MA 11: Magnetic Thin Films I

Time: Monday 15:00–17:45 Location: H33

MA 11.1 Mon 15:00 H33

Characterization of Gadolinium Thin Films — •Marianne Bartke[1], Lars Hellmich[1], Jamileh Beik Mohammadi[2], Claudia Mewes[2], Tim Mewes[2], and Anderas Hütten[1] — [1]Department of Physics, Center for Spinelectronic Materials and Devices, University of Bielefeld, D-33615 Bielefeld, Germany — [2]Department of Physics and Astronomy, MINT Center, University of Alabama, Tuscaloosa, Alabama 35487, USA

Gadolinium is well-known as a promising material for magnetic refrigeration. It is ferromagnetic below its Curie temperature at 293K and strongly paramagnetic at higher temperatures. A comparatively high magneto-caloric effect can be observed in a temperature range around this Tc up to 300K. Gd bulk materials have been studied extensively in the last couple of years. However, to the best of the author's knowledge, studies on thin film samples have not been reported yet. We report on Gd thinfilm samples which were prepared by means of sputter deposition. The impact of substrate temperatures and application of buffer materials on the crystal lattice structure has been evaluated. Magnetic properties of these samples, particularly temperature-dependent effective magnetization, gyromagnetic ratio and Gilbert damping parameter have been investigated by means of ferromagnetic resonance (FMR), VSM and transport measurements. Thus optimal preparation conditions for promising magneto-caloric materials have been evaluated.

MA 11.2 Mon 15:15 H33

Physical and electronic characterization of nanostructured MnSi — •Nico Steinki[1], David Schroeter[1], Patryk Krzysteczko[2], Alexander Fernándes Scarioni[2], Hans Werner Schumacher[2], Stefan Süllow[1], and Dirk Menzel[1] — [1]Institut für Physik der Kondensierten Materie, TU Braunschweig, Germany — [2]Physikalisch Technische Bundesanstalt, Braunschweig, Germany

The non-centrosymmetric B20 chiral magnet MnSi shows intriguing properties involving the existence of skyrmions. Recently, we have started production and physical characterization of MnSi thin film samples [1,2] revealing considerable changes in the magnetic phase diagram compared to bulk material [3]. To further characterize the skyrmionic phase in MnSi under geometrical constraints, we have proceeded by nanostructuring the MnSi thin films by electron beam lithography. In particular, Hall bar structures with different widths down to 100 nm have been produced. On these, we have measured the Hall effect and magnetoresistance between 1.5 and 80 K in a magnetic field up to 8 T, thus covering the temperature and field regime of the skyrmionic phase. Here, we will present first results regarding the characterization of the structures and the comparison in terms of the electronic transport properties between thin films and our nanostructures.

[1] J. Engelke et al., J. Phys. Soc. Jpn. **81**, 124709 (2012)
[2] J. Engelke et al., Phys. Rev. B **89**, 144413 (2014)
[3] D. Menzel et al., J. Kor. Phys. Soc. **62**, 1580 (2013)

MA 11.3 Mon 15:30 H33

Turn on/off the high-temperature ferromagnetism in Si1-xMnx thin films through Mn-ion implantation — •Parul Pandey[1], Vladimir Rylkov[2], Ye Yuan[1], Anna Semisalova[1], Vladimir Mikhalevskiy[3], Oleg Novodvorskii[3], Victor Tugushev[2], Manfred Helm[1], and Shengqiang Zhou[1] — [1]HZDR, Institute of Ion Beam Physics and Materials Research, Dresden, Germany — [2]NRC Kurchatov Institute, Moscow, Russia — [3]ILIT RAS, Shatura, Russia

Silicon based alloys with Mn-ions exhibits complex electric and magnetic phenomena which have direct implications in the contemporary microelectronic technology. Though, Si1-xMnx shows high-temperature ferromagnetism (TC) at low Mn content x~0.05-0.1, but the small solubility of Mn in Si leads to the formation of MnSi1.7 nanoparticles, which drives the system in an inhomogeneous phase and makes it irrelevant for the technological applications. However, a high Mn content screens the precipitation of such inhomogeneous phases. In this context, a set of thin films of Si1-xMnx (x=0.44-0.57) were prepared by pulsed laser deposition technique on Al2O3 (0001) substrate. We have found room-temperature ferromagnetism and a large moment for Si0.43Mn0.57 film as compared to the rest of samples. But, surprisingly, TC of Si0.43Mn0.57 drastically decreases from 300K to 40K as the Mn content was increased in the film through the ion-implantation process. In contrast, the stoichiometric film Si0.5Mn0.5 exhibits a huge increase in the moment by one-order in magnitude (with TC from 50K to 300K) after Mn-ion implantation.

