcavity. FMR at room temperature with a frequency of 9 GHz shows single particle resonance with linewidths of 6 mT. We determined a magnetocrystalline anisotropy $K_4 = (5 \pm 0,5) \cdot 10^3 \frac{J}{m^3}$ which is only 10% of the Fe bulk value. The behaviour of single particles in comparison to a statistical distribution will be discussed on the poster. Financial support by MERCUR (PR-2011-0007) is acknowledged.

[1] Kim et al., JACS, 129, 5812-5813 (2007)
[2] Banholzer et al., Nanotech. 22, 295713 (2011)

DF 12.31 Tue 10:30 Poster D

Experimental investigation and modeling of the spin structure in FePt@MnO heterodimer nanoparticles — •Xiao Sun[1], Alice Klapper[1], Oleg Petracic[1], Oskar Koehler[2], Heiko Bauer[2], Wolfgang Tremel[2], and Thomas Brueckel[1] — [1]Jülich Centre for Neutron Science JCNS-2 und Peter Grünberg Institut PGI-4, Forschungszentrum Jülich GmbH — [2]Institut für Anorganische und Analytische Chemie, Johannes Gutenberg-Universität Mainz

Magnetic nanoparticles (NPs) have attracted much interest for decades. We have focused on FePt@MnO heterodimer NPs consisting of a ferromagnetic FePt particle in contact to an antiferromagnetic MnO particle. Single FePt, single MnO and FePt@MnO dimer NPs with different sizes (5-20nm) have been studied using SQUID magnetometry employing zero field cooled (ZFC)/field cooled (FC) magnetization curves at various fields, hysteresis curves and thermoremanent (TRM)/ isothermoremanent (IRM) curves. An exchange bias effect in dimer particles has been observed by the shift of hysteresis loops at different temperatures suggesting a magnetic coupling between FePt and MnO. An exchange bias shift is not observed in single FePt or MnO NPs. Monte Carlo simulations of the spin structure in single MnO NPs and FePt@MnO dimer NPs are compared to the experimental findings. Neutron scattering experiments aiming to study the spin structure inside single MnO NPs and inside the MnO subunit of FePt@MnO heterodimers using polarized neutron diffraction are proposed.

DF 12.32 Tue 10:30 Poster D

Formation of ferrite nanoparticles monitored during the preparation process by Mössbauer spectroscopy — •Mathias Kraken[1], Nathalie Leise[1], Andre Borchers[1], Dirk Menzel[1], Jochen Litterst[1], Ingke-Christine Masthoff[2], Ilka-Marina Grabs[2], and Georg Garnweitner[2] — [1]Institut für Physik der kondensierten Materie, Technische Universität Braunschweig, 38106 Braunschweig, Germany — [2]Institut für Partikeltechnik, Technische Universität Braunschweig, Braunschweig, Germany

In the recent years, a broad variety of different preparation methods for magnetic nanoparticles has been established. In this context, the non-aqueous sol-gel method is a rather new process, based on the bottom-up approach, which produces spherical nanoparticles with a small size distribution [1].

Mixtures of $Fe(acac)_3$ with different solvents are placed in a reactor at temperatures above room temperature (typically 200°C). The physical properties of the formed particles depend on the time spent in the reactor.

We investigated solutions of $Fe(acac)_3$ with triethyleneglycol and benzyl alcohol for different reaction times in the reactor by dynamic light scattering, DC susceptibility and Mössbauer spectroscopy in order to gain more information about the process of the formation of the nanoparticles during the stay of the solution in the reactor.

[1] I.-M. Grabs et al., Cryst. Growth Des. 12, 1496 (2012).

DF 12.33 Tue 10:30 Poster D

Characterization of the elastic properties of hydrogels using nickel nanorods as probes — •Philipp Bender, Andreas Tschöpe, and Rainer Birringer — Universität des Saarlandes, Saarbrücken, Germany

With diameters below 42 nm, Ni nanorods are uniaxial ferromagnetic single-domain particles. The nanorods are synthesized by electrodeposition of nickel into porous alumina templates and after several preparation steps dispersed into gelatin gels matrices. Applying a homogeneous magnetic field during gelation results in magnetically textures ferrogels. When the gels are placed in a homogeneous magnetic field, the magnetic torque causes a rotation of the magnetic moments of the rods in field direction. The alignment can occur by a rotation out of the long rod axis working against shape anisotropy or by a rotation of the rods itself, which is restricted by the surrounding elastic network. In a static homogenous magnetic field the magnetic torque, the counteracting torque due to shape anisotropy and the mechanical torque, caused by the shear deformation of the surrounding gel matrix, are at equilibrium. This equilibrium condition was used to develop several methods to characterize the elastic properties of soft hydrogel matrices by magnetization measurements using nickel nanorods as probes. In

the present study the initial susceptibilty of the magnetization curves is evaluated in order to determine the shear modulus.

DF 12.34 Tue 10:30 Poster D

Enhanced anisotropy of Ni nanoparticles embedded in IrMn matrices — •Balati Kuerbanjiang[1], Ulf Wiedwald[2], Felix Häring[2], Johannes Biskupek[3], Ute Kaiser[3], and Ulrich Herr[1] — [1]Inst. of Micro and Nanomaterials, Ulm University, 89081 Ulm — [2]Inst. of Solid State Physics, Ulm University, 89069 Ulm — [3]Electron Microscopy Group of Materials Science, Ulm University, 89081 Ulm

Magnetic nanoparticles have huge potential in future applications such as data storage, nanosensors and biomedicals. However, superparamagnetic effect puts a limit on the minimum size of the particles in terms of usage. One way to overcome this limit is attaining exchange anisotropy by coupling the ferromagnetic (FM) particles to an antiferromagnetic (AFM) media. Different from most of the literature works, we developed a sample preparation system where we can independently change the type of FM and AFM materials, allowing us to study the effect in a flexible way. In this work, we have produced Ni nanoparticles using plasma gas condensation technique and *in-situ* embedded them in an IrMn matrix. We show that the embedded Ni nanoparticles display enhanced coercivity H_c and exchange bias H_{ex}. Furthermore, we find that the effect is stronger in smaller particles, and the extracted exchange energy values are in the range of the values found in FM/IrMn bilayer systems. The particle size dependencies of H_c and H_{ex} have been measured in detail, and we propose a micromagnetic model to describe the observed trends. By conducting FC/ZFC measurements, we show a clear increase of blocking temperature for embedded particles compared to identical non-embedded particles.

DF 12.35 Tue 10:30 Poster D

Quadratic magnetooptical effects in two-dimensional permalloy particles investigated by scanning X-ray microscopy — •S.A. Nepijko[1], O.V. Pylypenko[2], L.V. Odnodvorets[2], E. Kisker[3], H.J. Elmers[1], and G. Schönhense[1] — [1]Institute of Physics, University of Mainz, Staudingerweg 7, 55128 Mainz, Germany — [2]Sumy State University, Rimsky-Korsakov str. 2, 40007 Sumy, Ukraine — [3]Institute of Applied Physics, University of Düsseldorf, Universitätsstrasse 1, 40225 Düsseldorf, Germany

We have investigated the magnetization structure and magnetization curves of individual rectangularity shaped permalloy particles using scanning X-ray microscopy in the ultrasoft X-ray regime. Magnetic contrast originates from M-edge X-ray magnetic circular dichroism and from the transverse magnetooptical Kerr effect [1, 2]. We studied magnetization curves in dependence on the field direction for particles of different shapes and sizes. Adjacent particles cause a significant dipole interaction. Asymmetric magnetization loops indicate the presence of non-linear magnetooptical effects. [1] M. Schroeder et al., Nucl. Instrum. Methods Phys. Res., Sect. A, 467-468 (2001) 1404; [2] S.A. Nepijko et al., APA, published online: 19 Sept. 2012

DF 12.36 Tue 10:30 Poster D

Towards EMCD measurements of non-crystalline materials — •Jan Rusz[1], Shunsuke Muto[2], Vancho Kocevski[1], and Kazuyoshi Tatsumi[2] — [1]Department of Physics and Astronomy, Uppsala University, Sweden — [2]Department of Materials, Physics and Energy Engineering, Nagoya University, Japan

Electron magnetic circular dichroism (EMCD) is a young experimental technique that brings a promise of measurement of atom-specific magnetic characteristics at sub-nanometer resolution - an information that is not accessible by any other experimental technique yet. We propose a method of circumventing one of its major present obstacles, namely, the high demands on the quality of measured samples. Until now, only single-crystal samples could be measured. Those had to be oriented in a specific geometry, in order to exploit symmetries of the measurement set up. In the newly proposed method, theoretically analysed in Muto, Tatsumi, Rusz, Ultramicroscopy (in press), the symmetry requirements and specific orientations are effectively removed. Moreover, the method unveiled an exciting possibility to measure polycrystals and possibly even amorphous magnets. The method is based on modern methods of statistical analysis of the multivariate datasets, namely the multivariate curve analysis method (Tauler, 1995). Based on theoretical simulations we explore the feasibility of EMCD experiments on polycrystals and amorphous materials.

DF 12.37 Tue 10:30 Poster D

Exchange Bias in all-Manganite $La_{0.7}Sr_{0.3}MnO_3/SrMnO_3/La_{0.7}Sr_{0.3}MnO_3$ **Trilayers** — •Markus Jungbauer, Sebastian Hühn, Markus Michelmann, Camillo Ballani, and Vasily Moshnyaga — I. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

A great interest to exchange bias phenomenon in artificially layered thin films is caused by fundamental importance of this well-known but still controversially explained effect as well as by its promising applicability in spintronics (TMR and multiferroics). We studied exchange bias for all-manganite $La_{0.7}Sr_{0.3}MnO_3/SrMnO_3/La_{0.7}Sr_{0.3}MnO_3$ trilayers with ferromagnetic $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) and G-type antiferromagnetic $SrMnO_3$ (SMO) layers, grown on (001) $SrTiO_3$ substrates by metalorganic aerosol deposition (MAD). The field shift of the magnetic hysteresis loop H_E and the coercitivity H_C decay exponentially with temperature, vanishing at $T = 100\,K$. H_E exhibits a global maximum as a function of the SMO interlayer thickness at $t_{SMO} \approx 4.5\,nm$. We argue that the EB behaviour can be explained by the interplay of a spinglass state at the interface and theoretically proposed mechanism based on the Dzyaloshinskii-Moriya interaction[1]. Financial support of EU via FP7 (IFOX) is acknowledged.

[1] S. Dong, et al., Phys. Rev. Lett. **103**, 127201 (2009)

DF 12.38 Tue 10:30 Poster D

Magneto-resistive characterization of hybrid magnetic films — •Kadir Sentosun[1], Julia Trützschler[1], Manuel Langer[2], Ingolf Mönch[3], Roland Mattheis[4], Thomas von Hofe[1], Jurgen Fassbender[2], and Jeffrey McCord[1] — [1]Institute for Material Science, University Kiel, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Germany — [3]Leibniz Institute for Solid State and Materials Research, Dresden, Germany — [4]Institute of Photonic Technology, Jena, Germany

Thin films with an initial unidirectional anisotropy are patterned by ion irradiation [1] into stripe-like two dimensional structures with alternating directions of exchange bias (EB). By this a structure with laterally varying perpendicular alignment of EB is obtained. The magnetization behaviour of the NiFe/IrMn thin films is investigated by complementary methods: Structures of different stripe width are analysed by inductive magnetometry, the change of anisotropic magneto-resistance (AMR) with varying field angles is investigated by a four probe contact measurement technique, and the magnetization reversal is studied by Kerr microscopy. Transversal magnetization components related to domain wall activity are derived from the AMR measurements. The characteristic AMR sensitivity is maximized when the measuring current direction is along the net magnetization, also oriented parallel to the applied magnetic field direction. Pure uniaxial magnetic field sensitivity is obtained through the perpendicularly aligned magnetization modulation. [1] J. Fassbender and J. McCord, J. Magn. Magn. Mater. 320, 579-596 (2008)

DF 12.39 Tue 10:30 Poster D

Preparation of epitaxial FeMn/Co-exchange-bias systems on MgO single crystals — •Mathias Schmidt, Patrick Audehm, Eberhard Goering, and Gisela Schütz — Max-Planck-Institut für Intelligente Systeme, Heisenbergstr. 3, 70569 Stuttgart

Exchange bias systems are very important for several applications in the area of magnetic storage media. Inside that class of materials, FeMn/Co-thin films are one of the most prominent examples. For research issues, they are usually produced on Cu single crystals fitting almost perfectly to the lattice constant of FeMn, leading to epitaxial growth. For receiving a deeper understanding of the exchange-bias, which is still under strong debate, we used different methods as SQUID, AFM and MOKE but also XAS, XMCD and XRMR (X-Ray Magnetic Reflectometry). Because of the weak deformation resistance of Cu substrates, especially the latter method is nearly impossible to access, which is in principle necessary to receive a detailed magnetic and physical depth profile of the sample. Molecular beam epitaxy was used to produce FeMn/Co-systems on (100) MgO substrates. With the help of different buffer layers, we could achieve epitaxial properties through all sample layers, creating well defined interfaces. We will present the preparation process and the results of multiple characterization methods revealing new insights into the physical and magnetic properties of these exchange-bias systems.

DF 12.40 Tue 10:30 Poster D

Ferromagnetic-antiferromagnetic transition in 1D Fe-based nanocontacts — •Ilia N. Sivkov[1], Dmitriy I. Bazhanov[2], and Valeriy S. Stepanyuk[1] — [1]Max Planck Institute of Microstructure

Physics, Halle, Germany — [2]Physics Department, Moscow State University, Moscow, Russia

The recent progress in nanoelectronics and spintronics leads to an intensive experimental and theoretical study of spinpolarized electron transport in one-dimensional nanostructures - nanowires and nanocontacts. The spin-polarized electron transport through mixed magnetic nanostructures can increase significantly the data recording and transmission densities without increasing the size of nanostructures. In our recent study we have shown that it is possible to create the stable mixed Pd-Fe nanowires which exhibit a ferromagnetic-antiferromagnetic(FM-AFM) transition during stretching. We investigate this phenomena in finite atomic mixed chains suspended between Pt, Pd and Au leads using density functional theory. The spin-dependent transmission calculation was performed using non-equilibrium Green's function method and density functional theory. Effect of FM-AFM transition on conductance and magnetoresistance is discussed.

DF 12.41 Tue 10:30 Poster D

influence of top Ni layer on exchange bias and blocking temperature in Ni/NiMn/Ni trilayers — •Yasser Shokr[1], Mustafa Erkovan[1,2], Daniela Schiestl[1], Chii-Bin Wu[1], Mohammed Yaqoob Khan[1], and Wolfgang Kuch[1] — [1]Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin, Germany. — [2]Gebze Institute of Technology, Dept. of Physics, 41400 Kocaeli, Turkey

The exchange bias (EB) field and the blocking temperature for exchange bias (Tb) in the system Y ML Ni/X ML Ni25Mn75/12 ML Ni on Cu3Au(001) were investigated by magneto-optical Kerr effect (MOKE). The study concentrates on the influence of the antiferromagnetic (AFM) layer thickness on the EB field and on Tb. For every AFM layer thickness X the top ferromagnetic (FM) layer thickness Y has been changed from 0ML and then 12 ML to 22 ML in steps of 5 ML. we show that the EB field is reduced after deposition of the top Ni layer. This is interpreted in term of pining of uncompensated moments in the volume of the AFM layer. In addition, magnetic interlayer coupling between the two Ni layers influence the EB field.

DF 12.42 Tue 10:30 Poster D

Magnetic excitations in half- and overdoped manganites — Holger Ulbrich[1], •Thomas Bardenheuer[1], Paul Steffens[2], Yvan Sidis[3], Daniel Lamago[3], and Markus Braden[1] — [1]II. Physikalisches Institut, Universität zu Köln, 50937 Köln — [2]Institut Laue Langevin, Grenoble — [3]Laboratoire Léon Briilouin, CE Saclay, Gif sur Yvette Cedex

Magnetic excitations were studied by inelastic neutron scattering on various manganites that exhibit charge, orbital and spin ordering. At half-doping the magnetic excitation spectra can be perfectly modelled by a simple Heisenberg model of magnetic interaction which perfectly agrees with the Goodenough scenario of charge and orbital ordering. There seems to be no qualitative difference in all the half-doped manganites studies so far irrespective of their layered or three-dimensional character. For higher doping we observe a stripe-like arrangement of the electronic and magnetic ordering. Furthermore the magnetic excitation spectra closely resemble the hour-glass like dispersion observed in many high-temperature superconducting cuprates. Besides a large ratio of intra- to inter-stripe magnetic inteaction parameters, a short range of the magnetic ordering perpendicular to the stripes can be identified as decisive parameter to induce a hour-glass dispersion in insulating stripe phases.

[1] H. Ulbrich et al., Phys. Rev. Lett. **106**, 157201 (2011) [2] H. Ulbrich, Phys. Rev. B **84**, 094453 (2011) [2] H. Ulbrich, Phys. Rev. Lett. **108**, 247209 (2012)

DF 12.43 Tue 10:30 Poster D

Test of band structure calculations for Heusler compounds by spin-resolved photoemission spectroscopy — Michaela Kolbe[1], Stanislav Chadov[2], Elena Arbelo Jorge[1], Gerd Schönhense[1], Claudia Felser[2], Hans-Joachim Elmers[1], Mathias Kläui[1], and •Martin Jourdan[1] — [1]Institut für Physik, Johannes Gutenberg-Universität, Staudingerweg 7, 55128 Mainz — [2]Max-Planck-Institut für Chemische Physik fester Stoffe, Dresden

The electronic density of states of epitaxial thin films of the Heusler compound Co_2MnGa is probed in situ by spin-resolved ultraviolet photoemission spectroscopy. The experiments reveal several characteristic features in the intensity spectrum and a clear Fermi edge signature. A high spin polarization of 55% at the Fermi edge is followed by a sign change at the binding energy of 0.8 eV. Corresponding calculations of the band structure and the photoemission spectrum were performed employing a spin-polarized relativistic Korringa-Kohn-Rostoker code. Good agreement between the experimental data and calculations was obtained, including dynamical correlation effects [1].

[1] M. Kolbe et al., Phys. Rev. B, 86, 024422 (2012)

DF 12.44 Tue 10:30 Poster D

Carbon Nanotubes filled with Nanoparticles from the System Ni-Mn-Ga — •Marcel Haft, Silke Hampel, Markus Gellesch, Sabine Wurmehl, Lars Giebeler, Maria Dimitrakopolou, and Bernd Buechner — Leibniz-Institute for Solid State and Materials Research, IFW-Dresden, D-01171

Properties of nanoscale materials can completely change when scaling a bulk-material down to its smallest size. However, especially at nanoscale dimensions oxidation is a fundamental challenge in intermetallic materials, which has so far obstructed the investigation of attractive intermetallic materials at the nanoscale. In this work, we propose a novel approach for the synthesis of intermetallic (magnetic) nanoparticles which is based on the encapsulation of materials inside carbon nanotubes. Hereby carbon nanotubes function as a template for the formation of nanoparticles and nanowires with well-defined sizes and provide protective carbon shells which hinder oxidation of the nanoparticles. We present several wet chemical filling methods, both from solution and from melt of metal nitrates and halides. The samples were well characterized by means of electron microscopy (SEM, TEM), x-ray probes and temperature dependent magnetometry. We observe, that the metallic nanoparticles inside carbon nanotubes exhibit enhanced magnetic performance (increased coercitivity) compared to bulk material. So far Nickel, Manganese and Gallium were filled separately into carbon nanotubes as model compounds. In future we will fill nanoparticles of the respective binary compounds and eventually also the ternary Heusler compound Ni2MnGa into carbon nanotubes.

DF 12.45 Tue 10:30 Poster D

Interface-controlled Magnetism and Transport of Ultrathin Manganite Films — •Sebastian Hühn[1], Markus Jungbauer[1], Markus Michelmann[1], Oleg Shapoval[2], Alexander Belenchuk[2], Jo Verbeeck[3], and Vasily Moshnyaga[1] — [1]I. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany, — [2]IIEN, Academy of Sciences of Moldova, Academiei str., 3/3, MD-2028, Chisinau, Moldova — [3]EMAT, University of Antwerp, Groenenborgerlaan 171, B-2020 Antwerp, Belgium

The recent great fundamental and technological interest for interfaces in thin films of correlated oxides (manganites, aluminates, titanites and cuprates) is caused by two main reasons: 1) to stabilize the bulk-like magnetism, metallicity and ferroelectricity in ultrathin films and 2) to create new interface-originated properties not akin to the bulk phases. We investigate thin ferromagnetic manganite films with various interface modifications grown by metalorganic aerosol deposition (MAD) technique on $SrTiO_3$ substrates with different orientations. Structure and morphology is studied by AFM/STM, XRD, XRR and HREM; transport and magnetization by PPMS and MPMS, respectively. We observe ferromagnetic metallic behavior of a three unit cell thick interface engineered lanthanum manganite film, modified by 2 u.c. of strontium manganite, grown on STO(100). Financial support from EU FP 7, IFOX (interfacing oxides) project is acknowledged.

DF 12.46 Tue 10:30 Poster D

Magnetic resonance study of Heusler compounds — •A. Alfonsov[1], S. Rodan[1], M. E. Belesi[1], V. Kataev[1], B. Peters[2], F. Yang[2], M. Emmel[3], G. Jakob[3], H.-J. Elmers[3], S. Wurmehl[1], and B. Büchner[1] — [1]IFW Dresden, D-01169 Dresden, Germany — [2]Department of Physics, Ohio State University,191 West Woodruff Avenue Columbus, Ohio 43210, USA — [3]Institut für Physik, Johannes Gutenberg-Universität Mainz, D-55099 Mainz, Germany

Heusler alloys have attracted a considerable attention in recent years since these compounds are predicted to be halfmetallic ferromagnets. High magnetic moments and high values of the Curie temperature give them a significant potential for spintronics applications. To control the macroscopic physical properties of these materials it is crucial to have a precise knowledge of the structural and magnetic ordering also on a local scale. For instance, the halfmetallicity in these materials strongly depends on the local atomic order. To obtain such knowledge one has to call for local probe techniques. In this work we present recent nu-

clear magnetic resonance and electron spin resonance study of various Co-, Mn- and Fe-based Heusler compounds where we address the local structural and magnetic properties.

DF 12.47 Tue 10:30 Poster D

The influence of p- and n-doping on the intrinsic properties of the Heusler compound Fe_2VAl — •Franziska Seifert[1,2], Christian G.F. Blum[1], Frank Steckel[1], Christian Hess[1], Bernd Büchner[1], Sabine Wurmehl[1], Stefan Martin[2], and David Rafaja[2] — [1]Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden — [2]TU Bergakademie Freiberg, Germany

The Heusler compound Fe_2VAl is considered as a non-magnetic thermoelectric material. In this work, we studied the intrinsic properties of the Heusler compound Fe_2VAl and the influence of p- and n-doping on the intrinsic materials properties of the corresponding Si and Ti doped compounds using single crystals. Electron back scattering diffraction reveals the presence of a V-rich secondary phase in particular in crystals with Si and in the parent compound. The depletion of V from the Fe_2VAl matrix apparently leads to localized Fe moments and to ferromagnetism in the corresponding samples. Interestingly, the sample with Ti and less V depletion shows a significant enhancement of the figure of merit compared to the other samples.

DF 12.48 Tue 10:30 Poster D

First-principles study of the structural stability of Mn_3Z (Z=Ga, Sn and Ge) Heusler compounds — •D. Zhang[1], B. Yan[1,2], S.-C. Wu[1], J. Kuebler[3], G. Kreiner[1], and C. Felser[1,2] — [1]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany — [2]Johannes Gutenberg-Universität Mainz, Staudingerweg 9, 55128 Mainz, Germany — [3]Institut für Festkörperphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany

We investigate the structural stability and magnetic properties of cubic, tetragonal and hexagonal phases of Mn_3Z (Z=Ga, Sn and Ge) Heusler compounds using the first-principles density-functional theory. We propose that the cubic phase plays an important role as an intermediate state in the phase transition from the hexagonal to the tetragonal phase. Consequently, Mn_3Ga and Mn_3Ge behave differently from Mn_3Sn, because the relative energies of the cubic and hexagonal phases are different. These results agree with experimental observations from these three compounds. The weak ferromagnetism of the hexagonal phase and the perpendicular magnetocrystalline anisotropy of the tetragonal phase obtained in our calculations are also consistent with experiment.

DF 12.49 Tue 10:30 Poster D

Autocorrelation measurement with femtosecond laser pulses of correlated polaron dynamics in manganites — •Manuel Mchalwat, Christin Kalkert, Camillo Ballani, Vasily Moshnyaga, Markus Münzenberg, and Konrad Samwer — 1. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

In manganites the spatial and time scales of correlations range from microns and seconds as for the electronic phase separation down to 1 . . . 2 nm and femtoseconds as for the Jahn-Teller polarons. Recently it was shown that the third harmonic voltage in electrical transport is proportional to the concentration of correlated polarons. To get access to the their ultrafast dynamics we performend an autocorrelation measurement of the third harmonic voltage with femtosecond laser pulses thus photo-inducing correlated polarons. Further we discuss our results with respect to thermal and non-thermal influences.

The work has been supported by the DFG through SFB 602 TP A2 and by Femtolasers.

DF 12.50 Tue 10:30 Poster D

Theoretical study of the mechanical stability and magnetic properties of Mn_2-based Heusler compounds with heavy transition metals — •L. Wollmann[1,2], G. H. Fecher[1], and C. Felser[1] — [1]Max Planck Institute for Chemical Physics of Solids, Nöthnitzer Straße 40, 01187 Dresden, Germany — [2]Johannes Gutenberg University, Staudingerweg 9, 55128 Mainz, Germany

We have investigated by ab-initio calculations the class of Mn_2YZ Heusler compounds (with Y = Rh, Ru and Z = Ga, In, Tl, Ge, Sn, Pb) in order to explore their potential for applications in the field of spintronics. The calculations have been performed using the FPLAPW+(lo)-method as implemented in Wien2k. By applying uniaxial strain in the linear region in three directions it was possible to evaluate the mechanical stability. Proving that they do not adapt the cubic Heusler structure by evaluating the elastic properties, we report to have found promising candidates for new Heusler phases (tetragonal or lower symmetry) formed by the mentioned compositions. The mechanical properties, as well as the electronic and magnetic structure of tetragonal and cubic compounds will be discussed.

DF 12.51 Tue 10:30 Poster D

Magnetic and transport properties of the Heusler system $Ni_{2-x}Mn_{1+x}Sn$. — •Tina Fichtner, Guido Kreiner, Gerhard H. Fecher, Walter Schnelle, and Clauida Felser — Max-Planck-Institut für Chemische Physik fester Stoffe, Dresden

In the present work we have investigated a new series of polycrystalline alloys of the general composition $Ni_{2-x}Mn_{1+x}Sn$ with x = 0, 0.2, 0.4, 0.5, 0.6, 0.8, 1. The alloys were obtained as single-phase materials by inductive melting of the elements and subsequent annealing at 700°C. $Ni_{2-x}Mn_{1+x}Sn$ crystallizes in the cubic Heusler structure, thus forming a solid solution series from Ni_2MnSn to Mn_2NiSn. The stochiometric Heusler compounds of this series show ferro- or ferrimagnetic order with T_c ranging from 346 to 550 K, respectively. The magnetic moment at 1.8 K decreases in the series from 4.1 μ_B to 2.3 μ_B. The cubic symmetry is stable from low to high temperature. Instead of building a non-cubic structure, a miscibility gap forms pointing out an entropic stabilization of the cubic phase. Here, we report on the magnetic and transport properties with respect to the chemical disorder.

DF 12.52 Tue 10:30 Poster D

Electronic, structural and magnetic properties of $NiFe_2O_4$ ultra thin films — •Michael Voigt[1], Christian Caspers[1], Bernardus Zijlstra[1], Sebastian Flade[1], Sven Döring[2], Mihaela Gorgoi[3], Claus M. Schneider[1], and Martina Müller[1] — [1]Peter-Grünberg-Institut (PGI-6), Forschungszentrum Jülich — [2]Experimentalphysik, Universität Duisburg-Essen — [3]BESSY II, Helmholtzzentrum Berlin für Materialien und Energie

The spinel $NiFe_2O_4$ (NFO) is an insulating oxide that is ferrimagnetic with a Curie-temperature way above room temperature. This rare combination of properties makes this material intriguing for integration into heterostructures for spintronics. The magnetic properties of ultra-thin ferrite films, however, strongly differ from the bulk, i.e. an enhanced magnetization is observed for $d_{NFO} \leq 10$ nm, though the reason for this is still unclear.

To gain insights into this phenomenon, we investigated ultra-thin NFO films (d = 2 - 20 nm) deposited on $SrTiO_3$ via pulsed laser deposition, and studied the structural, magnetic and electronic properties via SQUID, XRD, NEXAFS and HAXPES. The latter two methods allow us to probe the oxidation states and the atomic coordination element specifically for the Ni- and Fe-cations. The Ni- & Fe-2p/3p spectra show that the ultra-thin films grow with bulk-like electronic properties. From the spectral shape we conclude, that even for lowest film thickness no cation inversion takes place. Furthermore, we deduce a two-phase growth mode from XRD data, in which NFO grows highly strained for d $\leq$ 4 nm and starts to relax for larger thicknesses.

DF 12.53 Tue 10:30 Poster D

Structural and magnetic properties of Ni-Co-Mn-Sn thin films — •Ramudu Machavarapu, Christian Mix, and Gerhard Jakob — Institut für Physik, Johannes Gutenberg-Universität Mainz, 55128 Mainz

Ni-Co-Mn-Sn alloys have drawn interest recently due to their multifunctional properties like magnetic shape memory effect (MSME), magnetocaloric effect and direct conversion of heat to electricity. It is well recognized that the austenite of the Ni-(Co)-Mn-X (X = In, Sn, Sb) alloys has a ferromagnetic state below the Curie temperature (TC) and a paramagnetic state above TC. However, the low-temperature martensite exhibits different magnetic behavior such as ferromagnetic, paramagnetic, antiferromagnetic and spin glass, depending on exact composition. These alloys also have shown thermoelastic martensitic transformations at high temperatures. To gain a deep understanding of the functional properties of these alloys, it is very important to investigate their structural and magnetic properties in detail.

Thin films of Ni-Co-Mn-Sn have been prepared on single crystalline MgO (100) substrate using DC magnetron sputtering. The preparation parameters like sputtering power, substrate temperature and argon gas pressure were optimized. Crystal structure of thin films was studied using X-ray diffraction. Detailed structural transformations and magnetic properties were investigated using superconducting quantum interference device (SQUID) magnetometer.

We acknowledge financial support by the DFG within priority program SPP 1239 (Ja821/3-3).

DF 12.54 Tue 10:30 Poster D

Zero Field ^{55}Mn NMR study of Ni-Mn-Ga shape memory alloys — •Maria Eleni Belesi, Christian G. F. Blum, Bernd Büchner, and Sabine Wurmehl — Leibniz Institute for Solid State and Materials Research, Dresden, Helmholtzstrasse 20, 01069 Dresden, Germany

Ferromagnetic shape memory alloys exhibit a structural transition from the high temperature austenitic phase to the low temperature martensitic phase. The structural transition can be driven either by temperature or by a magnetic field. Nuclear Magnetic resonance (NMR) is a powerful local technique which is well known to provide information on the static and dynamic phenomena accompanying structural phase transitions. We have performed ^{55}Mn NMR experiments at zero magnetic field on as-cast and annealed Ni-Mn-Ga samples prepared by arc melting. The evolution of the local structure from the high temperature austenitic phase to the low temperature martensitic phase is probed ^{55}Mn NMR lineshape measurements.

DF 12.55 Tue 10:30 Poster D

Martensitic Transition in Ni-Mn-Ga/Ni-Mn-Sn Multilayer Thin Films — •Niclas Teichert[1], Anna Möhn[2,3], Anja Waske[3], Biswanath Dutta[4], Tilmann Hickel[4], and Andreas Hütten[1] — [1]Department of Physics, Thin Films and Physics of Nanostructures, Bielefeld University, 33615 Bielefeld, Germany — [2]IFW Dresden, Institute for Complex Materials, 01069 Dresden, Germany — [3]TU Dresden, Institut für Festkörperphysik, 01062 Dresden, Germany — [4]Max-Planck-Institut für Eisenforschung GmbH, 40237, Düsseldorf, Germany

Both Ni-Mn-Sn and Ni-Mn-Ga are ferromagnetic shape-memory Heusler alloys and show a martensitic transition accompanied by a magnetocaloric effect (MCE) in a certain composition range. The MCE is inverse in Ni-Mn-Sn and conventional in Ni-Mn-Ga. We want to achieve a coupling of both effects in multilayer thin films in order to enhance the MCE. This approach gives rise to additional interface entropy, magnetic interaction across the interfaces and lateral strain due to the lattice mismatch.

