MA 49: POSTER II

Time: Thursday 15:00–18:00 Location: Poster A

MA 49.1 Thu 15:00 Poster A

Effects of the DM-interaction on thermodynamic properties of molecular spin systems — •Christian Heesing and Jürgen Schnack — Universitätsstr. 25, 33739 Bielefeld

The magnetism of many magnetic molecules is dominated by isotropic Heisenberg exchange interactions. For 3d elements anisotropic contributions are usually small. Nevertheless, they can have drastic consequences at low temperatures as for instance on bistability and quantum tunnelling in the case of easy-axis anisotropies.
In this contribution we investigate the effect of the Dzyaloshinskii-Moriya (DM) interaction [1,2] on thermodynamic magnetic observables such as the low-temperature magnetization. The full Hamiltonian contains Heisenberg exchange, Zeeman term, and Dzyaloshinskii-Moriya interaction. Thermodynamic observables are systematically compared for various ratios of DM and Heisenberg interaction strength.
[1] T. Moriya, Phys. Rev., 1960, 120, 90-98
[2] I. Dzyaloshinskii, J. Phys. Chem. Solids, 1958, 4, 241-255

MA 49.2 Thu 15:00 Poster A

Thermodynamic properties of deposited spin clusters — •Felix Kaiser, Henning-Timm Langwald, and Jürgen Schnack — Bielefeld University, Bielefeld, Germany

With regard to future technological applications magnetic clusters have attracted significant interest. Magnetic molecules or other structures of interacting magnetic centers may be deposited on a substrate to utilize the resulting increased addressability. However the resulting coupling to the substrate may also influence the (magnetic) properties of the deposited clusters. Thus the characterization of magnetic clusters deposited on a substrate is of significant importance to their future usage. One may be especially interested in comparing the properties of free and of deposited clusters.

On our poster we present theoretical results for deposited magnetic clusters on a metallic substrate. To describe the magnetic clusters we utilize the Heisenberg Hamiltonian with and without anisotropy while the metallic substrate is described via a band of conduction electrons which is exchange coupled to the magnetic cluster. The calculations are performed by means of the Numerical Renormalization Group method (NRG) which allows us to characterize thermodynamic properties for a wide range of temperatures and in dependence to a magnetic field.

MA 49.3 Thu 15:00 Poster A

XAS Study of the Spin-Crossover Molecules Fe(bpz)$_2$phen and Fe(bpz)$_2$bipy on Surfaces — •Lalminthang Kipgen[1], Holger Naggert[2], Matthias Bernien[1], Fabian Nickel[1], Jens Kopprasch[1], Qingyu Xu[1,3], Felix Tuczek[2], and Wolfgang Kuch[1] — [1]Institut für Experimentalphysik, Freie Universität Berlin, 14195 Berlin, Germany — [2]Institut für Anorganische Chemie, Christian-Albrechts Universität zu Kiel, 24098 Kiel, Germany — [3]Department of Physics, Southeast University, 211189 Nanjing, P.R. China

The Spin-crossover molecules Fe(bpz)$_2$phen and Fe(bpz)$_2$bipy (bpz=dihydrobis(pyrazolyl)borate, phen = 1,10-phenanthroline, bipy = 2,2-bipyridine) have recently attracted a lot of attention due to their suitability for vacuum deposition. Thin films and even single molecules on surfaces have been studied. However, if the molecules are in direct contact with another material, their spin-crossover properties may be altered or even suppressed. We have investigated submonolayers of Fe(bpz)$_2$phen and Fe(bpz)$_2$bipy on Au(111), Bi(111) and HOPG surfaces by means of X-ray absorption spectroscopy (XAS). We find that submonolayers of Fe(bpz)$_2$bipy on Au(111) do not exhibit thermal spin-crossover behavior. On HOPG, in contrast, these molecules show complete spin-state switching as a function of temperature. Submonolayers of Fe(bpz)$_2$phen on Bi(111) show a partial conversion of about 40 percent as a function of temperature and illumination with green light at T = 5 K. Financial support by the DFG (Sfb's 658 and 677) is gratefully acknowledged.

MA 49.4 Thu 15:00 Poster A

Giant magnetoresistance effects in gel-like matrices: comparing theoretical and experimental data — •Thomas Rempel[1], Judith Meyer[1], Lisa Teich[2], Martin Gottschalk[1], Karsten Rott[1], Christian Schröder[2], and Andreas Hütten[1] — [1]Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, PB 100131, D-33501 Bielefeld, Germany — [2]Bielefeld Institute of Applied Materials Research, University of Applied Sciences Bielefeld, PB 101113, D-33511 Bielefeld, Germany

High GMR effects of up to 260% have been shown by Meyer et al. by dispersing carbon coated cobalt nanoparticles into non-magnetic, conductive, water-based gel matrices. While these gels tend to dry out and lack reproducibility due to low gel viscosity, gels with a liquid-solid transition such as agarose gel showed high and reproducible GMR effects of up to 60% over a long period of time. Therefore, they represent a promising candidate for future, low cost printable GMR sensor devices. To investigate the influence of magnetic coupling and particle superstructures on the magnetoresistance for agarose based gel systems, we compare transport measurements with theoretical calculations, which indicate a collective behavior of the nanoparticles due to dipole-dipole interactions. By the use of a dual beam system consisting of a focused ion beam and a scanning electron microscope, the particle arrangement for different particle superstructures has been explored. The information about the particle arrangement was used to perform stochastic spin dynamics simulations based on a point-dipole approach to compare the results with the experimental data.

