MA 66: Poster 3

Time: Friday 9:30–13:00 Location: P2-OG2

MA 66.1 Fri 9:30 P2-OG2

Manipulation of AF-Coupled Thin Film Systems by Ion Beam Irradiation — •Leopold Koch[1,2], Fabian Samad[2], Benny Böhm[2], Fabian Ganss[2], Sri Sai Phani Kanth Arekapudi[2], Miriam Lenz[1], Sven Stienen[1], and Olav Hellwig[1,2] — [1]Institut für Ionenstrahlphysik und Materialforschung, Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstrasse 400, 01328 Dresden, Germany — [2]Institut für Physik, Technische Universität Chemnitz, 09126 Chemnitz, Germany

The tuning of the magnetic properties of antiferromagnetically (AF) coupled multilayer films by ion beam irradiation has been investigated. Stacks of Co/Pd respectively Co/Pt multilayers, AF-coupled by Ru or Ir interlayers, have been useful for studying the energy contribution of interlayer exchange, perpendicular anisotropy and long range dipole interactions. The system shows a complex mixture of magnetic phases that can be tuned by the number of repeats of the multilayers (X). A lateral homogeneous AF remanent structure occurs for small X due to the dominance of the AF-coupling. For large X the demagnetisation energy prevails and ferromagnetic stripe domains evolve. With ion irradiation the balance of the energy contributions can be locally manipulated, thus a lateral heterogeneous structure of magnetic phases may be realised. Initial irradiation studies will be discussed.

MA 66.2 Fri 9:30 P2-OG2

Influence of oxygen content on magnetic properties in La2/3Sr1/3MnO3-δ thin films — •Lei Cao[1], Oleg Petracic[1], Alexander Weber[2], and Thomas Brückel[1,2] — [1]Jülich Centre for Neutron Science JCNS and Peter Grünberg Institut PGI, JARA-FIT, Forschungszentrum Jülich GmbH, Jülich — [2]Jülich Centre for Neutron Science JCNS at Heinz Maier-Leibnitz Zentrum MLZ, Forschungszentrum Jülich GmbH, Garching

Complex oxides display a multitude of unique phenomena, such as various forms of magnetism, superconductivity, colossal magnetoresistance, ferroelectricity, and couplings between these states. While most studies on complex oxide thin films focus on the parameters of film deposition and the role of oxygen during preparation the role of oxygen content after sample preparation onto the physical properties is mostly unknown. We report on the fabrication of La2/3Sr1/3MnO3-δ thin films on SrTiO3 substrates by sputter deposition. Using an in-situ x-ray diffraction setup we investigate the crystallographic properties while annealing the samples in vacuum and at various temperatures. While annealing induces a desorption of oxygen, absorption of oxygen is realized in a controlled oxygen plasma of a sputtering setup. By employing superconducting quantum interference (SQUID) magnetometry and electrical resistivity measurements, we study the magnetic and transport properties of the as-prepared, annealed and plasma treated systems. We then relate the influence of oxygen absorption/desorption to the physical properties of the films.

MA 66.3 Fri 9:30 P2-OG2

Exchange bias in chemically disordered $Mn_{0.8}N_{0.2}$/CoFe systems — Simon Tilleke, •Katharina Fritz, Björn Büker, and Markus Meinert — Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany

In a recent publication [1], we reported on large exchange bias obtained in Ta/Θ-MnN/CoFe stacks at room temperature. In search for Mn-N phases with higher anisotropy energy, we investigated Mn-N films with lower nitrogen content to obtain other antiferromagnetic Mn-N phases, such as η-Mn_3N_2 or ζ-Mn_2N with the same deposition process.

We found an antiferromagnetic phase at the composition $Mn_{0.8}N_{0.2}$ that allows for large exchange bias with an interfacial exchange energy of Js = 0.39 mJ/m^2 (similar to Θ-MnN/CoFe), but with a significantly reduced critical thickness of the antiferromagnet and thus a higher magnetocrystalline anisotropy energy. X-ray diffraction identifies the $Mn_{0.8}N_{0.2}$ as a simple, chemically disordered fcc structure with no traces of an ordered ϵ-Mn_4N structure in the as-deposited state. Annealing at temperatures above 150 °C will, however, induce chemical ordering of the Mn and N atoms and a transformation into well-ordered ϵ-Mn_4N is completed at annealing temperatures above 200 °C. After the transformation, no exchange bias is detected, in line with the ferrimagnetic ground state of the ϵ-Mn_4N phase. Exchange bias up to 1400 Oe is obtained at room temperature at a $Mn_{0.8}N_{0.2}$-thickness of 20 nm.