We prepared different epitaxial Ni-Mn-Ga/Ni-Mn-Sn multilayer thin films on heated MgO(001) substrates by magnetron sputtering. The number of layers as well as the layer thickness is varied to study the effects of interfaces, strain and interdiffusion between the layers on the martensitic transition. This is done by temperature dependent resistivity and magnetoresistance measurements, magnetic measurments, X-Ray diffraction and Auger electron spectroscopy.

DF 12.56 Tue 10:30 Poster D

Tunnel magneto-Seebeck effect in tunnel junctions with perpendicular magnetic anisotropy — •Tim Eggebrecht[1], Marvin Walter[1], Vladyslav Zbarsky[1], Markus Münzenberg[1], Volker Drewello[2], Karsten Rott[2], Günter Reiss[2], Andy Thomas[2], Patrick Peretzki[3], Michael Seibt[3], Michael Czerner[4], Michael Bachmann[4], and Christian Heiliger[4] — [1]I. Physikalisches Institut, Universität Göttingen — [2]Department of Physics, Bielefeld University — [3]IV. Physikalisches Institut, Universität Göttingen — [4]I. Physikalisches Institut, Universität Giessen

In CoFeB/MgO/CoFeB tunnel junctions (MTJs) with in-plane magnetic anisotropy the tunnel magneto-Seebeck effect (TMS) has already been observed. Recently, MTJs with perpendicular magnetic anisotropy (PMA) were fabricated by reducing the thickness of the two CoFeB layers. The thickness has to be lower than 1.3 nm, as observed by other groups. These MTJs with 4 monolayers MgO barrier show a TMR of more than 40 % and a very low switching current density of $2 \cdot 10^5$ A/cm^2.

In this work, the tunnel magneto-Seebeck effect is studied in junctions with in-plane and perpendicular magnetic anisotropy. The heating is achieved with a diode laser which delivers powers of up to 150 mW. The influence of the thin CoFeB layers and the MgO barrier on the TMS is studied.

DF 12.57 Tue 10:30 Poster D

HF-ESR studies of the compounds $\{[Cu(bpy)_3][Cu_2(C_2O_4)_3]\cdot H_2O\}_n$ and $\{[Cu(bpy)_3][Mn_2(C_2O_4)_3]\cdot H_2O\}_n$ — •Dijana Žilić[1,2], Boris Rakvin[2], Marijana Jurić[2], Pavica Planinić[2], Damir Pajić[3], Krešo Zadro[3], Yulia Krupskaya[1], Vladislav Kataev[1], and Bernd Büchner[1] — [1]Leibniz Institute for Solid State and Materials Research IFW Dresden, Dresden, Germany — [2]Rudjer Bošković Institute, Zagreb, Croatia — [3]Faculty of Science, University of Zagreb, Zagreb, Croatia

The homometallic $\{[Cu(bpy)_3][Cu_2(C_2O_4)_3]\cdot H_2O\}_n$ (**1**) and the heterometallic $\{[Cu(bpy)_3][Mn_2(C_2O_4)_3]\cdot H_2O\}_n$ (**2**) compounds, where bpy = 2,2'-bipyridine, consist of a three-dimensional (3D), polimeric anionic network $[M_2(C_2O_4)_3]_n{}^{2n-}$ (where M = Cu^{2+} or Mn^{2+}) with cations $[Cu(bpy)_3]^{2+}$ occupying the vacancies of the network.

Frequency- and temperature-dependent high field electron spin resonance (HF-ESR) measurements on a polycrystalline sample of **1** and **2** are presented. Supported by X-band ESR on the polycrystalline of **1** and on the single crystal of **2**, as well as, SQUID magnetization measurements, the magnetic properties of the compounds **1** and **2** are discussed.

DF 12.58 Tue 10:30 Poster D

Domain-structure-induced giant magneto-impedance — •Matthäus Langosch, Thomas Karwoth, Haibin Gao, and Uwe Hartmann — Institute of Experimental Physics, Saarland University, P. O. Box 151150, D-66041, Saarbruecken, Germany

Recent magneto-impedance studies in the low frequency range up to 100 kHz confirm the GMI effect on <100> iron single crystals (iron whiskers) [1]. In this range, contributions of magnetic domain structures and domain wall dynamics have to be taken into account. Compared to optimized GMI samples like amorphous Co-based microwires, iron whiskers have cubic magneto crystalline anisotropy and the GMI effect shows a strong current dependence. The dependence is related to the Oersted-field-induced domain structure when the current is in the order of tens of mA. The magnitude and the phase of the effective circumferential permeability, obtained through calculations based on the standard skin effect formalism and the experimental data, show various magnetic field and current frequency regimes. Further experimental investigations including magneto-optical Kerr effect microscopy and pickup-coil measurements give a deeper insight in these GMI regimes.

[1] M. Langosch, H. Gao and U. Hartmann J. Phys. D: Appl. Phys. 45, 085001 (2012)

DF 12.59 Tue 10:30 Poster D

Giant magnetoimpedance of composite wires with an insulation layer — Ralf Betzholz[1], •Haibin Gao[1], Zhenjie Zhao[2], and Uwe Hartmann[1] — [1]Institute of Experimental Physics, Saarland University, P.O. Box 151150, D-66041 Saarbruecken, Germany — [2]Department of Physics, East China Normal University, 3663 Zhongshan North Road, 200062 Shanghai, P.R. China

Composite wires with a three-layered structure were investigated with regard to the origin of the giant magnetoimpedance (GMI) effect. The samples consisting of a copper core, a silicon dioxide layer and an outer Permalloy shell were prepared by RF magnetron sputtering. The GMI ratio was measured at various driving current frequencies and with different insulating layer thicknesses. A theoretical model based on coupling the Maxwell equations to the Landau-Lifschitz-Gilbert equation was developed to investigate the composite wire impedance and its dependence on external magnetic field, current frequency and insulating layer thickness. Reasons for discrepancies between the theory and experimental findings were discussed.

DF 12.60 Tue 10:30 Poster D

First-principles study of inorganic-organic hybrids: $(NH_4)_2CuCl_4$, $(CH_3NH_3)_2CuCl_4$ and $(C_2H_5NH_3)_2CuCl_4$ — •Pegah Zolfaghari[1], Gilles A de Wijs[1], and Robert A de Groot[1,2] — [1]Radboud university Nijmegen, Electronic Structure of Materials,Institute for Molecules and Materials, Netherlands — [2]Rijksuniversiteit Groningen, Solid State Materials for Electronics,Zernike Institute for Advanced Materials, Netherlands

Hybrid inorganic-organic compounds with the general formula $(C_nH_{2n+1}NH_3)_2CuCl_4$ are an interesting class of new materials in condensed matter physics. These materials provide a considerable opportunity for scientific studies. The ferromagnetic intra-layer interactions in Cu^{2+} organic-inorganic hybrids enable magnetic applications in electronic devices. The organic blocks are essential for the synthesis by the self-assembly. We report electronic structure calculations based on first principles methods as well as the LDA+U method. A linear relation between the intra-layer interaction and tilting of the $[CuCl_6]^{4-}$ octahedra is observed. The magnetic coupling between the octahedra

shows a weak quasi 2-D nearest neighbor character. This results in relatively low Curie temperatures.

DF 12.61 Tue 10:30 Poster D

Origin of the Giant Magnetocaloric effect — •Prasenjit Roy[1], Gilles A de Wijs[1], and Robert A de Groot[1,2] — [1]Electronic Structure of Materials, Radboud University Nijmegen, Institute for Molecules and Materials, Heyendaalseweg 135, 6525 AJ Nijmegen, The Netherlands — [2]Laboratory of Chemical Physics, Zernike Institute of Advanced Materials, Nijenborgh 4, NL-9747 AG Groningen, The Netherlands

Adiabatic demagnetization as tool for refrigeration at room temperature has been studied extensively over the past decade. Recently the origin of the colossal magneto-caloric effect has been discovered by electronic structure calculations: the coexistence of weak and strong magnetism in one compound: mixed magnetism. Current research focuses on the study of the relation between structure, chemical composition and details of the mixed magnetism in the MnFePSi systems, with emphasis on the behavior of the weakly magnetic part of the compounds.

DF 12.62 Tue 10:30 Poster D

Investigation of the magnetocaloric effect in La(Fe,Si,Co)13 compound in pulsed magnetic fields — •Mahdiyeh Ghorbani Zavareh[1,2], Iurii Scurschii[1], Konstantin Skokov[3], Oliver Gutfleisch[3], and Joachim Wosnitza[1] — [1]HZDR Institute of Ion-Beam Physics and Materials Research P.O. Box 510119, 01314 Dresden, Germany — [2]TU Dresden Helmholtzstr. 10, 01069 Dresden, Germany — [3]Materials Science, Technical University Darmstadt, Petersenstr. 23, 64287 Darmstadt, Germany

We report on direct measurements of the magnetocaloric effect (MCE) of La(Fe,Si,Co)13 compound, which belongs to a family of materials prospective for magnetic refrigeration applications. Measurements in quasi-static magnetic fields up to 2 Tesla have shown the change of temperature up to 6 K. A new technique of measuring the MCE directly in pulsed magnetic field has been developed. This allows to investigate MCE in magnetic fields up to 70 Tesla. The set-up has been tested by measuring MCE of polycrystalline gadolinium. We have measured MCE of La(Fe,Si,Co)13 compound in the fields up to 10 Tesla. The data obtained are in a good agreement with the quasi-static data.

DF 12.63 Tue 10:30 Poster D

Investigation of the magnetocaloric effect in La(Fe,Si,Co)13 compound in pulsed magnetic fields — •Mahdiyeh Ghorbani Zavareh[1,2], Iurii Scurschii[1], Konstantin Skokov[3], Oliver Gutfleisch[3], and Joachim Wosnitza[1] — [1]Dresden High Magnetic Field Laboratory, Helmholtz-Zentrum Dresden Rossendorf, D-01314 Dresden, — [2]TU Dresden Helmholtzstr. 10, 01069 Dresden, Germany — [3]Materials Science, Technical University Darmstadt, Petersenstr. 23, 64287 Darmstadt, Germany

We report on direct measurements of the magnetocaloric effect (MCE) of La(Fe,Si,Co)13 compound, which belongs to a family of materials prospective for magnetic refrigeration applications. Measurements in quasi-static magnetic fields up to 2 Tesla have shown the change of temperature up to 6 K[1]. A new technique of measuring the MCE directly in pulsed magnetic field has been developed. This allows to investigate MCE in magnetic fields up to 70 Tesla. The set-up has been tested by measuring MCE of polycrystalline gadolinium. We have measured MCE of La(Fe,Si,Co)13 compound in the fields up to 10 Tesla. The data obtained are in a good agreement with the quasi-static data.[1]J. Lyubina, O. Gutfleisch, M. D. Kuz'min, and M. Richter, J. Magn. Magn. Mater. 321, 3571 (2009).

DF 12.64 Tue 10:30 Poster D

Magnetic and Structural investigation of high performance Rare earth permanent magnets — •Sapana Tripathi, Eberhard Goering, Gisela Schütz, and Dagmar Goll — Max Planck Institut für Intelligente Systeme, Heisenbergstr. 3 ,70569 Stuttgart

The study of rare earth permanent magnets has a great importance from the viewpoints of both academic research and large variety of applications in modern technologies. The most powerful permanent magnetic material at present which derive their exceptional magnetic characteristic from the favorable combination of rare earth metal is Neodymium-Iron-Boron (Nd,Dy)2Fe14B magnets. In order to clarify the contribution of rare earth elements in magnetism, the magnetic characteristics have been determined quantitatively from X-ray magnetic circular dichroism (XMCD) , element specific hysteresis loops and magnetic moments using our new 7 Tesla magnet XMCD system, which is able to saturate the (Nd,Dy)2Fe14B magnets. Further investigations related to the micro structure are presented as energy dispersive X-ray analysis, high-resolution transmission electron microscopy and SQUID measurements. The results prove an unexpected very weak ferromagnetism rare earth side.

1. D. Goll H. Kronmüller High-performance permanent Magnets Naturwissenschaften (2000) 87:423*438 2. Karl J. Strnat Modern Permanent Magnets for Applications in Electro-Technology University of Dayton, Ohio Proceedings of the IEEE, Volume 78, Number 6, June 1990

DF 12.65 Tue 10:30 Poster D

Electronic and magnetic properties of Ti_4O_7 and Ti_5O_9 Magnéli phases — Ivetta V. Slipukhina, •Konstantin Z. Rushchanskii, Stefan Blügel, and Marjana Ležaić — Peter Grünberg Institut, Forschungszentrum Jülich and JARA, 52425 Jülich, Germany

For several decades binary transition-metal oxides have attracted increasing attention as resistively switching materials. Resistive switching in many of these oxides is claimed to be based on the formation and disruption of highly-conductive filaments, through which the current flow is realized. However, still very little is known about the composition, structure and dimensions of these filaments. Recent low-temperature conductivity and *in situ* current-voltage measurements confirmed that the conducting filaments in $Pt/TiO_2/Pt$ [1], as well as Fe-doped $SrTiO_3$ [2] are composed of Magnéli phases Ti_nO_{2n-1} (mostly n=4 or 5), which are mixed-valence compounds with two Ti^{3+} ($3d^1$ electronic configuration) and $(n-2)$ Ti^{4+} ($3d^0$ configuration) ions.

In this work we aimed to develop a fundamental understanding of the mechanisms that underlie the phase transitions in Magnéli phases like Ti_5O_9 and Ti_4O_7. With this aim we performed DFT calculations in order to illuminate the changes in their electronic structure on a microscopic level and establish relations between the structural, electronic and magnetic properties and their role in phase transitions.

We acknowledge the support by SFB917-Nanoswitches and the Helmholtz Young Investigators Group Programme VH-NG-409.

[1] D.-H. Kwon *et al.*, Nature Nanotech. **5**, 148 (2010).
[2] R. Münstermann *et al.*, Advanced Materials **22**, 4819 (2010).

DF 12.66 Tue 10:30 Poster D

Site occupancy analysis of cobalt in a M-type ferrite hard magnetic material — •Shunsuke Muto, Kazuyoshi Tatsumi, and Kazuma Hattori — Graduate School of Engineering, Nagoya University, Nagoya 464-8603, Japan

High angular resolution electron channeling X-ray spectroscopy (HARECXS), as a useful extension of atom location by channeling enhanced microanalysis (ALCHEMI), has been applied to local structure analysis in crystals with the development of digitally-controlled TEM. In this method, intensities of characteristic X-ray are measured by digitally and continuously changing the incident beam direction. The obtained dataset contains information on e.g. impurity sites and their occupancies in the crystalline material of interest. In this study we applied the method to Sr-M type ferrite (SrFe12O19) having large uniaxial anisotropy (a=0.588 nm, c=2.302 nm), and examined the effect of higher order Laue zones (HOLZ) on the quantitative analysis.

The site occupancy analysis of a magnetic impurity, cobalt in the M-type ferrite, substituting for the five kinds of the Fe sites. HARECXS analyses around two independent zone axes could be very effective to precisely determine the site occupancy of the trace element. We discuss the correlation between the impurity occupation sites and magnetic properties.

DF 12.67 Tue 10:30 Poster D

Magnetic and structural properties of $LiMn_{1-x}Ni_xPO_4$ — •Thomas Kolb[1], Alexander Ottmann[1], Carsten Jähne[1], Hans-Peter Meyer[2] und Rüdiger Klingeler[1] — [1]Kirchhoff Institute for Physics, University of Heidelberg, D-69120 Heidelberg, Germany — [2]Institut für Geowissenschaften, University of Heidelberg, D-69120 Heidelberg, Germany

We present structural and magnetic properties of $LiMn_{1-x}Ni_xPO_4$ with $0 \leq x \leq 0.5$ synthesized by solid state reaction as well as by microwave-assisted hydrothermal synthesis. For both doping series, chemical analysis, i.e. Mn:Ni:P, performed by means of energy-dispersive X-ray analysis confirms that the actual Ni content agrees well to the nominal composition. Powder x-ray diffraction implies single-phase materials with orthorhombic olivine structure (*Pnma*).

The evolution of lattice parameters obeys Vegard's law and agrees to the fact that replacing Mn^{2+} by smaller Ni^{2+} corresponds to negative chemical pressure $\Delta V/V \approx -8 \cdot 10^{-4}$/%Ni. While the onset of long-range antiferromagnetic order at $T_N = 32\,K$ does not depend on the Ni-content, there are changes in the magnetic anisotropy.

DF 12.68 Tue 10:30 Poster D

Thermal Expansion and Grüneisen scaling in single-crystalline $LiMn_{1-x}Ni_xPO_4$ — Christopher Dietl[1], •Lars Wallbaum[1], Kunpeng Wang[1], Carsten Jähne[1], Herbert Müller[3], Hans-Peter Meyer[2], and Rüdiger Klingeler[1] — [1]Kirchhoff Institute for Physics, University of Heidelberg, D-69120 Heidelberg, Germany — [2]Institut für Geowissenschaften, University of Heidelberg, D-69120 Heidelberg, Germany — [3]Institut für Festkörperphysik, Technische Universität Wien, A-1040 Wien, Austria

Li-based olivine phosphates LiMPO4 (M = Mn, Fe, Co, Ni) exhibit an enormous potential for applications. One the one hand, their electrochemical cyclability and high-temperature stability renders them next-generation cathode materials for Li-ion batteries. In addition, they exhibit complex ordering phenomena, large magnetoelectric effects and unusual ferrotoroidic domains which are supposed to be relevant for data storage applications. In order to study the fundamental properties we have grown $LiMn_{1-x}Ni_xPO_4$ single crystals by the travelling-solvent floating-zone method. Thermal expansion studies along the crystallographic axes by means of capacitive dilatometry imply strong magnetic-elastic coupling. The onset of long-range magnetic order is associated with pronounced lambda-like anomalies in the *a*- and *c*-axis thermal expansion and the magnetic specific heat. The data show a strong positive hydrostatic pressure dependence of T_N and a large fluctuation regime. The effect of Ni-doping on the magnetic anisotropy as probed by the spin-flop field is discussed.

DF 12.69 Tue 10:30 Poster D

Magnetic and defect-properties of Co implanted TiO_2 — •Oguz Yildirim[1,4], Steffen Cornelius[1,4], Mykola Vinnichenko[1], Maik Buterling[2], Andreas Wagner[2], Alevtina Smekhova[3], and Kay Potzger[1] — [1]Institute of Ion Beam Physics and Materials Research, HZDR, POB 510119, 01314, Dresden, Germany — [2]Institute for Radiation Physics, HZDR, POB510119, 01328, Dresden, Germany — [3]MSU, Faculty of Physics, Solid State Physics and Magnetism Departments,Moscow, Russia — [4]TU Dresden, Helmholtzstr. 10, 01069, Dresden, Germany

The magnetic and structrual properties of the potential diluted magnetic oxide (DMO), i.e. Co implanted TiO_2 thin films have been investigated. These films have been grown by magnetron sputtering on $SrTiO_3$ single crystals. Avoidence of possible magnetic contamination has been verified by magnetometry measurements after substrate preparation and deposition. For magnetic doping, implantations of Co^+ ions have been performed at atomic concentrations of 0.5%, 2.5% and 3% respectively. The dependencies between the fluence implanted, defect creation and ferromagnetic properties have been investigated using magnetometry, positron annihilation spectroscopy and structural characterisation.

This work is supported by the Initiative and Networking Fund of the German Helmholtz Association, Helmholtz-Russia Joint Research Group HRJRG−314, and the Russian Foundation for Basic Research, RFBR $\#12-02-91321-SIG-a$.

DF 12.70 Tue 10:30 Poster D

Coordination-driven magnetic-to-nonmagnetic transition in manganese doped silicon clusters — •Linn Leppert[1], Vicente Zamudio-Bayer[2,3], Konstantin Hirsch[2,3], Andreas Langenberg[2,3], Jochen Rittmann[2,3], Martin Kossick[2,3], Robert Richter[3], Akira Terasaki[4], Thomas Möller[3], Stephan Kümmel[1], Bernd von Issendorff[5], and J. Tobias Lau[2] — [1]Theoretische Physik IV, Universität Bayreuth, 95440 Bayreuth, GER — [2]Institut für Methoden und Instrumentierung der Synchrotronstrahlung, Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, 12489 Berlin, GER — [3]Institut für Optik und Atomare Physik, Technische Universität Berlin, 10623 Berlin, GER — [4]Cluster Research Laboratory, Toyota Technological Institute, 717-86 Futamata, Ichikawa, Chiba 272-0001, JP — [5]Fakultät für Physik, Universität Freiburg, 79104 Freiburg, GER

X-ray Magnetic Circular Dichroism (XMCD) spectroscopy allows to obtain fundamental insight into magnetic properties of free, size-selected clusters. We demonstrate using a combination of XMCD and non-empirical density functional theory that the magnetic moment of small Si clusters doped with a single Mn impurity is completely quenched as soon as a cluster size of 10 Si atoms is exceeded. This is a result of an abrupt increase of the impurity coordination from 10 to 11 Si atoms. Since the impurity coordination in small exohedrally doped Si clusters is close to that observed in bulk Si, smaller clusters are, contrary to intuition, far better suited for prediciting the magnetic properties of the bulk system than larger endohedrally doped clusters.

DF 12.71 Tue 10:30 Poster D

Pressure induced Ferromagnetism in undoped ZnO pellets — •Chen Yu-Chun[1], Eberhard Goering[1], Zumin Wang[1], Lars Jeurgens[2], Thomas Tietze[1], and Gisela Schütz[1] — [1]Max Planck Institute for Intelligent System, Stuttgart, Germany — [2]Empa, Swiss Federal Laboratories for Materials Science and Technology, Dübendorf, Switzerland

Room-temperature ferromagnetism (RTFM) has been found in undoped ZnO thin film1-2 and nanostructures3-4 even though bulk samples exhibit no ferromagnetic ordering. This unexpected phenomenon is still controversial; however, numerous reports have reconfirmed the presence of RTFM in ZnO and excluded unintended contribution from impurities. The origin of RTFM in d0 oxides is not yet fully understood. It is assumed that this amazing property could be ascribed to surface oxygen vacancies2,4. In our study we present that RTFM can be induced in bulk ZnO by pressing pure non-ferromagnetic ZnO nanoparticles into pellets. The possible mechanism behind this finding is short-range interaction between isolated spin moments is achieved after mechanical compression. The RTFM behavior can be further enhanced in post-annealed pellets. XPS analysis suggests that more oxygen-related vacancies created after thermal treatment play a crucial rule in this ferromagnetic behavior. It is also found that a carbon-free surface can facilitate the interaction between isolated spin moments. References 1. N. H. Hong, et al., J. Phys: Condens. Matter. 19, 036219 , 2007 2. P. Zhan, et al., J. Appl. Phys. 111, 033501, 2012 3. S. Banerjee, et al., 182501, 2007 4. J. I. Hong, et al., Nano Lett. 12, 576, 2012

DF 12.72 Tue 10:30 Poster D

Magnetic phases and anisotropy in ion irradiated SiC — •Yutian Wang[1], Lin Li[1], Slawomir Prucnal[1], Zhaorong Yang[2], Kay Potzger[1], and Shengqiang Zhou[1] — [1]Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, P.O. Box 510119, 01314 Dresden, Germany — [2]Key Laboratory of Materials Physics Institute of Solid State Physics, Chinese Academy of Sciences, Hefei 230031, People's Republic of China

SiC, as an important electronic and optoelectronic material, has been found to be ferromagnetic after ion or neutron bombardment. So far the original ferromagnetism is still unknown; however the fact that the intrinsic or artificial defects are closely related to the ferromagnetism is a consensus. We prepare ferromagnetic SiC by Ne ions irradiation. Our results show that the saturation magnetization has increased initially by increasing the irradiation fluence, then dropped to almost zero since a large irradiation fluence induced too much disorder[1]. We observe two coexisting magnetic phases. One is superparamagnetic with a blocking temperature around 50 K, while another one has a Curie temperature well above room temperature. The sample also exhibits magnetic anisotropy with the in-plane as the easy axis. Chemical or physical etchings were preformed to correlate the magnetization to the implantation depth. At last, the FDMNES fitting results of carbon K-edge of SiC XAS (X-ray absorption spectroscopy) also present in this contribution.

Refence: 1.Li, L., et al., Appl. Phys. Lett., 98, 222508 (2011).

DF 12.73 Tue 10:30 Poster D

Kerr- and Faraday microscope for space- and time-resolved studies — •Oliver Schmitt, Daniel Steil, Sabine Alebrand, Mirko Cinchetti, and Martin Aeschlimann — Department of Physics and Research Center OPTIMAS, TU Kaiserslautern, Germany

Characterization of the magnetic properties of thin films is extremely important both for fundamental studies as well as for technical applications. We present a multi-purpose magneto-optical microscope[1] for the investigation of structured magnetic thin films. The setup can be used for both static and dynamic (pump-probe) measurements. It is moreover compatible with samples with arbitrary magnetic anisotropy, as it allows Kerr measurements in polar and longitudinal geometry as well as in transmission (Faraday geometry). We demonstrate that the microscope can be used in the following modi: (i) static imaging mode

(in polar Kerr and Faraday geometry) with a spatial resolution of 1 micron. (ii) time-resolved mode (polar Kerr geometry) with a temporal resolution of four hundred femtoseconds.

DF 12.74 Tue 10:30 Poster D

Scanning magnetoresistance microscopy as a multifunctional tool — •Dmitriy Mitin[1], Michael Grobis[2], and Manfred Albrecht[1] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]San Jose Research Center, HGST, 3403 Yerba Buena Rd., San Jose, California 95135, USA

Scanning magnetoresistance microscopy (SMRM) is a powerful imaging technique, that uses conventional hard disk drive recording heads as a sensor for raster scanning in physical contact with a magnetic film sample. The modern vintages of MR heads are capable of reaching the resolution down to 15 nm in down-track direction, what is comparable with magnetic force microscopy. The unique ability to apply a localized field up to 1 T to the sample makes this tool attractive for recording experiments on continuous films as well as on nanostructures. Thanks to the high bandwidth of the embedded inductive coil system, ultra short magnetic field pulses in the sub-ns range can be applied. This fact allows using this setup as a research instrument for studying dynamic magnetization reversal processes on the nanoscale.

DF 12.75 Tue 10:30 Poster D

Temperature Dependent High Resolution Imaging of the Domain Structure of LSMO Thin Films via SEMPA — Robert M. Reeve, •Pascal Krautscheid, Markus König, Christian Mix, Michael Foerster, Gerhard Jakob, and Mathias Kläui — Institut für Physik, Johannes Gutenberg-Universität Mainz, 55699 Mainz, Germany

The domain configuration of 50 nm thick $La_{0.7}Sr_{0.3}MnO_3$ films has been directly investigated using scanning electron microscopy with polarization analysis (SEMPA). The films are grown using pulsed laser deposition and then rapidly transferred ex-situ in a protective environment to the analysis chamber to maintain the cleanliness of the surface. Magnetic imaging is subsequently carried out at variable temperatures in our ultra-high vacuum SEMPA chamber, without the requirement for prior treatment of the surface. We are able to demonstrate a spatial resolution of 20 nm for the magnetic images. The large scale domain structure reflects a primarily uniaxial anisotropy in the films, consistent with previous work [APL 99, 062508 (2011)] and ex-situ measurements using the magneto-optic Kerr effect. The temperature dependence of the image contrast is investigated between 30 K and ambient conditions and compared to the behavior of the magnetization curves obtained from superconducting-quantum interference device (SQUID) magnetometry on the same samples. The SEMPA contrast is observed to decrease faster than the magnetization, which can be explained by the mechanism of the generation of spin polarization (double exchange) in this material.

DF 12.76 Tue 10:30 Poster D

Quantitative MFM on a $BaFe_2(As_{0.24}P_{0.76})_2$ single crystal — •Fabian Rhein[1], Silvia Vock[1], Henry Stopfel[1], Ulrike Wolff[1], Volker Neu[1], Dmytro S. Inosov[2], Yong Liu[2], Chengtian Lin[2], Hans J. Hug[3], Niraj Joshi[3], Sevil Özer[3] und Ludwig Schultz[1] — [1]IFW Dresden, Institute for Metallic Materials, P.O. BOX 270116, 01171 Dresden, Germany — [2]Max Planck Institute for Solid State Research,Heisenbergstraße 1, 70569 Stuttgart, Germany — [3]Institute of Physics, University Basel, Klingelbergstrasse 82, CH-4056 Basel, Switzerland

The discovery of iron based superconductors (SC) in 2008, motivated the intensive investigation of characteristic properties of differently doped single crystals. In particular, the analysis of the temperature dependent magnetic penetration depth λ(T) and the properties of the vortex arrangement are important parameters to characterize a SC.
Quantitative magnetic force microscopy (MFM) enables the determination of these quantities. The measured MFM signal is a convolution between the stray field of a magnetic flux line and the magnetization of the tip. To be able to extract λ(T) from the measured data different methods exists. We show, that the commonly used monopole-monopole model[1,2] can be replaced by a more convenient tip calibration procedure[3] and a more realistic description of the magnetic flux line's stray field.
Furthermore we extracted the vortex arrangement by statistical evaluation methods.

DF 12.77 Tue 10:30 Poster D

A next-generation room-temperature AFM setup with optical access for magnetic imaging using a single spin sensor — •Thomas Häberle, Dominik Schmid-Lorch, Friedemann Reinhard, and Jörg Wrachtrup — 3. Physikalisches Institut und Forschungszentrum SCoPE, Universität Stuttgart, Germany

We work on a novel magnetic field sensor that is based on the nitrogen-vacancy (NV)-color center in diamond. The electron spin structure of the NV-center allows us to perform optically detected electron spin resonance (ESR) measurements, which can be made sensitive to the ambient magnetic field. Combined with an AFM, these atomic-sized color centers promise an even higher spatial resolution than the MFM [1] while reducing back-action on the sample to a minimum.

I present first results as well as the methods and instrumental setup used to conduct these measurements. The core component of the setup is a next-generation commercial AFM, featuring additional optical access. This allows readout of the spin state via confocal microscopy with simultaneous imaging and manipulation of the sample on a sub-nanometer scale with the AFM.

Applications of this technique are detection and imaging of single electron spins [2] and small nuclear spin ensembles.

[1]G. Balasubramanian et al., Nature Vol 455, 648-651 (2008)
[2]M.S. Grinolds et al., arXiv:1209.0203v1 [cond-mat.mes-hall] (2012)

DF 12.78 Tue 10:30 Poster D

Laterally resolved thermal imaging using magneto-optical indicator films — •Mikhail Kustov[1], Natalya Mamkina[2], Rostislav Grechishkin[2], and Jeffrey McCord[1] — [1]Nanoscale Magnetic Materials, Magnetic Domains, Institute for Materials Science, University of Kiel, 24143 Kiel, Germany — [2]Laboratory of Magnetoelectronics, Tver State University, 170000 Tver, Russia

A novel approach for imaging of lateral temperature distributions is demonstrated. The method involves an optical polarization microscope and a magneto-optical indicator film (MOIF), which is placed in contact with the investigated sample in the same way as for the imaging of magnetic stray fields [1]. Since the Faraday rotation is a function of the local saturation magnetization of the MOIF sensing layer and the saturation magnetization is a function of temperature, the MOIF can be exploited as a transducer of a local variation of temperature into a variation of magneto-optical contrast. In order to obtain maximum sensitivity the Curie temperature of the sensing layer is chosen to be close, but still above the temperature range of investigation. MOIFs with both planar and uniaxial magnetic anisotropy can be used.

Relying on optics, the imaging scheme has the potential to work up to high temporal resolution, only depending on thermal conductions. Temperature changes occurring within a few microseconds can be measured with lateral resolution. Temperature resolution of the order of 0.01K (for integral measurements) is demonstrated.

[1] R. Grechishkin et al., in: B. Azzerboni et al. (eds.), Magnetic Nanostructures in Modern Technology, pp.195-224.

DF 12.79 Tue 10:30 Poster D

Study of magnetocaloric properties of Gd_4Mn_8 molecules using the finite-temperature Lanczos method — •Christian Heesing and Jürgen Schnack — Universität Bielefeld, Universitätsstr. 25, D-33615 Bielefeld

The magnetocaloric effect can be used to cool or heat a system by varying the external magnetic field. To optimize this effect one needs magnetic molecules with big entropy changes when sweeping the field isothermally. Those big entropy changes can be found in molecules with a high density of low-lying high spin multiplets. In this contribution we discuss molecules of the Gd_4Mn_8 class [1] that have been studied by the finite-temperature Lanczos method [2] in the Heisenberg-model. This method generates very accurate approximations of thermal observables for Hilbert space dimensions of up to 10^{10}.