MA 49.5 Thu 15:00 Poster A

DNA origami as a microstructural tool for magnetic nanoparticle ordering — •Marianne Bartke and Andreas Hütten — Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany

Superparamagnetic beads have numerous applications within microfluidic systems, i.e. as mobile substrates, binds or magnetic labels, as well as to transport and separate analytes. Recently, the use of beads as self-assembling matter has attracted attention. Due to rotating homogeneous magnetic field, beads rapidly form ordered monolayers. If there is no magnetic field, the cluster structures rapidly disassemble. This work presents a method to prevent the decay of monolayers in the absence of a magnetic field employing DNA double strand *bridges* that connect adjacent particles. DNA with biotin can be linked to streptavidin coated magnetic beads, thus resulting in a DNA layer around these beads. These strands are complementary to a linker-DNA which induces a hybridization into DNA double strands. This hybridization between the linker strands and the oligonucleotides leads to a solidification of the monolayer that originally has been produced and stabilized by the external rotating magnetic field. The DNA bridges can be broken through controlled temperature change. Futhermore, DNA strands can also facilitate the creation of blocks of superparamagnetic cobalt nanoparticles by means of DNA origami. These new DNA stabilized superparamagnetic structures are auspicious innovations for DNA analysis and production of photonic crystal.

MA 49.6 Thu 15:00 Poster A

Structural and magnetic properties of self-assembled 3D nanoparticle macrocrystals — •Michael Smik, Elisa Volkmann, Genevieve Wilbs, Emmanuel Kentzinger, Jörg Persson, Ulrich Rücker, Oleg Petracic, and Thomas Brückel — Jülich Centre for Neutron Science JCNS and Peter Grünberg Institut PGI, JARA-FIT, Forschungszentrum Jülich GmbH, 52425 Jülich

We have refined self-assembly methods for the fabrication of 3D nanoparticle 'macrocrystals' composed of spherical iron oxide nanoparticles with 15 nm diameter. The macrocrystals were prepared using centrifuge assisted sedimentation with optimized temperature, centrifugation length and post-centrifugation procedures. Fabrication of macrocrystals up to 300 μm in size was possible. The samples were characterized using scanning electron microscopy (SEM) and grazing incidence small angle x-ray scattering (GISAXS) on single macrocrystals. The GISAXS experiments were performed at the new in-house instrument 'GALAXI' (Gallium Anode Low-Angle X-ray Instrument) and reveal close-packed hexagonal ordering with very large coherence lengths. Zero field cooled (ZFC) and field cooled (FC) magnetization curves have been recorded. They show pronounced inter-particle collective ordering due to dipole-dipole interactions.

MA 49.7 Thu 15:00 Poster A

Stabilization of L1$_0$ phase and suppression of twin structures

in FePt-Cu nanoparticles — •Anna Elsukova, Marina Spasova, Mehmet Acet, and Michael Farle — Experimental Physics, Faculty of Physics and CENIDE, University of Duisburg - Essen, 47057 Duisburg, Germany

FePt alloy has a high value of magnetic anisotropy energy in the thermodynamically stable ordered $L1_0$ phase and, therefore, the FePt nanoparticles are expected to remain ferromagnetic at small sizes, which makes them a potential candidate for manufacturing magnetic storage devices with high areal density. However, due to the fact that particles' preparation methods are kinetically controlled, the disordered magnetically soft A1 phase is stabilized instead and formation of metastable multi-twinned structures is observed.

In this work we report on the influence of Cu addition to the FePt on the stabilization of $L1_0$ phase and suppression of multi-twinned structures in small (around 6 nm) FePt-(Cu) gas-phase nanoparticles.

FePt-Cu nanoparticles with various concentrations of Cu were prepared by DC magnetron sputtering. The sputtering setup incorporates the furnace in order to anneal the particles in-flight prior to their deposition on a substrate. We have found that addition of Cu combined with in-flight annealing at 1273 K promotes the formation of single-crystalline $L1_0$ FePt-Cu particles in the gas-phase.

MA 49.8 Thu 15:00 Poster A

Characterization of Single and Clustered Nanoparticles — •Martin Gottschalk, Nadine Mill, Karsten Rott, and Andreas Hütten — Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany

Nanoparticles of all kinds of shapes and material properties receive increasing attention due to their widely spread applications possible. As a consequence there is the need for characterization of the properties of not just nanoparticle clusters but also single nanoparticles. By exploiting the features of a dual beam system, consisting of a SEM and a FIB-microscope, it is possible to apply an electrical contact to single cobalt nanoparticles. The particles are connected by gas deposited platinum lines to e-beam-lithographed, conductive gold paths. These paths are the teeth of a comb whose shaft is a contact pad that can be used for GMR- or TMR-measurements of the particles outside the dual beam system. To attain a current running through just the connected particle, the other gold paths, which are now dispensable, are to be cut by the ion beam. Otherwise there would be a short circuit caused by larger clusters of particles, lying on several gold paths of the two combs, whose occurrence cannot be avoided in the course of the dropping down. Evidently this procedure is also suitable for clusters, if the spacing between the gold paths is respectively adjusted. With this setup it is possible to investigate single and clustered particle properties like magnetoresistive effects.

MA 49.9 Thu 15:00 Poster A

Validation of high brilliant moderators for cold neutrons — •Tobias Cronert[1], Jan Philipp Dabruck[2], Paul Emanuel Döge[2], Yannik Bessler[1], Ulrich Rücker[1], Carsten Lange[3], Michael Butzek[1], Wolfgang Hansen[3], Rahim Nabbi[2], and Thomas Brückel[1] — [1]JCNS/ZEA1 - Forschungszentrum Jülich — [2]NET - RWTH Aachen — [3]TU Dresden

Investigation of magnetic phenomenons like chiral spin-density waves (SDW) and skyrmions requires a high flux of cold neutrons for polarized neutron spectroscopy and similar advanced applications. While neutron optics have evolved greatly during the last years, the moderator itself leaves much options for improvement. Using MCNPX, sophisticated moderator configurations are developed allowing for high neutron yields and a high beam brilliance. Calculations propose flat, so called 2-dimensional pancake moderators, of supercritical para hydrogen for the upcoming European Spallation Source. Validation of the calculations however is challenging, since neutron energy spectra from several MeV down to 0.1meV need very high levels of measurement equipment and easily accessible neutron sources. Highly specialized cold moderators, optimized to the energy and time structure of the future neutron sources will yield higher brilliance and available flux at the sample to improve the performance of magnetic scattering methods and neutron applications in Chemistry and Biology.