[1] M. Meinert *et al.*, Phys. Rev. B **92**, 144408 (2015)

MA 66.4 Fri 9:30 P2-OG2

Multifrequency ferromagnetic resonance study of the antiferromagnetic-ferromagnetic phase transition in FeRh — •Anna Semisalova[1,2], Jonathan Ehrler[1,3], Craig Barton[4], Thomas Thomson[4], Kilian Lenz[1], Jürgen Fassbender[1,3], Kay Potzger[1], and Jürgen Lindner[1] — [1]HZDR, Institute of Ion Beam Physics and Materials Research, Dresden, Germany — [2]Lomonosov MSU, Faculty of Physics, Moscow, Russia — [3]Technische Universität Dresden, Dresden, Germany — [4]University of Manchester, School of Computer Science, Manchester, UK

The first order phase transition of an equiatomic FeRh thin film from the antiferromagnetic (AFM) to the ferromagnetic (FM) state was studied using broadband ferromagnetic resonance (FMR). The films were deposited on MgO(001) substrates by means of magnetron sputtering of an alloy target. The position and linewidth of the FMR signal have been investigated in the frequency range up to 50 GHz. Conclusions on the temperature dependence of the magnetic damping are presented. The linewidth was found to be strongly affected by the exchange coupling due to reversible nucleation of AFM and FM domains in FeRh within the temperature range of the phase transformation.

MA 66.5 Fri 9:30 P2-OG2

Optical detection of ferromagnetic resonance via photoluminescence in diamond NV-centers — Martin Wagener, •Chris Koerner, and Georg Woltersdorf — Martin-Luther-University Halle-Wittenberg, Institute of Physics, von-Danckelmann-Platz 3, 06120 Halle(Saale), Germany

We optically detect electron spin resonance in nanoscale diamonds with NV-centers by photoluminescence measurements (ODMR). When the nano-diamonds are dispersed on top of an yttrium iron garnet (YIG) film the ferromagnetic resonance (FMR) of YIG becomes visible in the ODMR signal. This effect has previously been observed by Wolfe et al. [1,2]. Our work intends to unravel the physical origin of the cross coupling between FMR in YIG and the ODMR in the diamond NV-centers. In doing so we investigate the material dependence, the influence of spacer layers, and the frequency or field dependence of the coupling in the ODMR signal.

[1] C. S. Wolfe et al. Phys. Rev. B 89, 180406 (2014)
[2] C. S. Wolfe et al. ArXiv 1512.05418v2 (2016)

MA 66.6 Fri 9:30 P2-OG2

Coupling of magnetism and structural phase transition in V2O3/Co bilayers — •Changan Wang[1,2,3], Chi Xu[1,2], Ye Yuan[1,2], Yu-Jia Zeng[3], Manfred Helm[1,2], and Shengqiang Zhou[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research, Bautzner Landstr. 400, 01328 Dresden, Germany — [2]Technische Universität Dresden, 01062 Dresden, Germany — [3]Shenzhen Key Laboratory of Laser Engineering, College of Optoelectronic Engineering, Shenzhen University, 518060 Shenzhen, China

Exchange couplings across interfaces of hybrid magnetic heterostructures are being considered as unique opportunity for functional materials design. In this study, we show that both coercivity and magnetization of V2O3/Co bilayers are affected by the stress associated with structural phase transition across metal-insulator phase transition in V2O3. The change in coercivity is as large as 76% in a very narrow temperature range. The magnetic properties can be controlled by stress, which is significant for future multiferroic and spintronics applications.

MA 66.7 Fri 9:30 P2-OG2

Giant perpendicular exchange bias with antiferromagnetic MnN — •Philipp Zilske and Markus Meinert — Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University

Exchange bias systems have been extensively investigated due to their technological applications in magnetic sensors based on magnetic tunnel junctions or spin valves. Recently, a new exchange bias system

consisting of MnN/CoFe bilayers, which shows huge in-plane exchange bias up to 1800 Oe at room temperature, was discovered [1].

Here, we report on an out-of-plane exchange bias system that is also based on the antiferromagnet MnN. Ta/MnN/CoFeB/MgO stacks were grown on amorphous SiOx via reactive magnetron sputtering at room temperature. Diffraction measurements revealed a polycrystalline, columnar growth of the MnN in (001) direction. The dependence of the exchange bias field on the MnN and CoFeB thickness, as well as on the annealing temperature was investigated. This way, we achieved perpendicular exchange bias fields up to 3600 Oe with a coercive field around 350 Oe at room temperature. Furthermore, the anisotropy field was determined for the different stacks yielding values up to 3250 Oe. The perpendicular exchange bias reported here is larger than any previously reported value and possibly opens a route to magnetically stable, perpendicularly magnetized spin valves [2].