[1] T. N. Hooper *et al.*, Angew. Chem. Int. Ed. **51**, 4633 (2012)
[2] J. Schnack, O. Wendland, Eur. Phys. J. B **78** (2010) 535-541

DF 12.80 Tue 10:30 Poster D

The lanthaball molecules $\{Pr_{13}\}$, $\{Nd_{13}\}$, and $\{Ce_{13}\}$ - a family of classical Heisenberg systems? — Christian Schröder[1], •Jan Balluff[2], Anthony Chesman[3], Steven Yenias[4], and Marshall Luban[4] — [1]Dept. of Engineering Sciences and Mathematics, Univ. of Applied Sciences Bielefeld, Bielefeld, Germany — [2]Faculty of Physics, Univ. of Bielefeld, Bielefeld, Germany — [3]CSIRO Materials Science and Engineering, Clayton, Victoria, Australia — [4]Ames Laboratory & Dept. of Physics and Astronomy, Iowa State University,

USA

The lanthaball molecules {Pr_{13}}, {Nd_{13}}, and {Ce_{13}} are recently synthesized spherical polycarbonatolanthanoid clusters that show interesting magnetic properties. Within each molecule 12 rare-earth ions are located on the vertices of a slightly distorted icosahedron and one spin is placed in the center of the icosahedron. Recent measurements are indicative of intra-molecular antiferromagnetic coupling. However, because of the unquenched orbital momenta of the rare-earth ions one has to take into account spin-orbit-coupling effects which make an exact quantum mechanical treatment of such systems very difficult or even impossible. Here, we report on a classical approach based on a Heisenberg model where the total angular momenta of the rare-earth ions interact via a multiple exchange interaction scenario. We show that our calculations are in good agreement with our experimental data for all three molecules. Furthermore, we discuss extensions of our approach to include spin-orbit-coupling effects.

DF 12.81 Tue 10:30 Poster D

Electronic structure and magnetic properties of a macrocyclic dinickel complex — •Kai Trepte, Claudia Loose, and Jens Kortus — Institut für theoretische Physik

We present first-principle density functional theory (DFT) calculations on an triply bridged dinickel complex[1] including a hexaazadithiophenolate ligand. All DFT calculations are done using the all-electron NRLMOL program package. We focus on the electronic structure close to the Fermi level and calculate the magnetic exchange coupling J using the Heisenberg hamiltonian H=-2J$\vec{S_1}\vec{S_2}$ ($\vec{S_1}$=$\vec{S_2}$=1). We compare our results with known trends within this class of molecules[2].

[1] Inorg. Chim. Acta 362 (2009) 793-798

[2] Coord. Chem. Rev. 253 (2009) 2244 - 2260

DF 12.82 Tue 10:30 Poster D

Finite-temperature Lanczos investigations of anisotropic magnetic ring molecules — •Oliver Wendland and Jürgen Schnack — Bielefeld University, P.O. box 100131, D-33501 Bielefeld

We investigate magnetic properties of even-membered rings built of vanadium(III) with spin $s = 1$. Vanadium(III) ions are known to possess large anisotropies [1]. Thermodynamical observables are obtained by the finite-temperature Lanczos-method (FTLM), which has proven to be rather accurate [2].

[1] I. S. Tidmarsh, L. J. Batchelor, E. Scales, R. H. Laye, L. Sorace, A. Caneschi, J. Schnack and E. J. L. McInnes, Dalton Trans. (2009) 9402-9409

[2] J. Schnack, O. Wendland, Eur. Phys. J. B 78 (2010) 535-541

DF 12.83 Tue 10:30 Poster D

Influence of the gold atom on the magnetic properties of the Ni(II) dinuclear complex — •Jaena Park[1,2], Y. Krupskaya[1], V. Kataev[1], G. Steinfeld[3], N. Beyer[3], J. Lach[3], M. Golecki[3], U. Lehmann[3], M. Gressenbuch[3], B. Kersting[3], B. Büchner[1], and R. Klingeler[2] — [1]IFW Dresden, Germany — [2]University of Heidelberg, Germany — [3]University of Leipzig, Germany

Attaching a magnetic molecular complex to a surface, in particular to a metal surface, is important for molecular spintronics applications. In the present work we study the possibility of attaching a Ni-based dimer complex to a gold surface. We have investigated the influence of an attached gold atom on the magnetic properties of the Ni_2-complex. Here we report two Ni_2-complexes $[Ni_2L(dpbba)]ClO_4(2ClO_4)$ **(1)** and $[Ni_2L(dpbba)Au\,Ph]BPh_4(4BPh_4)$ **(2)** where a gold atom is attached to the phosphorus atom of the head part of **(2)**. Magnetization vs. field $M(H)$ at $T = 1.8\,\mathrm{K}$ and vs. temperature $M(T)$ at $\mu_0 H = 1\,\mathrm{T}$ were measured using a SQUID magnetometer. The analysis of the data using a Heisenberg spin Hamiltonian ($\mathcal{H} = 2JS_1S_2$) reveals that the intramolecular exchange interaction between two core Ni ions is ferromagnetic with $J = -23\,\mathrm{K}$ and $-26\,\mathrm{K}$ for **(1)** and **(2)**, respectively. Our high-field and high-frequency ESR measurements yield a g-factor of 2.17 for both complexes and a negative axial magnetic anisotropy $D = -0.063\,\mathrm{K}$ and $-0.056\,\mathrm{K}$ for **(1)** and **(2)**, respectively, which implies a bistable magnetic ground state in both cases. In conclusion, we observe that the magnetic properties of the Ni_2-complex are not significantly changed by the attachment of the gold atom.

DF 12.84 Tue 10:30 Poster D

Probing the local magnetic properties of $[\mathbf{Mn_6^{III}Cr^{III}}]^{3+}$ deposited on surfaces by SPES and XMCD — •Andreas Helmstedt[1], Aaron Gryzia[1], Niklas Dohmeier[1], Norbert Müller[1], Armin Brechling[1], Ulrich Heinzmann[1], Veronika Hoeke[2], Erich Krickemeyer[2], Thorsten Glaser[2], Mikhail Fonin[3], Samuel Bouvron[3], Philipp Leicht[3], Thomas Tietze[4], Eberhard Goering[4], and Karsten Kuepper[5] — [1]Faculty of Physics, Bielefeld University — [2]Faculty of Chemistry, Bielefeld University — [3]Department of Physics, University of Konstanz — [4]Max-Planck-Institut für Intelligente Systeme, Stuttgart — [5]Department of Physics, University of Osnabrueck

Comprehensive studies of the $[\mathbf{Mn_6^{III}Cr^{III}}]^{3+}$ single-molecule magnet deposited on Au and Si substrates by Spin-Resolved Electron Spectroscopy (SPES) and X-ray Magnetic Circular Dichroism (XMCD) are presented. $[\mathbf{Mn_6^{III}Cr^{III}}]^{3+}$ consists of two bowl-shaped Mn_3-triplesalen units linked by a hexacyanochromate. It exhibits a spin ground state of S_T=21/2. For excitation energies covering the Mn-$L_{2,3}$ region, the spin polarization of Auger electrons originating from the Mn^{III} ions in $[\mathbf{Mn_6^{III}Cr^{III}}]^{3+}$ has been measured at room temperature and without applying external magnetic fields. Radiation damage was monitored by XAS at the Mn-L_3 edge. Corresponding XMCD data have been obtained at 2K and 7T. The local magnetic properties of the Mn constituents in $[\mathbf{Mn_6^{III}Cr^{III}}]^{3+}$ SMM derived from spin polarization data in the paramagnetic phase are compared to results obtained by XMCD. Differences between both methods are discussed.

DF 12.85 Tue 10:30 Poster D

Investigation of $[\mathbf{Fe_6^{III}Cr^{III}}]^{3+}$ Molecules Deposited on Surfaces by XAS, SPES and XMCD — •Niklas Dohmeier[1], Andreas Helmstedt[1], Aaron Gryzia[1], Norbert Müller[1], Armin Brechling[1], Ulrich Heinzmann[1], Veronika Hoeke[2], Erich Krickemeyer[2], Thorsten Glaser[2], and Karsten Küpper[3] — [1]Faculty of Physics, Bielefeld University — [2]Faculty of Chemistry, Bielefeld University — [3]Department of Physics, University of Osnabrueck

$[\mathbf{Fe_6^{III}Cr^{III}}]^{3+}$ is a heptanuclear metal-organic coordination compound containing six Fe^{III} ions and one Cr^{III} embedded in an organic environment. An airbrush-based preparation method leads to large homogeneous samples. X-ray absorption spectroscopy (XAS) was used to monitor the sample oxidation state and its reduction during the performed spin-resolved photoemission measurements (SPES). The spin polarization of the Auger electrons following the excitation with circularly polarized synchrotron light in the region of the Fe-$L_{2,3}$ absorption edge is measured to reveal information about the magnetic properties of $[\mathbf{Fe_6^{III}Cr^{III}}]^{3+}$. The results were compared to corresponding X-ray magnetic circular dichroism (XMCD) measurements performed at 4 K and 6.9 T. Sum rules are applied to both data sets. SPES and XMCD data for the reference material Fe_2O_3 are presented as well.

DF 13: PV VI

Time: Tuesday 14:00–14:45 Location: H1

Plenary Talk DF 13.1 Tue 14:00 H1

The Thin-Disk Laser - from Physics to Industrial Applications — •Thomas Graf — Institut für Strahlwerkzeuge (IFSW), University of Stuttgart

The unique properties of the thin-disk laser result from the arrangement of the laser-active medium as a thin crystal disk which is pumped very intensively and efficiently by diode lasers and which can be cooled much more homogeneously than conventional solid-state slab or rod lasers. The thin-disk geometry was originally motivated by the reduction of thermally induced aberrations to facilitate the generation of good beam quality at high average powers. But the thin gain medium has also significant advantages for the generation of ultra-short pulses (e.g. due to reduced nonlinearities) and the application in industrial materials processing (e.g. due to the ruggedness against back reflections). All this makes the thin-disk laser an interesting tool for many applications ranging from fundamental science to industrial manufac-

turing. Starting from the basic laser physics the presentation will discuss the specific properties of thin-disk lasers and highlight some of the many fascinating applications ranging from the measurement of the proton radius to cutting of carbon fiber reinforced plastics (CFRP). The examples also illustrate how the specific requirements of given applications determine the goals for the development of suitable laser sources.

DF 14: Thermoelectric and Spincaloric Transport in Nanostructures

Time: Wednesday 9:30–12:00 Location: H1

Invited Talk DF 14.1 Wed 9:30 H1

Transport in Old and New Thermoelectric Materials — •David Singh — Oak Ridge National Laboratory, USA

Thermoelectric performance is a multiply contra-indicated property of matter. For example, it requires (1) high thermopower and high electrical conductivity, (2) high electrical conductivity and low thermal conductivity and (3) low thermal conductivity and high melting point. The keys to progress are finding an optimal balance and finding ways of using complex electronic and phononic structures to avoid the counter-indications mentioned above. In this talk, I discuss some of the issues involved in the context of recent results. These include the surprising doping dependence of the thermopower in PbTe and PbSe, and the interplay between acoustic and optical phonons in PbTe. Certain new materials as well as new concepts based on low dimensional electronic structures are discussed.

Invited Talk DF 14.2 Wed 10:00 H1

Binary oxide structures as model systems for thermoelectric transport — •Peter J. Klar and Christian Heiliger — I. Physikalisches Institut, Justus-Liebig-Universität

The binary oxides ZnO or the different phases of the Cu-O system can be considered to a large extent as semiconductors and can be fabricated by various techniques ranging from rf-sputtering to molecular beam epitaxy. Controlled doping to vary the free carrier concentration as well as alloying are feasible in the usual way. Standard semiconductor technologies can be employed to fabricate nano and microstructures. Thus, different morphologies can be achieved even for bulk material and micro and nanostructures can be prepared in a controlled way. A thorough understanding of the bulk thermoelectric properties of these oxides forms the basis of studying the various types of nano and microstructured samples. To obtain an understanding of the influence of grain boundaries, interfaces, and phase segregation on the thermoelectric transport, local and global properties need to be studied by experiment and to be analyzed by multi-scale theoretical models. Several examples of our approach will be presented.

Invited Talk DF 14.3 Wed 10:30 H1

Functional oxides films: from single crystals to polycrystalline substrates — •Wilfrid Prellier — Laboratoire CRISMAT, ENSICAEN, CNRS, 6 Bd Mal Juin, F-14050 Caen Cedex, France

Complex oxides represent a class of materials with several of exiting properties including magnetism, superconductivity or multiferroics. Thus, there are interesting for both fundamental research and applications. Using epitaxial strain, it is also possible in a thin film to modify the electronic properties as compare to bulk materials. While usually, the material is deposited on a single crystal to achieve the perfect epitaxy, it is also possible to synthesise the film on other type of substrate. In the first case, the film can be also be made artificially using the superlattices approach. In this talk, I will present recent results on superconductor superlattices [1,2] as well as our recent developed approach on thermoelectric films grown on a polycrystalline ceramic sample.[3] At the end, it will provide insight into current perspectives and future trends of functional oxide thin films.

[1]*P. Boullay et al., Phys. Rev. B 83, 125403 (2011). [2]*D. Di Castro et al, Phys. Rev. B 86, 134524 (2012). [3] *D. Pravarthana et al., submitted (2012)

Invited Talk DF 14.4 Wed 11:00 H1

The Planar Nernst Effect and the Search for Thermal Spin Currents in Ferromagnetic Metals — •Barry Zink — University of Denver, Denver, Colorado, USA

In recent years some groups have reported that a pure spin current can be generated simply by applying a thermal gradient to a ferromagnetic material. This effect, called the spin Seebeck effect (SSE), has generated tremendous interest in the interaction of heat, charge and spin in ferromagnetic systems. In this talk we will present our recent measurements of thermoelectric and thermomagnetic effects in thin film metallic ferromagnets made using a micromachined thermal isolation platform that removes potentially confounding effects introduced by a highly thermally conductive bulk substrate. The main result is the observation of a transverse thermopower, called the planar Nernst effect (PNE). Measurements of the field-dependent (traditional) Seebeck effect and anisotropic magnetoresistance (AMR) confirm that the PNE is caused by spin-dependent scattering. This PNE should therefore be present in any attempted measurement of the SSE in a metal system where spin-dependent scattering of electrons occurs. Furthermore our "zero substrate" experiment shows no signal with the symmetry of the SSE, suggesting that the presence of the substrate is required to cause such a signal. This work was performed in collaboration with A. D. Avery, and M. R. Pufall, and supported by the US NSF CAREER award (DMR-0847796)

Invited Talk DF 14.5 Wed 11:30 H1

Tunneling magneto thermopower in magnetic tunnel junction nanopillars — Niklas Liebing[1], Santiago Serrano-Guisan[1,2], Patryk Krzysteczko[1], Karsten Rott[3], Günter Reiss[3], Jürgen Langer[4], Berthold Ocker[4], and •Hans Werner Schumacher[1] — [1]PTB, Braunschweig, Germany — [2]INL, Braga, Portugal — [3]U. Bielefeld, Bielefeld, Germany — [4]Singulus AG, Kahl am Main, Germany

Magneto-thermoelectric properties of magnetic nanostructures have attracted a broad attention over the last years. However only recenly first studies of the magneto-thermoelectric properties of magnetic tunnelling junctions (MTJ) have been published. These studies included the prediction [1] and experimental observation [2-4] of tunnelling magneto thermo power (TMTP). In this talk we will discuss our recent results on TMTP of CoFeB/MgO/CoFeB MTJ nanopillars [3]. For TMTP measurements the thermally induced voltage V_T across the MTJ is measured as function of magnetic field. The thermopower signal V_T scales linearly with the temperature gradient and reveals a similar spin dependence as the TMR. We observe a spin-dependent change of the Seebeck coefficient of up to 0.2 mV/K and a correspondingly large TMTP ratio of up to 90 per cent. This might enable future spin-caloritronics applications of CoFeB/MgO/CoFeB based MTJs. [1] M. Czerner et al. Phys. Rev. B 83, 132405 (2011), [2] M. Walter et al., Nature Mat. 10, 742 (2011), [3] N. Liebing et al. PRL 107, 177201 (2011), [4] W. Lin et al., Nat. Comm. 3, 744 (2012).

DF 15: High- and low-k-dielektrics (joint session with DS)

Time: Wednesday 9:30–10:30 Location: H11

DF 15.1 Wed 9:30 H11

Dielectric signature of charge order in lanthanum nickelates — •Pit Sippel, Stephan Krohns, Peter Lunkenheimer, and Alois Loidl — Experimental Physics V, University of Augsburg, Germany

The technical progress of electronics requires new materials which have enhanced electrical properties, are cheaper, and are composed of non-scarce elements. In the last years charge-ordered nickelates, due to

their extraordinary high-dielectric constant, have been found to be promising materials for the use as dielectrics in capacitive circuit elements [1]. However, the mechanism giving rise to their high dielectric constants is still under debate. Therefore we have performed a thorough structural, magnetic, and dielectric investigation of various isostructural $La_{2-x}(Ba,Ca,Sr)_xNiO_4$ compounds. For commensurably charge-ordered nickelates, a correlation between electronic phase separation and the permittivity is observed [2]. The dielectric spectra of these compounds show a superposition of two relaxational processes. The stronger one is most probably related to a non-intrinsic effect. The second one seems to originate from an intrinsic process. To gain further insight into the origin of the mechanisms leading to the observed relaxation spectra, ceramics and singlecrystalline samples have been examined.

[1] S. Krohns et al., Nat. Mat. **10**, 899 (2011).
[2] P. Sippel et al., Eur. Phys. J. B **85**, 235 (2012).

DF 15.2 Wed 9:50 H11

Mixed Sr/Ba oxides as high-k dielectric material on Si(100) — •Shariful Islam[1], Karl Hofmann[2], and Herbert Pfnür[1] — [1]Institut für Festkörperphysik, Leibniz Universität Hannover — [2]Inst. f. Bauelemente der Mikroelektronik, Leibniz Universität Hannover

Mixed Sr/Ba oxide layers can be grown perfectly lattice matched as crystalline and epitaxial layers on Si(100). At a mixing Sr/Ba ratio of 30:70, a band gap of 4.3eV was found. Here we demonstrate that band alignment is possible both for p- and n-type Si with a band offset of $>$ 1eV. Dielectric constants of 27 ± 1 were determined for layer thickness between 4 and 16 nm, corresponding to capacitance equivalent thickness (CET) between 0.5 and 2.6 nm. The capacitance-voltage curves in MOS diodes fabricated by covering the oxide layers with 100 nm of Au show small hysteresis ($<$ 1 mV) indicating a small density of rechargeable traps in the oxide films. Trap densities at the Si/oxide interface were determined by the conductance method to be close to 4×10^{10} $eV^{-1}cm^{-2}$. These properties are coupled with low leakage currents ($<$ 4 mA/cm^2 at 5 nm thickness). These electrically excellent properties contrast with its limited thermal stability. At temperatures above 450°C the oxides are transformed into a well defined and again crystalline $(Ba_{0.8}Sr_{0.2})_2SiO_4$, which turns out to be stable up to desorption above 750°C, forming a band gap of 6 eV. First electrical measurements on this material will be discussed, too.

DF 15.3 Wed 10:10 H11

Combinatorial Preparation of Dielectric Films — •Achim Walter Hassel and Andrei Ionut Mardare — Institute for Chemical Technologygy of Inorganic Materials, Johannes Kepler University Linz, Austria

Valve metals such as Al, Hf, Nb, Ta, Ti, Zr are well known sources for thin anodic oxide films that can be used as dielectrics. Al and Ta are used in capacitors, Hf is handled as the new gold standard for high-k dielectrics. Each of the oxides on the pure metals has its advantages and disadvantages. In an attempt to optimise these properties an new approach is presented. Binary and ternary thin film libraries of these metals are prepared as compositional spreads on glass or silicon. Using scanning characterisation techniques such XRF, XRD, EXD the parent metal properties are linked to the oxide formation data, its specific resistance and dielectric constant. All these information is extracted from a series of experiments performed using scanning droplet cell microscopy (SDCM). A comprehensive data set is generated for each of these libraries, showing how properties are depending on the composition.

DF 16: Dielectric and ferroelectric thin films

Time: Wednesday 10:40–12:20 Location: H11

DF 16.1 Wed 10:40 H11

Magnetic field enhanced structural instability in EuTiO3 — •Annette Bussmann-Holder[1], Jürgen Köhler[1], Zurab Guguchia[2], and Hugo Keller[2] — [1]Max-Planck-Institute for Solid State Research, Stuttgart, Germany — [2]Physik Institut der Universität Zürich, Zürich, Switzerland

EuTiO3 undergoes a structural phase transition from cubic to tetragonal at TS=282K which is not accompanied by any long range magnetic order. However, it is related to the oxygen ocathedra rotation driven by a zone boundary acoustic mode softening. Here we show that this displacive second order structural phase transition can be shifted to higher temperatures by the application of an external magnetic field (ΔTS˜4K for *0H=9T). This observed field dependence is in agreement with theoretical predictions based on a coupled spin-anharmonic-phonon interaction model. The observed magnetic field dependence of TS demonstrates that a strong spin-phonon coupling is present in this compound already at high temperatures which suggests that spin fluctuations are present at these temperatures most likely driven by the oxygen ion octahedral rotation.

DF 16.2 Wed 11:00 H11

Controlling conductivity at domain walls in BiFeO3 thin films — •Ji Hye Lee, Akash Bhatnagar, Young Heon Kim, Dietrich Hesse, and Marin Alexe — Max Planck Institute of Microstructure Physics, Weinberg 2, D-06120 Halle (Saale), Germany

The study of domain walls regarded as natural interfaces in ferroic materials has been brought into attention due to their abnormal properties compared to the host materials. One of these materials, multiferroic BiFeO3 (BFO), which shows high transition temperature of both ferroic order parameters, has been intensively explored because of its unique characteristics of the domain walls, such as increased magnetoresistance, remarkable photovoltaic effect and enhanced conductivity. However, until now there have been only few attempts to control and tune the physical properties of domain walls in a designed way. Among them, tuning the conduction at domain walls is one of the most effective ways with high potential for future applications. The present talk will cover the unusual behavior of domain walls in BFO, especially regarding the abnormal conductivity. We will show several approaches to achieve tuning and control of the domain wall conductivity by doping. Temperature dependent behavior of domain wall conductivity conducted by an SPM based microscopic technique as well as macroscopic measurements have been used to unveil the role of oxygen vacancies and the effects of foreign atoms (by chemical doping) in the conduction mechanism of domain walls and host material.

DF 16.3 Wed 11:20 H11

Ferroelectric switching kinetics controlled by reversible elastic strain — •Kathrin Doerr[1,2], Andreas Herklotz[1,2], Er-Jia Guo[1,2], Ludwig Schultz[2], Hans Christen[3], and Michael Biegalski[3] — [1]MLU Halle-Wittenberg, Institute for Physics, 06099 Halle, Germany — [2]IFW Dresden, Postfach 270116, 01171 Dresden, Germany — [3]Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830, USA

Ferroelectricity is known to couple strongly to distortions of the crystallographic lattice. It is natural to expect a strain dependence of the switching dynamics. To overcome the limitation by varying defect states in several different films, we have introduced the application of piezoelectric substrates for reversible strain control in epitaxial ferroelectric films. This enabled the study of switching times in capacitors comprised of epitaxial $BiFeO_3$ and $PbZr_{0.52}Ti_{0.48}O_3$ (PZT) films in reversibly controlled strain states using pulsed measurements of the switched polarization. The strain effect is found to be fundamentally different in low and high electric fields identified here as creep and depinning regimes of domain wall motion, respectively.

DF 16.4 Wed 11:40 H11

Investigation of growth conditions on structural and ferroelectric properties of strained NaNbO3 thin films grown by PLD — •Jan Sellmann, Jutta Schwarzkopf, Andreas Duk, Sonia Gnanapragasam, Albert Kwasniewski, Martin Schmidbauer, Toni Markurt, and Roberto Fornari — Leibniz-Institute for Crystal Growth, Max-Born-Str. 2, 12489 Berlin, Germany

Alkaline niobates have recently attracted much attention due to their promising piezoelectric properties and high Curie temperatures. It is known that the ferro-/piezoelectric properties of these perovskites are strongly correlated to distortions of the oxygen octahedra as well as to the stoichiometry of the films. In the present work, epitaxial NaNbO3 films have been deposited by Pulsed Laser Deposition under different growth conditions on various lattice-mismatched substrates, resulting

in either compressive or tensile lattice strain. Systematical high resolution XRD and aberration corrected HR-TEM investigations of these films reveal that the incorporated lattice strain and the out of plane lattice parameter c depend both on the lattice mismatch to the substrate material and on the film stoichiometry governed by the applied deposition parameters like oxygen partial pressure and Na/Nb ratio in the PLD target. The chemical composition of the films is also considered to markedly affect the leakage current, therefore NaNbO3 targets with sodium excess were used in order to compensate Na deficiency in the films and the associated dielectric loss. First results have shown that epitaxially strained NaNbO3 films on SrTiO3 substrates exhibit ferroelectric behavior with a remnant polarization of 24*E-6 C/cm^2.

DF 16.5 Wed 12:00 H11

Crystallization and ferroelectric activity of poly(vinylidene fluoride) thin films doped with ionic liquids — •Feipeng Wang[1], Peter Frübing[1], Alexander Lack[1], Andreas Taubert[2], and Reimund Gerhard[1] — [1]Applied Condensed-Matter Physics, Department of Physics and Astronomy, Faculty of Science, University of Potsdam, 14476 Potsdam-Golm, Germany — [2]Institute of Chemistry, University of Potsdam, Potsdam-Golm, Germany

Ferroelectric PVDF films are obtained with doping of different types of ionic liquids (ILs). Selected ILs are used: 1-ethyl-3-methylimidazolium, combined with nitrate, or ethyl sulfate, or trifluoromethanesulfonate, respectively; as well as 1-butyl-3-methylimidazolium hexafluorophosphate. The doping of ILs enhances the crystallinity of PVDF. Crystalline β-phase (ferroelectric) dominant films are spin coated from solutions containing an IL of around 1 to 2 wt%. The content of β phase in PVDF decreases with larger anions. Additionally, high symmetry of the anions' charge centroid leads to lower polar phase (β or γ phase) content. For drop-cast films, the crystalline phases are non-uniform across the films' thickness.

The PVDF films exhibit remanent polarization values above 50 mC/m2. Large anions and/or cations produce PVDF films with lower conductivity and higher breakdown strength. The ferroelectric films show comparable pyroelectricity to stretched PVDF. The dipolar interaction between anions of ionic liquid and CH2 groups in the PVDF chain is considered to facilitate the formation of the β phase.

DF 17: Glasses III (joint session with CPP, DY)

Time: Wednesday 12:30–13:10 Location: H11

DF 17.1 Wed 12:30 H11

Nonlinear dielectric response of glass-forming systems — •Thomas Bauer, Peter Lunkenheimer, Stefan Kastner, and Alois Loidl — Experimental Physics V, Center for Electronic Correlations and Magnetism, University of Augsburg, 86135 Augsburg

In the present contribution, we report a thorough investigation of Type A and other glass-forming liquids by nonlinear dielectric spectroscopy. This is done by comparing and quantifying the difference of high- and low-field permittivity as well as by the determination of higher harmonics after applying a high ac field up to 849 kV/cm. In earlier works [1,2], a strong increase of the dielectric loss was found at the high-frequency flank of the α-relaxation peak while the field dependence was negligible at low frequencies. This finding is consistent with the box model, assuming correlated dielectric and thermal relaxation times within dynamical heterogeneities. We show measurements extending into the frequency region of the so-called excess wing that indicate a complete lack of this nonlinear effect for this spectral feature. In addition, we report the higher-order response of glycerol and propylene carbonate for a broad temperature range and various electric fields. The third-order susceptibility shows a significant hump, that can be ascribed to molecular correlations [3] and cannot be explained by trivial saturation effects of the dipolar polarization, known since long.

[1] R. Richert and S. Weinstein, Phys. Rev. Lett. **97**, 095703 (2006).
[2] L.-M. Wang and R. Richert, Phys. Rev. Lett. **99**, 185701 (2007).
[3] C. Crauste-Thibierge, C. Brun, F. Ladieu, D. L'Hôte, G. Biroli, and J-P. Bouchaud, Phys. Rev. Lett. **104**, 165703 (2010)

DF 17.2 Wed 12:50 H11

Pressure dependent void size in SiO_2 investigated with the Pulsed Low Energy Positron System (PLEPS) — •Luca Ravelli[1], Werner Egger[1], Marco Zanatta[2], Roberto Sennen Brusa[2], and Günther Dollinger[1] — [1]Universität der Bundeswehr, München, Germany — [2]Università di Trento, Trento, Italy

Positron annihilation lifetime spectroscopy (PALS) is a very powerful tool for the non-destructive detection and characterization of open volume defects such as vacancies, vacancy clusters and voids in different materials, ranging from metals to semiconductors and insulators. In combination with a mono-energetic pulsed beam of variable energy it is possible to tune the positron implantation depth. The analysis of the lifetime spectra as a function of the implantation energy allows to measure defect depth profiles from the surface to the bulk of the sample.

As an example we show a study of the evolution of defects, and in particular of voids, present in SiO_2 glasses compressed with 0, 2, 4, 6 and 8 GPa. Because of the small size and the shape of the samples (small cylinders with diameter from 3 mm for the reference sample to 2 mm for one subjected to the highest pressure) a conventional positron lifetime measurement in sandwich configuration was impossible. The measurements were performed with the Pulsed Low Energy Positron System (PLEPS) at the high intensity positron source NEPOMUC (NEutron-induced POsitron source MUniCh) at the research reactor FRM-II. The results have shown a decrease of the void-size with increasing pressure.

DF 18: Nanostructured oxide thermoelectrics

Time: Wednesday 12:30–13:30 Location: H9

DF 18.1 Wed 12:30 H9

Thermoelectric properties of p-type $Bi_2Sr_2Co_2O_9$ glass-ceramics — •Matthias Jost[1,3], Julian Lingner[1,2], Martin Letz[2], and Gerhard Jakob[1] — [1]Johannes-Gutenberg Univeristät, Institut für Physik, Staudinger Weg 7, Mainz D-55128 — [2]Schott AG, Hattenbergstraße 10, Mainz D-55122 — [3]Technische Universität Darmstadt, Institut für Mikrowellentechnik und Photonik, Merckstraße 25, Darmstadt D-64283

In the oxide system of Bi-Sr-Co glass melts were prepared by adding a small amount of glass formers. A crystallization leads to crystalline phases of $Bi_8Sr_8Co_4O_25$, $BiSrCo_2O_x$ and $Bi_2Sr_2Co_2O_9$ (BC-222) densely embedded into a residual glass phase. We show that it is possible via such glass-ceramic approach to obtain microstructured bulk material with low thermal conductivity and relatively high electrical conductivity. We further show that these materials are stable under thermal cycling for temperatures up to 700°C. A characterization of the thermoelectric properties leads to values of ZT between 0.008 and 0.018.

DF 18.2 Wed 12:50 H9

Glass-ceramics as a new material class for high temperature oxide thermoelectrics — •Julian Lingner[1,2], Gerhard Jakob[1], and Martin Letz[2] — [1]Universität Mainz — [2]Schott AG Mainz

The research on thermoelectric materials has progressed enormously over the last years and is still growing because of the global demand for eco-sensitive energy conversion. Innovative approaches like bulk-nanostructuring helped to increase the efficiency of the investigated materials. Materials which withstand high temperatures above 500°C are especially in great demand because the thermoelectric efficiency is proportional to the temperature and the possible fields of application broaden. It is of great importance to find materials which are able to operate under these circumstances while at the same time being naturally abundant and non-toxic. This presentation focuses on glass-ceramics as a new material class for high temperatures in thermo-

electrics. Starting from a base glass via a controlled thermal treatment, a certain crystal structure is embedded in the glass-matrix leading to many new properties of the material. Especially the possibility to induce small crystallites, the pore-free surface combined with the high-temperature durability of this material class support this approach. Measurements of different systems of glass-ceramic thermoelectric materials are presented.

DF 18.3 Wed 13:10 H9

Indium-oxide-based Seebeck gas sensors — •Markus Mischo[1], Volker Cimalla[2], Oliver Ambacher[1,2], and Friedemann Völklein[3] — [1]Laboratory for Compound Semiconductor Microsystems, Department of Microsystems Engineering - IMTEK, University of Freiburg, Germany — [2]Fraunhofer Institute for Applied Solid State Physics Freiburg, Germany — [3]RheinMain University, Institute of Microtechnologies

The intention of this research is to develop a highly sensitive long-lasting ozone sensor based on the thermoelectric effect. The thermoelectric, or Seebeck effect is the direct conversion of temperature differences into electricity. Direct thermoelectric gas sensors are based on the dependency of the Seebeck coefficient on the surrounding gas concentration. Beside the Seebeck coefficient there are several other important parameters which have an influence on the thermoelectric power. Generally, the thermoelectric power is characterized by the figure of merit ZT: ZT = $(S^2\sigma/\kappa)$T where S, σ, κ and T are the major influencing parameters, namely the Seebeck coefficient, the specific electronic and thermal conductivity, respectively, and the temperature. Compounds such as InN, InAs, and InOx have good thermoelectric properties. In addition, the Fermi level and the surface band bending can be modified by specific gas adsorption, while thermal conductivity is decreased by reducing the grain size in the material. These effects are used for a highly-sensitive Seebeck gas sensor. The sensors are able to compete with conventional resistive gas sensors regarding accuracy, reproducibility and response time.