MA 49.10 Thu 15:00 Poster A

A High-Resolution Confocal Scanning Polarizing Microscope for Low-Temperature Magneto-Optical Imaging — •Matthias Lange, Stefan Guénon, Reinhold Kleiner, and Dieter Koelle — Physikalisches Institut and Center for Collective Quantum Phenomena in LISA$^+$, Universität Tübingen, Auf der Morgenstelle 14, D-72076 Tübingen, Germany

The magneto-optical Kerr effect (MOKE) is widely used for the investigation of magnetic materials. We present a confocal laser scanning microscopy setup that is capable of simultaneously imaging the surface's reflectivity (conventional image), the in-plane and out-of-plane magnetization components, and electric transport characteristics of the sample. The magnetization components are imaged exploiting the longitudinal and polar MOKE. Information on the electric transport characteristics can be gained from local laser heating, combined with the detection of beam-induced changes of the voltage across current-biased samples, which yields a spatial resolution of $\sim 1\,\mu$m. Through the use of a high numerical aperture microscope objective, an optical resolution of about 220 nm at a wavelength of 405 nm is achieved. The sample is mounted on a continuous flow cryostat providing a temperature range between 5 K and 300 K. An electromagnet is used to apply magnetic fields of up to 800 mT with variable in-plane orientation.

MA 49.11 Thu 15:00 Poster A

Enhancement of the Magneto-optical Kerr effect using Si capping layers — •Nicolas David Mueglich and Arno Ehresmann — Department of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel

Investigations on the enhancement of the longitudinal Magneto-optical Kerr effect with amorphous silicon capping layers[1] are shown for different exchange bias multilayer systems. The Kerr Amplitude, as the fundamental material property defining the achievable signal-to-noise ratio in magneto-optical readout measurements, was measured for the magnetic materials $Ni_{80}Fe_{20}$, $Co_{70}Fe_{30}$ and Co in dependence of angle and polarization of the incident light and the thickness of the silicon capping layer. The results were compared to calculations using the 4x4 transfer matrix method. Strong enhancement of the Kerr Amplitude for certain combinations of the silicon layer thickness and the angle of incidence can be achieved and may be used to tailor magnetic layer systems with maximized contrast in magneto-optical read out measurements.

[1] Nakamura, K.; Asaka, T.; Asari, S.; Ota, Y.; Itoh, A., Enhancement of Kerr rotation with amorphous Si film, Magnetics, IEEE Transactions on , vol.21, no.5, pp.1654,1656, Sep 1985, doi: 10.1109/TMAG.1985.1063911

MA 49.12 Thu 15:00 Poster A

Laser-Induced Modifications of Co/Pt Multilayer Films Studied with Tabletop Resonant Magnetic Scattering — •Christian Weier[1], Roman Adam[1], Denis Rudolf[1], Robert Frömter[2], Patrik Grychtol[3], Gerrit Winkler[2], André Kobs[2], Hans Peter Oepen[2], Margaret M. Murnane[3], Henry C. Kapteyn[3], and Claus M. Schneider[1] — [1]Forschungszentrum Jülich GmbH, Peter Grünberg Institut (PGI-6), JARA-FIT, 52425 Jülich, Germany — [2]Universität Hamburg, Institut für Angewandte Physik, Jungiusstr.11, 20355 Hamburg, Germany — [3]University of Colorado, Department of Physics and JILA, Colorado 80309 Boulder, USA

Extreme ultraviolet light sources based on high-order harmonic generation (HHG) have recently been used to investigate magnetization dynamics on the femtosecond timescale with element selectivity. In these studies the photon energy has been tuned to the M-absorption edges of Fe, Co and Ni located at 52 eV, 61 eV and 67 eV. In addition, HHG sources are well suited for resonant magnetic scattering (RMS) experiments, where magnetic domains can be resolved with nanometer precision. We present RMS investigations of Co/Pt multilayer films before and after an intense laser illumination and discuss the influence of laser-induced modifications on the scattering image.

MA 49.13 Thu 15:00 Poster A

Formation of remanence states in permalloy rectangles investigated via magnetotransport and SEMPA — •Björn Beyersdorff[1,2], Philipp Staeck[2], André Kobs[2], Mahmoud Reza Rahbar Azad[2], Stefan Rössler[2], Robert Frömter[2], and Hans Peter Oepen[2] — [1]DESY, Notkestraße 85, 22607 Hamburg, Germany — [2]INF, Universität Hamburg, Jungiusstr. 11a, 20355 Hamburg, Germany

Permalloy rectangles of $1000 \times 500 \times 20\,\text{nm}^3$, structured by Focused Ion Beam milling, are investigated with Scanning Electron Microscopy with Polarization Analysis (SEMPA) and magnetotransport at room temperature. For these rectangles the well-known Landau, diamond and single domain C- and S-states are local minima of the energy land-

scape. By means of SEMPA we found that the remanence state can be tuned by varying the angle of a previously applied external saturation field within the film plane. The Landau state is only found for fields within an angle of $\alpha < 10°$ to the hard axis, while for angles $\alpha > 15°$ the C/S-state is found. This result can be understood with the help of micromagnetic simulations. An in situ magnetoresistance setup is used to further investigate the magnetization reversal [1]. The characteristics of the MR curves can be used to identify the remanence state and even allows to differentiate between the iso-energetic C-/S-states from symmetry arguments. Finally, it is shown that the observed variance of remanence states within nominally identical rectangles is due to structural variation, while stochastic influences of thermal activation are of minor importance. [1] A. Kobs et al., PRB 80, 134415 (2009).