MA 11.4 Mon 15:45 H33

***c*-axis oriented MnBi thin Films with high anisotropy grown from a stoichiometric $Mn_{55}Bi_{45}$ target** — •Sareh Sabet, Erwin Hildebrandt, and Lambert Alff — Institute of Materials Science, Technische Universität Darmstadt, 64287 Darmstadt, Germany

There is an increased interest in the intermetallic compound MnBi as rare-earth free permanent magnet candidate to be used in magneto-optical memory applications as well as the hard magnetic component in an exchange spring magnet. The usual approach for the growth of MnBi thin films is stacking of individual Mn and Bi layers. Here, we report the synthesis of fully *c*-axis oriented MnBi thin films with high anisotropy from a single target with $Mn_{55}Bi_{45}$ (at. %) composition. The films were grown by DC magnetron sputtering at room temperature onto quartz glass substrates. The ferromagnetic low-temperature phase (LTP) was formed by a subsequent *in-situ* annealing step in vacuum. The out-of-plane and in-plane coercivity increases as expected with temperature and reaches 12 kOe and 14 kOe at 300 K, respectively. The maximum saturation magnetization is about 600 emu/cm^3. We have estimated a lower bound for the uniaxial anisotropy to be around $1{\cdot}10^7$ erg/cm^3.

MA 11.5 Mon 16:00 H33

Fe-N phase diagram of MBE grown thin films — •Dominik Gölden, Erwin Hildebrandt, and Lambert Alff — Institute of Materials Science, Technische Universität Darmstadt, Germany

The iron nitride system has been widely investigated due to the large variety of mechanical, electrical, and magnetic properties of the different phases. We explored the phase diagram of Fe-N thin films grown by molecular beam epitaxy (MBE). At elevated temperatures around 350 °C, γ'-Fe_4N is the most stable phase. At low temperatures, α'-Fe_8N, ϵ-Fe_3N and FeN were obtained by varying the growth rate and the nitrogen supply. At identical growth conditions the choice of substrate materials results in preferential growth of different iron nitride phases. The structural and magnetic properties of the thin films were in agreement with bulk properties. α'-Fe_8N, which is not a real thermodynamical phase, could not be obtained without admixture of other Fe-N phases. No evidence for the ordered phase α''-$Fe_{16}N_2$ was found even when the Fe-N phase diagram was scanned by thin film deposition with high resolution. While γ'-Fe_4N related materials might be useful for spintronics, the Fe-N system is probably not suited for permanent magnetic materials due to the high volatility of N.

15 min. break

MA 11.6 Mon 16:30 H33

Structural, magnetic and electrical properties of sputter deposited Mn-Fe-Ga thin films — •Alessia Niesen, Christian Sterwerf, Manuel Glas, Jan-Michael Schmalhorst, and Günter Reiss — Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany

Structural and magnetic properties of DC sputter deposited $Mn_{3-x}FeGa$ were investigated. The crystallinity of the Mn-Fe-Ga thin films (40 nm thick) was confirmed using XRD. XRR and AFM measurements were utilized to investigate the surface, roughness, thickness and density of the deposited Mn-Fe-Ga. Depending on the stoichiometry, the deposition temperature, as well as the used substrate ($SrTiO_3$ (001) and MgO (001)) or buffer layer (TiN) the Mn-Fe-Ga crystallizes in the cubic $D0_3$ or the tetragonally $D0_{22}$ distorted phase (c = 7.14 Å). The main drawback for applications is the island growth of the Mn-Fe-Ga, confirmed by AFM measurements. Low roughness ($\leq$ 1nm) and the $D0_{22}$ phase was observed for each used deposition temperature and composition of the Mn-Fe-Ga on $SrTiO_3$. Strong PMA was confirmed via AHE and AGM measurements. Low saturation magnetization (M_s $\approx$ 200 kA/m) and high coercivity fields (Hc $\leq$ 2 T) in the oop direction can be reached by tuning the composition. TiN buffered $Mn_{2.7}Fe_{0.3}Ga$ revealed sharper switching of the magnetization compared to the unbuffered layers. XAS and XMCD measurements showed Mn-O at the interface due to the MgO capping and no Mn-O in the bulk. The XMCD spectra revealed ferromagnetic coupling between the Mn and the Fe atoms.

MA 11.7 Mon 16:45 H33

Interface effects in $La_{1/3}Sr_{2/3}FeO_3/La_{2/3}Sr_{1/3}MnO_3$ heterostructures — •Markus Waschk[1], Markus Schmitz[1], Alexander Weber[2], and Thomas Brückel[1] — [1]Jülich Centre for Neutron Science JCNS and Peter Grünberg Institut PGI, JARA-FIT, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany — [2]Jülich Centre for Neutron Science JCNS at Heinz Maier-Leibnitz Zentrum MLZ, Forschungszentrum Jülich GmbH, Lichtenbergstr. 1, 85747 Garching, Germany

Transition metal oxides (TMO) show functionalities which make them promising candidates for sensors or devices in future information technologies, because of electronic correlations and/or ordering phenomena. Such devices will consist of heterostructures of different TMO's, where interfaces play a crucial role. Due to the sensitivity of TMO's to external parameters such as strain, and electronic doping, magnetic and electric fields, their properties are easily altered at the interface.
We have chosen the system LSFO/LSMO on $SrTiO_3$ as a model system to study interfaces effects systematically. LSFO is an antiferromagnet, which shows a Verwey transition at the Neél and charge ordering temperature $T_V = T_N = T_{CO} = 200\,K$. The drastic increase in resistivity with decreasing temperature offers the opportunity to study the influence of the electronic structure of LSFO on the interfacial magnetization of the ferromagnet LSMO. We will present our oxide molecular beam epitaxy growth process and structural analysis. Particularly with regard to the magnetization profile, polarized neutron reflectometry results will be presented to explain the interface behavior of the system.