DF 19: Poster 2

Time: Wednesday 15:00–17:30 Location: Poster B2

DF 19.1 Wed 15:00 Poster B2

The electronic structure of tetragonal CuO — •Simon Moser[1,2], Luca Moreschini[2], Davide Innocenti[2,3], Young Jun Chang[2,4], Aaron Bostwick[2], Eli Rotenberg[2], and Marco Grioni[1] — [1]Ecole Polytechnique Federale de Lausanne — [2]Advanced Light Source, Lawrence Berkeley National Laboratory — [3]University of Rome Tor Vergata — [4]University of Seoul

The cupric oxide CuO exhibits an insulating ground state with a correlation-induced charge-transfer gap and antiferromagnetism. It is, in principle, the most straightforward parent compound of the doped cuprates, and therefore has been theoretically studied as a model material for high temperature superconductivity.

Bulk CuO crystallizes in a low-symmetry monoclinic form, in contrast to the rocksalt structure typical of late 3d transition metal monoxides. It was recently synthesized by epitaxial growth on $SrTiO_3$ substrates in a higher symmetry tetragonal structure with elongated c-axis (Siemons *et* al. PRB 79, 2009). Extrapolating the behavior of other 3d transition metal monoxides, this phase of CuO is predicted to have a much higher Neel temperature than its bulk counterpart.

At beamline 7 of the Advanced Light Source, we have grown tetragonal CuO thin films by pulsed laser deposition and investigated their electronic structure by angle-resolved photoelectron spectroscopy (ARPES). These measurements represent the first mapping of the band structure of this new material, not available in bulk phase, and will serve as a reference point for future doping experiments.

DF 19.2 Wed 15:00 Poster B2

Free energy barriers of oxygen vacancy migration in TiO_2 — Michael Wehlau, •Jan Michael Knaup, and Thomas Frauenheim — BCCMS, Universität Bremen, Germany

To understand the memristive effect in reduced TiO_2, it is of supreme importance to understand the migration behavior of oxygen vacancy (V_O) defects in the material. A basic building block of this understanding are the free energy barriers of (V_O) migration and the influence of various external driving forces on these barriers. Previous results show that due to the immense dielectric constant of titania, the thermodynamic effect of external electric fields is very small even close to dielectric breakdown. However, since the ionic shifts causing this high permeability may influence the migration barriers, these must be analyzed in detail. We perform meta dynamics simulation of the migration of single (V_O) defetcs in rutile TiO_2, based on the Density-Functional based Tight-Binding (DFTB) method. To this end, we develop generally applicable collective variables that allow drive the dynamics of the vacancy rather than attempting to achieve this effect indirectly by driving surrounding atoms. Our results show that using the right kind of collective variables, meta dynamics is well suited to explore the migration mechanisms point defects in solids. Our findings on the free diffusion of (V_O) are in good agreement with previous results.

DF 19.3 Wed 15:00 Poster B2

Optical resonances of self-organized monocrystalline Au nanoparticles embedded in a $SrTiO_3$ matrix — •Hendrik Bernhardt[1], Christian Katzer[1], Christke Sandra[1], Frank Schmidl[1], Gabriele Schmidl[2], Wolfgang Fritzsche[2], Jörg Petschulat[3], Thomas Pertsch[3], and Markus Rettenmayr[4] — [1]Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena, Helmholtzweg 5, D-07743 Jena, Germany — [2]Institute of Photonic Technology, IPHT, Albert-Einstein-Straße 9, D-07745 Jena, Germany — [3]Institut für Angewandte Physik, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, D-07743 Jena, Germany — [4]Institut für Materialwissenschaft und Werkstofftechnologie, Friedrich-Schiller-Universität Jena, Löbdergraben 32

Gold nanoparticles in dielectric thin films are well known as plasmonically active material due to the excitation of localized surface plasmon resonances. Apart from the dielectric properties of the ambient medium and the inter-particle distances also shape and size of the particles can influence the resonance frequency. In this work, we report on ellipsoidal and orientated Au nanoantennas, which can be prepared in a crystalline high index ambient, i.e. $SrTiO_3$ (STO), via laser ablation. By controlling the deposition parameters, we are able to tune size, shape and distribution density of the crystalline gold nanoparticles. The plasmonic activity of the highly oriented nanoantennas thereby is observed in transmission spectroscopy experiments. Furthermore we will present transmission electron microscopy and x-ray diffraction data.

DF 19.4 Wed 15:00 Poster B2

Voltage-dependent impedance analysis of metal/ta-C/Si heterostructures — •Julian Alexander Amani, Tristan Koppe, Hans Hofsäss, and Ulrich Vetter — II. Physikalisches Institut, Georg-August-Universität Göttingen, Deutschland

Whether tetrahedral amorphous carbon (ta-C) is used as electrode coating for electrochemical impedance spectroscopy (EIS) or as coating on medical implants, knowledge of its impedance properties is essential.

Different electrical equivalent circuits (EECs) have been proposed to reproduce the electrical properties of ta-C, so far, ignoring the knowledge of the voltage-dependence of its DC conductivity. Considering voltage-dependence of elements in an EEC facilitates correct assignment of circuit components to different parts of the investigated system and, hence, permits selection of the EEC with most accurate description of the underlying physics.

In this work, voltage-dependent impedance spectra were measured and compared to simulations, eliminating the ambiguity of the different proposed circuits. It could be shown that a Voigt-type circuit of a voltage-dependent resistance and a voltage-independent constant-phase element (CPE) describes the ta-C layer correctly. In contrast to most impedance analyses, the voltage- and frequency-dependence of the system was calculated and compared to the measured values in the complete parameter-space, not only for a single frequency spectra at each bias voltage separately. Possibility of large-signal analysis in time-domain allowed realistic simulations of the extremely non-linear resistive behaviour of ta-C.

DF 19.5 Wed 15:00 Poster B2

Tunable ferroelectric imprint and Mn valency in $PbTiO_3$ /$La_{0.7}Sr_{0.3}MnO_3$ nanostructures — •Ingo Krug[1], Ionela Vrejoiu[2,3], Alessio Morelli[2], Florian Nickel[1], Daniel Gottlob[1], Hatice Doganay[1], Robert Laskowski[4], Nick Barrett[5], Jiale Wang[5], and Claus M. Schneider[1,6,7] — [1]Peter Grünberg Institut (PGI-6), Forschungszentrum Jülich, DE-52425 Jülich, Germany — [2]Max Planck Institut für Mikrostrukturphysik, DE-06120 Halle, Germany — [3]Max Planck Institute of Solid State Physics, DE-70569 Stuttgart, Germany — [4]Institute of Materials Chemistry, Vienna University of Technology, A-1060 Vienna, Austria — [5]CEA, DSM/IRAMIS/SPCSI/LENSIS, Bâtiment 462, F-91191, Gif-sur-Yvette cedex, France — [6]JARA Jülich-Aachen Research Alliance, Forschungszentrum Jülich, DE-52425 Jülich — [7]Fakultät für Physik and Center for Nanointegration Duisburg-Essen (CeNIDE), DE-47048 Duisburg, Germany

In $PbTiO_3$ / $La_{0.7}Sr_{0.3}MnO_3$ nanostructure arrays we confirmed a self-organizing pattern consisting of out-of plane 180° ferroelectric domains. The pattern was observed in Piezo-Force microscopy (PFM) as well as X-ray absorption spectroscopy (XAS) and threshold photoemission (TPES) using X-ray Photoemission Electron Microscopy (XPEEM). As found by PFM and XAS, the pattern correlates with the LSMO thickness as well as with the Mn valency state, indicating an electronic reconstruction at the interface. The observed effects could provide new ways of constructing multiferroic or magnetoelectric devices tuning the LSMO magnetism.

DF 19.6 Wed 15:00 Poster B2

Structural and Compositional Inhomogeneity of a Fe-SrTiO3 Film Studied by Electron Microscopy and Spectroscopy — •Hongchu Du[1,2,3], Chun-Lin Jia[1,2], and Joachim Mayer[1,2,3] — [1]Ernst Ruska-Centrum für Mikroskopie und Spektroskopie mit Elektronen, Forschungszentrum Jülich GmbH, Jülich, 52425, Germany — [2]Peter Grünberg Institut, Forschungszentrum Jülich GmbH, Jülich, 52425, Germany — [3]Gemeinschaftslabor für Elektronenmikroskopie (GFE), RWTH Aachen, Aachen, 52074, Germany

Lattice defects are essential for the microscopic switching mechanism in all the classes of the resistive switching effects. Hence a thorough understanding of electronically active defects is required to be able to correlate microscopic structures with the resistively switching properties. Aberration corrected High-resolution (S)TEM provides real structural analysis down to the atomic level. Different techniques like HRTEM, ADF-STEM, and EELS enable revealing the microscopic details of the electronically active defects, thereby allowing a better understanding of how lattice defects interrelate with the resistively switching effects.

In this study, we observed that the Fe-SrTiO3 film has structural and compositional inhomogeneity by HRTEM, STEM, and EELS. Lattice parameter increment was observed in both the distort particle-like area and antiphase boundaries. The antiphase boundaries may be formed by 1/2 unit cell displacement of the antiphase domain in [110] direction with respect to the film. EELS profile shows that Fe are mainly distributed in the film. Enrichment of Fe was found in the strained area and at the interface.

DF 19.7 Wed 15:00 Poster B2

Kelvin probe force microscopy investigations of the contact charging of single crystalline insulators — •Monika Mirkowska[1,2], Markus Kratzer[2], Christian Teichert[2], and Helmut Flachberger[1] — [1]Chair of Mineral Processing, Department Mineral Resources and Petroleum Engineering, Montanuniversität Leoben, Austria — [2]Institute of Physics, Montanuniversität Leoben, Austria

Detailed knowledge about the contact charging behavior of dielectric materials is of great interest for technological applications like tribocharging separation of mineral particles. The underlying mechanisms are still not well understood. Here, an attempt is made to study the electric charging of well-defined surfaces (quartz and calcite monocrystals) upon contact with a conventional AFM tip. Measurements were performed in a fluid cell under controlled temperature (30 * 100 °C) and relative humidity (4 * 40 % RH) conditions. Kelvin probe force microscopy was applied to verify the electrostatic characteristic of the surfaces before and after contact charging. Both, tribocharging due to rubbing and static contact charging with applied tip bias have been investigated. The influence of humidity, contact time, contact force, and probe bias has been studied. The relative humidity turned out to play a key role in the charging process.

DF 19.8 Wed 15:00 Poster B2

Laser-induced nanostructure fabrication in fused silica surfaces: experiment and theory — •Pierre Lorenz, Frank Frost, Martin Ehrhardt, and Klaus Zimmer — Leibniz-Institut für Oberflächenmodifizierung e. V., Permoserstraße 15, 04318 Leipzig, Germany

The fabrication of dielectric nanostructures is a big challenge for laser methods. The IPSM - LIFE method (IPSM - LIFE: laser induced front side etching using in situ pre-structured metal layers) allows the easy and fast production of complex surface structures into dielectric with lateral sizes down to 20 nm. At the IPSM - LIFE process, the irradiation of thin metal film deposited onto the fused silica substrate with low laser fluences results in the formation of complex metal structures by self-assembly processes and to a formation of a surface structure into the dielectric due to the melting, restructuring and resolidification of the dielectric surface. Further laser irradiation of the formed metal structures with high laser fluences causes the formation of complex patterns at the dielectric surface. The resultant structures were studied by scanning electron microscopy (SEM) and atomic force microscopy (AFM). The experimental results were compared with surface structures obtained from finite element method (FEM) simulations.

DF 19.9 Wed 15:00 Poster B2

Determination of the quality factor of microstructured dielectric surfaces by wave-front reconstruction — •Kay-Michael Voit, Hauke Bruening, Juliane Tschentscher, and Mirco Imlau — School of Physics, Osnabrueck University, Osnabrueck, Germany

We present our research results on the determination of the quality factor Q of micro- and nanostructured surfaces by means of (non-)linear light-matter interaction. Such structured surfaces play an important role in the field of advanced functional materials e.g. in nonlinear optics/photonics. However, there is so far no method for a contact-free, nondestructive control of the structure during synthesis and/or probing the structures' lifetime. First, an experimental setup for the optical measurement of periodic micro- and nanostructured surfaces within the range of $0 < Q < 1$ an $\delta Q = 0.1$ is presented. Taking into account the related boundary conditions, we show simulations of the optical far-field pattern resulting from microstructures with different quality factors. The wave front reconstruction is performed by a mixture of ray-tracing and Fresnel-Huygens/Kirchhoff diffraction theory. Possibilities for in-field application and calibration are discussed and a comparison between theoretical and experimental results is given.

DF 19.10 Wed 15:00 Poster B2

Electronic Structure of Rare-Earth Scandates $RScO_3$ (R= Pr, Nd, Sm, Eu, Gd, Tb, and Dy) — •Karsten Kuepper[1], Christine Derks[1], Andrei Postnikov[2], Reinhard Uecker[3], and Manfred Neumann[1] — [1]Department of Physics, University of Osnabrück, D-49069 Osnabrück — [2]LCP-A2MC, University of Lorraine, F-57078 Metz, France — [3]Institute for Crystal Growth, D-12489 Berlin

Scandium based double oxides with other rare earth lanthanides of type $RScO_3$ (R=Pr,Nd,Sm,Eu,Gd,Tb, and Dy) find a number of potential interesting applications, first of all in its quality of a high dielectric constant (high-k) material. Here we present the results of a detailed electronic structure investigation, applying a number of complementary x-ray spectroscopic techniques, namely x-ray photoelectron spectroscopy (XPS), x-ray absorption spectroscopy (XAS), and x-ray emission spectroscopy (XES) in combination with theoretical LDA+U electronic structure calculations [1,2,3]. We find an overall excellent agreement between experiment and theory. Furthermore, we discuss a band gap variation in dependence of R, analyzed by means of O K XAS and XES [2].

[1] M. Raekers et al., Phys. Rev. B 79, 125114 (2009).
[2] C. Derks et al., Phys. Rev. B 86, 155124 (2012).
[3] A.V. Postnikov et al., Ferrolelectrics, in press.

DF 19.11 Wed 15:00 Poster B2

Oxygen Related Defects and the Reliability of Strained High-κ Dielectric Films in Field Effect Transistors: A First Principles Investigation — •Ebrahim Nadimi[1,2,4], Rolf Öttking[2], Philipp Plänitz[2], Martin Trentzsch[3], Christian Radehaus[2], and Michael Schreiber[1] — [1]Institut für Physik, Technische Universität Chemnitz — [2]GWT-TUD GmbH Geschäftsstelle Chemnitz — [3]Global Foundries, D-01109 Dresden, Germany — [4]Faculty of Electrical and Computer Engineering, K.N. Toosi University of Technology, Tehran, Iran

The strain engineering of the silicon channel in metal-oxide-field-effect

transistors (MOSFET) along with the high-k (HK) and metal gate (MG) technology has been used in order to improve the performance of these transistors. Applying both techniques raises the question: what would be the interaction of these two techniques. The main concern in HK/MG stacks is the reliability and degradation of the gate dielectric which is mainly related to the oxygen vacancies. In this work we try to study the influence of mechanical stress on the electronic properties of such defects. First principles calculations based on the density functional theory and beyond that (hybrid functionals) were applied to investigate the formation energy and induced trap levels. The calculations reveal that mainly the charged defects are responding to the mechanical stress. In agreement with experimental results which show larger negative bias temperature instability (NBTI) for compressively stressed samples, the calculated formation energy of positively charged defects reduces by compressive stress while it rises with tensile stress.

DF 19.12 Wed 15:00 Poster B2

Restoring the k-value in damaged ultra-low k materials — •Oliver Böhm[1,2], Roman Leitsmann[2], Philipp Plänitz[2], Thomas Oszinda[3], and Michael Schreiber[1] — [1]Institut für Physik, Technische Universität Chemnitz, 09107 Chemnitz — [2]AQcomputare GmbH, Annaberger Str. 240, 09125 Chemnitz, Germany — [3]GLOBALFOUNDRIES Dresden Module Two GmbH & Co. KG, Germany

The decreasing feature size of integrated circuits results in a smaller distance between the conduction layers, which is accompanied by an increasing resistance capacitance (RC) delay. To reduce this effect materials with an ultra-low dielectric constant can be used. However, the technical application of ultra-low k (ULK) materials is connected to several problems. After the etching of trenches or vias typically a considerable amount of carbon depletion and subsequently the formation of OH-groups can be observed. This results in moisture uptake and consequently in a strongly increased dielectric constant. To restore the k-value, a post-etch treatment is necessary.

In this study we use state of the art density functional theory (DFT) combined with a nudged elastic band (NEB) method to investigate different silylation processes. The efficiency of several silazanes and siloxanes will be compared. Furthermore, the influence of other post-etch treatments on the k-restoring will be briefly discussed. Finally, based on the obtained results an improved scheme for the k-restoring process of ultra-low k materials will be proposed.

DF 19.13 Wed 15:00 Poster B2

Microgoblet Lasers for Label-free Biosensing — •Jan Fischer[1], Sarah Wiegele[1], Tobias Grossmann[1], Torsten Beck[1], Martin Mai[1], Uwe Bog[2], Timo Mappes[2], and Heinz Kalt[1] — [1]Institut für Angewandte Physik, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany — [2]Institut für Mikrostrukturtechnik, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Biosensors for label-free detection offer a huge variety of applications in life science. We report on laser dyes embedded in goblet-shaped polymeric microresonators. These resonators are fabricated in a simple and low-cost manufacturing process suitable for mass production. The dye-doped polymer poly(methyl methacrylate) (PMMA) is directly processed on a silicon substrate. The developing and etching process is followed by a thermal reflow step which smoothes the surface and enhances the Q-factor significantly. The emission of these microgoblet lasers is in the visible region and can be varied using different laser dyes. The surface of the resonators can be functionalized with different receptors sensitive to wanted molecules. Binding of molecules can be detected by measuring the spectral shift of the resonant whispering gallery mode.

DF 19.14 Wed 15:00 Poster B2

Ultrafast holographic spectroscopy — •Andreas Buescher, Kay-Michael Voit, Hauke Bruening, Holger Badorreck, and Mirco Imlau — School of Physics, Osnabrueck University, Germany

A novel experimental approach for the study of small-polaron-related changes of the complex permittivity in lithium niobate is presented. Our approach is based on holographic spectroscopy [K. Voit and M. Imlau, Materials (2013)] that has been established as an important tool for the analysis of light-induced changes of the complex dielectric permittivity at optical frequencies. The study of dispersive permittivity features in lithium niobate is driven by our recent discovery of efficient small-polaron based hologram recording with single laser pulses [H. Bruening et al., Opt. Express **20**, 13326 (2012)]. In order to study the underlying mechanisms, holographic spectroscopy must be extended to a dynamic tool with temporal resolution of the small polaron formation time ($\approx 100\,fs$). We have addressed this demand by the design of a novel type of nonlinear optical setup that includes holographic techniques, a broad-band probing light source by means of supercontinuum generation as well as a classical pump-probe setup equipped with an optical delay line for sub-ps temporal resolution. The concept is verified experimentally using Fe-doped lithium niobate.
Financial support by the Deutsche Forschungsgemeinschaft (IM 37/5, INST190/137-1) is gratefully acknowledged.

DF 19.15 Wed 15:00 Poster B2

Simulation of the melting temperature reduction of TiO_2 by oxygen deficiency — •Jason Marx, Jan Michael Knaup, and Thomas Frauenheim — BCCMS, Universität Bremen, Germany

The memristive effect in TiO_2 is governed by the externally driven migration of oxygen in a reduced bulk oxide. In the unipolar switching regime, this defect migration leads to the formation and dissolution of metallic Ti_4O_7 nanofilaments through the insulating bulk TiO_{2-x}. The mechanism of this phase transition is so far not understood at all. One possibility is the local melting of the bulk titania which is usually either amorphous or in the rutile structure followed crystallization into the Ti_4O_7 Magnéli phase upon cooling. As an initial step towards understanding the formation of Magnéli phase nanofilaments, we perform Density-Functional based Tight-Binding (DFTB) modeluclar dynamics (MD) simulations of bulk TiO_{2-x} at defect concentrations ranging from 0 to the equivalent of Ti_4O_7 stoichiometry at constant cell volume. From the particle trajectories we deduce the melting point by analyzing the RDF, the self-diffusion coefficient and the Linemann index. Special care is taken to analyze the actual dynamics properties of the material, instead of thermostat artifacts. We find a significant lowering of the the melting temperature with rising defect concentration. This lowering is larger than can be explained by the reduction in excluded volume alone. The results indicate that local variations in defect concentration leading to local melting point variations play an important role in the filament formation process.

DF 19.16 Wed 15:00 Poster B2

Piezoresponse force microscopy studies of (K,Na)NbO3-based ceramics for piezoactuator applications — •Danka Gobeljic[1], Vladimir V. Shvartsman[1], Ke Wang[2], Wook Jo[3], Jing-Feng Li[2], Jürgen Rödel[3], and Doru C. Lupascu[1] — [1]Institute for Materials Science, Universität Duisburg-Essen, Essen 45141, Germany — [2]State Key Laboratory of New Ceramics and Fine Processing, Tsinghua University, Beijing 10008, P.R. China — [3]Institute of Materials Science, Technische Universität Darmstadt, Darmstadt 64287, Germany

One of the most promising, environmentally friendly, lead-free piezoceramics are (K,Na)NbO3 (KNN)-based materials. Purposeful doping makes KNN especially suitable for high-precision, temperature-stable actuator applications, providing high piezoelectric constant d33 and strain, which shows significant stability in a range from room temperature up to 175°C. We present results of a Piezoresponse Force Microscopy (PFM) study on 0.95(Na0.49K0.49Li0.02)(Nb0.8Ta0.2)O3-0.05CaZrO3 ceramics at different temperatures. For both poled and unpoled states of KNN samples a reorganization of domain structure was observed with temperature increase. It is related to a sequence of phase transformation in this material. Measured temperature dependences of the local longitudinal piezoelectric coefficients are in reasonable agreement with temperature behavior of the macroscopic low signal piezoelectric coefficient. Obtained results provide nanoscopic insight on mechanisms of enhanced electromechanical properties in the studied KNN-based ceramics.

DF 19.17 Wed 15:00 Poster B2

Electrical and optical properties of tungsten doped VO_2 thin films — •Sebastian Vatterodt[1], Jura Rensberg[1], Danilo Buerger[2], Heidemarie Schmidt[2], and Carsten Ronning[1] — [1]Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena, 07743 Jena, Germany — [2]Institut für Materialsysteme der Nanoelektronik, Technische Universität Chemnitz, 09107 Chemnitz, Germany

Single crystalline vanadium oxide (VO_2) undergoes a reversible metal to insulator transition (MIT) accompanied by a structural transition from metallic rutile phase (R) to insulating monoclinic phase (M1) at a temperature of about 68°C. Most likely, this transition is caused by electron-electron correlation which leads to a splitting of the V^{4+} 3d valence band. Therefore, a band gap with an energy of about

0.6 eV is observed in the insulating phase. Furthermore, it is well known that the transition temperature in VO_2 can be decreased by high valent dopants, i.e. tungsten, which are incorporated into the lattice. Here we investigated the influence of tungsten doping on the electronic structure. Thus we grew VO_2 thin films on sapphire by pulsed laser deposition (PLD) with different tungsten content. The films were characterized by measuring both their transmittance in the UV-VIS-NIR spectral range and their sheet resistivity as a function of the temperature. The changes of the electronic structure, i.e. the position of the V^{4+} 3d band, due to tungsten doping are discussed and compared with theoretical band structure calculations.

DF 19.18 Wed 15:00 Poster B2

Nanoscale characterization of electroactive polymer nanocomposites with ferroelectric crystalline additions — Dmitry Kiselev[1], •Vladimir Shvartsman[2], Maksim Silibin[3], Alexander Solnyshkin[3], and Doru Lupascu[2] — [1]National University of Science and Technology (MISiS), Moscow, Russia — [2]Institut für Materialwissenschaft, Universität Duisburg-Essen, Essen, Germany — [3]National Research University of Electronic Technology (MIET), Moscow, Russia

Ferroelectric polymers, in particular polyvinylidene fluoride (PVDF) and its copolymers, offer an attractive combination of properties such as relatively high spontaneous polarization, piezoelectricity, chemically inert behavior, electrical strength, and durability. Recently, attention of researchers has more and more often been attracted to objects simultaneously having properties of polymers and classical ferroelectrics. Such objects are composite films based on polymeric materials with addition of ferroelectrics, e. g. barium lead zirconate titanate (BPZT).

In this work, we report on local ferroelectric and piezoelectric properties of nanostructured polymer composites P(VDF-TrFE)+xBPZT (x = 0 - 50 %). High-resolution imaging of ferroelectric domains, local polarization switching, and polarization relaxation dynamics were studied by piezoresponse force microscopy. In particular, we found that BPZT inclusion usually show a strong unipolar piezoresponse signal, as compared to the polymer matrix. By scanning under high dc voltage films can be polarized uniformly under both positive and negative electric fields. Stabilty of the polarized state is discussed.

DF 19.19 Wed 15:00 Poster B2

Measurement of Elastic Properties of Some Epoxy Materials in a Broad Frequency Range — •Ulrich Straube[1], Christoph Pientschke[1,2], and Sabine Kern[1,2] — [1]Martin-Luther-University Halle, Institute of Physics, Germany — [2]Martin-Luther-University Halle, Interdisciplinary Center of Materials Science, Germany

Composite materials containing embedded piezoelectric fibers in epoxy materials are important for the fabrication of ultrasound transducers for medical applications. The elastic stiffness and compliance coefficients of these epoxy materials must be known for optimising and modeling of such composites.

Measurement methods for the determination of the Young's modulus and the shear elastic modulus are described. The methods contain the Hz-range with dynamical mechanical analysis (DMA), mechanical resonator methods in the kHz-range and several ultrasound methods in the lower MHz-range.

These methods are utilized for the mechanical characterisation of epoxy materials used in ultrasound transducers. Selected results spanning a broad frequency range are presented.

DF 19.20 Wed 15:00 Poster B2

Large-scale 3D simulation and analysis of acoustic waves in piezoelectric materials — •Tristan Koppe, Julian Amani, Hans Hofsäss, and Ulrich Vetter — 2. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Bulk and surface acoustic waves (BAW/SAW) are used to create compact, cost-efficient and easy to produce (sometimes even CMOS compatible) high frequency filters, resonators and compressors with superior properties essential for modern mobile and wireless communications. Numerical simulations of SAW/BAW structures have become a powerful tool for research and development of new devices and applications. A finite element package for SAW and BAW simulations has been designed to describe non-periodic three dimensional SAW/BAW devices in time domain. The simulation features the computation of systems with several million elements. Especially 2H-AlN thin films on substrates with various interdigital transducer configurations are considered.

DF 19.21 Wed 15:00 Poster B2

Time-domain large-signal simulation of electrical equivalent circuits with non-linear components — •Julian Alexander Amani, Tristan Koppe, Hans Hofsäss, and Ulrich Vetter — II. Physikalisches Institut, Georg-August-Universität Göttingen, Deutschland

When investigating dielectric properties of a heterostructure, simulation of electrical equivalent circuits (EECs), modelling the measured impedance response, has proven useful to identify different contributions to the system.

An in-house developed simulation software capable of including arbitrary, even non-linear, resistance or capacitance models is presented. It utilises bias voltage, signal amplitude, frequency and temperature dependence of each element to calculate the impedance response of the circuit. Considering signal amplitude facilitates simulation of non-linear responses, in addition to the linear response of the system. Time-domain analysis permits extraction of the calculated signal over time at each component, thus allowing hypothetical oscilloscope measurements at each, even usually experimentally inaccessible, component.

Variation of additional parameters (e. g. bias voltage, temperature) allows eliminating circuit ambiguity. However, usually the measured frequency response is fitted without varying another parameter or for each variation separately. Since this software considers the response of each element to the varying parameter, the comparison of measured and calculated results is done in the full parameter space instead of fitting single frequency responses.

DF 19.22 Wed 15:00 Poster B2

Characterisation of nonlinear capacitors as alternative energy storage — •Sebastian Lemm[1], Wolfram Münchgesang[1], Martin Diestelhorst[1], Mandy Zenkner[2], Thomas Grossmann[2], Claudia Ehrhardt[2], Jens Glenneberg[3], Alexandra Buchsteiner[3], Horst Beige[1], Stefan G. Ebbinghaus[2], and Hartmut S. Leipner[3] — [1]Institute of Physics, Martin-Luther-University, D-06099 Halle, Germany — [2]Institute of Chemistry, Martin-Luther-University, D-06099 Halle, Germany — [3]Interdisciplinary Center of Materials Science , Martin-Luther-University, D-06099 Halle, Germany

The storage of energy requires the knowledge of the DC properties of the dielectric inside the capacitor. To characterise eligible materials like $BaTiO_3$ for this special application we performed measurements under AC and DC conditions. As could be shown AC measurements are only of limited suitability to draw conclusions about the applicability of the materials. In the presentation we compare different measerement methods like DC charge-discharge measurements, low frequency measurements of the dielectric permittivity, and DC-conductivity which were performed on samples of different compositions like thin films of spin coated $BaTiO_3$-polymer composites and $BaTiO_3$-composites with anorganic matrix. Furthermore we tried to find correlations between the macroscopic dielectric properties and the microstructure of the materials investigating the materials by ESEM and TEM. It has been proven that a complicated interplay between many microscopic effects is responsible for the macroscopic dielectric properties.

The work was supported by BMBF within the project Superkon.

DF 19.23 Wed 15:00 Poster B2

Holographic image recording in nominally undoped, thermally reduced $LiNbO_3$ using small bound polarons — •Sarah Masch, Hauke Brüning, and Mirco Imlau — School of Physics, Osnabrück University, Germany

An experimental setup for the study of holographic image recording is presented that uses a new type of hologram recording mechanism in nominally undoped, thermally reduced $LiNbO_3$. By means of single intense ns-laser pulses ($\lambda = 532\,\mathrm{nm}$) short-lived volume gratings with high diffraction efficiencies occur [1,2]. These gratings are based on spatially modulated densities of small bound polarons and can be described as mixed gratings as they originate from both the light-induced absorption of the polarons as well as from a polaronic change of the refractive index. Due to their fast generation on the fs-scale, such small polaron-based gratings offer unique properties needed for real-time holographic applications. We demonstrate the successful application of this type of recording mechanism using cross polarized beams for both recording and read-out. The impact of our findings for ultrafast real-time holography is discussed.

[1] H. Bruening et al., Optics Express 20, 13326 (2012)
[2] M. Imlau et al., Optics Express 19, 15322 (2011)

*Financial support by the DFG (IM37/5 and INST190/137-1) and DAAD (50445542) is gratefully acknowledged.

DF 20: Focus Session: Organic ferroelectrics

Time: Thursday 9:30–12:20 Location: H11

Invited Talk DF 20.1 Thu 9:30 H11

Organic Perovskites : Intriguing Magnetic Ferroelectrics — •Naresh Dalal — Florida State University, Tallahassee, FL 32310, USAA

In an effort to synthesize lead-free perovskite ferroelectrics, we have prepared a new class of metal-organic lattices with a perovskite (ABX3) achitecture[1,2]These are compounds using early transition metals as the A-site, dimethyl amine (or other homologues) as the B site and the O's of a carboxylic acid as the X sites. The new perovskites exhibit order-disorder as well as displacive phase transitions,with ferroelectric or antiferroelectric behaviors. They can become ferro- or antiferromagnets if magnetic ions such as Fe, Cu (II) utilize magnetic ions such as Cu(II) or Mn (II) ions or their combinations thereof . We will present polarization and NMR, specific heat and NMR relaxation data that show these materials to be glasses. The talk will present experimental as well as theoretical data showing these materials exotic ground states.

[1]Jain, Ramachandran, Clark, Zhou, Dalal, Kroto, Cheetham J. Am. Chem. Soc. 2009, 131, 13625-13627. [2]Besara, Jain, Dalal, Kuhns, Reyes, Kroto, Cheetham. Proc. Nat. Acad. Sci,, USA, 2011, 108, 6828-6832.

Invited Talk DF 20.2 Thu 10:10 H11

Ferroelectricity in organic and hybrid organic-inorganic compounds — •Alessandro Stroppa and Silvia Picozzi — CNR-SPIN Via Vetoio, 67100, L'Aquila (Italy)

Ferroelectric materials, whose spontaneous polarizations can be switched under an external electric field, have a wide range of applications in device electronics. The first ferroelectric crystal, Rochelle salt was discovered in 1920. Recent discoveries of ferroelectricity in organic solids have been limited to some well-known polymer ferroelectrics or a few low molecular mass compounds. Computational approaches based on density functional theory represent a valuable tool in order to predict or suggest new organic ferroelectrics with large values of polarization needed for device applications. In particular, the modern theory of polarization is used to estimate the ferroelectric polarization in insulating compounds and symmetry analysis gives an important help for gaining insights into the mechanisms responsible for the ferroelectric polarization. In this contribution we will focus on the description of the ferroelectric properties of organic compounds, based on density functional theory. We will focus on simple organic molecular crystals as well as complex organic-inorganic systems, such a metal-organic frameworks (MOFs). In particular, MOFs with a perovskite topology show promising new routes for the cohexistence of ferroelectricity and magnetism, i.e. multiferroicity.