MA 49.14 Thu 15:00 Poster A

High Resolution Imaging of Spin Current-driven Magnetization Manipulation in Nanoscale Structures using SEMPA — •Pascal Krautscheid, Robert M. Reeve, and Mathias Kläui — Institut für Physik, Johannes Gutenberg-Universität, 55128 Mainz

For proposed spintronic devices such as memory, logic and sensors a control over the static spin configuration and an ability to understand and manipulate the dynamics is required. The initial configuration, such as the domain wall spin structure can be tailored through the geometry. Manipulating the magnetic state of a system including the domain wall spin configuration can subsequently be achieved by utilizing the electron spin degree of freedom. The interaction between a spin current and the magnetic moments of a system is governed by an adiabatic and a non-adiabatic spin torque and can be described by the implicit Landau-Lifshitz-Gilbert equation [1]. In order to understand the origin of the non-adiabatic torque and the dependence on damping we study a magnetic vortex state within permalloy-disks with different rare earth doping levels [2] and image the vortex core displacement on current injection [3]. An alternative spin current source is the spin-hall effect which can also be employed for magnetization manipulation which we study in wires of materials with different spin-hall angles. We use a scanning electron microscope with polarization analysis, which offers the necessary high-resolution magnetic imaging. [1] A. Thiaville et al., Europhys. Lett. 69, 990 (2005).[3] B. Krüger et al., Phys. Rev. Lett. 104, 077201 (2010).[2] T. A. Moore et al., Phys. Rev. B 80, 132403 (2009).

MA 49.15 Thu 15:00 Poster A

Sherman mapping of Fe(001)-p(1x1)-O: exchange vs. spin-orbit interaction — •Christian Thiede[1], Christian Langenkämper[1], Anke B. Schmidt[1], Stephan Borek[2], Jürgen Braun[2], Jan Minár[2], Hubert Ebert[2], and Markus Donath[1] — [1]Physikalisches Institut, Universität Münster, Germany — [2]Ludwig-Maximilians-Universität München, Germany

A recent development in spin-polarimeter design is the introduction of a spin-polarizing electron mirror which permits multichannel spin-polarization analysis. An electron beam specularly reflected from high Z-targets such as W(001) carries spin information due to spin-orbit interaction.[1] The use of a ferromagnetic target such as Fe(001)-p(1x1)-O provides a high figure of merit [2], easy access to spin information and opens the way for multichannel analysis for two transverse spin-polarization directions in one set-up. For the spin component parallel to the scattering plane, the asymmetry is entirely caused by exchange interaction. Large reflectivity and figure of merit were found [3]. For the spin component perpendicular to the scattering plane, the asymmetry is additionally influenced by spin-orbit interaction.

We present reflectivity and Sherman maps for the latter scattering geometry in comparison with data for the other. We discuss the data in the context of theoretical predictions based on ab initio calculations.

[1] Kolbe *et al.*, Phys. Rev. Lett. **107**, 207601 (2011)
[2] Okuda *et al.*, Rev. Sci. Instrum. **79**, 123117 (2008)
[3] Thiede *et al.*, Phys. Rev. Appl. **1**, 054003 (2014)

MA 49.16 Thu 15:00 Poster A

A new setup for temperature and frequency dependent ferromagnetic resonance measurements at high magnetic fields — •Moritz Riebisch, Mehmet Acet, Ralf Meckenstock, Horst Zähres, and Michael Farle — Universität Duisburg-Essen, Fakultät für Physik, AG Farle

A new setup for temperature and frequency dependent magnetic resonance measurements at high magnetic fields up to 12 T was built. It consists of a superconducting magnet and a gas-flow cryostat in a ^{4}He bath. The FMR-probe is placed inside the gas-flow cryostat and contains a field modulation coil, a temperature sensor and the short-circuited end of a semi-rigid coaxial cable. The sample is placed in the near-field region of the short circuit and can be excited with microwave frequencies between 1 and 20 GHz. The sample temperature can be varied between 4.2 and 300 K. First data on the the field-induced transition between the antiferromagnetic and the ferromagnetic state of Mn_3GaC are presented [1], [2].

Financial support by DFG is acknowledged.

[1]: Journal of Applied Physics **115**, 043913 (2014); doi: 10.1063/1.4862903
[2]: Applied Physics Letters **100**, 202404 (2012); doi: 10.1063/1.4717181

MA 49.17 Thu 15:00 Poster A

TMOKE study for characterizing magnetic properties of ferromagnetic thin films — •maryam youhannayee, aniela schefzyk, adrian jaspers, and mathias getzlaff — Institut für Angewandte Physik, heinrich heine universität , düsseldorf, germany

Nowadays magneto optic Kerr effect (MOKE) is one of the standard tool for investigating magnetic properties of magnetic systems such as ferromagnetic thin films and nanoparticles. In this research, we have built up a set up to measure the transverse magneto optic Kerr effect (TMOKE) which results in a change of intensity of p-polarized laser beam after reflection from ferromagnetic ultrathin films. Lock-in technique have also been used in order to increase the signal-to-noise ratio . The measurements were carried out on Fe thin films with a thickness of 0.5 mm and Co with a thickness of 5 and 15 nm with a capping layer of Cr/Au and without coating. The thin films are prepared by electron beam evaporation on a GaAs crystal under ultra-high vacuum condition. Hysteresis loops show properties of Fe and Co like coercivity, remanence and saturation behavior.

MA 49.18 Thu 15:00 Poster A

Fabrication and characterization of micro-Hall-Magnetometers for high-resolution local magnetic induction measurements — •Maryam Akbari, Merlin Pohlit, and Jens Müller — Physikalisches Institut, Goethe-Universität, Frankfurt (M), Germany

Micro-Hall magnetometry is an ultra-sensitive tool for studying the magnetic properties of individual micro- and nanostructures by detecting their magnetic stray field. To that end the samples are positioned onto the surface of a homebuilt sensor, where a series of adjacent lithographically-defined Hall crosses allows for spatially-resolved measurements with micron-size resolution. The technique is based on a sensor element made from a high-mobility two-dimensional electron gas (2DEG) in a GaAs/AlGaAs heterostructure. The main aspect of the presented work is to investigate the suitablility of a more advanced 2DEG wafer material, e.g., in terms of a shallower 2DEG to further increase the sensitivity by minimizing the sample to sensor distance. It is important to characterize the wafer material's transport properties (e.g. charge-carrier density, electron mobility) and, in particular, it is noise behavior by performing fluctuation spectroscopy. Additionally the versatility of the magnetometers is demonstrated by various measuring techniques including eight-terminal Hall gradiometry and, as a new application, FORC-measurements (first order reversal curves) for investigating interaction effect in ensembles of nano magnets.