[1] M. Meinert et al., Phys. Rev. B **92**, 144408 (2015)
[2] J. Y. Chen et al., Appl. Phys. Lett. **104**, 152405 (2014)

MA 66.8 Fri 9:30 P2-OG2

Magnetic Force Microscopy studies of synthetic perpendicular anisotropy antiferromagnets modified by ion beam irradiation — •Fabian Samad[1], Benny Böhm[1], Leopold Koch[1,2], Fabian Ganss[1], Sri Sai Phani Kanth Arekapudi[1], Miriam Lenz[2], Sven Stienen[2], and Olav Hellwig[1,2] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]Institute for Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstrasse 400, 01328 Dresden, Germany

By using ion beam irradiation of different energy and flux we modify and tune the magnetic reversal and microstructure in synthetic perpendicular anisotropy antiferromagnets consisting of [(Co/Pt)Co/Ru] multilayer systems. The magnetic energy balance between antiferromagnetic interlayer exchange and dipolar fields in the initial state of the samples has been tuned to have two local energy minima, one for laterally correlated and vertically anti-correlated magnetic structure (single domain antiferromagnet) and the other for laterally anti-correlated and vertically correlated magnetic structure (ferromagnetic stripe domains) [1]. Ion beam irradiation is then subsequently used to locally alter the magnetic microstructure from one state to the other to create laterally co-existing phases and study their reversal behavior in external magnetic fields using Magnetic Force Microscopy.

[1] O. Hellwig, J. B. Kortright, A. Berger and E. E. Fullerton, "Magnetic Reversal in Antiferromagnetically Coupled Perpendicular Films", J. Magn. Magn. Mater. 2007, 319, 13.

MA 66.9 Fri 9:30 P2-OG2

Impact of ion irradiation on magneto-resistance properties of synthetic antiferromagnets based on $[(Co/Pt)_{X-1}Co/Ru]_N$ multilayers — •Benny Böhm[1], Fabian Samad[1], Leopold Koch[1,2], Sri Sai Phani Kanth Arekapudi[1], Fabian Ganss[1], Miriam Lenz[2], Sven Stienen[2], and Olav Hellwig[1,2] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstrasse 400, 01328 Dresden, Germany

In this study integral magnetic properties and local microstructure in synthetic perpendicular anisotropy antiferromagnets consisting of $[(Co/Pt)_{X-1}Co/Ru]_N$ multilayers are modified using ion irradiation. The magnetic domain structure in the perpendicular anisotropy system is systematically modified by introducing antiferromagnetic exchange (via the Ru-thickness). This also results in two singular reversal modes (magnetic phases), one phase in which the AF exchange dominates (results in no magnetic stray field on the surface) and the other in which the dipolar interaction dominates leading to ferromagnetic stripe domains. Furthermore, ion irradiation with different kinetic energies and fluences is employed to locally modify the microstructure, therefore switching from one phase to another, resulting in laterally co-existing AF and FM-regions. Initial magneto-transport measurements on magnetic heterostructures will be presented.

[1] Olav Hellwig, Taryl L. Kirk, Jeffrey B. Kortright, Andreas Berger & Eric E. Fullerton, "A new phase diagram for layered antiferromagnetic films", Nature Materials 2, 112 - 116 (2003)

MA 66.10 Fri 9:30 P2-OG2

Ion irradiation induced cobalt/cobaltoxide heterostructures: from materials to devices — •Donovan Hilliard[1,2], Oguz Yildirim[1], Ciarán Fowley[1], Sri Sai Phani Kanth Arekapudi[2], Marcin Perzanowski[3], Hamza Cansever[1,4], Lakshmi Ramasubramanian[1,2], Olav Hellwig[1,2], and Alina Deac[1] — [1]Helmholtz-Zentrum Dresden - Rossendorf — [2]Technische Universität Chemnitz — [3]Institute of Nuclear Physics PAN — [4]Technische Universität Dresden

Spintronic devices are often patterned from continuous films into micro- or nanostructures. Fabrication of those nano-devices is self-limited and depends on the lateral resolution of the chosen fabrication method. Ion irradiation offers an alternative route to introduce smaller magnetic patterns limited by the size of the ion beam. Irradiation of oxide materials can cause chemical reduction and lead to the local formation of metallic species. By using the oxide family of ferromagnets (e.g., Fe, Ni and Co), reduction leads to the formation of ferromagnetic and conducting volumes limited by the size of the ion irradiated area that are embedded into a non-magnetic and insulating matrix. On the other hand, the physical mechanism behind ion irradiation-induced oxide reduction could not be explained. Therefore, our studies focus on ion (H, He, Ne, O) irradiated cobalt-oxide (CoO or Co3O4) systems in order to explain the physics behind the process. Also, the knowledge is being exploited to tune exchange-bias direction, prepare nano contacts for synchronized spin torque oscillators, and to form topographically stabilized magnetic skyrmions.