10 min. break

Invited Talk DF 20.3 Thu 11:00 H11

Coupling of charge and spin order in organic charge transfer salts — •Martin Dressel — 1. Physikalisches Institut, Universität Stuttgart

Organic charge-transfer salts are renown for their conducting and even superconducting properties. But the metallic phase is not stable in reduced dimensions: at low temperatures the electronic charges and spins tend to arrange themselves in an orderly fashion due to relatively strong correlations. There is a growing number of molecular materials, such as TTF-CA, TMTTF, and BEDT-TTF salts, where electronic degrees of freedom and electronic interactions are directly responsible for electric polarization and ferroelectric transition, termed electronic ferroelectricity. This would enable wide applications for organic ferroelectrics in fast switching, sensor and data storage technology.

Recently, it was discovered that charge order not only produces ferroelectricity but also breaks the symmetry of the magnetic degree of freedom in organic quantum spin chains. An intense discussion takes place whether in two-dimensional organic compounds with a high degree of frustration ferroelectric order can induce magnetic order, leading to charge-order driven multiferroicity. There are even first hints for a spin-driven multiferroic state in compounds for which the on-site Coulomb repulsion is reduced making inter-site interaction more important.

No complete picture is possible at this point, nevertheless, we have the vision that the interplay of magnetic and electronic ferroicity paves the way towards organic spintronics.

Invited Talk DF 20.4 Thu 11:40 H11

Electrodynamics and ferroelectricity in two-dimensional molecular solids — •Silvia Tomic[1], Tomislav Ivek[1,2], Marko Pinteric[1,3], Matija Culo[1], Bojana Korin-Hamzic[1], and Martin Dressel[2] — [1]Institut za fiziku, Zagreb, Croatia — [2]1.Physikalisches Institut, Universität Stuttgart, Germany — [3]Fakulteta za gradbeništvo, Univerza v Mariboru, Slovenia

A variety of organics with reduced dimensionality and competing interactions between charges, spins and lattice display a multiplicity of ordering phenomena and complex phase diagrams. Novel forms of the low-temperature phases featuring ferroelectricity in the two-dimensional molecular solids have been in the focus of intense activity in recent years. Open issues concern the nature of collective charge excitations in the charge- and spin-order-driven ferroelectric phases as well as their coupling to applied dc and ac fields. And while some of their features resemble the well-established electrodynamics of conventional charge-density waves in 1D, I will demonstrate that others appear quite different and have not been encountered until now. In the charge-ordered phase with the formation of ferroelectric domains below the metal-to-insulator phase transition, the charge response seems to be reasonably well understood within a recent theoretical model. Conversely, rather intriguing is the dielectric response in Mott insulator phases with either canted antiferromagnetism or spin liquid. The result that neither charge disproportionation nor charge fluctuations could be detected by standard experimental techniques leaves the issue of spin-charge coupling fully open.

DF 21: Resistive Switching (jointly with DF, KR, HL)

Time: Friday 9:30–12:45 Location: H32

DF 21.1 Fri 9:30 H32

***Ab initio* study of defects in $SrTiO_3$ bulk and (100) surfaces** — •Ali Al-Zubi, Gustav Bihlmayer, and Stefan Blügel — Peter Grünberg Institut (PGI) & Institute for Advanced Simulation (IAS), Forschungszentrum Jülich and JARA, 52425 Jülich, Germany

Oxygen vacancies are believed to play a major role in the conduction mechanisms that enable resistive switching in oxide materials. Employing density functional theory (DFT) and the DFT+U model,we use the full-potential linearized augmented plane wave method as implemented in the `FLEUR` code to study the formation of point defects in the perovskite $SrTiO_3$ with varying coordination. We calculated the formation energy of an O-vacancy in both bulk supercells and (100) surface including different, c(2×2) and p(2×2), in-plane unit cells and different terminations. After performing full relaxation, we found that the bulk and SrO-terminated surface have a nonmagnetic, while TiO_2-terminated surface has a ferromagnetic solution. Using the c(2×2) unit cell, the vacancy formation energy was smaller for the bulk than for the SrO- and even TiO_2-terminated surface. On the other hand, the p(2×2) unit cell shows that TiO_2-terminated surface has the lowest formation energy, more than 1 eV lower than the bulk value. Similar comparisons will be presented when including the the DFT+U model

that is used to correct the bulk bandgap and improve the localization of the defect states.

We gratefully acknowledge financial support of the DFG, SFB 917 Nanoswitches–A4 project.

DF 21.2 Fri 9:45 H32

Resistive switching properties in ion beam modified $SrTiO_3$ — •Jura Rensberg, Benjamin Roessler, Christian Katzer, Frank Schmidl, and Carsten Ronning — Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena, Germany

Resistive switching phenomena, which are for instance observed in perovskite-type transition metal oxides, attract intensive attention for their potential application in future nonvolatile memory. Strontium titanate ($SrTiO_3$) exhibits bipolar resistive switching between a high- and a low-resistance state when applying an appropriate electric field. It is often proposed that the underlying mechanism for bipolar resistive switching in $SrTiO_3$ originates from oxygen-vacancy migration along filaments based on extended defects such as dislocations or grain boundaries.

Here we report on well-defined damage formation due to ion irradiation which allows a better control of the lateral and vertical defect arrangements and concentrations. Therefore, we deposited 100 nm single crystalline $SrTiO_3$ thin films with low intrinsic defect concentration on niobium doped $SrTiO_3$ substrates by pulsed laser deposition and implanted these samples with swift heavy gold ions. After irradiation the films were characterized using transmission electron microscopy and Rutherford backscattering spectrometry. Under ion irradiation, the as-deposited crystalline films undergo amorphisation due to the formation and overlap of amorphous tracks. The electrical properties of $SrTiO_3$, i.e. the resistive switching properties are discussed in terms of damage concentration.

DF 21.3 Fri 10:00 H32

Cation defect engineering in SrTiO3 thin films by PLD with Verification and implication on memristive properties — Sebastian Wicklein[1], •Chencheng Xu[1], Alessia Sambri[2], Salvatore Amoruso[2], David Keeble[3], Annemarie Köhl[1], Werner Egger[4], and Regina Dittmann[1] — [1]Peter Grünberg Institut 7, Forschungszentrum Jülich GmbH, Germany — [2]Università degli Studi di Napoli Federico II, Dipartimento di Scienze Fisiche & CNR-SPIN, I-80126 Napoli, Italy — [3]University of Dundee, School of Engineering, Physics and Mathematics, Dundee DD1 4HN, Scotland — [4]University Bundeswehr, D-85577 Munich, Germany

The origin of the c-axis expansion in homoepitaxial STO thin films is investigated by positron annihilation lifetime spectroscopy (PALS): Low laser fluence results in Ti vacancy rich sample while high laser fluence for the Sr vacancy rich sample.

XPS measurement on the ablated spot on the targets shows that increased laser fluence ablates more Ti. The ToF (Time of Flight) data from OES (optical emission spectrometry) indicate a preferred scattering of Ti because of background gas. The two effects together lead to tunable stoichiometry of the film.

In the MIM (metal insulator metal) structure Sr-rich films exhibit the most stable switching behavior and highest on/off ratio, while in the LC AFM (local conducting atomic force microscopy) switching the on/off ratio of Ti is the higest.

DF 21.4 Fri 10:15 H32

Resistive Switching in thermally oxidized Titanium — •Daniel Blaschke[1], Ilona Skorupa[1], Bernd Scheumann[1], Andrea Scholz[1], Peter Zahn[1], Sibylle Gemming[1], Kay Potzger[1], Agnieszka Bogusz[2], and Heidemarie Schmidt[2] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, P.O. Box 510119, 01314 Dresden - Germany — [2]Dept. Electr. Eng. & Inf. Techn., TU Chemnitz, 09107 Chemnitz

In recent years the resistive switching of binary transition metal oxides like NiO, Nb2O5 and TiO2 has attracted considerable attention for application in nonvolatile memory storage systems.

For our investigations we used a thin rutile TiO2 film, which was prepared by the thermal oxidation of a 100nm thick e-beam evaporated Ti film. The oxidation temperatures were varied from 500°C to 800°C at an oxygen partial pressure of 1 atmosphere. We will present the dependence of the crystal structure and the switching behavior on the oxidation temperature as well as an interesting feature on the time-dependent evolution of the resistance during the Reset process.

The project is funded by the Initiative and Networking Fund of the Helmholtz Association (VH-VI-422).

DF 21.5 Fri 10:30 H32

Non-volatile resistive switching in multiferroic YMnO3 thin films — •Agnieszka Bogusz[1,2], Ilona Skorupa[1], Andrea Scholz[1], Oliver G. Schmidt[2,3], and Heidemarie Schmidt[2] — [1]Institute of Ion Beam Physics and Materials Research, Helmholz-Zentrum Dresden-Rossendorf, 01314 Dresden, Germany — [2]Faculty of Electrical Engineering and Information technology, Chemnitz University of Technology, 09107 Chemnitz, Germany — [3]Institute for Integrative Nanosciences, IFW-Dresden, 01069 Dresden, Germany

Intensive research on multiferroic materials [1] is driven by the possibility of creating novel, miniaturized tunable multifunctional devices [2]. This work investigates resistive switching behavior of YMnO3 thin films, which can be utilized in new generation memory devices. Series of YMnO3 films were grown by pulsed laser deposition on Si substrates with Pt bottom electrode at temperatures varying between 500°C and 850°C. Characterization of as-grown samples by X-ray diffraction and scanning electron microscopy was followed by determination of electrical properties of films in metal-insulator-metal (MIM) configuration. Results showed that the YMnO3 films grown at 800°C exhibit the best resistive switching properties with high resistance ratio (>10000) of high over low resistance state. Switching mechanism is ascribed to the structural transitions within the film upon applied current.

[1] A. Bogusz et al., Defect Diffus. Forum 323-325, 115 (2012)

[2] Y. Shuai, H. Schmidt et al., J. Appl. Phys. 109, 124117 (2011); J. Appl. Phys. 111, 07D906 (2012)

DF 21.6 Fri 10:45 H32

Practical guide for validated memristance measurements — •Nan Du[1,2], Yao Shuai[3], Wenbo Luo[3], Christian Mayr[4], Rene Schüffny[4], Oliver G. Schmidt[1,2], and Heidemarie Schmidt[1] — [1]TU Chemnitz, Faculty of Electrical Engineering and Information Technology, 09107 Chemnitz, Germany — [2]Institute for Integrative Nanosciences, IFW Dresden, Helmholtzstraße 20, 01069 Dresden, Germany — [3]Helmholtz Research Center Dresden-Rossendorf, 01328 Dresden, Germany — [4]TU Dresden, Department of Electrical Engineering and Information Technology, 01062 Dresden, Germany

L.O. Chua predicted rather simple charge-flux curves for active and passive memristors and presented active memristor circuit realizations already in the 70s. However, despite the fact that memristors give rise to complicated hysteretic current-voltage curves, memristors are traced in current-voltage curves. Here we give a practical guide how to use normalized charge-flux curves for the prediction of current-voltage characteristics of memristors with stable electrical characteristics in dependence on the shape and amplitude of the input voltage or input current signals. In the case of memristive BiFeO3 thin film capacitor structures [1] the normalized charge-flux curves superimpose for different numbers of measurement points and a different measurement time per measurement point. Such normalized charge-flux curve can be used for the prediction of current-voltage characteristics of plastic synapses in neuromorphic systems [2]. [1] Y. Shuai et al., J. of Appl. Phys. 109, 124117-124117-4 (2011). [2] C. Mayr et al., NIPS 2012, in press.

Coffee break (15 min)

DF 21.7 Fri 11:15 H32

Creating an Oxygen Gradient in Nb_2O_5 by Argon Irradiation for Resistive Switching Memory — •Helge Wylezich[1], Hannes Mähne[1], Daniel Blaschke[2], Stefan Slesazeck[1], and Thomas Mikolajick[1] — [1]NamLab gGmbH, Nöthnitzer Str. 64, D-01187 Dresden — [2]Helmholtz-Zentrum Dresden-Rossendorf, D-01314 Dresden

It is common knowledge that an oxygen gradient is mandatory for bipolar resistive switching [1]. We confirmed this by investigations of thin films with Nb_2O_5 as switching layer. Samples with two inert Pt electrodes are nearly symmetric and do not show bipolar resistive switching behavior. Replacing one Pt electrode with a reactive one – for example Al or Nb – results in an unsymmetrical device. These samples could be switched reproducible. It is also possible to create an oxygen gradient by depositing a stack of two different niobium oxide layers. While the first layer consists of stoichiometric Nb_2O_5 the second layer is sputtered substoichiometric [2].

A new approach is to get an oxygen gradient by irradiating the oxide layer with argon. Two effects appear: The argon sputters the surface of the Nb_2O_5 layer and so the oxide thickness decreases. Because the Nb-atoms are heavier than the O-atoms, the oxygen sputter rate is

higher and the surface becomes niobium rich. The investigated samples consist of a Pt-Nb_2O_5-Pt stack. The oxide layer was irradiated by different Ar-doses before top electrode deposition. At the highest dose Φ = 3e16 cm^{-2} the resulting oxygen gradient enables resistive switching.
[1] Bertaud et al. (TSF 520, 2012)
[2] Mähne et al. (MEMCOM Workshop 2012)

DF 21.8 Fri 11:30 H32

Multilevel resistive switching in Ar+ irradiated BiFeO3 thin films — •Yao Shuai[1], Xin Ou[2], Wenbo Luo[2], Nan Du[3], Danilo Bürger[2,3], Oliver G. Schmidt[3,4], and Heidemarie Schmidt[3] — [1]State Key Laboratory of Electronic Thin Films and Integrated Devices, UESTC, China — [2]Helmholtz-Zentrum Dresden-Rossendorf e.V., Institute of Ion Beam Physics and Materials Research, Germany — [3]University of Technology Chemnitz, Faculty of Electrical Engineering and Information Technology, 09107 Chemnitz, Germany — [4]Institute for Integrative Nanosciences, IFW Dresden, Helmholtzstraße 20, 01069 Dresden, Germany

Low energy Ar+ ion irradiation has been applied to an Au/BiFeO3/Pt capacitor structures before deposition of the Au top electrode. The irradiated thin films exhibit multilevel resistive switching without detrimental resistance degradation, which makes the intermediate resistance states more distinguishable as compared to the non-irradiated thin film [1]. The stabilization of resistance states after irradiation is discussed based on the analysis of conduction mechanism during the resistive switching in BiFeO3 with a rectifying Au top electrode and a nonrectifying Pt bottom electrode [2]. Furthermore, it is shown how the conduction mechanisms change from room temperature to 423 K.
[1] Y. Shuai, X. Ou et al., IEEE Device Letters, 2012, in press. [2] Y. Shuai, S. Zhou, D. Bürger, M. Helm, H. Schmidt, J. Appl. Phys. 109 (2011), 124117-4.

DF 21.9 Fri 11:45 H32

Influence of thickness ratio on resistive switching in BiFeO3:Ti/BiFeO3 bilayer structures — •Tiangui You[1], Wenbo Luo[2], Yao Shuai[1,2], Nan Du[1], Danilo Bürger[1,3], Ilona Skorupa[3], Oliver G. Schmidt[1,4], and Heidemarie Schmidt[1] — [1]Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]University of Electronic Science and Technology of China, 610054 Chengdu, China — [3]Helmholtz-Zentrum Dresden-Rossendorf, P.O. Box 510119, 01314 Dresden, Germany — [4]IFW-Dresden, 01069 Dresden, Germany

Nonvolatile resistive switching in BiFeO3 (BFO) [1] has attracted increasing attention; however, the underlying resistive switching mechanism is still controversial which restricts its application in nonvolatile memory devices. BFO:Ti/BFO bilayer structures with a 540 nm thick BFO layer and different thickness of BFO:Ti layer were grown on Pt/Sapphire substrates by pulsed laser deposition using the same growth conditions. Circular Au top electrodes were prepared with magnetron sputtering. Au/BFO/Pt single layer structures show a symmetric I-V curve without hysteresis due to the formation of Schottky contacts at both the top and bottom interface. However, Au/BFO/BFO:Ti/Pt bilayer structures exhibit an obvious resistive switching behavior under both voltage polarities. The influence of the thickness of BFO:Ti on the conduction mechanisms in Au/BFO/BFO:Ti/Pt bilayer structures is discussed to reveal similarities and differences between single and bilayer structures.

Reference [1] Y. Shuai et al., J. Appl. Phys., 109, 124117(2011)

DF 21.10 Fri 12:00 H32

Nanoscale resistive switching in epitaxial and polycrystalline BiFeO3 thin films — •Yao Shuai[1], Wenbo Luo[1], Chuangui Wu[1], Wanli Zhang[1], Oliver G. Schmidt[2,3], and Heidemarie Schmidt[2] — [1]State Key Laboratory of Electronic Thin Films and Integrated Devices, UESTC, China — [2]University of Technology Chemnitz, Faculty of Electrical Engineering and Information Technology, 09107 Chemnitz, Germany — [3]Institute for Integrative Nanosciences, IFW Dresden, 01069 Dresden, Germany

Nonvolatile [1], bipolar, and multilevel [2] resistive switching has been observed in ca. 500 nm thick polycrystalline BiFeO3 thin films with rectifying, circular Au top electrodes and a nonrectifying Pt bottom electrode. The diameter of the Au top electrodes amounts to ca. 0.5 mm. By scanning a positionable top contact with a diameter of only 10 nm over polycrystalline BiFeO3 thin films under a constant applied dc voltage, the high and low resistance state can be locally written and afterwards read. It has been observed that for thinner polycrystalline BiFeO3 films with a thickness below 300 nm, no resistive switching can be observed either with large or with small scale top contacts. Bipolar resistive switching can also be realized in ca. 50 nm thick epitaxial BiFeO3 films on SrRuO3/SrTiO3 with a positionable top contact. This resistance is mainly determined by the ferroelectric polarization and the barrier height of the top and bottom contact. For thicker epitaxial BiFeO3 films the unique relation between ferroelectric polarization and resistance state is diminished.
[1] Y. Shuai et al., J. Appl. Phys. 109 (2011). [2] Y. Shuai et al., IEEE Device Letters (2012) in press.

DF 21.11 Fri 12:15 H32

An electronic implementation of amoeba anticipation — •Mirko Hansen[1], Karlheinz Ochs[2], Martin Ziegler[1], and Hermann Kohlstedt[1] — [1]Faculty of Engineering, Christian-Albrechts-Universität zu Kiel, 24143 Kiel, Germany — [2]Ruhr-Universität Bochum, 44780 Bochum, Germany

In nature, the capability to memorize environmental changes can already be observed in unicellular organisms like amoebas[1]. An amoeba changes its locomotive speed when it is exposed to unfavorable conditions. If a series of unfavorable conditions is applied, the amoeba later on behaves similarly on a single incident. Pershin et al.[2] are able to emulate this behavior using a simple resistive switching circuit model consisting of an inductor, a capacitor and a resistive switching device. We experimentally implement this model using a resistive switching device. A theoretical analysis of the circuit is presented to gain further insight into the functionality of this model and to give advice for the implementation of resistive switching devices in LC-circuits.

[1] T. Saigusa, A. Tero, T. Nakagaki, Y. Kuramoto, Phys. Rev. Lett. **100**, (2008) 018101
[2] Y. V. Pershin, S. La Fontaine, M. Di Ventra, Phys. Rev. E **80**, (2009) 021926

DF 21.12 Fri 12:30 H32

Lattice dynamics in Sb- and Te-based phase-change materials — •Ronnie Ernst Simon[1,2], Ilya Sergueev[3], and Raphaël Pierre Hermann[1,2] — [1]Jülich Centre for Neutron Science JCNS and Peter Grünberg Institut PGI, Jara-FIT Forschungszentrum Jülich GmbH, D-52425 Jülich, Germany — [2]Faculté des Sciences, Univer- sité de Liège, B-4000 Liège, Belgium — [3]Deutsches Elektronen- Syn- chrotron, D-22607 Hamburg, Germany

Phase-change materials exhibit a significant change of the optical reflectivity and electrical resistivity upon crystallization which renders these materials applicable for optical storage devices and non-volatile electronic memories. In order to understand the switching kinetics between the amorphous and the metastable crystalline states a detailed knowledge of the lattice dynamics of the different phases is crucial. A suitable technique for the investigation of lattice dynamics is nuclear inelastic scattering (NIS) which gives access to the element specific density of phonon states (DPS). We performed NIS measurements in Sb- and Te-based phase-change materials in the amorphous and crystalline phases. We have recently extended the experimental possibilities by demonstrating the feasibility of high pressure NIS measurements, up to 75 GPa, in Sb_2Te_3 .
The ESRF is acknowledged for the provision of synchrotron radiation beamtime at ID18.

DF 22: Poster II

Magnetic Measurement Methods, Magnetic Thin Films,Micro- and Nanostructured Materials, Magnetization Dynamics,Computational Magnetism,Spin-dependent Transport Phenomena,Spincaloric Transport, Spin-Injection and - Currents in Heterostructures,Spintronics

Time: Friday 10:30–13:30 Location: Poster D

DF 22.1 Fri 10:30 Poster D

Nanoscale sensing of a magnetic topology — •Alexander Gerstmayr[1], Raphael Bindel[2], Dominik Reitzle[3], Marcus Liebmann[2], Markus Morgenstern[2], Berndt Koslowski[3], and Fedor Jelezko[1] — [1]Institut für Quantenoptik, Universität Ulm, Deutschland — [2]Institut IIb, RWTH Aachen, Deutschland — [3]Festkörperphysik, Universität Ulm, Deutschland

For years, the nitrogen-vacancy (NV) center in diamond has been in the spotlight for studies of electron spin coupling. Also the coupling to other near color centers in diamond was studied recently. We will explore single atom control techniques for sensing external spins and imaging them using scanning probe microscopy. External magnetic fields cause a frequency shift of the electron spin resonance of our NV-center, which is detectable by Optically Detected Magnetic Resonance (ODMR). For even higher magnetic sensitivity (down to few nT of AC field), pulsed experiments are performed. One single NV-center located in a diamond tip is the main part of the future Atomic Force- and Magnetic Resonance Microscope (AFM/MRM). Due to the possibility of single-spin detection in NV-centers under ambient conditions, this combination of AFM and MRM is planned to work even at room temperature as well as also at low temperature (4 K). We will be able to locate single spins on the nanoscale.

DF 22.2 Fri 10:30 Poster D

Exploring the magnetization dynamics and interaction effects of single microparticles with Hall-magnetometry — •Martin Lonsky[1], Merlin Pohlit[1], Sven Heinz[1], Pintu Das[1], Natalija van Well[1], Yuzo Ohno[2], Hideo Ohno[2], and Jens Müller[1] — [1]Physikalisches Institut, Goethe-Universität, Frankfurt (M), Germany — [2]Laboratory for Nanoelectronics and Spintronics, Tohoku University, Sendai, Japan

Micro-Hall-magnetometry is a powerful technique for studying the magnetization dynamics of micrometer- and nanometer-scale particles. Our sensors are based on the two-dimensional electron gas in GaAs/AlGaAs heterostructures and allow for magnetic stray-field measurements of *individual* micron-sized particles positioned on one or several lithographically defined Hall crosses. Besides the standard experiment of measuring magnetization switching in ferromagnets, we extend the fields of application of this technique to susceptibility and static and dynamic magnetic flux measurements. In order to further optimize the compatibility with standard fabrication methods of nanotechnology we aim to establish planar contact geometries as opposed to In/Sn soldered contacts. We recently demonstrated the high resolution of our devices by tracking the domain wall dynamics in a single CrO_2 micro-grain that has been positioned with a micromanipulator [1]. A further step will be to study interaction effects between individual grains and the influence of intrinsic and extrinsic pinning on the domain wall dynamics.

[1] P. Das et al., APL 97, 042507 (2010).

DF 22.3 Fri 10:30 Poster D

Magnetometry on the nanometer scale using nanogranular tunnel resistors prepared by focused electron-beam-induced deposition — •Peter Gruszka, Marcel Winhold, Christian H. Schwalb, and Michael Huth — Physikalisches Institut, Goethe-Universität, Max-von-Laue-Str.1, 60438 Frankfurt am Main

By using conventional methods of magnetometry one can experience difficulties when having small amounts of sample materials. Our novel approach uses focused electron-beam-induced deposition (FEBID) for the realization of small magnetic structures using the precursor $Co_2(CO)_8$ (Dicobaltoctacarbonyl). The magnetic structures are deposited on thin cantilever structures that are equipped with nanogranular tunnel resistors (NTRs) at the bending edge of the cantilever also prepared by FEBID.[1] Applying an external magnetic field to the cantilever induces a magnetic torque resulting in a deflection of the cantilever that can be measured due to a resistance change of the NTR sensor elements. The all-electric measurement enables us to measure precisely the temperature dependent magnetic properties of sample volumes as small as $1\mu m^3$.

[1] Schwalb et al., Sensors 2010, 10, 9847-9856

DF 22.4 Fri 10:30 Poster D

Treshold magnetic circular dichroism as a contrast mechanism for imaging magnetization dynamics of thin films — •Maximilian Staab, Hans-Joachim Elmers, Mathias Kläui, and Gerd Schönhense — Johannes Gutenberg-Universität, 55099 Mainz, Germany

Investigations of thin magnetic films like Co/Pt or Co/Au promise novel findings to overcome existing limits of data storage devices. Threshold magnetic circular dichroism (MCD) in photoemission is a phenomenon which allows gathering information about the details of the electronic structure near E_F [1]. Photons generated from a femtosecond laser excite electrons at the magnetic surface and eject them from the material. The yield of electrons is directly influenced by the relative orientation of the magnetization direction of the surface layer and the helicity of the incoming photons. By changing the helicity one obtains yield asymmetries of the order of 10% and more, making threshold MCD a great contrast mechanism for imaging dynamical processes in magnetic materials.

The combination of photoemission electron microscopy with MCD sensitivity and a femtosecond laser setup is capable of investigating magnetization dynamics with great spatial and time resolution. The process of ultrafast demagnetization and the current-induced domain wall motion by spin torque transfer are two very interesting phenomena which will be explored.

Project funded by DFG EL172/15.

[1] K. Hild et al., Phys. Rev. B 82, 195430 (2010)

DF 22.5 Fri 10:30 Poster D

Manipulating the Heat Conductivity of $La_{0.67}Ca_{0.33}MnO_3$ using External Magnetic Fields — •Christoph Euler, Christian Mix, Tino Jäger, Ramudu Machavarapu, Mathias Kläui, and Gerhard Jakob — University of Mainz, Germany

Recently research has been conducted on the interaction between electron spin and heat conduction. It was shown that heat currents can generate spin currents in magnetic nanostructures, which in turn can manipulate the magnetization [1]. Such spin-caloric mechanisms are frequently studied in thin films.

$La_{0.67}Ca_{0.33}MnO_3$ (LCMO) is a doped manganese oxide displaying huge magnetoresistivity (CMR)[2]. LCMO is a paramagnetic insulator above $T_C \approx 230\,K$ and ferromagnetic and semiconducting below. LCMO films ($d \approx 200\,nm$) are deposited on $SrTiO_3$ substrates using pulsed laser deposition in an O_2 atmosphere. The samples are characterized using XRD, AFM and VSM. A 3ω method is then used to determine the out-of-plane thermal conductivity.

The transport properties of LCMO have been studied previously [3]. In a material displaying CMR, by virtue of the Wiedemann-Franz law it should also be possible to modify the heat conductivity of a sample by applying external magnetic fields in a low-temperature magnetic cryostat. First results of the thermal conductivity are presented.

[1] K. Uchida et al., Nature 455, 778 (2008).
[2] R. von Helmolt et al., Phys. Rev. Lett. 71 (1993) 2331.
[3] G. Jakob et al., Phys. Rev. B58 (1998) 14966.

DF 22.6 Fri 10:30 Poster D

Effects of mechanical stress to GMR/TMR elements — •Stefan Niehörster, Andy Thomas, and Günter Reiss — Universität Bielefeld, Germany

By applying a mechanical stress to thin film giant magnetoresistance (GMR) and tunnel magnetoresistance (TMR) elements, it is possible to influence their resistive behavior because of the inverse magnetostriction. Dependent on the direction between the applied mechanical stress and the magnetic field, it is possible to increase/decrease the GMR/TMR ratio and to influence the shape of their hysteresis. With the applied stress perpendicular to the magnetic field, the TMR ratio decreased from 192% to 151%. A parallel stress increased the TMR ratio from 193% to 208%. In this case, the applied stress was just limited by the mechanical breakdown of the wafer. Otherwise, the changes in the ratios and the shape of the hysteresis were reversible.

DF 22.7 Fri 10:30 Poster D

Development of a maganite-film-based AMR sensor for low magnetic fields using the planar Hall effect — •Camillo Ballani, Sebastian Hühn, Markus Jungbauer, Markus Michelmann, and Vasily Moshnyaga — I. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

The anisotropic magnetoresistance (AMR) is widely used for sensing of both direction and absolute value of magnetic fields. Besides conventionally used ferromagnetic metallic materials, like permalloy ($Ni_{80}Fe_{20}$), thin epitaxial manganite films, e.g. $La_{0.7}(Sr_{1-y}Ca_y)_{0.3}MnO_3$, show large AMR ratios at temperatures slightly below T_C, which can be tuned close to room temperature by changing the Sr/Ca ratio.[1] For a special AMR geometry, called "planar

Hall effect", the measured transverse voltage is directly proportional to the sample magnetization, M, thus allowing one to obtain very high field sensitivity at low fields $H \lesssim H_C$. With the goal to achieve low H_C and high AMR ratios, we have grown thin manganite films on $SrTiO_3$ substrates with different orientations by metalorganic aerosol deposition technique and studied the dependence of planar Hall effect on the temperature and applied magnetic field. Using the optimized films, we developed a prototype of a manganite-film-based magnetic field sensor. Financial support from EU FP 7 Project IFOX (interfacing oxides) is acknowledged.

[1] J. Appl. Phys. 93, 6354 (2003)

DF 22.8 Fri 10:30 Poster D

Magnetic and transport properties of MnSi thin films — •Josefin Engelke[1], Niklas van Elten[1], Tommy Reimann[1,2], Dirk Menzel[1], and Stefan Süllow[1] — [1]Inst. für Physik d. Kond. Materie, TU Braunschweig, Germany — [2]Forschungs-Neutronenquelle Heinz Maier-Leibnitz (FRM II), TU München, Germany

The ferromagnetic compound MnSi has recently aroused great interest since a variety of different phases is observed in the magnetic phase diagram. Besides a helical spin structure a topologically stable skyrmion phase occurs in a small temperature region close to the ordering temperature. By reducing the dimensionality from bulk to thin films it is expected that the skyrmions are present over a larger temperature regime. Using molecular beam epitaxy we have grown MnSi thin films by simultaneous deposition of Mn and Si. Magnetization and magnetoresistivity measurements have been carried out and related to the magnetic phase diagram. We observe a thickness dependence of the ordering temperature, which can be explained by the reduction of spin-spin interactions in the vicinity of the film surface. In comparison to bulk MnSi critical magnetic fields are enhanced, which is interpreted in terms of the reorientation of the helix affected by the film anisotropy.

DF 22.9 Fri 10:30 Poster D

Towards novel functionality with metal and complex oxide thin films prepared with molecular beam epitaxy — •Alexander Weber[1], Markus Waschk[1], Alexandra Steffen[2], Sabine Pütter[2], and Thomas Brückel[1] — [1]Jülich Centre for Neutron Science JCNS-2 und Peter Grünberg Institut PGI-4: Streumethoden, Forschungszentrum Jülich GmbH — [2]Jülich Centre for Neutron Science JCNS, Forschungszentrum Jülich GmbH, Außenstelle am FRM II, Garching

At the Jülich Centre for Neutron Science two state of the art Oxide Molecular Beam Epitaxy systems were commissioned in 2010. Up to now we managed to produce thin metal and oxide films in single layers as well as multilayers, like Fe/Cr, LaSrMnO3 a.s.f. with high crystalline quality and very low roughness. Here we present the results on LaMnO3/SrMnO3 (LMO/SMO) multilayers grown on SrTiO3 with inter layer roughness of one mono layer. The multilayers show an interface induced ferromagnetic behavior within the LMO in contrast to the antiferromagnetic behavior of the single layers. The structural analysis concerning layer thickness and unit cell size was done with X-ray reflectometry and X-ray diffraction. We carried out a thickness dependent study of the magnetic moment induced by the interfaces with SQUID magnetometry. Here we observed a raise in the net magnetic moment of the LMO with decreasing layer thickness. To study the depth resolved magnetization profile within the LMO we measured several multilayers with varying layer thickness on D17 at the ILL. The results fit well to our simple model for the magnetic profile.