MA 49.19 Thu 15:00 Poster A

Investigation of a Spin forbidden transition on the molecular nanomagnet Fe3CrPh using Torque detected broad band electron spin resonance (TDESR) in combination with Photon induced methods — •Eric Heintze[1], Michael Slota[1], Marian Blankenhorn[1], Andrea Cornia[2], Joris van Slageren[3], Brad Moores[4], Christian L. Degen[4], Martin Dressel[1], and Lapo Bogani[1] — [1]1. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany — [2]Dipartimento di Scienze Chimiche e Geologiche and UdR INSTM, Università di Modena e Reggio Emilia, via G. Campi 183, 41125 Modena, Italy — [3]Institut für Physikalische Chemie, Universität Stuttgart, Pfaffenwaldring 55, 70569 Stuttgart, Germany — [4]Department of Physics, HPF F6, ETH Zürich, Otto Stern Weg 1, 8093 Zürich, Switzerland

We show TDESR to measure the high frequency electron spin resonance spectra of the molecular nanomagnet Fe3CrPh. We demonstrate the use of a mechanically-detected EPR setup with optical excitations and tunable frequency sources to induce magnetic resonance transitions which are detected using cantilever torque magnetometry. Furthermore we show how we combined TDESR with Photon excited

Torque Magnetometry (PheToM) to excite and detect a spin forbidden transition in Fe3CrPh. The results are compared to simulations, W-Band-ESR and AC-SQUID data. We present an interferometric setup to increase the sensitivity of TDESR and we provide the key points for the improvement of the sensitivity down to sub-monolayer coverages, as required for molecular spintronic devices and investigations.

MA 49.20 Thu 15:00 Poster A

Investigation of light-induced magnetic changes in nanomagnets using static and dynamic SQUID magnetometry — •Michael Slota[1], Eric Heintze[1], Andrea Cornia[2], Martin Dressel[1], and Lapo Bogani[1] — [1]1. Physikalisches Institut, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany — [2]Dipartimento di Scienze Chimiche e Geologiche and UdR INSTM, Università di Modena e Reggio Emilia, via G. Campi 183, 41125 Modena, Italy

The behavior of nanomagnets in molecular spintronic materials can be changed by using external stimuli such as photons. Although the use of photons offers a clean way to control spin states, undesired effects as heating processes makes the investigation of light-induced properties challenging. We demonstrate the use of static and dynamic susceptibility measurements under continuous light irradiation via a SQUID magnetometer to quantify heating effects and extract magnetic changes, where the used light-coupling setup enables a distinct control of the irradiation strength on a sample. The molecular nanomagnet Fe3CrPh serves as an example, of which a short lived light-induced spin forbidden transition from S=6 to S=7 has already been detected in Torque-detected ESR combined with Photon-excited Torque Magnetometry (PheToM) as a change of the magnetic response. In near future this technique is used to detect spin changes novel classes of molecular spintronic systems, where light-induced currents manipulates spintronic properties rather than light directly.

MA 49.21 Thu 15:00 Poster A

Circularly polarized microwave radiation for ferromagnetic resonance experiments — Hannes Maier-Flaig[1,2], •Sho D. Watanabe[1,2,3], Rudolf Gross[1,2,4], Hans Huebl[1,4], and Sebastian T. B. Goennenwein[1,4] — [1]Walther-Meißner-Institut, Bayerische Akademie der Wissenschaften, D-85748 Garching — [2]Physik-Department, TU München, 85748 Garching, Germany — [3]Department of Physics, Keio University, 223-8522 Yokohama, Japan — [4]Nanosystems Initiative Munich, 80799 München, Germany

Ferromagnetic resonance (FMR) is a widely applied spectroscopy method allowing to probe magnetization dynamics and the spin-wave spectrum of a ferromagnet. In conventional FMR setups, linearly polarized microwave radiation is used. In contrast, circularly polarized microwave magnetic fields allow to selectively excite a magnetic dipole transition with $\Delta m_s = \pm 1$. We follow the approach by Henderson *et al.* [1] for the generation of cicularly polarized microwave radiation, but apply this principle to coplanar waveguide stuctures. Circularly polarized microwave radiation is created in a structure composed of half-wavelength resonators, with a sample space of about 1.15 mm^2. We discuss the properties of our resonators and present first FMR spectra.

[1] J.J. Henderson *et al.*, Rev. Sci. Instrum. **79**, 074704 (2008).

MA 49.22 Thu 15:00 Poster A

VekMag - a vector magnet for BESSY II — •Hanjo Ryll[1], Florin Radu[1], Radu-Marius Abrudan[2], Hartmut Zabel[2], Wolfgang Kuch[3], Georg Woltersdorf[4], and Christian Back[5] — [1]Helmholtz-Zentrum Berlin, Germany — [2]Ruhr-Universität Bochum, Germany — [3]Freie Universität Berlin, Germany — [4]Martin-Luther-Universität Halle-Wittenberg, Germany — [5]Universität Regensburg, Germany

VekMag is a vector superconducting magnet station, which is being jointly developed by Universität Regensburg, Freie Universität Berlin, Ruhr-Universität Bochum, and Helmholtz-Zentrum Berlin. The instrument will be installed at the PM2 dipole beamline of the synchrotron facility BESSY II in Berlin. The instrument is designed for the time-resolved research of future spintronic materials, such as multi and single-layer magnetic thin films, nanostructures, and molecules. Experimental probes include XAS, XMCD/XMLD measurements, resonant soft X-ray scattering methods, as well as time-resolved ferromagnetic resonance (FMR) and electron paramagnetic resonance (EPR) using XMCD. The available temperature range extends from 2 K up to 500 K. It will provide a 9 T field in the beam direction, a 2 T vector field in the horizontal plane, and a 1 T full vector field.