MA 66.11 Fri 9:30 P2-OG2

Tunnel Junction Fabrication for Tunneling Anisotropic Magnetoresistance Spectroscopy — •Michaela Schleuder[1,3], Matthias Althammer[1,3], Matthias Pernpeintner[1], Hans Huebl[1,3,4], Daniel Meier[2], Günter Reiss[2], and Rudolf Gross[1,3,4] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, Garching, Germany — [2]Universität Bielefeld, Bielefeld, Germany — [3]Physik-Department, Technische Universität München, Garching, Germany — [4]Nanosystems Initiative Munich (NIM), Munich, Germany

Magnetic tunnel junctions (MTJs) consisting of one ferromagnetic metal electrode, an insulating barrier, and a normal metal counter electrode exhibit the so-called tunneling anisotropic magnetoresistance. Due to spin-orbit interaction, the resistance of the MTJ depends on the relative orientation of the magnetization with respect to the crystallographic axes of the ferromagnet. We discuss the fabrication strategies for MTJs based on the Heusler alloys Co_2FeAl and Co_2FeSi using MgO as the insulating barrier and Pt or Au as the counter electrode. The fabrication consists of a three-step electron lithography process, including subsequent Ar-ion etching and SiO_2 sputter deposition. We present optical micrographs and atomic force microscopy images of the optimized fabrication steps with junction sizes down to the nm regime, confirming the successful fabrication of MTJs.

We show first results on the electrical characterization of these MTJs. This optimized fabrication scheme paves the way for more complex device patterns.

MA 66.12 Fri 9:30 P2-OG2

Lattice effects accompanying the colossal magnetoresistance effect in $HgCr_2Se_4$ — •S. Hartmann[1], E. Gati[1], C. Lin[2], Y. Shi[2], Y. Li[2], J. Müller[1], and M. Lang[1] — [1]Physikalisches Institut, Goethe Universität, SFB/TR49, 60438 Frankfurt, Germany — [2]Institute of Physics, Chinese Academy of Sciences, Beijing, China

Understanding the origin of large or colossal magnetoresistance (CMR) effects, observed in a wide range of materials, remains a challenging field of research in magnetism. The occurrence of electronic and magnetic phase separation in some of these materials has led researchers to suggest percolating magnetic polarons as one route for describing the CMR effect. In fact, studies on the semi-metallic CMR material EuB_6 revealed that the magnetically-driven delocalization of charge carriers is accompanied by pronounced lattice distortions [1], consistent with the scenario of percolating magnetic polarons. With reference to these results we performed high-resolution thermal expansion and magnetostriction measurements on the half-metallic CMR material $HgCr_2Se_4$, where the paramagnetic to ferromagnetic transition at 105 K drives an insulator-to-metal transition with an 8-orders-of-magnitude decrease of the longitudinal resistivity [2]. We will discuss the phenomenology of the coupling of charge and magnetic degrees of freedom to the lattice distortion and compare our results to other CMR materials. [1] Manna et al., PRL 2014; [2] Guan et al., PRL 2015

MA 66.13 Fri 9:30 P2-OG2

Single crystal growth and structure of $Li_2Fe_{1-x}Mn_xSiO_4$ —

•Hagen Schray[1], Christoph Neef[1], Hubert Wadepohl[2], and Rüdiger Klingeler[1] — [1]Kirchhoff Institut für Physik, Universität Heidelberg, 69120 Heidelberg, Deutschland — [2]Anorganisch-Chemisches Institut, Universität Heidelberg, 69120 Heidelberg, Deutschland

$Li_2Fe_{1-x}Mn_xSiO_4$ single crystals were grown by means of the optical floating zone technique at elevated Ar-pressure of up to 50 bar. The growth parameters and in particular the effect of pressure are discussed with respect to Mn-doping and the oxygen stoichiometry of the system. The microstructure of the grown single crystals and crystallites was studied by EDX and electron microscopy. A mm^3 sized Li_2FeSiO_4 single crystal was successfully obtained which features the known high temperature structure with *Pnmb*-symmetry. Single crystal and powder XRD were applied to study the doping series $Li_2Fe_{1-x}Mn_xSiO_4$ and to refine the structure of the end member Li_2FeSiO_4 in detail. For this crystal, magnetic studies confirm high crystallinity showing up in a λ-type antiferromagnetic transition at $T_N = 17$ K and evidence for magnetic correlations up to $\leq$50 K.

MA 66.14 Fri 9:30 P2-OG2

Hall effect in $Fe_{3-x}Mn_xSi$ Heusler alloys — •Johannes Kroder, Gerhard Fecher, Guido Kreiner, and Claudia Felser — MPI CPfS, Dresden

The Hall effect occurs in all conducting materials when a magnetic field is applied perpendicular to the current. For ferromagnetic materials the effect may also be observed without applied field which is called anomalous Hall effect (AHE). Intrinsic and extrinsic contributions to the AHE can be distinguished. The intrinsic contribution is associated with the Berry curvature which is present in all ferromagnets. It is usually assumed that the AHE is not present in antiferromagnets because of the vanishing net magnetization. However, Chen *et al.* [1] pointed out that the AHE can also be observed in antiferromagnets with non-collinear spin structure due to a non vanishing Berry curvature. This was recently experimentally confirmed by Nayak *et al.* [2]. It is therefore interesting to investigate the well-known Heusler alloys $Fe_{3-x}Mn_xSi$ (0.75 < x < 1.75). These compounds show a transition from collinear to non-collinear ferrimagnetic order below 60 K accompanied with a change of the Berry curvature. We report on the series of polycrystalline $Fe_{3-x}Mn_xSi$ prepared by arc melting and characterized by temperature dependent Hall measurements.