DF 22.10 Fri 10:30 Poster D

Conical Spin-Spiral State in an Ultrathin Film — •N. Romming[1], Y. Yoshida[1], S. Schröder[2], P. Ferriani[2], D. Serrate[1], A. Kubetzka[1], K. von Bergmann[1], S. Heinze[2], and R. Wiesendanger[1] — [1]Institute of Applied Physics, University of Hamburg, Jungiusstrasse 11, D-20355 Hamburg, Germany — [2]Institute for Theoretical Physics and Astrophysics, Christian-Albrechts-Universität zu Kiel, D-24098 Kiel, Germany

We report a transverse conical spin spiral as the magnetic ground state of a double-layer Mn on a W(110) surface. Using spin-polarized scanning tunnelling microscopy, we find a long-range modulation along the [001] direction with a periodicity of 2.4 nm coexisting with a local row-wise antiferromagnetic contrast. First-principles calculations reveal a transverse conical spin-spiral ground state of this system which explains the observed magnetic contrast. The canting of the spins is induced by higher-order exchange interactions, while the spiralling along the [001] direction is due to frustrated Heisenberg exchange and Dzyaloshinskii-Moriya interaction. In addition, we show how the spin spiral's cone angle can be determined experimentally and how this sample can be used as a reference system to fully characterize the spin direction of SP-STM tips.

DF 22.11 Fri 10:30 Poster D

Growth of thin $La_{0.7}Sr_{0.3}MnO_3$ films on $SrTiO_3$ substrates with different orientations — •Danny Schwarzbach, Markus Jungbauer, Sebastian Hühn, Markus Michelmann, and Vasily Moshnyaga — I. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Thin film peculiarities like oxygen vacancies, epitaxial strain, orbital reconstruction at the interface and especially the polar catastrophe are of great interest for the physics and technology of correlated oxide films. We studied the growth and preparation of epitaxial films of $La_{0.7}Sr_{0.3}MnO_3$ with a thickness $d = 5-120$ nm on $SrTiO_3$ substrates with (100), (110) and (111) orientations, to get more insight on the above effects.

All films were found to be coherently strained and show qualitatively similar ferromagnetic and metallic behaviour. However, the orientation of substrates influences significantly the values of Curie point T_C, metal-to-insulator transition temperature T_{MI}, coercive field H_C and magnetic anisotropy.

Especially the (111) films show the highest T_C and T_{MI} as well as the lowest H_C. For example, the film with $d = 30$ nm reveals $T_C = 362$ K and $H_C(5\text{ K})$ less than 2 - 5 Oe, which indicates practically the absence of magnetic anisotropy. The results are discussed within the orbital reconstruction and polar catastrophe, which both depend on the crystal orientations.

Support of EU Seventh Framework Programme via IFOX is acknowledged.

DF 22.12 Fri 10:30 Poster D

Exchange bias in DyCo/NiFe bilayer — •Kai Chen[1], Dieter Lott[1], Andreas Schreyer[1], R.S Iskhakov[2,3], S.V Stolyar[2,3], and V.Yu Yakovchuk[2] — [1]Institute for Materials Research, Helmholtz-Zentrum Geesthacht, 21502 Geesthacht , Germany — [2]Kirensky Institute of Physics SB RAS, Krasnoyarsk, 660036,Russia — [3]Siberian Federal University, Krasnoyarsk, 660041, Russia

High in-plane exchange bias up to 40 mT at room temperature was found through-out the whole hard ferrimagnetic layer of DyCo which is coupled to NiFe layer. The exchange bias effects can be achieved here by magnetizing the DyCo in perpendicu-lar direction in respect to the film plane. The direction of the shifts of the in-plane hysteresis is dependent on the direction of the pre-magnetization in the one or other direction. Results from magnetic optical Kerr effect (MOKE), X-ray magnetic cir-cular dichorism (XMCD) and Polarized Neutron Reflectometry (PNR) are discussed to investigate the mechanism behind.

DF 22.13 Fri 10:30 Poster D

Magnetization reversal analysis of thin magnetic films studied by magnetooptic Kerr effect including superimposed uniaxial and cubic magnetic anisotropy — •Timo Kuschel[1], Jaroslav Hamrle[2], Jaromir Pistora[2], Kesami Saito[3], Subrojati Bosu[3], Yuya Sakuraba[3], Koki Takanashi[3], Henrik Wilkens[4], and Joachim Wollschläger[4] — [1]University of Bielefeld, Germany — [2]Technical University of Ostrava, Czech Republic — [3]Tohoku University of Sendai, Japan — [4]University of Osnabrück, Germany

Fe and $Co_{50}Fe_{50}$ films on MgO(001) are investigated by vectorial magnetometry via magnetooptic Kerr effect (MOKE). Measurements using s- and p-polarized incident light and an external magnetic field either parallel or perpendicular to the incidence plane of light are performed. Additionally, different in-plane orientations of the crystalline samples with respect to the external magnetic field are analyzed.

The observed magnetic reversal processes reveal two in-plane magnetic easy axes (MEAs) of different strength which are not orthogonal. Atypical magnetization curves including multidomain states with some magnetic moments providing antiparallel alignment to the external field (if projected to the direction of the external field) confirm the appearance of differently strong MEAs. This magnetic structure can be explained by a cubic magnetic anisotropy (CMA) induced by the crystalline film structure superimposed by an additional uniaxial magnetic anisotropy (UMA) which is not parallel to one of the MEAs of the CMA. The results are compared with regular magnetic films having a UMA parallel to one of the MEAs of the CMA.

DF 22.14 Fri 10:30 Poster D

Raman spectroscopy on thin manganite films — •Sebastian Merten[1], Sebastian Hühn[1], Antje Krüger[1], Christin Kalkert[1], Burkhard Schmidt[2], and Vasily Moshnyaga[1] — [1]I. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Abteilung Mineralogie, Geowissenschaftliches Zentrum, Georg-August-Universität Göttingen, Goldschmidtstraße 1, 37077 Göttingen, Germany

A commonly believed picture is the colossal magnetoresistance effect in thin manganite films is related to a first order magnetic phase transition which can be also coupled to a structural phase transition from an orthorhombic (Pnma) to a rhombohedral ($R\bar{3}c$) structure. This structural change can be reflected in Raman spectra which provide information of the phonon modes specific to the structural phases involved. Here we report on the Raman spectroscopy of epitaxial manganite films of $La_{0.7}Sr_{0.3}MnO_3$, $La_{0.7}Ca_{0.3}MnO_3$ and $(La_{65}Pr_{45})_{0.7}Ca_{0.3}MnO_3$ grown on MgO (100)-substrates. We observed the known Raman peaks characteristic for both structures as was identified in previous works. Moreover, the details of the phase transition and phase competition could be obtained from the temperature behaviour of the Raman peaks. In addition first results of Surface-enhanced Raman spectroscopy (SERS) will be presented on $La_{0.7}Ca_{0.3}MnO_3$. We covered the surface of the films with commercially available gold nanoparticles with the dimensions of 25x60 nm and detected an enhancement of 2-3 orders of magnitude. SFB 602(TPA2) is acknowledged.

DF 22.15 Fri 10:30 Poster D

Magnetocaloric effect in layered thin film Heusler-type materials — •Anna Möhn[1,2], Anja Waske[1], Niclas Teichert[3], Andreas Hütten[3], and Jürgen Eckert[1,4] — [1]IFW Dresden, Institute for Complex Materials, Dresden, Germany — [2]TU Dresden, Institut für Festkörperphysik, Dresden, Germany — [3]Universität Bielefeld, Fakultät für Physik, Bielefeld, Germany — [4]TU Dresden, Institut für Werkstoffwissenschaft, Dresden, Germany

The magnetocaloric effect (MCE) is the increase of temperature of a material upon the application of a magnetic field and decrease when it is removed [1]. Materials which exhibit a giant MCE have a strong coupling between crystallographic structure and magnetism [2]. However, the abrupt structural change that is the origin of "giant" magnetocaloric effects, also leads to significant strain occuring in the material. The effect of strain on the magnetocaloric performance is yet unclear. To systematically study the influence of strain, we investigate a bilayer model system which introduces strain by a lattice mismatch at the interface of two different magnetocaloric materials. Experimentally we investigated sputtered thin film samples of different NiMnGa, NiMnSn and NiCoMnSn composition which show regular and inverse MCE, respectively. We determined the magnetic properties of the thin films as a function of temperature and applied magnetic field. Furthermore we determined the magnetic properties of multilayered samples which are consist of different NiMnGa and NiMnSn alloys.

[1] Giauque et. al., Phys. Rev., 43, 768 (1933)
[2] Liu et. al., Nature Mater., 11, 620 (2012)

DF 22.16 Fri 10:30 Poster D

Magnetic Properties of the Fe-GaAs(110) Interface with ultrathin films investigated by In-Situ MOKE Measurements — Tim Iffländer, Martin Wenderoth, •Steffen Rolf-Pissarczyk, Steffen Weikert, Lars Winking, and Rainer G. Ulbrich — IV. Phys. Inst., Georg-August-Universität Göttingen

We have investigated the magnetic properties of ultrathin Fe Films epitaxially grown on the GaAs(110) and the InAs(110) surface. The films were deposited in a two-step process at 130 K to avoid any interface mixing. In-situ STM and LEED measurements proved an abrupt interface and an epitaxial growth of the Fe-GaAs system. In-situ magneto-optical kerr effect (MOKE) measurements at RT were conducted for different longitudinal, transversal and polar orientations of the applied magnetic field with respect to the (110) surface of the GaAs sample. For the 2-3 ML thickness regime deposited at low-temperature an interchange of the easy-axis from the [110] to the [001]-axis was in contrast to at RT grown Fe films observed. Moreover, we found a magnetic anisotropy along the [001]-axis which is connected to a polar magnetization component.

In addition, several MOKE hysteresis loops for different magnetic field directions and a fixed laser beam were taken to distinguish easy-axis from hard-axis behaviour. Hence we were able to show that in comparison to the in-plane [001]-axis the out-of plane direction is not a magnetic easy-axis. These results indicate a strong spin-orbit coupling in these compound systems. This work was supported by the Deutsche Forschungsgemeinschaft SFB 602 TP A7 and SPP 1285.

DF 22.17 Fri 10:30 Poster D

Domain formation in laminated FeCoBSi films for ME sensor applications — •Necdet Onur Urs[1], Christine Kirchhof[1], Dirk Meyners[1], Robert Jahns[2], Eckhard Quandt[1], Reinhard Knöchel[2], and Jeffrey McCord[1] — [1]Institute for Materials Science, Kiel University, Germany — [2]Institute of Electrical and Information Engineering, Kiel University, Germany

Magnetic domain activities in magnetoelectric (ME) sensors severely limit the sensor sensitivity, which can be solved by laminating the magnetic layers with non-magnetic materials. Magnetron-sputtered FeCoBSi/Ta multilayer thin films of different thicknesses and their single layer counterparts with the same total thickness are investigated by magneto-optical Kerr microscopy. All samples are annealed under a magnetic field to obtain a well defined uniaxial anisotropy. The domain structure changes depending on the FeCoBSi layer thickness [1]. The coupling between the domains of the adjacent magnetic layers through magneto-static interaction causes the domain walls to align themselves to their peers in the neighboring layers eliminating the magnetic charges from the interior of the films [1]. Magnetic hysteresis loops show a significant drop in coercivity [2]. In patterned samples, the magnetic closure domains display a transition from a modified spike domain to a closure domain structure and the domain rotation starts to become dominant in the magnetization reversal process. As a result Barkhausen noise in ME-sensors is reduced considerably. [1] J. C. Slonczewski, B. Petek, B. E. Argyle, IEEE Transactions on Magnetics (1988) [2] J. McCord and J. Westwood, J. Appl. Phys. 87, 6592 (2000)

DF 22.18 Fri 10:30 Poster D

FMR and MOKE characterization of $Co_{40}Fe_{40}B_{20}$ thin films — •Andres Conca, Jochen Greser, Thomas Sebastian, Stefan Klingler, Britta Leven, and Burkard Hillebrands — FB Physik und Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

Magnetic tunneling junctions are being widely used for read heads in hard discs, sensors in robotics or machine controllers. A major breakthrough was provided by the introduction of the alloy CoFeB. With a control of the exact stack composition and of the annealing conditions tunelling magnetoresistance ratios (TMR) as large as 604% [1] have been reported.

Here, we report on the characterization of $Co_{40}Fe_{40}B_{20}$ thin films deposited by magnetron rf-sputtering on SiO_x substrates. The dynamic properties and material parameters were studied by measuring the ferromagnetic resonance using a stripline-vector network analyzer (VNA-FMR). The quasi-static anisotropic switching properties were measured with a magneto-optical Kerr effect setup in longitudinal geometry with a rotational sample stage. A discussion of the values of the saturation magnetization, the Gilbert damping parameter and the exchange constant is presented.

Financial support by the MBWWK of Rhineland-Palatinate and the EFRE programm in the frame of the Spin Technology Platform (STeP) is gratefully acknowledged.

[1] S. Ikeda, *et al*, Appl. Phys. Lett. **93**, 082508 (2006).

DF 22.19 Fri 10:30 Poster D

Post-annealing effects in the Heusler compound Co_2MnSi revealed by magnetoresistance and anomalous Hall effect measurements — •Inga-Mareen Imort, Patrick Thomas, Savio Fabretti, and Andy Thomas — Thin Films and Physics of Nanostructures, Bielefeld University, Germany

Co-based Heusler compounds are prominent candidates for spintronic application due to the predicted half-metallic behavior, i.e. 100% spin polarization at the Fermi level, and the required high Curie temperatures. The degree of structural disorder can affect the spin polarization, and therefore, the electrical and magnetic transport properties. Local disorder as well as crystallographic quality of thin films can be influenced by post-annealing. The Co_2MnSi layers were deposited using dc/rf-magnetron sputtering on single-crystal MgO (001) substrates, and ex-situ annealed at temperatures in the range from 350°C to 500°C. The structural quality of our samples, especially the crossover from amorphous to crystalline structure, was tested by X-ray diffraction scans. After etching typical Hall bar structures, we mea-

sured the temperature and field dependent evolution of the anomalous Hall resistance ρ_{AHE} and the longitudinal resistance ρ_{xx} with the sample annealing temperature, in order to investigate the influence of defects, i.e. dislocations and grain boundaries, and atomic disorder on the magnetoresistance and the anomalous Hall effect in Co_2MnSi. This work has been supported by the NRW MIFW.

DF 22.20 Fri 10:30 Poster D

On the micromagnetic origin of the spin-reorientation transition in Ni_xPd_{1-x} alloys — •Daniel Gottlob[1,2], Ingo Krug[1], Florian Nickel[1], Hatice Doganay[1], Stefan Cramm[1], and Claus M. Schneider[1,2] — [1]Peter-Gruenberg Institut 6, Forschungszentrum Juelich, 52425 — [2]Fakultaet fuer Physik, Universitaet Duisburg-Essen, 47057 Duisburg

We chose the model system Ni_xPd_{1-x} to investigate different mechanisms involved in inverse spin-reorientation transitions (iSRTs). The 3d-4d hybridization between Ni and Pd and the strain variation by composition offer a way to tune magnetic anisotropy. Aberration-corrected LEEM-PEEM with its high spatial resolution is the ideal tool to investigate the magnetic domain-structure and do temperature- and composition-gradient dependent studies on microwedges and thin films. By alloying Paladium into Nickel the epitaxial strain of a thin film may be varied and the critical film thickness at which an iSRT occurs can be controlled. Close to the critical thickness the iSRT can also be induced by variation of the temperature. We present first results imaging the iSRT in NiPd by aberration corrected PEEM at the FZ Jülich Beamline UE56/1-sgm at BESSY. We prepared NiPd thin films in situ in a microwedged structure by molecular beam epitaxy. Both elements have been co-deposited using an aperture-shadowing technique to create a thickness wedge on the sample. On this poster we present LEEM and PEEM data mapping the wedge in terms of structural and magnetic properties.

DF 22.21 Fri 10:30 Poster D

Magnetic anisotropy of strained La0.7Sr0.3CoO3 thin films probed by XMCD — •Peter Nagel[1], Michael Merz[1], Felix Eilers[1,2], Dirk Fuchs[1], Hilbert von Löhneysen[1,3], and Stefan Schuppler[1] — [1]KIT, Institut für Festkörperphysik — [2]KIT, Fakultät für Physik — [3]KIT, Physikalisches Institut, Karlsruhe, Germany

The magnetic properties of perovskite-type La1-xSrxCoO3 have their origin in the variety of possible valence and spin states of the Co ion and in strong electronic correlations. Bulk La0.7Sr0.3CoO3 is known to be a ferromagnetic metal below Tc=240 K and to exhibit large Joule magnetostriction. This motivated us to investigate a complementary magnetoelastic effect: the effect of biaxial strain on the magnetization. La0.7Sr0.3CoO3 thin films were grown on lattice-mismatched substrates (LaAlO3 , SrTiO3, MgO and LSAT) by pulsed laser deposition. X-ray diffraction confirmed the films to be subjected to compressive or tensile strain, respectively. Near-edge x-ray absorption fine structure (NEXAFS) and x-ray magnetic circular dichroism (XMCD) at the Co L2,3 edge and the O K edge provided spectroscopic information on the electronic and magnetic structure. Sum rules were used to extract magnetic moments from the XMCD spectra. The difference between in-plane and out-of-plane magnetic moments was found to vary with the biaxial strain. We gratefully acknowledge the Max Planck Institute for Intelligent Systems (E. Goering, T. Tietze, G. Schütz) for the use of their XMCD end station and the synchrotron light source ANKA for the provision of beam time.

DF 22.22 Fri 10:30 Poster D

Correlations between the surface morphology and the atomic structure of thin layers of Fe_3Si on GaAs(001) and their magnetic properties — •Sani Noor[1], Igor Barsukov[2], M. Samet Özkan[1], Lina Elbers[1], Benjamin Geisler[2], Peter Kratzer[2], Michael Farle[2], and Ulrich Köhler[1] — [1]Experimentalphysik IV, AG Oberflächen, Ruhr-Universität Bochum — [2]Fakultät für Physik and Center for Nanointegration (CeNIDE) Universität Duisburg-Essen

Among the FM/SC combinations that represent one possible approach necessary for the realization of spintronic devices Fe_3Si/GaAs is an interesting choice due to its properties like a low lattice mismatch, half-metallic behaviour and high thermal stability.

In this contribution we consider the structural and magnetic properties of thin near-stoichiometric Fe_3Si layers on GaAs(001) with varying thicknesses. Methods employed include STM, LEED, in situ MOKE, SQUID magnetometry and FMR. Emphasis is laid on the correlations between these properties such the nucleation at low coverage and its superparamagnetic behaviour and the layer morphology at higher coverage and magnetic anisotropies. Furthermore, atomic scale STM data is compared with STM simulations.

DF 22.23 Fri 10:30 Poster D

Pattern formation and transformation in a magnetic model system — •Matthias Kronseder, Martin Buchner, and Christian Back — Universität Regensburg, Deutschland

Magnetic phase transitions in ultra thin films have been subject to intensive studies in the last decade. Particular interest has been dedicated to the spin reorientation transition (SRT) found in some ultra thin magnetic films with a strong perpendicular anisotropy. In addition, the magnetic domain pattern exhibits a distinct evolution, i.e. a transformation between individual phases of those patterns, while approaching the SRT. Here, we concentrate on the dynamics near phase transitions. We use a laboratory based imaging technique with high spatial resolution, which is threshold photoemission magnetic circular dichroism (TP-MCD) in combination with photoemission electron microscopy (PEEM). The magnetic phase transitions of the system Fe/Ni/Cu(001) has been investigated with respect to its temporal and temperature dependence. Furthermore we investigate its behavior in external magnetic fields.

DF 22.24 Fri 10:30 Poster D

Preparation and characterization of ultrathin Ni films on W(110): electronic structure and magnetism — •Henry Wortelen[1], Anke B. Schmidt[1], Martin Weinelt[2], and Markus Donath[1] — [1]Physikalisches Institut, Westfälische Wilhelms-Universität Münster, 48149 Münster — [2]Fachbereich Physik, Freie Universität Berlin, 14195 Berlin

An effective way to study the electronic structure of the band ferromagnet nickel at the magnetic phase transition is to lower the Curie temperture by going from bulk samples to ultrathin films.

In this contribution, we present a comprehensive investigation of ultrathin nickel films grown on W(110), as the film thickness is reduced from 10 to 1 monolayer. A combined study with scanning tunneling microscopy, low-energy electron diffraction, magneto-optic Kerr effect, and spin-resolved inverse photoemission reveals the close relation between film thickness, morphology, electronic structure, and magnetism. Our results indicate changes in coercivity, spin asymmetry, and spectral intensity of surface states as a function of film thickness and quality.

DF 22.25 Fri 10:30 Poster D

An oxide MBE system as a user instrument for quasi *in-situ* neutron reflectometry studies — •Sabine Pütter[1], Alexandra Steffen[1], Stefan Mattauch[1], and Thomas Brückel[1,2] — [1]Jülich Centre for Neutron Science JCNS, Forschungszentrum Jülich GmbH, Outstation at FRM II, Lichtenbergstr. 1, 85747 Garching — [2]Jülich Centre for Neutron Science JCNS and Peter Grünberg Institute, JCNS-2, PGI-4: Scattering methods, Forschungszentrum Jülich GmbH, 52425 Jülich

Molecular Beam Epitaxy (MBE) is a fascinating method to deposit high quality epitaxial thin films. The Jülich Centre for Neutron Science (JCNS) opens its state-of-the-art MBE system at the FRM II in Garching to friendly users who are interested in preparing tailored samples for the investigation with the JCNS neutron reflectometer MARIA (magnetic reflectometer with high incident angle) or other methods.

The MBE is equipped with 6 effusion cells, two electron guns for electron-beam evaporation with 4 crucibles each and an oxygen plasma source. Standard in-situ surface analysis tools like reflection high and low energy electron diffraction, Auger electron spectroscopy analysis are also available.

We will give examples for high quality metal and complex oxide thin film systems like e.g. $La_{1-x}Sr_xMnO_3/SrTiO_3$ with focus on stoichiometry, morphology and thickness and give detailed information about what kind of samples we can provide to you.

DF 22.26 Fri 10:30 Poster D

Roughness investigations of a CoFeB-MgO nanowire — •Tim Zacke[1], Tomek Schulz[1], Su Jung Noh[1], Benjamin Krüger[1], Capucine Burrowes[1], Dafiné Ravelosona[2], and Matthias Kläui[2] — [1]Institut of physics, University of Mainz, Mainz, 55128, Germany — [2]Institut d'Elecronique Fondamentale, Univerité Paris Sud, Orsay, 91405, France

We have investigated the impact of roughness on the domain wall dynamics in a nanowire, consisting of the multilayer stack CoFeB/MgO,

which exhibits a high magnetic perpendicular anisotropy. These investigations were carried out by numerical simulations using the object oriented micro magnetic framework (OOMMF) based on the Landau-Lifshitz-Gilbert (LLG) - equation and the micromagnetic model. By varying the key roughness parameters (correlation length and amplitude), we determine the dependence on the pinning strength (wall propagation field) on these parameters and correlate the wall width with these. To compare with experimental results, we nucleate a DW in a CoFeB/MgO by an Oersted field generated by a gold wire on top of the magnetic wire. We then measure the wall propagation field at variable temperature down to 4K. This allows us to determine by comparison between experimental and theoretical results the effective magnetic roughness of the wire. Comparison to high resolution microscopy images allows us to ascertain to what extent the visible roughness and the magnetic roughness correlate yielding insights on the homogeneity of the magnetic properties at the wire edge.

DF 22.27 Fri 10:30 Poster D

Investigations of magnetic properties of thin (Mn,Zn)Fe2O4 films on SrTiO3 — •Martin Welke[1], Stephan Borek[2], Kerstin Brachwitz[3], Annette Setzer[3], Michael Lorenz[3], Pablo Esquinazi[3], Marius Grundmann[3], Karl-Michael Schindler[2], Angelika Chassé[2], and Reinhard Denecke[1] — [1]Wilhelm-Ostwald-Institut für Physikalische und Theoretische Chemie, Universität Leipzig — [2]Institut für Physik, Universität Halle — [3]Institut für Experimentelle Physik II, Universität Leipzig

The work presented deals with Mn-Zn ferrite (Mn0.5Zn0.5Fe2O4) film on Strontiumtitanate (SrTiO3) as preparative studies towards multiferroic layer systems. The ferrite film was prepared by PLD in 6*10-5 mbar O2 at a substrate temperature of 620 °C. XRD phi scans reveal an in plane epitaxial relationship of [100](Mn,Zn)Fe2O4 || [100]SrTiO3. Subsequently SQUID magnetometry measurements are planned in order to obtain magnetization loops. Furthermore, angular dependent XMCD measurements at remanent magnetization have been carried out. There was no remanent out-of-plane magnetization observed in XMCD. In addition, XMLD measurements have been performed in order to proof the antiferromagnetic coupling between Fe atoms. While the measured Mn L2,3 spectra corresponded well to bulk spectra published in literature [1], the Fe L2,3 spectra proof to exhibit defect induced magnetism in XMCD. Theoretical simulations are performed to obtain a detailed understanding. [2]

[1] M. Magnuson et al., Phys. Rev. B, 2006, 74, 172409
[2] E. Stavinski and F.M.F. de Groot, Micron, 2010, 687

DF 22.28 Fri 10:30 Poster D

Synthesis and properties of ultrahtin, epitaxial, B2 ordered FeRh thin films — •Ralf Witte[1,2], Richard Brand[1], Robert Kruk[1], and Horst Hahn[1,2] — [1]Institute of Nanotechnology, Karlsruhe Institute of Technology — [2]Joint Laboratory Nanomaterials, Materials Science Departement, TU Darmstadt

The B2 ordered phase (CsCl structure) of equiatomic FeRh alloys possess interesting magnetic properties. It is antiferromagnetically (AFM) coupled at room temperature and shows a transition to a ferromagnetic phase (FM) at about 400 K. This behavior has been observed in bulk material and as well in thin films. Generally, stabilization of the FM phase is associated with the Rh spin state; in the AFM phase the magnetic moment on the Rh atom is zero, while it gets polarized in the FM state. It has been calculated [1] that the FM state can be stabilized at room temperature in (freestanding, single crystalline) films with a thickness below a critically value of nine atomic layers. This effect is attributed to the increased polarizability of the Rh atoms at the surface, which in turn stabilizes the FM state in the entire film. We present results on the synthesis and properties of such ultra thin, epitaxial FeRh films on MgO substrates prepared by electron beam evaporation. The samples are characterized using e.g. high-resolution X-ray diffraction, atomic force microscopy, SQUID magnetometry, X-ray photo electron spectroscopy and Fe Moessbauer spectroscopy. [1] S. Lounis, Phys. Rev. B 67, 094432 (2003)

DF 22.29 Fri 10:30 Poster D

Magnetization reversal of percolated ferrimagnetic Fe-Tb nanodot arrays — •Christian Schubert[1], Phani Arekapudi[1], Birgit Hebler[1], Florin Radu[2], Marcus Daniel[1], and Manfred Albrecht[1] — [1]Institute of Physics, Chemnitz University of Technology, D-09107 Chemnitz, Germany — [2]Department for Magnetization Dynamics, Helmholtz Zentrum Berlin, Germany

Amorphous ferrimagnetic rare earth-transition metal alloys with high perpendicular magnetic anisotropy are suitable in hard disk drives to overcome the superparamagnetic limit. In particular for thermally assisted bit patterned recording media [1] amorphous Fe-Tb is a promising functional layer providing good adjustability of anisotropy, Curie temperature, and saturation magnetization [2].

We present an investigation of structural and magnetic properties of percolated amorphous Fe-Tb nanodots produced by co-deposition on pre-patterned substrates with pillar diameters of 30 nm and a period of 60 nm. The magnetic films follow closely the morphology of the pre-pattern forming exchange coupled nanodots and trench material. Despite the exchange interaction the nanodots reveal a single domain magnetization state and reverse via a more coherent rotation process as deduced from in-field MFM and angular MOKE measurements. Contrary to this the reversal of the continuous trench material is dominated by domain wall motion and the coercive field is enhanced due to pinning effects caused by the nanodot array.

[1] Akagi et al., J. Magn. Magn. Mater. 324, 309 (2012)
[2] Mimura et al., IEEE Trans. Magn. 12, 779 (1976)

DF 22.30 Fri 10:30 Poster D

Investigation of Domain Pattern and Magnetisation Reversal Process in Hexagonal Nano-Scaled Antidot Lattices — •Joachim Gräfe[1], Felix Häring[2], Ulf Wiedwald[2], Paul Ziemann[2], Ulrich Nowak[3], Gisela Schütz[1], and Eberhard Goering[1] — [1]Max Planck Institute for Intelligent Systems, Stuttgart, Germany — [2]Department of Solid State Physics, Ulm, Germany — [3]Department of Physics, Konstanz, Germany

Antidot lattices in magnetic materials can be a way to form artificial magnonic lattices as an approach towards spin-wave filters for spintronics [1]. Furthermore, the introduction of an antidot lattice provides a significant modification of static properties of the samples like the coercivity and magnetic anisotropy [2]. In this work we present results from investigations into the static regime of antidot lattice properties of in-plane (Fe) and out-of-plane (GdFe) systems. Results from x-ray microscopy indicate control over the formation and propagation of magnetic domains by the antidot pattern. Angular and spatially resolved MOKE measurements prove that the easy axes orientation is governed by the antidot lattice geometry, resulting in a six-fold symmetry of preferential magnetic axes. We present two distinct magnetisation reversal mechanisms occurring along the easy and hard axes in the antidot lattice.

[1] B. Lenk et al., Phys. Rep. 507 (2011) 107-136
[2] G. Ctistis et al., Nano Lett. 9 (2009) 1-6

DF 22.31 Fri 10:30 Poster D

Magnetic properties of Co/Pt multilevel systems — •Patrick Matthes, Benno Oehme, Robert Rückriem, and Manfred Albrecht — Chemnitz University of Technology, Chemnitz, Germany

For both fundamental and technological reasons multilevel film systems with perpendicular magnetic anisotropy has gained importance in recent research. These structures may have applications as storage devices [1], pseudo spin valves or magnetic field sensors [2, 3]. In this study ferromagnetic layers of Co/Pt multilayer stacks with various coercivities separated by a non magnetic Pt-spacer which ensures exchange decoupling have been prepared by dc-magnetron sputtering at room temperature. These flat films have been investigated by Vibrating Sample Magnetometer, Magnetic Force Microscopy and Magnetoresistance measurements to analyze the magnetic switching behaviour and magnetoresistance effect. Furthermore patterned samples with periods below 100 nm have been prepared to investigate the influence of reduced dimensions on the switching behaviour and thermal stability. This study is further supported by micromagnetic simulations.

[1] M. Albrecht al., J. Appl. Phys. **97**, 103910 (2005)
[2] J.F. Feng et al., J. Magn. Magn. Mater. **324**, 2298 (2012)
[3] L. You et al., Appl. Phys. Lett. **100**, 172411 (2012)

DF 22.32 Fri 10:30 Poster D

Artificial spin-ice systems prepared by focused electron beam induced deposition. — •Evgeniya Begun, Fabrizio Porrati, and Michael Huth — Physikalisches Institut, Goethe-Universität, D-60438 Frankfurt am Main, Germany

Spin-ice systems are interesting for the study of fundamental aspects of magnetic monopoles, as well as for magnetic information processing. Besides of the rather narrow class of materials with ice-type magnetic disorder, there exists the possibility of artificial spin-ice creation. Here we present first results on the preparation of cobalt-based artificial

spin-ice structures of different configurations grown by focused electron beam induced deposition (FEBID) using the precursor dicobaltoctacarbonyl $Co_2(CO)_8$. The obtained spin-ice structures are in the form of two-dimensional regular arrays of elongated magnetic cobalt islands, which have a metal content of about 70-85 at.%. For the optimization of a one-domain state in each individual Co element the length (from 100 to 500 nm), the width (from 30 to 50 nm), the thickness (from 25 to 50 nm) and the lattice constant (from 200 to 400 nm) have been varied. The arrays have been grown to cover areas from 1 to 10 μm^2 in order to exclude edge effects. First results of magnetic force microscopy measurements done at room-temperature are presented.