MA 49.23 Thu 15:00 Poster A

Nitrogen Vacancy center based nanoscale magnetometry enchanced by repetitive quantum error correction. — •Priyadharshini Balasubramanian[1], Thomas Unden[1], Daniel Louzon[3], Martin Plenio[2], Alex Retzker[3], Boris Naydenov[1], and Fedor Jelezko[1] — [1]Institute of Quantum Optics,University of Ulm — [2]Institute for Theoretical Physics, University of Ulm — [3]Racah Institute of Physics, The Hebrew University of Jerusalem,Israel

Nitrogen Vacancy (NV) center in diamond is proving to be an indispensible tool in numerous areas, specially NV based magnetometer has shown unprecedented sensitivity and spatial resolution owing to its long coherence time and atomic size. Such sensitive magnetic field probe has a sensitivity which is intrinsically limited by its phase memory time($\delta B \propto 1/\sqrt{T * T2}$). Here we experimentally demonstrate the approach presented in[Arrad,G et al.PRL 112,(2014)] of combining sensing with quantum error correction, which promises to tackle noise of high frequency where dynamical decoupling fails. The experiment uses a robust nuclear spin (13C) as an auxiliary qubit to store the coherence of the sensing qubit, while the sensor(e-spin of NV)is reset. Combined with echo based sensing protocol, the proposed method is shown to correct bit flip errors on the electron spin, while sensing in the code-space in orthogonal direction.Even with a limited gate fidelity(80%), we show significant improvement in the sensitivity even after 2 rounds of error correction.The presented method has the potential to handle complex noise, thus reaching the realm of magnetometry for detecting weak magnetic field associated with biological molecules.

MA 49.24 Thu 15:00 Poster A

Magnetic and Charge Ordering in $La_{1/3}Sr_{2/3}FeO_3$ powder samples, single crystals, and thin films — •Markus Waschk, Alexander Weber, Jörg Persson, and Thomas Brückel — Jülich Center for Neutron Science JCNS and Peter Grünberg Institut PGI: Streumethoden, Forschungszentrum Jülich GmbH, 52428 Jülich

In recent years the multifunctional oxides are considered promising candidates for future, highly efficient storage devices in information technology. Transition metal oxides with mixed valances, exhibit fascinating magnetic and electronic properties, governed closely to the system of correlated electrons. A very interesting material is the distorted perovskite $La_{1/3}Sr_{2/3}FeO_3$ (LSFO). This complex compound, as well as showing charge disproportionation through mixed valency, also exhibits magnetic and charge ordering. The complex interplay between these effects is extremely interesting, where the magnetic ordering in terms of antiferromagnetic order and the charge order occur at circa 200 K. A Verwey "like" transition is also seen as a significant jump in resistivity measurements. In order to understand LSFO in detail, the consideration of different self-made sample types (powder, single crystal and thin films) is necessary. This will lead to a further understanding of the underlying mechanism of the complex ordering. Characterization of these highly stoichiometric single phase samples with X-rays, magnetization and polarized neutron measurements provides a greater insight into the intrinsic magnetism and crystal structure and their influence on each other.

MA 49.25 Thu 15:00 Poster A

Exchange bias in antiferromagnetic Heusler alloy Ru2MnGe thin films — •Jan Balluff, Markus Meinert, and Günter Reiss — Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany

The Heusler compounds Ru2MnZ are experimentally known to be antiferromagnetic with Neel temperatures above room temperature [1,2]. Hence, they might be suitable as exchange biasing materials for spintronic devices. Here we report on results for the Ru2MnGe compound. Magnetic characterization of epitaxially grown samples on MgO and polycrystalline samples on thermally oxidized Si was done. A notable exchange bias at low temperatures was measured. We evaluate the exchange bias and discuss possible improvements of the effect, e.g. domain wall pinning. [1] Fukatani et al. (2013). Journal of the Korean Physical Society, 63(3), 711-715. [2] Ishida et al. (1995). Physica B: Condensed Matter, 210(2), 140-148.

MA 49.26 Thu 15:00 Poster A

Preparation and characterization of perpendicularly magnetized $Mn_{3\pm x}Ge$ thin films — •Manuel Glas[1], Daniel Ebke[2], and Günter Reiss[1] — [1]Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany. — [2]Max-Planck-Institute for Chemical Physics of Solids, Dresden, Germany

The continuous miniaturization process for spintronic devices requires consistently new materials with a low current density for spin transfer torque (STT) switching. The tetragonally distorted $Mn_{3-x}Ga$ seemed to be a promising candidate for STT-switching MRAM devices. However, to achieve a high TMR effect the interface between the ferromagnetic electrodes and MgO barrier plays an important role. Recent results showed that a Ga/MgO interface lowers the TMR effect drastically.[1] Therefore we replaced the Ga by Ge, due to the predicted non-vanishing TMR effect.[1] Different $Mn_{3\pm x}Ge$ (x = -0.4, 0.2, 0.6) stoichiometries were prepared on $SrTiO_3$ substrates to achieve epitaxial (001)-oriented thin films. The crystallographic and magnetic properties were investigated by X-ray diffraction, X-ray reflection and anomalous Hall effect. All samples showed a single $D0_{22}$ phase. However, the surface roughness and magnetic properties exhibit a strong dependence on the stoichiometry. The lowest surface roughness of 1.3 nm and highest perpendicular anisotropy ($\mu_0 H_c = 3.7$T) was found for $Mn_{3.2}Ge$. By increasing the Mn content to $Mn_{3.6}Ge$ an increasing in-plane anisotropy was observed.
[1] Y. Miura and M. Shirai, Magnetics, IEEE Transactions on 50, 1 (2014).

MA 49.27 Thu 15:00 Poster A

Magnetic dichroism study on $Mn_{3+x}Co_{1-x}Ga$ thin film using a ombination of X-ray absorption and photoemission spectroscopy — •Siham Ouardi[1], Takahide Kubota[2], Gerhard H. Fecher[1], Stanislav Chadov[1], Shigemi Mizukami[2], Tetsuya Nakamura[3], Eiji Ikenaga[3], Shigenori Ueda[3,4], and Claudia Felser[1] — [1]Max Planck Institute for Chemical Physics of Solids, Dresden, Germany. — [2]WPI-Advanced Institute for Materials Research (WPI-AIMR), Tohoku University, Sendai 980-8577, Japan — [3]Japan Synchrotron Radiation Research Institute, SPring-8, Hyogo, Japan — [4]National Institute for Materials Science, SPring-8, Hyogo, Japan

Using circularly and linearly polarised radiation and a combination of bulk-sensitive hard X-ray photoelectron spectroscopy and X-ray-absorption spectroscopy (XAS) we studied the electronic and magnetic structure of epitaxial $Mn_{3-x}Co_{1+x}Ga$ thin films. Element-specific magnetic moments and spin-resolved partial densities of states were determined by using XAS and XMCD. The valence states were investigated by using linear dichroism in the angular distribution and comparing the results to spin-resolved densities of states based on a first-principles analysis with fully relativistic Korringa-Kohn-Rostoker calculations.