[1] Chen *et al.*, PRL 112, 017205 (2014); [2] Nayak *et al.*, Sci. Adv., e1501870 (2016)

MA 66.15 Fri 9:30 P2-OG2

Isotropic, high coercive field in melt-spun tetragonal Heusler Mn_3Ge — •Adel Kalache[1], Susanne Selle[2], Guido Kreiner[1], Gerhard H. Fecher[1], Thomas Höche[2], and Claudia Felser[1] — [1]Max Planck Institut CPFS, Dresden, Germany — [2]Fraunhofer Institute for Microstructure of Materials and Systems IMWS, Halle, Germany

Tetragonally distorted Heusler are known for their high crystalline anisotropy, tunable magnetization and high Curie temperature and therefore are candidates for rare-earth-free permanent magnets. We report on nanostructured Mn_3Ge ribbons with a composition ranging from 77 to 74 at.% Mn prepared using induction melting, melt-spinning and subsequent heat treatment. Obtained ribbons show hard magnetic properties due to the highly anisotropic tetragonal $D0_{22}$ structure of Mn_3Ge. Depending on the composition and the amount of ferrimagnetic Mn_5Ge_2 as a secondary phase, a coercivity of up to $\mu_0 H_C = 2.62$ T was obtained for the $Mn_{75}Ge_{25}$ composition. Microstructure investigations by transmission electron microscopy confirmed the formation of the secondary phase. All samples show isotropic coercive fields, i.e. independent of the direction of the applied magnetic field in contrast to already known epitaxial thin films. The Curie temperature was found to be higher than 800 K, which is the temperature of the phase transition from the tetragonal $D0_{22}$ structure to the hexagonal $D0_{19}$ structure. Despite its low magnetization, the large coercive field in Mn_3Ge represents an opportunity to study exchange-spring magnets consisting of soft and hard magnetic phases.

MA 66.16 Fri 9:30 P2-OG2

Critical thicknesses of magneto-electronic properties in $La_{0.7}Sr_{0.3}MnO_3$ — •M. Wilhelm[1], T. Gerber[1], P. Lömker[1], R. Heinen[1], F. Gunkel[2], R. Dittmann[6], A. Gloskovski[3], W. Drube[3], M. Gorgoi[4], and M. Müller[1,5] — [1]Forschungszentrum Jülich GmbH, Peter Grünberg Institut, PGI-6 — [2]IWE2, RWTH Aachen University — [3]DESY Photon Science, Hamburg — [4]HZB, BESSY II, Berlin — [5]Fakultät für Physik, and CENIDE, Universität Duisburg-Essen — [6]Forschungszentrum Jülich GmbH, Peter Grünberg Institut, PGI-7

Transition metal oxides, like perovskite manganites, are extensively investigated due to their richness of underlying physics and potential technological applications. Special attention is paid to the half-metallic ferromagnetic oxide $La_{0.7}Sr_{0.3}MnO_3$ (LSMO), due to its high spin polarization ($\sim$95 %) and the high Curie temperature (370K), which makes it a promising candidate for room temperature spintronic applications. We have investigated the structural, magnetic and electronic properties of heteroepitaxially grown $La_{0.7}Sr_{0.3}MnO_3$ thin films on a $SrTiO_3$ (001) substrate by means of XRD, VSM and HAXPES, respectively. In particular, we have performed a detailed study on the thickness-property relationship, in which the LSMO film thickness was gradually reduced from 20 nm (bulk) down to the ultra-thin film regime of 0.8 nm. We observe a critical thickness between 0.8 - 1.2 nm, which is completely nonferromagnetic as well as nonmetallic. Further, we have estimated a metal-insulator transition occurring at $\sim$3 nm.

MA 66.17 Fri 9:30 P2-OG2

Growth, Structure, and Properties of La2BIrO6 (B = Co, Mg, Zn) Double Perovskite Single Crystals — •Ryan Morrow[1], Mihai Sturza[1], Anja Wolter-Giraud[1], Sabine Wurmehl[1,2], and Bernd Büchner[1,2] — [1]Leibniz Institute for Solid State and Materials Research Dresden IFW, Dresden, Germany — [2]Institute for Solid State Physics, Technische Universität Dresden, Dresden, Germany

Double perovskites have received a great deal of attention in recent times due to their magnetic properties. However, the vast majority of experimental data thus far in this field has been generated with powder samples resulting in numerous open questions concerning the underlying principles governing the magnetic properties of these complex oxides. Here it is shown that, using a flux method, double perovskite iridate single crystals as large as 3 mm with formula La2BIrO6 (B = Co, Mg, Zn) have been grown. The structure and properties of the crystals are characterized and are in agreement with previous powder data. Therefore, future more detailed experiments will be possible.