DF 22.33 Fri 10:30 Poster D

Spin structure manipulation in nickel nanostructures by magneto-elastic coupling to piezoelectric PMN-PT substrates — •Simone Finizio[1], Michael Foerster[1], Carlos A. F. Vaz[1,2], Tetsuya Miyawaki[3], Joshua L. Hockel[4], Gregory P. Carman[4], and Mathias Kläui[1] — [1]Institut für Physik, Johannes Gutenberg Universität, Mainz, Germany — [2]SwissFEL, Paul Scherrer Institut, Villigen PSI, Switzerland — [3]Department of Crystalline Materials Science, University of Nagoya, Nagoya, Japan — [4]Department of Mechanical and Aerospace Engineering, University of California, Los Angeles, USA

In recent years, there has been an increasing interest in current-less control of magnetization for reduced energy consumption in memory devices. One possible route to achieve such goal is given by the magneto-elastic coupling, through the exploitation of voltage-driven piezoelectric effects to manipulate the magnetization of a ferromagnetic thin film grown on a piezo-substrate. Here, we report XMCD-PEEM imaging of Ni ring-shaped nanostructures grown on PMN-PT. By applying an out-of-plane electric field, a piezoelectric strain is induced in the plane of the film, leading to reproducible modifications of the spin structure due to strain-induced anisotropy in Ni. The characterization shows a clear influence of the piezoelectric strain on the magnetization of the Ni nanostructures, where the nucleation of magnetic domains to 45° with respect to the applied strain direction is observed.

DF 22.34 Fri 10:30 Poster D

Magnetic vortices in permalloy cap structures in confined geometry — •Dennis Nissen[1], Mi-Young Im[2], Peter Fischer[2], and Manfred Albrecht[1] — [1]Institute of Physics, Chemnitz University of Technology, D-09126 Chemnitz, Germany — [2]Center for X-ray Optics, Lawrence Berkeley National Laboratory, California 94720, USA

Vortex states, which are characterized by the chirality of the in-plane magnetization and the out-of-plane component of the vortex core[1], are of great fundamental importance and relevant for application. One approach to realize such magnetic vortex states is to manufacture large arrays of spherical SiO_2-particle monolayers followed by film deposition of permalloy. In this way, it is possible to obtain magnetic cap structures on the particles forming vortex states[2].
We will present the fabrication process of spherical SiO_2-particle monolayers with a particle diameter in the range between 50 nm and 4,5 μm, which act as templates for further film deposition, and furthermore the possibility to create particular particle arrangements using additional pre-patterns. Moreover, we will show investigations of the magnetic properties studied by magnetic force microscopy and magneto-optic Kerr effect magnetometry. In this context particular attention is paid to the magnetic reversal mechanism of a vortex as a function of external field. In addition, recent studies on the formation process of vortex states in large arrays of cap structures using magnetic transmission X-ray microscopy will be presented. [1]T. Shinjo et al. Science 289 (2000) 930. [2]R. Streubel et al. Phys. Rev. B 85, (2012) 174429.

DF 22.35 Fri 10:30 Poster D

Dynamic response of periodic magnetic domain patterns in submicron sized Co2MnGe-Heusler wires — •Katherine Gross, Frank Brüssing, Kurt Westerholt, and Hartmut Zabel — Institut für Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum, D-44780 Bochum,Germany

We have investigated the dynamic response of periodic magnetic domain patterns in submicron sized Co2MnGe-Heusler ferromagnetic wires by measuring the in-phase and out-of phase magnetic susceptibility via the magneto-optical Kerr effect with an ac-magnetic field applied parallel or perpendicular to the wire axis. In magnetic remanence the magnetization in the Co2MnGe wires aligns along the growth induced uniaxial anisotropy axis transverse to the wire axis, forming highly regular domain patterns with 180° domain walls. The application of an ac-field perpendicular to the wire axis results in a oscillating motion of the domain walls (DW) along the wire axis. For small field amplitudes just above the depinning field the DW dynamics can be described by a slide-like motion and an analytical expression can be used to extract the depinning field and the domain wall mobility. When applying the ac-magnetic field along the wire axis the magnetization in the perpendicular domains responses by coherent rotation towards the direction of the wire axis. In both configurations the complex ac-susceptibilty is described by a Cole-Cole type of relaxation time approach.

DF 22.36 Fri 10:30 Poster D

Domain wall magnetoresistance and depinning in $La_{0.66}Sr_{0.33}MnO_3$ nanowires — Michael Foerster[1], Luis Peña[1], •Simone Finizio[1], Laurence Mechin[2], Felix Büttner[1,3], André Bisig[4], Stefan Eisebitt[3], and Mathias Kläui[1] — [1]Institut für Physik, Johannes Gutenberg Universität, Mainz, Germany — [2]GREYC, UMR 6072, CNRS-ENSICAEN-UCBN, Caen Cedex, France — [3]Institut für Optik und Atomare Physik, Technische Universität Berlin, Berlin, Germany — [4]SwissFEL, Paul Scherrer Institut, Villigen PSI, Switzerland

Magnetic domain walls (DWs) and their reliable displacements are key ingredients for novel magnetic memory and sensing devices with switching by domain wall motion. $La_{0.66}Sr_{0.33}MnO_3$ (LSMO) is a ferromagnetic metal with a high spin polarization, which promises large spin transfer torque (STT) effects, and a T_c close to room temperature (370K) that allows for the investigation of magnetotransport and STT effects with tuneable parameters. We have measured the magnetoresistance of LSMO nanostructures at 4.3K, observing the magnetoresistance associated with DWs in an LSMO wire by comparing hysteresis loops with fields along different directions. Depinning of DWs was observed as function of the applied magnetic field along the wire, with good quantitative agreement with simulations. The injection of current pulses leads to changes in the signal that are probably due to local changes in the magnetization, which occur due to Joule heating combined with the low T_c.

DF 22.37 Fri 10:30 Poster D

Magnetization Reversal Mechanisms in Co-Antidot Arrays — Manuel Langer[1], •Rantej Bali[1], Ewa Kowalska[1], Andreas Neudert[1], Kilian Lenz[1], Kay Potzger[1], Mikhail Kostylev[2], Adekunle Adeyeye[3], Jürgen Fassbender[1], and Jürgen Lindner[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf e.V., 01328 Dresden, Germany — [2]School of Physics, University of Western Australia, Crawley 6009, Australia — [3]Department of Electrical and Computer Engineering, National University of Singapore, 117576 Singapore

Co-antidots with holes arranged in the form of a square lattice, with lattice parameter of 415 nm and hole diameter d = 145 to 255 nm were fabricated using DUV photolithography. For arrays with film thickness of 50 nm, the angular dependence of the saturation field (H_s) shows presence of four-fold anisotropy with the hard axes along the <01> directions and easy axes was along the diagonal <11> directions. Spikes in the H_s were measured along the intermediate <12> directions. Kerr microscopy suggests that the reversal mechanism along the <01> is domain-wall (DW) depinning followed by propagation within the continuous channels along the <01>, whereas along the <11> the mechanism tends towards nucleation and growth. We postulate that the H_s-spikes occur because DW-propagation requires domino-like spin-reorientations through the continuous channels, whereas nucleation can only occur when a coherent region is formed with the spins oriented along the applied field. The frustration caused by the two possible spin-reorientation paths results in the larger H_s. We attempt to model these mechanisms using OOMMF and investigate the influence of varying d.

DF 22.38 Fri 10:30 Poster D

All-optical switching in CoTb alloys: composition and thickness dependent studies — •Ute Bierbrauer[1], Sabine Alebrand[1], Michel Hehn[2], Matthias Gottwald[2,3], Daniel Steil[1], Daniel Lacour[2], Mirko Cinchetti[1], Martin Aeschlimann[1], Eric E. Fullerton[3], and Stéphane Mangin[2] — [1]Dep. of Physics and Research Center OPTIMAS, TU Kaiserslautern, Germany — [2]IJL, Université de Lorraine, Nancy, France — [3]University of California, San Diego, USA

All-optical switching (AOS), i.e. switching of magnetic domains by means of circularly polarized fs laser pulses, has been demonstrated up to now only in GdFeCo [1]. However, it is still not clear if AOS is

related to the specific properties of GdFeCo or if it also occurs in other materials.

We focus on AOS in high anisotropy CoTb alloys [2], demonstrating that AOS is possible for a certain Tb concentration range. Interestingly this concentration range corresponds to the one where the compensation point is above room temperature. We further investigate the dependence of AOS on the film thickness. Overall we discuss possible influences of the material specific magnetic properties, like e.g. the coercive field and the saturation magnetization. We find indications that such properties cannot be ignored, when trying to get a deeper understanding of AOS.

[1] C.D. Stanciu et al., PRL 99, 047601 (2007) [2] S. Alebrand et al., APL 101, 162408 (2012)

DF 22.39 Fri 10:30 Poster D

Control of Magnetic Domains and Domain Walls by Thermal Gradients — •Martin Stärk, Johannes Boneberg, Mikhail Fonin, and Elke Scheer — Department of Physics, University of Konstanz, Germany

Investigation and control of domains and domain walls in magnetic materials is very important for the understanding of the magnetism in thin films and nanostructures as well as for the development of future spintronic devices. Recently, the interaction between spin-currents or magnetic fields and domain configurations attracted considerable attention. With respect to new data storage media techniques as heat assisted magnetic recording, thermal effects in spin-polarized materials and nanostructures might get important.

From the theoretical point of view, nanometer-sized domain walls can be moved with a speed of 50 m/s by temperature gradients of around 50 K/μm (D. Hinzke et al., Phys. Rev. Lett. 107, 027205 (2011)). In order to investigate this behavior experimentally, we use ns-pulsed laser interference to generate temperature patterns with variable periods between 200 nm and 20 μm and thermal gradients of up to several hundred K/μm on thin films of ferromagnetic metals.

Using this technique, we study the effects on out-of-plane Co/Pd multilayer systems with magnetic force microscopy before and after the illumination. Thereby, a change in the domain distribution is observed.

DF 22.40 Fri 10:30 Poster D

investigation of magnetic domain structure and domain wall in Co2Mn0.6Fe0.4Si — •tomohiro koyama[1], phillip pirro[1], thomas brächer[1], thomas sebastian[1], ikhtiar i[2], yusuke ohdaira[2], takahide kubota[3], hiroshi naganuma[2], mikihiko oogane[2], yasuo ando[2], and burkard hillebrands[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Department of Applied Physics, Graduate School of Engineering, Tohoku University, 980-8579, Sendai, Japan — [3]WPI Advanced Institute for Materials Research, Tohoku University, 980-8577, Sendai, Japan

The interaction between magnetic domain walls (DW) and spin waves is much attractive from the viewpoint of physical interests and applications. The full Heusler compound Co2Mn0.6Fe0.4Si (CMFS) is one of the suitable materials to investigate it because of its long decay length of spin waves. For the advance of the research, we have characterized domain structures and DWs in CMFS. The micro structures were fabricated from CMFS film with 30 nm thickness sputtered on MgO substrate by electron beam lithography and ion etching. The magnetic domain structure and DWs in CMFS were directly observed by using magnetic force microscopy. We found that in a square pad the Landau closure domain was formed by oscillatory reducing the external field to zero. In addition, the creation of a single DW in an L-shaped wire was performed. The effect of excited spin waves on these domain structures will be discussed. T.K. gratefully acknowledges the Alexander von Humboldt foundation for a postdoctoral fellowship.

DF 22.41 Fri 10:30 Poster D

Brillouin light scattering investigations of perpendicular standing spin waves at Au and Ag nanoparticles on top of a $Ni_{81}Fe_{19}$ film — •Thomas Meyer, Björn Obry, and Burkard Hillebrands — FB Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

In the last decades localized plasmons excited in metallic nanoparticles providing a local field enhancement were used to increase the signal strength and spatial resolution like in the case of surface enhanced Raman spectroscopy. We present Brillouin light scattering (BLS) studies of perpendicular standing spin waves in a thin $Ni_{81}Fe_{19}$ film with single Au and Ag nanoparticles on top. An increase of the BLS signal as well as a frequency shift of the spin waves due to the metal nanoparticles is observed. To describe this, and besides their plasmonic properties, other influences of the nanoparticles on the magnetization dynamics have to be taken into account. In order to identify the contributions to the observed signal changes, investigations using different materials, sizes and shapes of the structures have been performed.

DF 22.42 Fri 10:30 Poster D

Magnetoresistance of an individual ferromagnetic nanotube under microwave irradiation — •Tobias Stückler[1], Florian Heimbach[1], Rupert Huber[1], Daniel Rüffer[2], Eleonora Russo-Averchi[2], Martin Heiss[2], Anna Fontcuberta i Morral[2], and Dirk Grundler[1,3] — [1]Physik-Dep. E10, TU München, D-85748 Garching — [2]LMSCX, IMX, EPF Lausanne, CH-1015 Lausanne — [3]STI, EPF Lausanne, CH-1015 Lausanne

The magnetic states predicted for ferromagnetic nanotubes have generated great interest in both theoretical and experimental nanomagnetism research. Using atomic layer deposition, we have prepared 40 nm thick Ni nanotubes by conformal coating of single-crystalline GaAs nanowires with a diameter of about 300 nm. Subsequently, we position a several-μm-long nanotube on a Si substrate and integrate four metallic contacts. At room temperature, we measure the magnetic field dependent resistance under microwave irradiation using a neighboring antenna. We report on characteristic resonance features which we attribute to excited spin waves. Financial support by the EC (FP7/2007-2013) under Grant Agreement No. 228673 (MAGNONICS), the DFG via NIM, the SNF, and QSIT is gratefully acknowledged.

DF 22.43 Fri 10:30 Poster D

Azimuthal Spin-Wave Modes in Permalloy Coated Glass Fibers — •Lukas Nagrodzki, Felix Balhorn, Wolfgang Hansen, and Stefan Mendach — Institut für Angewandte Physik, Universität Hamburg, Germany

We show by means of broadband microwave spectroscopy that Permalloy cylinders with micron-sized diameters exhibit pronounced azimuthal spin-wave modes, which can be tuned over several GHz by an external magnetic field. For the preparation of these devices we have deposited thin layers of Permalloy on glass fibers with diameters of a few microns by thermal evaporation. They show resonant behavior with multiple resonances when magnetized along the fiber axis. We interpret those resonances as interfering spin waves propagating in azimuthal direction. The data can be well reproduced using an analytical model for spin waves in thin films employing periodic boundary conditions as also used for rolled-up Permalloy spin-wave resonators previously introduced by our group [1, 2].

Financial support by the Deutsche Forschungsgemeinschaft via SFB668 is acknowledged.

[1] F. Balhorn et al., PRL **104**, 037205 (2010); [2] F. Balhorn et al., APL **100**, 222402 (2012)

DF 22.44 Fri 10:30 Poster D

Time-Resolved Magnetic Imaging in an Energy-Filtered, Aberration-Corrected Photoemission Electron Microscope — •Florian Nickel[1], Daniel Gottlob[1], Ingo Krug[1], Alexander M. Kaiser[2], Denys Makarov[3], Gungun Lin[3], Stefan Cramm[1], Hatice Doganay[1], Oliver G. Schmidt[3], and Claus M. Schneider[1,4] — [1]Peter Grünberg Institut 6, Research Center Jülich, 52425 Jülich — [2]SPECS Surface Nano Analysis GmbH, 13355 Berlin — [3]Institute for Integrative Nanosciences, IFW Dresden, Helmholtzstr. 20, 01069 Dresden — [4]Fakultät für Physik und Center for Nanointegration Duisburg-Essen (CeNIDE), Universität Duisburg-Essen, 47048 Duisburg

Information technology relies on reliable storage and fast switching of material states. These states can be governed either by magnetic or electrical degrees of freedom, which offers a wide variety of design concepts. Common to all storage concepts is that manipulation of the information state takes place on a characteristic time and length scale, which is in the picosecond respective nanometer range. All requirements are combined in the method of time-resolved photoemission microscopy (TR-PEEM). Recently, we installed a state-of-the-art PEEM with energy-filtering system and aberration corrector (FE LEEM-P90 AC by SPECS) at the FZ-Jülich Beamline UE56/1-SGM @ BESSY. In this poster we present the extension of the microscope setup for synchrotron pump-probe measurements. We will present details about the technical performance of the setup as well as first results on magnetization dynamics in ferromagnetic nanoelements.

DF 22.45 Fri 10:30 Poster D

Supercritical parametric generation in a $Ni_{81}Fe_{19}$ microstripe — •Thomas Brächer[1,2], Philipp Pirro[1], Alexander A. Serga[1] und Burkard Hillebrands[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Graduate School Materials Science in Mainz, Gottlieb-Daimler-Straße 47, 67663 Kaiserslautern, Germany

Parallel parametric amplification [1] is an alternative method to excite spin-wave dynamics in microstructured elements, as recent experiments have shown the applicability of the technique to micron-sized $Ni_{81}Fe_{19}$ structures.[2,3]

We report on the supercritical evolution of parametrically generated spin-wave modes as a function of applied microwave power in a $Ni_{81}Fe_{19}$ microstripe employing parallel parametric amplification. The experimental observation is carried out using Brillouin light scattering microscopy. We find that depending on the applied external magnetic field, different transitions of the observed spin-wave mode profiles, like a transition from the first to the second transverse mode at low magnetic fields, can be found.

Thomas Brächer is supported by a fellowship of the Graduate School Materials Science in Mainz (MAINZ) through DFG-funding of the Excellence Initiative (GSC 266).

[1] E. Schlömann et al., J. Appl. Phys. 31, 386S (1960)
[2] T. Brächer et al., Appl. Phys. Lett. 99, 162501 (2011)
[3] H. Ulrichs et al., Phys. Rev. B 84, 094401 (2011)

DF 22.46 Fri 10:30 Poster D

Spin pumping in YIG/Pt bilayer — •Markus Härtinger[1], Sibylle Meyer[2], Stephan Geprägs[2], Matthias Opel[2], Hans Huebl[2], Sebastian T.B. Goennenwein[2], Christian Back[1], and Georg Woltersdorf[1] — [1]Department of Physics, Universität Regensburg, 93040 Regensburg, Germany — [2]Walter-Meißner-Institut, Bayerische Akademie der Wissenschaften, 85748 Garching, Germany

Spin pumping adds an additional damping mechanism to the instinsic damping propierties of a magnetization precession by emission of an angular momentum flow. When the latter is relaxed, e.g. in a material with large spin orbit scattering like Pt, the spin current is efficiently damped, resulting in an increased FMR linewidth. Here we report on this effect in a bilayer of the insulating ferrimagnet Yttrium Iron Garnet (YIG) and platinum (Pt). The samples consist of ultrathin epitaxial YIG layers grown by pulsed laser deposition on GGG(111) (Gadolinium Gallium Garnet) substrates. The platinum capping layers are deposited in-situ. We have determined the magnetic properties by performing ferromagnetic resonance (FMR) measurements on YIG layers as well as on bilayer YIG/Pt samples in a frequency range from 2 to 20 GHz. In the pure YIG samples we find very narrow resonance lines corresponding to a Gilbert damping constant of approximately $\alpha = 0.001$. Due to the spin pumping an additional platinum layer on top of the YIG samples results in a significant broadening of the FMR linewidth proportional to the microwave frequency. In order to substantiate this we measured the platinum and YIG thickness dependence of this additional damping.

DF 22.47 Fri 10:30 Poster D

Inverse Spin Hall Effect in $Ni_{80}Fe_{20}$ / Normal Metal Bilayers — •Martin Obstbaum, Markus Härtinger, Thomas Meier, Fabian Swientek, Christian H. Back, and Georg Woltersdorf — Institut für Experimentelle und Angewandte Physik, Universität Regensburg,93040 Regensburg, Germany

We investigate the inverse spin Hall effect in $Ni_{80}Fe_{20}$/normal metal bilayers. Pure spin currents are generated by spin pumping at ferromagnetic resonance and a dc-voltage is measured in the plane of the bilayer system. For Pt and Au as normal metals the observed inverse spin Hall effect and the corresponding spin Hall angle are consistent with literature values. In the case of $Ni_{80}Fe_{20}$/Ta - bilayers a giant spin Hall angle has recently been reported [1], however, we do not detect a measurable voltage due to the inverse spin Hall effect in $Ni_{80}Fe_{20}$/Ta bilayers. In fact, from our angle and temperature dependent measurements we conclude that for $Ni_{80}Fe_{20}$/Ta bilayers the voltage generated at ferromagnetic resonance is solely a consequence of the anisotropic magnetoresistance.

[1] Liu et al. Science 336, 555 (2012)

DF 22.48 Fri 10:30 Poster D

Femtosecond spin dynamic in ferromagnetic Fe/Ru/Ni nanopillars — •Jorge Martin[1,2], Marco Battiato[4], Roman Adam[1,2], Dennis Rudolf[1,2], Chan La-o-vorakiat[3], Justin M. Shaw[5], Emrah Turgut[3], Pablo Maldonado[4], Stefan Mathias[3,6], Patryk Grychtol[3], Hans T. Nembach[5], Thomas J. Silva[5], Martin Aeschlimann[6], Henry C. Kapteyn[3], Margaret M. Murnane[3], Peter M. Oppeneer[4], and Claus M. Schneider[1,2] — [1]Peter Grünberg Institut PGI-6 ,Forschungszentrum Jülich, 52425 Jülich, Germany — [2]JARA, Fundamentals of Information Technology — [3]Department of Physics and JILA, University of Colorado and NIST, Boulder, CO, USA — [4]Department of Physics and Astronomy, Uppsala University, SE-75120 Uppsala, Sweden — [5]Electromagnetics Division, National Institute of Standards and Technology, Boulder, CO, USA — [6]University of Kaiserslautern and Research Center OPTIMAS, 67663 Kaiserslautern, Germany

High harmonics generation, driven by a femtosecond pulsed laser, has provided a unique insight into the spin dynamics in ferromagnetic multilayered samples, due to the development of ultrafast probing techniques that combine femtosecond time resolution with element selectivity. We patterned Fe/Ru/Ni layers into an array of equally spaced nanopillars. Following optical pump, we employed the resonant transversal magneto optical Kerr effect for tracing the response of Fe and Ni layers separately, to gain deeper comprehension of the interplay of optically induced demagnetization-magnetization processes.

DF 22.49 Fri 10:30 Poster D

Ultrafast Demagnetization in a Kondo-Lattice System — •Alexander Baral and Hans-Christian Schneider — University of Kaiserslautern

We present theoretical results on the magnetization dynamics after ultrashort pulse excitation in a Kondo-lattice model, i.e., a system of 2D carriers coupled by an exchange interaction to a virtual lattice of localized spins. For the itinierant carriers, we include a spin-orbit coupling of the Rashba type as well as carrier-carrier and carrier-phonon scattering. In the framework of this model and starting from a mean-field description and using a dynamical exchange splitting, we investigate the magnetization dynamics after ultrashort-pulse excitation. Such an excitation leads to a demagnetization dynamics reminiscent of that found in 3d- and 4f-ferromagnetic metals.[1] We compute time- and momentum-dependent carrier distribution functions from carrier-carrier and carrier-phonon Boltzmann scattering integrals. In addtion, in our model, the exchange splitting is time-dependent, so that also the spin-mixing changes with time. It is shown that the dynamical exchange splitting and also the dynamical change of the spin mixing hava an important qualitative and quantitative influence on the demagnetization and remagnetization dynamics. [1] Koopmans, B. et al., Nature Mater. 9, 259*265 (2010).

DF 22.50 Fri 10:30 Poster D

Influence of hot electrons on the ultrafast quench of magnetization in Ni and FePt — •Martin Lüttich[1], Jakob Walowski[1], Andreas Mann[1], Johannes Mendil[1], Markus Münzenberg[1], Unai Atxitia[2], and Oksana Chubykalo-Fesenko[2] — [1]I. Physikalisches Institut Georg-August-Universität Göttingen, Göttingen, Germany — [2]Instituto de Ciencia de Materiales de Madrid, Madrid, Spain

Since the first investigation of ultrafast magnetization dynamics in 1996, the question on driving mechanism(s) is still not resolved entirely. According to the predicted superdiffusive spin transport, we investigate the influence of hot electrons on the relative demagnetization.

Magnetization dynamics of an in-plane magnetized Ni film and an out-of-plane magnetized FePt film is measured using the all-optical pump-probe technique for various pump pulse fluences. To clarify the influence of hot electrons on the relative demagnetization, experiments with temporarily stretched pump pulses from 50 fs up to 2.5 ps are performed. These results are compared to simulations based on the Landau-Lifshitz-Bloch equation, which is based on the thermal model, and featured by the consideration of two spin temperature dependent relaxation times $\tau_{||}$ and $\tau_{\perp}$. The electron temperature needed as input for the simulations is obtained from independent experiments on reflectivity dynamics. Compared to experiments, using ultrashort 80 fs pump pulses containing same energy per pulse, a lower maximum electron temperature is reached, but it is maintained for a longer time with the longer pump pulses.

DF 22.51 Fri 10:30 Poster D

Femtosecond spin dynamics in ferromagnet/metal bi-layers — •Daniel Simon[1,2], Roman Adam[1,2], Moritz Plötzing[1,2], Christian Weier[1,2], Dennis Rudolf[1,2], and Claus M. Schneider[1,2] —

[1]Peter Grünberg Institut (PGI-6), Forschungszentrum Jülich, 52425 Jülich, Gemany — [2]JARA - Fundamentals of Future Information Technologies

Laser-induced demagnetization of ferromagnetic films is known to be an effect on the timescale of a few hundred femtoseconds. Among many proposed mechanisms, spin-flip processes [1] and spin-superdiffusion [2, 3] have been proposed to explain these ultrafast developments. In the presented work, we investigate spin dynamics of ferromagnet (4nm)/metal (20nm) bi-layers in a backside-pump/frontside-probe setup using infrared (800nm) pump and blue (400nm) probe laser pulses. This geometry allows us to probe the magnetization dynamics spatially separated from the pumping. Our measurements show an influence of the pump pulse on the magnetization even though a direct pumping is suppressed by the metal layer, giving rise to an interpretation based on a non-local effect, namely spin currents.

[1] B. Koopmans, et al. Nature Materials 9, 259 (2010).
[2] D. Rudolf, et al. Nature Communications 3, 1037 (2012).
[3] M. Battiato, et al. Phys. Rev. Lett. 105, 027203 (2010).

DF 22.52 Fri 10:30 Poster D

Comparing the ultrafast demagnetization of Gadolinium and Terbium — •Martin Teichmann[1,2], Robert Carley[1,2], Björn Frietsch[1,2], Kristian Döbrich[1,2], Jan Wolter[1,2], John Bowlan[1,2], and Martin Weinelt[1,2] — [1]Freie Universität Berlin — [2]Max-Born-Institut Berlin

The laser-driven ultrafast demagnetization dynamics of the rare earths gadolinium and terbium show distinct behavior. We performed time- and angle-resolved photoemission experiments using high-order harmonics on Gd and Tb, revealing the occupied band structure in the 3rd Brillouin zone. By following the time evolution of the spin-split valence bands individually, we are able to separate the different effects acting during demagnetization, namely spin transport and electron-phonon scattering, while simultaneously monitoring the magnetization via the exchange splitting.

We see that the dynamics of the electron-phonon scattering is very similar in Gd and Tb, while the spin transport accounts for their differences.

DF 22.53 Fri 10:30 Poster D

A Non-Equilibrium Band-Structure View of Ultrafast Magnetization Dynamics — •Robert Carley[1,2], John Bowlan[1], Kristian Döbrich[2], Björn Frietsch[1,2], Martin Teichmann[1,2], Jan Wolter[1], and Martin Weinelt[1] — [1]Freie Universität Berlin, Germany — [2]Max-Born-Institut, Berlin, Germany

We present recent results from ultrafast laser-driven magnetization dynamics experiments on the rare-earth local-moment ferromagnet Gadolinium. Our experiment combines angle-resolved photoemission spectroscopy (ARPES) with the VUV photon energies and time resolution made possible by high-order harmonic generation to scrutinize the non-equilibrium band structure following excitation of the ferromagnet by a short infrared pulse. On the timescale of a few picoseconds, transient changes of the minority and majority components of the exchange-split valence band reveal significant insight into the underlying microscopic processes. Furthermore, linear magnetic dichroism in photoemission allows us to directly follow the magnetic response of the localized 4f electrons, from which the magnetic moment arises.

DF 22.54 Fri 10:30 Poster D

Spin motive force induced by moving vortex in magnetic nanostructures — •Ajay Gangwar[1], Hans G. Bauer[1], Matthias Noske[2], Markus Weigand[2], Hermann Stoll[2], Gisela Schütz[2], Georg Woltersdorf[1], and Christian H. Back[1] — [1]University of Regensburg, Regensburg, Germany — [2]Max Planck Institute for Intelligent Systems Stuttgart, Germany

Recently, voltage signals due to spin motive force (SMF) have been observed in magnetic elements with a moving magnetic vortex core [1]. However a moving vortex core also represents a change of the magnetic inductance and therefore also leads to a large electro motive force (EMF). An unambiguous separation of EMF and SMF signals is necessary for the interpretation of the SMF voltage. For this reason we simultaneously measure the voltage signal and the position of the moving magnetic texture in a sub-micron permalloy (Py) disk with high temporal and spatial resolution in a scanning X-ray transmission microscope (STXM). In this way we determine directly the phase relation between the obtained voltage signals and the position of the vortex core with respect to the nanoscale voltage probes. This technique allows us to unambiguously separate contributions from EMF (due to the change of magnetic induction) and SMF (due to the moving magnetic texture). We separate EMF and SMF by performing measurements in various configurations and by reversing the vortex core polarity.

[1] K. Tanabe et al., Nature Communications 3, 845 (2012).

DF 22.55 Fri 10:30 Poster D

Dynamic vortex core reversal studied with micromagnetic simulations — •Hans G. Bauer, Georg Woltersdorf, and Christian H. Back — Universität, Regensburg, Germany

Thin discs of soft magnetic material can have non-trivial ground states of the magnetization. When the demagnetization energy forces the magnetization to lie in the plane of the disc, ground states of curling magnetization (vortex) exist with the magnetization in the middle pointing out-of-plane (vortex core). The ground state is degenerate with respect to the vortex core pointing either up or down (polarity) and the rotation sense of the in-plane magnetization (chirality).

While both are in principle capable of representing a bit in data storage we study two cases of polarity switching, where the vortex core polarity is reversed by a) a short rotating field pulse and b) a combination of sub-GHz and GHz excitations.

First we address the problem of the minimal time required to selectively switch the vortex core with short pulses. In the second study we investigate the threshold amplitude needed for switching at GHz-frequencies when the vortex core is already displaced from its equilibrium position by a low frequency excitation of the vortex, the so-called gyro-frequency. Both results are finally compared to the experimental findings in [1] and [2].

[1] M. Kammerer et al., Phys. Rev. B 86, 134426 (2012)
[2] M. Sproll et al. (to be published)

DF 22.56 Fri 10:30 Poster D

Collective Switching of Nanoparticles in Magnetic Arrays — •David Altwein, Elena Vedmedenko, Robert Wieser, and Roland Wiesendanger — Institute of Applied Physics, University of Hamburg, Jungiusstr. 11, 20355 Hamburg, Germany

Numerical simulations of the switching of ensembles of superparamagnetic nanoparticles in the framework of the Langevin Spin Dynamics as well as the path integral formalism are reported and compared with experimental results. The particles have been coupled via dipolar or RKKY interactions. In the case of a strong coupling a collective switching of particles has been observed. The continuous decrease of the coupling's strength leads to a continuous decrease in the coherency of the switching. The phase shift of the switching as a function of the interaction strength shows a gradual change similar to that of the order parameter in the second order phase transition. This dynamical phase transition is discussed and compared with existing theoretical models.

DF 22.57 Fri 10:30 Poster D

Synchronization between two pointcontact spin torque nano-oscillators — •Thomas Kendziorczyk and Tilmann Kuhn — Institut für Festkörpertheorie, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster

It has been predicted theoretically and observed experimentally that a direct current traversing a magnetic multilayer exerts a spin torque on the magnetic system which can compensate the natural damping and lead to self-sustaining magnetic oscillations in the GHz range. Due to the easy frequency tunability of the spin torque nano-oscillators (STNOs) this effect has great potential for the construction of nano-sized microwave generators. The main problem which has to be solved for future applications is the low output power of a single STNO. Some experiments have already been performed which show that it is possible to synchronize two STNOs. The output power for N synchronized STNOs could in principle scale with N^2. However, in order to construct larger arrays of STNOs a good knowledge about the interaction mechanism between them is indispensable. We will show by means of micromagnetic simulations, that there can exist several different synchronized states for two STNOs depending on the inter-contact distance and the initial phase difference of the free running oscillators. The multistability can be explained by the dispersion of the involved spin waves, which provide the main mechanism for the synchronization.

DF 22.58 Fri 10:30 Poster D

Temperature dependent spin transport and precession in non-local spin valves with transparent interfaces — •Björn Burkhardt[1], Nils Motzko[1], Piotr Laczkowski[2], and Laurent Vila[2] — [1]Institut für Physik, Johannes Gutenberg Universität Mainz, 50099 Mainz, Germany — [2]Laboratoire Nanostructure et Magnetisme, CEA/INAC, 38054 Grenoble, France

In magnetic memory applications and spintronic devices a controlled switching of the magnetization is necessary. One possibility to manipulate the magnetization is to employ pure spin currents, for example in non-local spin valve (NLSV) configurations [1]. Here, the spin diffusion length and the spin flip time of the non-magnetic spin conduit material between two ferromagnetic wires play crucial roles for the efficiency of the resulting pure spin currents. We use aluminum and copper as non-magnetic spin conduits between two Permalloy stripes. Measuring the non-local spin signal as a function of temperature, we found a non-monotonous dependence and a maximum of the non-local signal and spin diffusion length at 23 K for Al and 38 K for Cu. These effects can be explained by different scattering mechanisms and probabilities at various temperatures. To determine this for Al-NLSVs we use Hanle measurements [2]. These show a small periodic effect caused by the spin precession which allowing us to deduce the spin diffusion parameters.