MA 49.28 Thu 15:00 Poster A

Travelling solvent floating zone growth of Ni-Mn-Sn Heusler alloys — •Seunghyun Khim[1], Christian C. F. Blum[1], Maria Belesi[1], Ahmad Omar[1], Bernd Büchner[1,2], and Sabine Wurmehl[1,2] — [1]Leibniz Institute for Solid State and Materials Research, Helmholtzstrasse 20, 01069 Dresden, Germany — [2]Institute for Solid State Physics, TU Dresden, 01069 Dresden, Germany

We present a travelling solvent floating zone growth of Heusler alloys $Ni_2Mn_{1+x}Sn_{1-x}$. In certain Mn-rich compositions, this alloy undergoes a martensitic transition from a high temperature cubic $L2_1$ to a low temperature orthorhombic/tetragonal phase. Owing to a strong entanglement between the structure and magnetism, multifunctional properties such as shape memory effects, exchange bias, inverse magnetocaloric, and giant magnetoresistance are realized in this alloy. As the structure and magnetic properties are highly sensitive to disorder, microstructure and an inclusion of a secondary phase, a high quality single crystal is an ideal platform to investigate the intrinsic nature of those properties along with the anisotropies of the material. In this motivation, we have grown $Ni_2Mn_{1+x}Sn_{1-x}$ compounds by using the travelling solvent floating zone technique. We will discuss the evolution of structural and magnetic properties with varying the Mn/Sn ratio combining different techniques as nuclear magnetic resonance.

MA 49.29 Thu 15:00 Poster A

Spin polarization in Co2MnGe thin films observed by magnetooptics — •rajkumar patra[1], d. Bürger[1], a. Bildhaiya[1], n. du.[1], c. fischer[2], m. kreller[3], h. stöcker[4], b. abendroth[4], s. pofahl[5], o. g. schmidt[5], and h. schmidt[1] — [1]TU Chemnitz — [2]Metrolux GmbH — [3]DREEBIT GmbH — [4]TUBA Freiberg — [5]IFW Dresden

Band theory [1] predicts that Co2MnGe Heusler alloys in L21 phase are fully spin-polarized. Here we investigate Co2MnGe thin films in L21, B2, and L21 / B2 mixed phase by magnetooptics [2]. As confirmed by XRD, three thin film samples have been prepared by dc magnetron sputtering on SQ1 glass substrates, namely one 150 nm thick sample with perfect L21 phase, one 150 nm thick sample with B2 phase, and one 200 nm thick sample in L21 / B2 mixed phase. In agreement with the electronic band structure [1] and spin polarization of Co2MnGe in L21 phase, magnetooptics reveals a strongly magnetic field dependent response in the spectral range around 3.5 eV. In addition, the spin easy-axis of a laser-treated Co2MnGe sample is rotated by ca. 30° with respect to the spin easy-axis of the pristine sample which lies along the z-axis. Because Heusler alloys with spin polarization will reveal magnetic field dependent magnetooptical features, we expect that magnetooptical investigations will play an important role in the future when characterizing Heusler alloys in different heterostructures which are highly relevant for spintronic applications [3]. [1] S. Ouardi et al., Phys. Rev. B 84 (2011), [2] K. Mok, H.S. et al., Rev. Sci. Instr. 82 (2011), [3] M. Jourdan et al., Nat. Commun. 5 (2014)

MA 49.30 Thu 15:00 Poster A

Order-disorder transitions in $Co_2FeAl_{0.5}Si_{0.5}$ probed via in-situ neutron diffraction — •Ahmad Omar[1], Matthias Frontzek[2], Alexey Alfonsov[1,3], Bernd Büchner[1,4], and Sabine Wurmehl[1,4] — [1]IFW Dresden, 01069, Germany — [2]Paul Scherrer Institute, 5232 Villigen, Switzerland — [3]Molecular Photoscience Research Center, Kobe University, Kobe 657-8501, Japan — [4]Institut für Festkörperphysik, TU Dresden, 01062, Germany

The $Co_2FeAl_{0.5}Si_{0.5}$ Heusler compound is predicted to be a half-metallic ferromagnet in the ordered $L2_1$ structure [1], and a high TMR ratio has been reported [2]. Heusler compounds are prone to anti-site disorders which strongly affect the physical properties. It is thus pertinent to understand the existential regimes of different disorders and order-disorder transitions. Here we present neutron diffraction measurements performed in-situ during annealing of powder samples. We have also measured pre-annealed powder samples at room temperature to compare the effect of annealing. We do not observe any sharp transition between the $L2_1$-B2 and B2-A2 disorders, which is in contrast to literature [3]. The transitions seem to be predominantly entropy-driven, although the T_{Curie} and the transition temperature seem coupled. Also, zero-field NMR on powder with alternate annealing, as per neutron data, shows a higher $L2_1$ ordering. In summary, we gain an understanding of the order-disorder transitions and propose an alternate annealing for improved ordering. Ref.: [1] Fecher et al. J. Phys. D: Appl. Phys. 40 (2007) 1582-1586 [2] Tezuka et al. Appl. Phys. Lett. 94 (2009) 162504 [3] Balke et al. Appl. Phys. Lett. 90 (2007) 242503

MA 49.31 Thu 15:00 Poster A

Transport properties of MgAgAs-type half-Heusler compounds — •Enkhtaivan Lkhagvasuren, Guido Kreiner, Siham Ouardi, Walter Schnelle, Gerhard Fecher, and Claudia Felser — Max Planck Institute for Chemical Physics of Solids, Dresden, Germany

Half Heusler compounds are found to be promising candidates for many technological applications.