MA 11.8 Mon 17:00 H33

Growth of epitaxial thin films of Ir-based novel double-perovskites by pulsed laser deposition — •Supratik Dasgupta, Vikas Shabadi, Philipp Komissinskiy, and Lambert Alff — Institute of Material Science, Technische Universität Darmstadt, Germany

Double perovskites ($A_2BB'O_6$) with $3d$-$5d$ cations in their B-B'-sites have various interesting properties. Double perovskites with Cr at their B-site have received particular attention due to their high ferrimagnetic ordering temperature, T_c. So far, Sr_2CrOsO_6 has been reported to have the highest T_c of about 725 K [1]. Theoretical calculations have predicted that the compound Sr_2CrIrO_6 (SICO) might even have a higher T_c. In addition to the high T_c, SICO is expected to be a half-metallic material being of high interest for spintronic applications. However, the metastable compound SICO so far has not yet been synthesized. Here, we report the epitaxial growth of SICO by pulsed laser deposition (PLD). The choice of substrate has turned out to be the key parameter to obtain phase-pure thin films. [1] Y. Krockenberger *et al.*, Phys. Rev. B **75**, 020404(R) (2007).

MA 11.9 Mon 17:15 H33

Spectroscopy of quadratic magnetooptic tensor of Fe/MgO thin films — •Robin Silber[1,2], Jan Dušek[3], Lukáš Beran[3], Jaromír Pištora[1], Günter Reiss[2], Martin Veis[3], Timo Kuschel[2], and Jaroslav Hamrle[1] — [1]VSB - Technical University of Ostrava, Czech Republic — [2]CSMD, Physics Department, Bielefeld University, Germany — [3]Charles University in Prague, Czech Republic

The magnetooptic Kerr effect (MOKE) is a well known and very useful physical phenomenon. MOKE at single wavelength is broadly used for detailed characterization of magnetic materials [1]. MO spectroscopy on the other hand is powerful tool for probing the electronic structure of the magnetic material. Most of the MOKE techniques rely solely on effects linear in magnetization, assuming that contributions of higher order in magnetization are negligible. Here, we present a technique of quadratic MOKE (QMOKE) spectroscopy that is based on the 8-directional method [2]. QMOKE spectra of Fe thin films grown on MgO substrate were acquired. From these, further two complex spectra of the quadratic magnetooptic tensor [3,4] are yielded, using standard Yeh's 4×4 matrix calculations. Finally, comparison with ab initio calculations is discussed.

[1] T. Kuschel et al., J. Phys. D: Appl. Phys. 44, 265003 (2011)
[2] K. Postava et al., J. Appl. Phys. 91, 7293 (2002)
[3] Š. Višňovský, Czech. J. Phys. B 36, 1424 (1986))
[4] J. Hamrle et al., J. Phys. D: Appl. Phys. 40, 1563 (2007)

MA 11.10 Mon 17:30 H33

Towards optically controlled magnetization reversal in ferromagnetic (Co/Pt)n and (Co/Pd)n multilayers — •Umut Parlak[1], Daniel Bürgler[1], Roman Adam[1], Gholamreza Shayeganrad[2], Shaukat Khan[2], and Claus M. Schneider[1] — [1]Peter Grünberg Institute, PGI-6, Research Centre Jülich, 52425 Jülich, Germany — [2]Center for Synchrotron Radiation (DELTA), TU Dortmund, 44227 Dortmund, Germany

Recent studies demonstrate that optical control of the magnetization state by femtosecond laser pulses is feasible in ferromagnetic layers [1] as well as ferrimagnetic rare earth compounds [2]. Moreover, this all-optical manipulation is reversible and reproducible. Nevertheless the optically induced magnetization reversal strongly depends on both material properties and laser beam parameters; e.g. polarization state, fluence and exposure time. Here we investigate the range of material and laser parameters that play a role for the switching process in ferromagnetic (Co/Pt)n and (Co/Pd)n multilayers. We use a laser oscillator and a laser amplifier both having a central wavelength of 800 nm, pulse duration of about 40 fs, and a repetition rate of 80 MHz and 1 kHz, respectively. Kerr and Faraday microscopies are employed to image the domain state before and after the laser exposure. Depending on the laser parameters, a laser-exposed area undergoes magnetization switching, demagnetization or other magnetic modifications.

[1] C. H. Lambert, et al. Science 345,6202 (2014)
[2] C. D. Stanciu, et al. Physical Review Letters 99,4 (2007)