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[2] G. Mihajlovic et al., Phys. Rev. Lett. 104, 237202 (2010)

DF 22.59 Fri 10:30 Poster D

Spin Hall and spin Nernst effect in dilute ternary alloys — •Katarina Tauber[1], Dmitry Fedorov[1], Martin Gradhand[2], and Ingrid Mertig[1,3] — [1]Max-Planck-Institut für Mikrostrukturphysik, Halle, Germany — [2]H.H. Wills Physics Laboratory, University of Bristol, United Kingdom — [3]Martin-Luther-Universität Halle-Wittenberg, Halle, Germany

We present an ab initio study of the spin Hall as well as the spin Nernst effect. Both refer to the creation of a transverse spin current caused by an applied electric field or a temperature gradient, respectively. For the considered Cu-based dilute alloys, the dominant skew scattering mechanism was analysed for several pairs of impurities. We investigated the dependence of the transport properties of ternary alloys on the relative concentration of the two types of impurities. The efficiency of all systems with respect to the spin current generation is discussed in detail. All calculations are based on a fully relativistic Korringa-Kohn-Rostoker method and solution of a linearized Boltzmann equation, successfully applied to the SHE [1] and SNE [2] in binary alloys. The considered ternary alloys appeared to be well described by Matthiessen's rule. However, for the Hall resistivity deviations from Matthiessen's rule can have both signs in contrast to the longitudinal resistivity with only positive deviations.

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DF 22.60 Fri 10:30 Poster D

Magneto-resistance in electromigrated magnetic nanocontacts — •André Loescher[1], Mohamad-Assaad Mawass[1,5], Robert M. Reeve[1], Jakoba Heidler[2], Jan Rhensius[2,3], Laura J. Heyderman[2], Regina Hoffmann[4], and Mathias Kläui[1,2,3] — [1]Johannes Gutenberg-Universität Mainz, Germany — [2]Paul Scherrer Institut, Villigen, Switzerland — [3]Universität Konstanz, Germany — [4]Physikalisches Institut and DFG-Center for Functional Nanostructures, Karlsruhe Institute of Technology, Germany — [5]Max-Planck-Institut für Intelligente Systeme, Stuttgart, Germany

Magnetotransport measurements on magnetic nanocontacts have been performed with the aim to understand the interactions between spin-polarized charge carriers and magnetization on the nanoscale. Here, we study the evolution of magnetoresistance (MR) in electromigrated ferromagnetic junctions obtained in clean ultra-high vacuum (UHV) conditions. While previously Permalloy ($Ni_{80}Fe_{20}$) nanocontacts with variable constriction width have been investigated, the fundamental behaviour of magnetization in such nanocontacts is not fully understood, with measurement artifacts often complicating the interpretation of results. *In-situ* controlled electromigration of notched half ring structures was performed in order to tailor the size of the contact. The MR was measured as a function of the constriction width in order to study the magnetic properties and characterize the strength and extent of the domain wall pinning potential. Furthermore, the MR ratio at remanence is observed to reach 50% and exhibit a previously unobserved sign change in contacts that approach the atomic limit.

DF 22.61 Fri 10:30 Poster D

Spin Seebeck effect in FM/NM/NM hybrid structures — •Michael Schreier[1], Kathrin Ganzhorn[1], Mathias Weiler[1], Matthias Althammer[1,2], Sibylle Meyer[1], Rudolf Gross[1], and Sebastian T.B. Goennenwein[1] — [1]Walther-Meißner-Institut, Garching, Germany — [2]Univeristy of Alabama, Center for Materials for Information Technology MINT, Tuscaloosa, AL, USA

In the spin Seebeck effect thermally excited magnetic moments in a ferromagnet (FM) give rise to a pure spin current which is then detected in a normal metal (NM), usually platinum. Platinum, however, can be subject to a pronounced magnetic proximity effect, which induces a static magnetic polarization adjacent to the interface to the FM. This could eventually give rise to additional contributions by the anomalous Nernst effect in the longitudinal spin Seebeck geometry [1]. Therefore, we have conducted a series of measurements and simulations on YIG/Pt, YIG/Au/Pt, YIG/Cu/Pt, YIG/Au and YIG/Cu samples to verify whether recent spin Seebeck experiments have to be reevaluated on these terms. We find that contributions by the anomalous Nernst effect to the measured voltage signals [2] are much smaller, likely entirely negligible, than those from the spin Seebeck effect. Furthermore, the reported [1] inverse relation between the platinum film thickness and the spin Seebeck voltage can be explained by taking the spin diffusion in the NM into account. This work is supported by the DFG via SPP1538.

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[2] M. Weiler et al., Phys. Rev. Lett. 108, 106602 (2012)

DF 22.62 Fri 10:30 Poster D

Efficient integration method for the intrinsic anomalous Hall conductivity — •Alexander Mook[1], Falko Pientka[1,2], Ingrid Mertig[1,3], and Peter Zahn[1,4] — [1]Institut für Physik, Martin-Luther-Universität, Von-Seckendorff-Platz 1, D-06120 Halle — [2]Fachbereich Physik, Freie Universität, D-14195 Berlin — [3]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle — [4]Helmholtz-Zentrum Dresden-Rossendorf, D-01314 Dresden

Haldane has already presented the expression of the intrinsic anomalous Hall conductivity as an integral over the Fermi surface as expected for Fermi-liquid theory [1] replacing the volume integral of the occupied states in the Brillouin zone.

We implemented both integration methods and applied them to a 4-band (sp^3) tight-binding Hamiltonian including both exchange splitting and spin-orbit coupling. Furthermore, we used an adaptive tetrahedral mesh refinement being based on the 8-tetrahedra-shortest-interior-edge method [2] to obtain convergence when integration over avoided crossings is necessary. Our investigations show that the results of both methods agree very well.

The adaptive integration method is applicable to advanced ab initio electronic structure schemes which provide besides the band energies also the Berry curvature.

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DF 22.63 Fri 10:30 Poster D

Spin Nernst Angle: Definition and qualitative Estimation for Cu Alloys — •Peter Zahn and Sibylle Gemming — Helmholtz-Zentrum Dresden-Rossendorf, D-01314 Dresden, Germany

The spin Nernst effect describes the occurrence of a spin current perpendicular to an applied thermal gradient and the spin quantization axis in a non-magnetic material. To quantify the effect, the spin Nernst angle will be defined in a more general way than in ref. [1]. This allows for a clear separation of the transverse spin current into two opposite contributions proportional to the spin Hall angle and the spin Nernst angle, respectively. Qualitative trends for Cu alloys with 3d, 4d, and 5d defects extending a resonant scattering model by Fert and Levy [2] will be presented.

The work was supported by the Initiative and Networking Fund of the German Helmholtz Association, Helmholtz Virtual Institute MEMRIOX (VH-VI-442).

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DF 22.64 Fri 10:30 Poster D

Zinc ferrite, an oxide for spintronics? — •Michael Bonholzer, Kerstin Brachwitz, Annette Setzer, Pablo Esquinazi, Michael Lorenz, and Marius Grundmann — Universität Leipzig, Institut für Experimentelle Physik II, Linnéstr. 5, 04103 Leipzig

Bulk zinc ferrite is known as an antiferromagnetic insulator with normal spinel structure [1, 2]. But in thin films grown by pulsed laser deposition, semiconducting behaviour of the conductivity is found [1, 3]. The conductivity can be tuned over several orders of magnitude by changing the growth conditions [3]. Magnetism in thin films is also affected by growth conditions and shows different properties compared to bulk as well. Zinc ferrite thin films have a ferrimagnetic magnetisation curve with a high saturation magnetisation and a coercive field of about 10 mT at room temperature. Curie temperature is expected to be well above 800 K [2, 3]. The unexpected properties can be explained by disorder caused by oxygen vacancies [3]. Also theoretical calculations show the semiconducting and ferrimagnetic behaviour of slightly distorted zinc ferrite. They also predict a high spin polarisation [4].
The properties make zinc ferrite a promising material for spintronic applications. First results on magnetic tunnel junctions consisting of a zinc ferrite bottom electrode, a magnesium oxide barrier and a cobalt top electrode show a tunnel magnetoresistance up to 25%.
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DF 22.65 Fri 10:30 Poster D

Quantitative analysis of the spin Hall magnetoresistance in-normal metal/ferromagnetic insulator hybrids — •F. Witek[1], S. Meyer[1], M. Althammer[2], S. Geprägs[1], M. Opel[1], R. Gross[1,3], A. Gupta[2], Y.-T. Chen[4], G.E.W. Bauer[4,5], H. Nakayama[5], E. Saitoh[5,6], and S.T.B. Goennenwein[1] — [1]Walther-Meißner-Institut, BAdW, Garching, Germany — [2]MINT Center, U. of Alabama, Tuscaloosa, USA — [3]Fakultät für Physik, TU München, Germany — [4]Kavli Institute of NanoScience, Delft, The Netherlands — [5]Institute for Materials Research, Tohoku U., Sendai, Japan — [6]The Advanced Science Research Center, JAEA, Tokai, Japan

Pure spin currents are a fascinating manifestation of spin physics in the solid state. We here report on a recently discovered magnetoresistance effect, arising from spin current flow across NM/FM interfaces. We observe this so-called spin Hall magnetoresistance (SMR) in $Pt/Y_3Fe_5O_{12}$ (Pt/YIG), Pt/nonferromagnetic metal/YIG, and Pt/Fe_3O_4 hybrid structures. The SMR effect stems from non-equilibrium spin transfer from the magnetic insulator into the Pt, in combination with spin Hall/inverse spin Hall effect. The SMR therefore characteristically depends on the orientation of the magnetization in the adjacent ferromagnet as observed in experiment. We show that the SMR is qualitatively different from the conventional anisotropic magnetoresistance effect arising in magnetic metals, and utilize the SMR to quantify the spin Hall angle and the spin diffusion length in the Pt layers. Financial support by the DFG via SPP 1538 SpinCAT and Nanoinitiative Munich (NIM) is gratefully acknowledged.

DF 22.66 Fri 10:30 Poster D

Determination of the magnetic depth profile of high-quality Fe_3O_4/ZnO heterostructures by polarized neutron reflectometry — •Michael Zapf[1], Ozan Kirilmaz[1], Sebastian Brück[1], Nina-Juliane Steinke[2], Nadezda Tarakina[3], Martin Kamp[3], Eberhard Goering[4], Michael Sing[1], and Ralph Claessen[1] — [1]Physikalisches Institut, Universität Würzburg, Germany — [2]Rutherford Appleton Laboratory, Chilton, UK — [3]Technische Physik, Universität Würzburg, Germany — [4]Max Planck Institute for Intelligent Systems, Stuttgart, Germany

Magnetite (Fe_3O_4) is one of the most promising materials for use as a spin injector into a semiconducting host. We demonstrate epitaxial growth of Fe_3O_4 films on the polar surfaces of ZnO single crystals. X-ray photoelectron spectroscopy evidences that the MBE-grown samples are phase-pure and nearly stoichiometric. The growth mechanism, the surface and film structure, the chemical profile and magnetic properties have been investigated in our previous publications.

To gain detailed information on the magnetic profile, polarized neutron reflectometry measurements were performed. Values for film thickness, roughness and magnetic moment were obtained from the reflectivity curves and checked against X-ray reflectometry, transmission electron microscopy and magnetometry data. A several nanometer thick region of reduced magnetization in the strained Fe_3O_4 layers near the heterointerface could be resolved. Thereby the efficiency of spininjection into ZnO could be strongly affected.

DF 22.67 Fri 10:30 Poster D

Exploring spin-filter tunneling in magnetic oxide hybrids — •Bernardus Zijlstra[1], Christian Caspers[1], Sebastian Flade[1], Michael Voigt[1], Jürgen Schubert[2], Claus M. Schneider[1], and Martina Müller[1] — [1]Peter-Grünberg-Institut (PGI-6), Forschungszentrum Jülich — [2]Peter-Grünberg-Institut (PGI-9), Forschungszentrum Jülich

A key requirement for the development of spintronic devices is the ability to electrically generate highly spin-polarized currents. Magnetic oxides that posses a spin-filter functionality are an interesting route for achieving this. In order to study the spin-filter tunneling mechanism, EuO was utilized as a representative of this magnetic oxide class.

With regard to studying the influence of band structure on the spin-filtering effect, a model-system was realized. Single-crystalline, ultrathin layers of EuO(100) were grown on lattice-matched Sn-doped In_2O_3(100) and characterized by RHEED, XRD and TEM. Moreover, the electrical behavior in this system was studied by spin-filter tunneling experiments.

Furthermore, single-crystalline EuO(100) was epitaxially grown on Si(100) with the final aim of studying spin injection through a magnetic tunnel barrier into a semiconductor. Contrary to earlier predictions of thermodynamic stability of EuO on silicon, formation of an intermediate silicide-layer was observed. To overcome this problem, the silicon surface was passivated by an ultrathin SiO_x layer and magnetotransport experiments were performed on such $EuO/SiO_x/Si$ heterostructures.

DF 22.68 Fri 10:30 Poster D

FMR measurements: Thickness dependence of YIG film investigated by spin pumping — •René Röser[1], Andreas Kehlberger[1], Gerhard Jakob[1], Benjamin Jungfleisch[2], Burkard Hillebrands[2], Ulrike Ritzmann[3], Denise Hinzke[3], Dong Hun Kim[4], Caroline Ross[4], Ulrich Nowak[3], and Mathias Kläui[1] — [1]Institute of Physics, Johannes Gutenberg-University Mainz, 55099 Mainz, Germany — [2]Department of Physics, Institute of Technology Kaiserslautern, 67663 Kaiserslautern, Germany — [3]Department of Physics, University of Konstanz, 78457 Konstanz, Germany — [4]Department of Materials Science and Engineering, MIT, Cambridge, MA 02139, USA

The production method pulsed laser deposition (PLD) offers the opportunity to study high quality YIG ($Y_3Fe_5O_{12}$) films in the sub micrometer thickness regime (Yiyan Sun et al., Appl. Phys. Lett. 101, 152405 (2012)). Especially thin bilayer systems consisting of YIG coated with materials with high spin orbit coupling became focus of the general interest. These systems turned out to be an important mechanism for the generation of a spin current in nonmagnetic conductors by spin pumping (C.W. Sandweg et al., Phys. Rev. Lett. 106, 216601 (2011)). We present studies of a variety of YIG films produced by PLD. The films are characterized by the thickness, surface roughness and crystalline order. Furthermore the intrinsic magnetic properties are investigated by a SQUID and a Vector Network Analyzer-FMR setup. In order to determine the spin wave excitation spectrum in thin YIG films, which are coated with platinum, we compare films of thicknesses up to 300nm.

DF 22.69 Fri 10:30 Poster D

Nernst vs. spin-Seebeck effects in Py thin films — •M. Schmid[1], S. Srichandan[1], M. Vogel[1], C. Strunk[1], C. Back[1], D. Meier[2], T. Kuschel[2], J.M. Schmalhorst[2], and G. Reiss[2] — [1]1Physics department University of Regensburg, Regensburg, Germany — [2]Thin Films and Physics of Nanostructures, Department of Physics, University of Bielefeld, Germany

Magneto-thermal effects are investigated in Permalloy (Py) films deposited on different substrates (MgO and GaAs). The transverse voltage V_y is measured with attached Pt stripes on the Py. The measurements are taken with different in plane temperature gradients (along x) up to 50 K and an applied in plane magnetic field at various angles. The obtained signals can be identified as a combination of the anomalous (ANE) and the planar (PNE) Nernst effects. The PNE follows a $\cos(\Theta)\sin(\Theta)M\nabla T$ dependence, with M the magnetization, ∇T the temperature gradient and Θ being the angle between the two. The PNE voltage is of the order of μV which is consistent with the literature [1]. The ANE exhibits a $\cos(\Theta)$ relation with an amplitude of about 100 nV and is connected to an out of plane temperature gradient. Additionally, a small, but non-negligible contribution of the spin-Seebeck effect is considered but its magnitude is orders smaller than reported in the literature [2]. A COMSOL simulation of the temperature distribution supplements our interpretation. Finally, we studied Nernst

effects in Py films deposited SiN membranes.

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DF 22.70 Fri 10:30 Poster D

In search of spin caloric effects in thin permalloy films using different setups for transverse spin Seebeck effect measurements — •Timo Kuschel[1], Daniel Meier[1], Takashi Kikkawa[2], Ken-ichi Uchida[2], Eiji Saitoh[2], Jan-Michael Schmalhorst[1], and Günter Reiss[1] — [1]University of Bielefeld, Germany — [2]Tohoku University of Sendai, Japan

In spin caloritronics the spin Seebeck effect (SSE) (generation of a spin current by a temperature gradient) plays an important role. After the original observation in thin permalloy films on sapphire substrates in the transverse geometry (TSSE) in 2008 many scientific groups tried to measure the TSSE on different materials. Often an additional out-of-plane temperature gradient generates an anomalous Nernst effect (ANE) which contributes to the measured signal.
We built up a setup for TSSE measurements and investigated thin permalloy films on sapphire and MgO substrates. While our measurements reveal a symmetric contribution concerning the external magnetic field due to the anisotropic thermopower (planar Nernst effect), an additional asymmetric contribution due to the TSSE or ANE is not observed in most cases. For comparison we used the original setup in Japan and obtained different results for the same samples. An asymmetric contribution due to the TSSE or ANE is now contributing for nearly every sample. This inconsistency is discussed in the context of setup differences and probable out-of-plane temperature gradients.

DF 22.71 Fri 10:30 Poster D

Anisotropic magneto-thermopower and control of temperature gradients in (113) oriented (Ga,Mn)As thin films — •Mathias Frank[1], Sibylle Meyer[1], Lukas Dreher[2], Wladimir Schoch[3], Rudolf Gross[1,4], and Sebastian T. B. Goennenwein[1] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Walter Schottky Institut, Technische Universität München, Garching, Germany — [3]Institut für Quantenmaterie, Universität Ulm, Ulm, Germany — [4]Physik-Department, Technische Universität München, Garching, Germany

For caloritronic experiments, it is of crucial importance to control the direction and amplitude of temperature gradients within a given sample. We have implemented and compared different methods to apply and measure longitudinal and transverse temperature gradients in a (Ga,Mn)As thin film. We further studied the anisotropic magneto-thermopower (AMTP), i.e. the characteristic dependence of the thermopower with respect to the orientation of the magnetization vector. Our data show that the AMTP can be adequately modeled only if the symmetry of the (Ga,Mn)As crystal is explicitly taken into account. We quantitatively compare the AMTP data with the anisotropic magnetoresistance (AMR) data taken on the same (113) - oriented (Ga,Mn)As thin film and with corresponding model calculations. Moreover, we address the differences between the magnetoresistance and the magneto-thermopower coefficients. Financial support by DFG via SPP 1538 is gratefully acknowledged.

DF 22.72 Fri 10:30 Poster D

Dynamical heating of ferrimagnetic structures in a wide range of magnetic fields — •Thomas Langner, Vitaliy Vasyuchka, Benjamin Jungfleisch, Andrii Chumak, Alexander Serga, and Burkard Hillebrands — Fachbereich Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, Erwin-Schroedinger-Str. 56, 67663 Kaiserslautern, Germany

Precessing magnetic moments can generate heat due to the decay of the precessional motion and the following transfer of energy into the phonon system. We placed a polycrystalline disc of yttrium iron garnet (YIG) in an external magnetic field and excited it with high power microwaves. The temperature of the disc was monitored with an infrared camera. Beside large heating at the ferromagnetic resonance (FMR) we show an unexpected heat generation with applied microwave frequencies around 3.5 GHz for magnetic fields between 0 and 200 Oe far below the FMR. In spite of practically the same absorption of microwaves the heating becomes smaller with higher magnetic field values in the mentioned range. The behavior can then be understood by resonant magnetic excitations of the grain structure inside the polycrystalline material. This assumption can be confirmed by a comparison to the behavior of a monocrystalline YIG structure and by an excitation of the polycrystalline sample by microwaves of higher frequencies.

Financial support by Deutsche Forschungsgemeinschaft within priority program SPP 1538 "Spin Caloric Transport" is gratefully acknowledged.

DF 22.73 Fri 10:30 Poster D

Structural and magnetic properties of $NiFe_2O_4$ thin films prepared by different deposition techniques — •Christoph Klewe[1], Timo Kuschel[1], Daniel Meier[1], Gerhard Götz[1], Liming Shen[2], Arunava Gupta[2], Karsten Küpper[3], Jan-Michael Schmalhorst[1], and Günter Reiss[1] — [1]Bielefeld University, Germany — [2]University of Alabama, Tuscaloosa, AL, USA — [3]University of Osnabrück, Germany

Recent advances in the field of spin caloritronics have urged the search for ferro- or ferrimagnetic, insulating materials in thin film form. One material which promises to be suitable for studies of the longitudinal Spin Seebeck effect is Nickelferrite ($NiFe_2O_4$). We fabricated $NiFe_2O_4$ thin films on $MgAl_2O_4$ (001) substrates by direct liquid injection chemical vapour deposition(DLI-CVD) and dc magnetron co-sputtering in a pure oxygen atmosphere. Stoichiometric measurements were performed using energy dispersive x-ray spectroscopy (EDX), x-ray fluorescence (XRF) and sputter x-ray photoelectron spectroscopy (XPS). Structural properties were investigated by x-ray diffraction analysis (XRD) and scanning electron microscopy (SEM). Magnetic properties were determined from magnetooptic Kerr effect (MOKE) and alternating gradient magnetometry (AGM) measurements. Temperature dependent measurements were carried out in order to investigate the resistivity and determine the bandgap. The results were compared to identify the best deposition technique and parameters with regard to the insulating properties of the ferromagnetic films.

DF 22.74 Fri 10:30 Poster D

Cooling Nanodevices by Spin Currents — •Jochen Brüggemann[1], Stephan Weiss[2], Peter Nalbach[1], and Michael Thorwart[1] — [1]1. Institut für theoretische Physik, Universität Hamburg, 20355 Hamburg, Deutschland — [2]Theoretische Physik, Universität Duisburg-Essen & CENIDE, 47048 Duisburg, Deutschland

In analogy to the demagnetization cooling for macroscopic devices, we aim to develop and analyze a magnetocaloric cooling cycle for nanodevices. For a proof of principle, a simple model consists of the following: First, an interacting quantum dot, which is tunnel coupled to ferromagnetic leads; second, dot electrons which can interact via exchange interaction with a localized impurity spin; and third, a Holstein phonon for the mechanical degrees of freedom. Using the real-time diagrammatic perturbation theory in lowest order in the hybridization of the leads, we determine the impurity spin dynamics as well as the mean energy of the mechanical oscillator as functions of the system parameters and the bias voltage. In agreement with previous findings, we reproduce an effective cooling of the impurity spin in the stationary limit. In the transient nonequilibrium regime, we realize a cooling cycle aiming at accumulating an increased ground state population of the phonon due to the cooling of the impurity spin as compared to the initial preparation.

DF 22.75 Fri 10:30 Poster D

Steady-state measurements of thermal effects in GaMnAs/GaAs/Pt systems — •Nadezda Panarina[1], Ivan Soldatov[1], Christian Hess[1], Rudolf Schäfer[1], Sibylle Meyer[2], Sebastian Gönnenwein[2], Wolfgang Limmer[3], and Wladimir Schoch[3] — [1]IFW Dresden, Dresden, Germany — [2]WMI, Garching, Germany — [3]Universität Ulm, Ulm, Germany

The steady-state measurements were performed on the GaAs/GaMnAs/ Pt system, where the so-called spin Seebeck effect is claimed to exist. The main principle of the steady-state technique lies in attaining and controlling thermal equilibrium and stable thermal gradient along the sample, which provides enhanced accuracy of the experimental data. It was possible to detect the transverse electric signal on the Pt strips deposited at different distances to the heater. The behavior of the detected signal (sign and value) depended strongly on the experimental details, such as position of the heater on the sample (on top or side), the range of the magnetic field sweep (varying from tens up to hundreds of mT) and temperature of measurement. Moreover, the transverse voltage was registered directly on the GaMnAs film in the same run of the experiments. This fact questions the role of Pt layers in detecting the thermal-gradient-induced signal and suggests the transverse thermopower, or planar Nernst, origin of the magneto-electric effects observed in the thin ferromagnetic film of GaMnAs.

DF 22.76 Fri 10:30 Poster D

Spin wave mediated heating in a magnetic insulator — •Vitaliy I. Vasyuchka, Alexander A. Serga, Andrii V. Chumak, and Burkard Hillebrands — FB Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany

We present the results on spin wave mediated heating in films of a magnetic insulator using a thermography technique. The experiments were performed using a single-crystal yttrium iron garnet (YIG) film. We have found conditions when the direction of the heating of the sample can be controlled by an external magnetic field. In this case a large shift of the temperature maximum away from the excitation antenna of up to a few millimeters was observed. It was understood as a result of the interplay between the unidirectional heating and the diffusion of heat into the cold part of the YIG film. We found that the temperature maximum and its shift relative to the excitation antenna strongly depend on the speed of spin waves.

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DF 22.77 Fri 10:30 Poster D

Ground state, static vortices, and dynamic excitations in magnon Bose-Einstein condensates — •Patryk Nowik-Boltyk[1], Oleksandr Dzyapko[1], Vladislav Demidov[1], Natasha Berloff[2], and Sergej O. Demokritov[1] — [1]Universität Münster; Institut für Angewandte Physik — [2]University of Cambridge, Department of Applied Mathematics and Theoretical Physics

Although the basic properties of magnon Bose-Einstein condensates have been extensively studied during the last 5 years, details of the ground state, topological defects and induced dynamics of the condensate have not been addressed so far. Here we present a detailed study of the ground state of the condensate and static vortices as well as the dynamics of the condensate by means of space- and time-resolved Brillouin Light Scattering spectroscopy. We show that the intrinsic degeneracy of the condensate results in formation of a non-uniform ground state demonstrating a standing-wave of the condensate density. We also experimentally observed static defects in the condensate in a form of quantized vortices. The study of induced dynamics was performed using spatially and temporary non uniform external magnetic fields. For relatively slow field pulses we observe a quasi-adiabatical accommodation of the condensate density at the place of the field. If we use very short and fast field pulses, travelling density waves can be observed. If the field is varied periodically in the megahertz frequency range, traveling density waves are also observed. The dispersion relation of the newly observed waves is determined.

DF 22.78 Fri 10:30 Poster D

Nonlinear emission of spin-wave caustics from an edge mode of a micro-structured $Co_2Mn_{0.6}Fe_{0.4}Si$ waveguide — •Thomas Sebastian[1,2], Philipp Pirro[1], Thomas Brächer[1,2], Takahide Kubota[3], Hiroshi Naganuma[4], Alexander A. Serga[1], Mikihiko Oogane[4], Yasuo Ando[4], and Burkard Hillebrands[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, 67663 Kaiserslautern, Germany — [2]Graduate School Materials Science in Mainz, 67663 Kaiserslautern, Germany — [3]WPI Advanced Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan — [4]Department of Applied Physics, Graduate School of Engineering, Tohoku University, Sendai 980-8579, Japan

The low Gilbert damping of the Heusler compound $Co_2Mn_{0.6}Fe_{0.4}Si$ (CMFS) makes the material a promising candidate for the utilization in perspective *magnon-spintronic* devices [1].

We present the nonlinear emission of spin-wave caustics [2] from a localized edge mode [3] in a CMFS waveguide at twice and three times the excitation frequency observed by Brillouin light scattering microscopy. The propagation characteristics of these strongly directed beams are confirmed by analytic modeling using the anisotropic dispersion for spin waves in magnetic thin films.

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DF 22.79 Fri 10:30 Poster D

Magnon temperature measurement: new insights into spin Seebeck effect — •Milan Agrawal[1], Vitaliy I. Vasyuchka[1], Alexander A. Serga[1], Alexy D. Karenowska[2], Gennadiy A. Melkov[3], and Burkard Hillebrands[1] — [1]Fachbereich Physik and Forschungszentrum OPTIMAS, Technische Universität Kaiserslautern, Kaiserslautern, 67663, Germany — [2]Department of Physics, University of Oxford, Oxford OX1 3PU, UK — [3]Faculty of Radiophysics, Taras Shevchenko National University of Kyiv, 03127 Kyiv, Ukraine

The study of magnon-phonon interaction is very important for the advancement of the emerging field of spin caloritronics [1]. The distribution of magnon and phonon temperatures in ferromagnets can explain the thermal spin-transport phenomena which have been observed electrically by measuring the induced inverse spin Hall voltage in normal metal placed over the ferromagnet [2-3]. Here, we report on the measurement of spatial distribution of magnon temperature in magnetic system imposed to a lateral thermal gradient by studying the variation of local magnetization. Our measurements reveal a strong correlation between magnons and phonons, and state that the contribution of magnons to the spin Seebeck effect in magnetic insulators is negligible or rather small. Furthermore, typical length scale of phonon-magnon interaction is calculated. Our results give new insights into the magnon contribution to the spin Seebeck effect.

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DF 22.80 Fri 10:30 Poster D

Heat-induced damping manipulation in YIG/Pt heterostructures — •Matthias Benjamin Jungfleisch[1], Toshu An[2], Kazuya Ando[2], Yosuke Kajiwara[2], Ken-ichi Uchida[2], Vitaliy I. Vasyuchka[1], Andrii V. Chumak[1], Alexander A. Serga[1], Eiji Saitoh[2], and Burkard Hillebrands[1] — [1]Fachbereich Physik and Landesforschungszentrum OPTIMAS, Technische Universität Kaiserslautern, D-67663 Kaiserslautern, Germany — [2]Institute for Material Research, Tohoku University, Sendai 980-8577, Japan.

One of the main objectives in the field of magnon spintronics is the control and manipulation of magnetization relaxation and the generation of spin waves.

Here, we show the manipulation of spin-wave damping utilizing a temperature difference across the thickness of an yttrium iron garnet (YIG)/platinum (Pt) multi-structure. This temperature difference ΔT gives rise to the longitudinal spin Seebeck effect: an imbalance between the effective magnon and the effective electron temperatures causes a spin current across the YIG/Pt interface. Since the created spin current transfers spin angular momentum, a torque is exerted on the magnetization. Consequently, the magnetization precession is either enhanced or suppressed depending on the sign of ΔT. This damping variation can be expressed as a change of the ferromagnetic resonance linewidth ΔH_{FMR} that is measured by spin pumping in the adjacent Pt layer as well as by microwave reflection.

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Correlation of Inverse Spin Hall Effect to the crystal growth of magnetic films — •Philipp Fuhrmann, Evangelos Papaioannou, and Burkard Hillebrands — Fachbereich Physik, Technische Universität Kaiserslautern, D-67663 Kaiserslautern, Germany

Spin transfer torque and spin pumping phenomena in magnetic hetero structures have attracted a lot of interest in the field of spintronics. Spin pumping and Inverse Spin Hall Effect (ISHE) in ferromagnetic / normal metal systems have been extensively investigated over the last years, covering dependencies on layer thickness and choice of material. However no systematic studies have been performed regarding the influence of the growth modes of the ferromagnetic / normal metal systems on spin pumping and ISHE.

In this work we present the correlation of crystal growth to ISHE. Structural properties of high quality epitaxial Fe films, covered with a Pt layer, are shown by Scanning Tunnel Microscopy and X-Ray Reflectivity. Characteristic roughness parameters are extracted by height-height correlation analysis. Magnetization properties are studied with the help of longitudinal Kerr effect. We show the dependence of ISHE on the crystal quality, and we correlate ISHE to surface roughness and magnetic anisotropies.

DF 22.82 Fri 10:30 Poster D

^{1}H-NMR in the heterometallic complex Mn_2Ni_3 — •Marco Günther[1], Liang Gong[1], Markus Brettschneider[1], Evgenia Vavilova[2], Vladislav Kataev[3], Animesh Das[4], Franc Meyer[4],

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We studied the quasi-linear heterometallic complex Mn_2Ni_3, a recently synthesized single-molecule magnet by means of solid state proton NMR. The proton spectra is observed down to T=1.5 K where strong static hyperfine fields due to the $|S^z_{tot}$ =-7> ground state arise. The spectra is simulated with respect to the dipole summation of electronic moments at the local probe sites.

Proton T_1-relaxation rate probes the electronic dynamics in the paramagnetic regime down to the ground state formation within two orders of magnitude. For the lowest temperatures, we present our measurements of the field-depending relaxation experiments.