We present transport properties of several half Heusler compounds with wide range of band gap from 3 eV to 0.3 eV. The compounds show MgAgAs type cubic crystal structure (space group $F\bar{4}3m$).

LiZnAs and LiZnP show electrical resistivity of 10^{-1} Ωcm and 10^{-2} Ωcm at room temperature respectively. LiZnAs shows more than five order magnitude of electrical resistivity change in the temperature range from 100K to 150K.

MA 49.32 Thu 15:00 Poster A

The effect of the microstructure on the structural dopant-host coordination of Co implanted TiO2 films — •Oguz Yildirim[1,2], Steffen Cornelius[1], Georgy Zukov[3], Andrey Novikov[3], Elena Ganshina[3], Alexander Granovsky[3], Alevtina Smekhova[3], Carsten Baehtz[4], and Kay Potzger[1] — [1]Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf e.V. , D-01328 Dresden, Germany — [2]Technische Universität Dresden, D-01062 Dresden, Germany — [3]Lomonosov Moscow State University (MSU), Faculty of Physics, Moscow, Russia — [4]Rossendorf Beamline, European Synchrotron Radiation Facility, F-38043 Grenoble, France

TiO2 films, exhibiting amorphous, polycrystalline anatase or epitaxial anatase structures have been implanted with Co ions up to an atomic concentration of 5%. The influence of the structure of the host lattice on the local environment of the implanted Co atoms was investigated

by a variety of techniques. For decreasing structural order, more oxide coordination was found for Co ions. I.e., for the epitaxial and polycrystalline films, Co atoms exhibit a mixed oxidation state of (+2) and (0) interpreted as substitutional and metallic environment at x-ray absorption measurements, respectively. The presence of metallic Co clusters inside the epitaxial film has also been confirmed by magnetometry and transmission electron microscopy. Substitutional CoTi for implanted epitaxial and polycrystalline anatase TiO2 films was confirmed by magneto-optic (MO) spectroscopy. On the other hand, for the amorphous film, the Co ions show oxidic environment.

MA 49.33 Thu 15:00 Poster A

Influence of oxygen vacancies on the magnetic properties of $ZnFe_2O_4$ — •Karen L. Salcedo Rodríguez[1], Martin Hoffmann[2,3], Jhon J. Melo Quintero[1], Gustavo Pasquevich[1], Pedro Mendoza Zelis[1], Leonardo A. Errico[1], Silvana J. Stewart[1], Wolfram Hergert[2], and Claudia E. Rodríguez Torres[1] — [1]National University of La Plata, Argentina — [2]Martin Luther University Halle-Wittenberg, Germany — [3]Max Planck Institute for Microstructure Physics, Halle, Germany

We continue our experimental and theoretical study on bulk $ZnFe_2O_4$ (ZFO) powders [1]. ZFO samples were annealed in vacuum up to 600°C to control and increase the number of oxygen vacancies. The x-ray diffraction patterns indicate that all samples consist of single-phase ferrite. However, the magnetic measurements show the coexistence of ferromagnetic-like and paramagnetic components. For the saturation magnetization, the paramagnetic susceptibility and the Mössbauer spectroscopy, we observed a qualitative difference for samples which were annealed at temperatures either below or above 400°C.

Furthermore, we studied with *ab initio* calculations ZFO in the normal/inverted spinel structure and in the oxygen-deficient regime. The comparison between the experimental and calculated hyperfine parameters indicated a reduction of inversion by increasing the annealing temperature up to 400°C. For higher temperatures, we attributed the oxygen vacancies formation for the observed increase in the saturation magnetization and paramagnetic susceptibility.

[1] PRB 89, 104411 (2014)

MA 49.34 Thu 15:00 Poster A

Cyclic magnetocaloric behavior of Ni-Mn-In Heusler alloys — •Tino Gottschall[1], Konstantin P. Skokov[1], Elias Palacios[2], Ramon Burriel[2], and Oliver Gutfleisch[1] — [1]TU Darmstadt, Institute of Material Science, Alarich-Weiss-Str. 16, 64287 Darmstadt, Germany — [2]Institute of Materials Science of Aragon, University of Zaragoza, Spain

The origin for the inverse magnetocaloric effect in Ni-Mn based Heusler alloys is a first-order magnetostructural transition between a low temperature paramagnetic/antiferromagnetic martensite and a high temperature ferromagnetic austenite phase. In order to utilize a material as a refrigerant in a magnetocaloric cooling device both the adiabatic temperature change ΔT_{ad} and the entropy change ΔS should be as large as possible. For direct measurements of the adiabatic temperature change it is possible to vary the measurement speed in a broad range and also the cyclic behavior can be investigated. In order to determine the entropy change either calorimetry or magnetic measurements can be performed. Unlikely these methods are typically rather slow in comparison to the conditions in a real magnetocaloric cooling device and they do not provide any information about the reversible part. But especially for Heusler alloys with large thermal hysteresis this is a crucial issue which will be discussed in this work.

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MA 49.35 Thu 15:00 Poster A

Influence of the composition on the martensitic transformation and structure of epitaxial Ni-(Co-)Mn-Sn thin films. — •Daniel Kucza, Niclas Teichert, and Andreas Hütten — Center for Spinelectronic Materials and Devices, Physics Department, Bielefeld University, Germany

Due to its promising magentocaloric properties, structure, transformation temperatures, thermal hysteresis and surface morphology (AFM) of epitaxial Ni-Co-Mn-Sn thin films were examined. Measured with different compositions these Heusler alloys show a structural transition carried out from the low temperature martensitic to the high temperature austenitic phase. The compositions of the four alloys is set between $Ni_{50}Co_0Mn_{36}Sn_{13}$ and $Ni_{47}Co_3Mn_{37}Sn_{12}$. The films itself are prepared by magnetron co-sputtering from elemental targets on MgO(001) substrates.

The structure and surface morphology of the films is determined by X-ray diffraction and atomic force microscopy. To study the transformation temperatures and thermal hysteresis, several temperature dependent X-ray diffractions of a complete circle of cooling and heating of each sample are carried out.

The results show a widening of the thermal hysteresis with a change in the composition in case of increasing Co content.