MA 66.18 Fri 9:30 P2-OG2

In-Operando Studies of Ultrathin Magnetic Oxides: $NiFe_2O_4$ and $La_{0.7}Sr_{0.3}MnO_3$ — •Ronja Anika Heinen[1], Marek Wilhelm[1], Patrick Lömker[1], Katrin Neureiter[1], Timm Gerber[1], Andrei Gloskovskii[2], Wolfgang Drube[2], and Martina Müller[1] — [1]Forschungszentrum Jülich GmbH, PGI-6, Jülich, Germany — [2]Deutsches Elektronen-Synchrotron Desy, Hamburg, Germany

Transition metal (TM) oxides exhibit a variety of physical properties due to their high tunability of spin, orbital and charge degrees of freedom. The initial way to tailor these properties is a precisely controlled growth process in order to prepare single-crystalline thin films. In the next step, electric or magnetic fields can be applied in order to tune and probe the magnetic and electric response and chemical compositions.

In our experiments, we investigate ultrathin films of the transition metal ferro(i)magnetic oxides $NiFe_2O_4$ (NFO) and $La_{0.7}Sr_{0.3}MnO_3$ (LSMO) on $SrTiO_3$(001) substrates. We use in-operando HAXPES with excitation energies of $E = 4000 - 6000$ eV and apply bias voltages of $U = \pm 3\,V$ in order to analyse the electronic shifts of the chemical fingerprint of NFO and LSMO heterostructures. Furthermore, the ultra thin films are characterised in terms of electrical properties under applied in-plane and out-of-plane magnetic field. Also the magnetic response, i.e. the coercive field and saturation magnetization, are measured under applied electrical field via SQUID. The results provide insight into the interfacial band arrangement and chemical distribution of ultrathin 3d TM magnetic oxides.

MA 66.19 Fri 9:30 P2-OG2

Novel materials for antiferromagnetic spintronics — Jan Balluff, •Kevin Diekmann, Markus Meinert, and Günter Reiss — Bielefeld University

Antiferromagnetic spintronic devices often rely on antiferromagnets with large spin-orbit coupling and require a Néel temperature well above 300 K for room temperature operation. Currently, there is only a limited number of materials available that fulfill these criteria, such as PtMn, Ir_xMn_{1-x}, FeRh and a few others. These materials have in common that they contain a noble metal to some extent, which is obviously undesirable for a large-scale application of these materials due to the low availability and therefore high price.

Here we present an effort to identify novel antiferromagnetic Heusler compounds with high Néel temperature. We use high-throughput ab initio calculations to find stable phases and perform additional DFT calculations to identify the magnetic ground state and to determine the critical temperature. Overall, 69 Heusler compounds are identified as antiferromagnetic, of which 20 compounds are predicted to have $T_N > 290\,\mathrm{K}$. The method is applicable to arbitrary structure types and is not limited to Heusler compounds.

MA 66.20 Fri 9:30 P2-OG2

Study of spin reorientation in $\mathbf{NdFe_{0.5}Mn_{0.5}O_3}$ — Ankita Singh[1], Avijeet Ray[1], Anil Kumar Jain[2], Padmanabhan Balasubramanian[1], Tulika Maitra[1], and •Vivek Kumar Malik[1] — [1]Department of Physics, Indian Institute of Technology Roorkee, Roorkee 247 667, India — [2]Solid State Physics Division, Bhabha Atomic Research Center, Mumbai, 400 085, India

The structural, magnetic, and electronic properties of $NdFe_{0.5}Mn_{0.5}O_3$ have been studied in detail using bulk magnetization, neutron/x-ray diffraction and first principle density functional theory. The material crystallizes in the orthorhombic *Pbnm* structure, where both Mn and Fe occupy the same crystallographic site (4*b*). Mn/Fe sublattice of the compound orders in to a G-type antiferromagnetic phase close to 250 K. The magnetic structure belongs to Γ_1 irreducible representation with spins aligned along the crystallographic *b* direction which is highly unusual, since most of the orthoferrites and orthochromites order in the Γ_4 representation below the Néel temperature. Below 70 K, the magnetic structure coexists as a sum of two irreducible representations ($\Gamma_1+\Gamma_2$) as seen from neutron diffraction. At 6 K, the magnetic structure belongs entirely to Γ_2 representation with spins aligned antiferromagnetically along the crystallographic *c* direction having a small ferromagnetic component (F_x). The unusual spin reorientation and correlation between magnetic ground state and electronic properties have been investigated using first principle calculations in the GGA+U+SO formalism.

MA 66.21 Fri 9:30 P2-OG2

Comparative study of CoFeAlB and CoFeB FMR properties for spin torque devices — •Andres Conca[1], Thomas Meyer[1], Takafumi Nakano[2], Yasuo Ando[2], and Burkard Hillebrands[1] — [1]FB Physik and Landesforschungszentrum OPTIMAS, TU Kaiserslautern, Germany — [2]Department of Applied Physics, Tohoku University, Japan

The magnitude of critical current required for switching in spin transfer torque (STT) devices is ruled by the product of the Gilbert damping parameter α and the square of the saturation magnetization M_s of the electrode material. $Co_{40}Fe_{40}B_{20}$ is dominantly used as free layer electrode in MgO-based MTJs. The material has a low α around 0.0042 but the large M_s hinders the use in STT devices. In this sense, research has been carried out to dope CoFeB alloys in order to reduce the magnetization without destroying the low damping properties. Here, we present results of the FMR properties of film series of $Co_{36}Fe_{36}Al_{18}B_{10}$ with different annealing temperatures. The dependence of the linewidth, α, and M_s have been obtained. Additional information regarding the exchange constant is gained through measurements of the perpendicular standing spin waves (PSSW). An additional CoFeB series has also been measured for comparison. The data proves a significant reduction of M_s and the exchange constant in CoFeAlB compared to CoFeB while α remains similar or even smaller for most of the annealing temperatures. The evolution of α with annealing shows a different behavior for both materials. This proves the suitability of CoFeAlB for STT devices. Support by M-era.Net and HEUMEM is acknowledged.

MA 66.22 Fri 9:30 P2-OG2

Inertia effects in the real-time dynamics of a quantum spin coupled to a Fermi sea — •Mohammad Sayad, Roman Rausch, and Michael Potthoff — I. Institut für Theoretische Physik, Universität Hamburg

Inertia effects in spin dynamics have been discussed intensively in the recent years by means of LLG-type approaches for classical spins only. However, in case of a quantum spin, inertia effects have not yet been studied. As compared to spin precession and damping, nutation is a higher-order effect, thus it is not a priori clear whether or not spin nutation is suppressed by quantum fluctuations. In order to clarify this issue, we consider the Kondo impurity model and study the spin dynamics, initiated by switching the direction of a magnetic field, by means of the time-dependent density-matrix renormalization group. We identify quantum effects by a systematic comparison of the spin dynamics for different spin quantum numbers S with the tight-binding spin-dynamics theory for the classical-spin Kondo model. We find a qualitative and with increasing spin-quantum numbers also quantitative agreement between quantum and semiclassical dynamics. The quantum-spin dynamics, however, exhibits a rapid damping of the nutational motion. Apart from the longitudinal spin dynamics reflecting the time-dependent Kondo effect, nutational damping is essentially the only characteristics of the quantum nature of the spin occurs on femtosecond-time scale and is basically independent of the relaxation time scale for the precessional motion.

M. Sayad et al., Europhys. Lett. 116, 17001 (2016)

MA 66.23 Fri 9:30 P2-OG2

Ultrafast spin dynamics in CoFeB/MgO/CoFeB magnetic tunnel junctions — Leon Duschek, •Jakob Walowski, Christian Denker, Ulrike Martens, and Markus Münzenberg — Ernst-Moritz-Arndt Universität, Greifswald

Magnetization dynamics in CoFeB layers with out-of-plane magnetic anisotropy (PMA) separated by a crystalline MgO isolating layer are probed in all-optical pump-probe experiments.

In 2013 He et al. [1] have shown, that the laser excitation in such layer systems can induce an exchange of spins through the MgO barrier. Extending those measurements to samples with patterned circular structures with diameters from 1 μm to 5 μm enables the observation of both processes in individual MTJs. Due to the small sizes and a crystalline structure, the exchange of spins through the MgO barrier takes place by coherent tunneling. The investigated magnetic layers have thicknesses from 0.9 μm to 1.3 μm, to ensure PMA. The dynamics are probed using both, the Kerr rotation and ellipticity. Because the stacks are thinner than the penetration depth of the laser light, each component provides the information at different depths of the layer stack [2]. Thus we observe the dynamics from both magnetic layers individually, gaining insight into the processes inside, which stem from spin-flip scattering and from spin-polarized transport. Both, the spin dynamics and the spin transport depend on the properties of the magnetic electrodes and the tunnel barrier.

[1] W. He et al., Scientific Reports 3, 2883 (2013)
[2] J. Wieczorek et al., PRB 92, 174410 (2015)

MA 66.24 Fri 9:30 P2-OG2

Ultrafast Magnetization Dynamics in $\mathbf{[FePt]_{1-\chi}\ Mn_\chi}$ — •Cinja Seick[1], Ute Bierbrauer[2], Nataliia Safonova[3], Benjamin Stadtmüller[2], Manfred Albrecht[3], Martin Aeschlimann[2], Daniel Steil[1], and Stefan Mathias[1] — [1]I. Physikalisches Institut, Universität Göttingen, Germany — [2]Department of Physics and Research Center OPTIMAS, University of Kaiserslautern, Germany — [3]Institute of Physics, University of Augsburg, Germany

We study the magnetization dynamics of $[FePt]_{1-\chi}\ Mn_\chi$ in order to investigate the influence of adding Mn to the ferromagnetic compound FePt, which is relevant for technological applications(1) and basic research(2). In our TR-MOKE studies on $[FePt]_{1-\chi}\ Mn_\chi$, we found a drastic decrease of the demagnetization time in comparison to pure FePt(3). Furthermore, we compare fluence-dependent measurements of the system to the predictions of the M3TM and find a sudden decrease in the demagnetization time at medium demagnetization strength, which is not present for pure FePt. This two differences seem to be caused by the added Mn.

References:

(1) D. Weller et al., Annu. Rev. Mater. Sci. **30**, 611-644 (2000)
(2) C-H. Lambert et all., Science **345**, 1337-1340 (2014)
(3) S. Iihama et al., J. Phys. D: Appl. Phys. **49**, 035002 (2016)

MA 66.25 Fri 9:30 P2-OG2

Generation of ultrashort current pulses by the inverse spin Hall effect — •Jonathan Weber and Georg Woltersdorf — Martin Luther Universität Halle-Wittenberg

We use optical pump pulses to generate current pulses using the spin-dependent Seebeck effect and the inverse spin Hall effect (ISHE) in normal metal/ferromagnet bilayers. For this the bilayer structures are used to terminate a coplanar waveguide. The optical excitation from an ultrafast amplified laser system injects an ultrashort spin current pulse into the ferromagnetic layer via the spin-dependent Seebeck effect [1]. Subsequently, this spin current pulse is converted into a charge current pulse inside the normal metal layer via the ISHE. The electric signal that is generated by the ISHE is recorded by a fast sampling oscilloscope with a bandwidth of approximately 50 ps. Based on other experiments we expect an actual pulse length of only a few hundred femtoseconds [1, 2]. By normalizing the ISHE signals to the pump pulse energy we find an optical pulse to THz pulse conversion efficiency that is comparable to the tilted pulse front approach [3].

[1] A. Melnikov. et. al.: arXiv:1606.03614[physics.optics] (2016)
[2] T. Seifert, T. Kampfrath, et. al.: doi:10.1038/nphoton.2016.91
[3] H. Hirori, et.al.: Appl. Phys. Lett. 98, 091106 (2011)

MA 66.26 Fri 9:30 P2-OG2

Temperature dependence of Current-Induced-Domain-Wall-Motion — •Tianping Ma[1], Robin Bläsing[1], Chirag Garg[1,2], Tom Lichtenberg[1], See-Hun Yang[2], and Stuart Parkin[1,2] — [1]Max Planck Institute for Microstructure Physics, Halle (Saale), D06120, Germany — [2]IBM Almaden Research Center, 650 Harry Road, San Jose, California 95120, USA

Racetrack memory, which uses current to control the motion of magnetic domain walls, is one of the most promising next generation memory devices. Using a combination of four spin-orbit-coupling derived phenomena, namely, perpendicular magnetic anisotropy (PMA), the Spin Hall Effect (SHE), the Dzyaloshinskii-Moriya exchange Interaction(DMI) and a synthetic antiferromagnetic (SAF) structure, Current-Induced-Domain-Wall-Motion (CIDWM) velocities can reach more than ~1,000 m/s. However, temperature, as another important parameter which will influence the CIDWM behaviour, has not yet been deeply investigated. As temperature changes, many physical parameters will change and thereby influence the CIDWM. Moreover, temperature will likely greatly influence any pinning of the domain walls: thermal fluctuations will likely affect the CIDWM threshold current intensity. Here in this work, we have performed CIDWM measurements over a wide range of temperature (80K to 440K). We observe a pronounced temperature dependence of the domain-wall motion velocity, the threshold current intensity and the SHE induced spin current injection efficiency. These measurements help us to gain a better understanding of the physics behind CIDWM.

MA 66.27 Fri 9:30 P2-OG2

Control of the magnetization dynamics through the Magneto-Elastic coupling effect — •Simone Finizio[1], Sebastian Wintz[1,2], Eugenie Kirk[1], Anna Suszka[1], Sebastian Gliga[3], and Jörg Raabe[1] — [1]Paul Scherrer Institut, Villigen PSI, Switzerland — [2]Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany — [3]University of Glasgow, Glasgow, UK

The magnetoelastic (ME) coupling has recently become of interest thanks to its numerous applications, e.g. in the fabrication of magnetoelectric multiferroics. This effect has been recently studied quasistatically on micro- and nanostructured magnetostrictive materials strained using piezoelectric substrates. However, due to limitations in the radio frequency (RF) properties of piezoelectric materials, the influence of the ME coupling on the magneto-dynamical processes has not yet been investigated in depth. Here, thanks to a newly-developed approach that allows the in-situ straining of magnetostrictive materials whilst preserving good RF properties of the substrate, we present a first study of the influence of the ME coupling on the gyration dynamics of magnetic vortices in microstructured magnetostrictive elements using time-resolved x-ray magnetic microscopy. In particular, we observe that the application of a strain to the magnetostrictive material leads to a reduction of the gyration eigenfrequency, and to a modification of the orbit of the vortex core, both of which can be controlled by changing the magnitude of the applied strain.