MA 57: Posters Magnetism II

Time: Thursday 15:00–18:00 Location: P3

MA 57.1 Thu 15:00 P3

Entropy estimation in high-throughput calculations — •Rafael Vieira[1], Olle Eriksson[1], Torbjörn Björkman[2], and Heike C. Herper[1] — [1]Department of Physics and Astronomy, Uppsala University, Box 516, SE-75120 Uppsala, Sweden — [2]Physics, Faculty of Science and Engineering, Åbo Akademi, FI-20500 Turku, Finland

The increasing interest in the application of magnetocaloric materials for magnetic cooling devices has led to an intensive search for new materials with a more attractive performance to cost ratio. High-throughput studies based on first-principles calculations can play a crucial role to detect new magnetocaloric materials and help to estimate trends for material tuning. To identify systems of interest in a large body of data, screening parameters are required and must be carefully chosen considering a balance between accuracy and cost of the calculations.

A key quantity to characterize the performance of these systems is the entropy variation between two magnetic phases. To estimate this quantity in a cost-efficient but accurate way, we test several approaches taking FeRh as a test system. A model for a first-principles estimation of the entropy variation between magnetic phases is proposed, considering three distinct and independent entropy contributions: electronic, lattice, and magnetic. Estimated values are presented, and the model applicability for computing the entropy variation as a screening parameter for magnetocaloric performance is discussed.

MA 57.2 Thu 15:00 P3

Advanced characterization of magnetocaloric materials in pulsed magnetic fields — •T. Gottschall[1], E. Bykov[1,2], C. Salazar Mejía[1], Y. Skourski[1], and J. Wosnitza[1,2] — [1]Dresden High Magnetic Field Laboratory (HLD-EMFL), HZDR, Germany — [2]Institut für Festkörper- und Materialphysik, TU Dresden, Germany

The direct determination of the adiabatic temperature change as a function of magnetic field and starting temperature is of central importance for a profound characterization of magnetocaloric materials. Recently, a technique was developed to measure the temperature change in pulsed magnetic fields by using ultra-thin thermocouples attached to the sample. In this work, we give an overview of the most recent results that have been obtained in pulsed fields at the Dresden High Magnetic Field Laboratory.

This work was supported by HLD at HZDR, member of the European Magnetic Field Laboratory (EMFL) and the Helmholtz Association via the Helmholtz-RSF Joint Research Group Project No. HRSF-0045.

MA 57.3 Thu 15:00 P3

Magnetocaloric effect in $DyCo_2$ and $Ho_{0.5}Dy_{0.5}Al_2$ rare-earth compounds — •E. Bykov[1,2], T. Gottschall[1], A. Karpenkov[3], K. Skokov[4], S. Taskaev[5,6,7], Y. Skourski[1], and J. Wosnitza[1,2] — [1]Dresden High Magnetic Field Laboratory (HLD-EMFL), HZDR, Germany — [2]Institut für Festkörper- und Materialphysik, TU Dresden, Germany — [3]Faculty of Physics, Tver State University, Russia — [4]Institute of Material Science, TU Darmstadt, Germany — [5]Departament of Physics, Chelyabinsk State University, Russia — [6]National University of Science and Technology MISiS, Russia — [7]National Research South Ural State University, Russia

Two of the most promising materials for magnetic gas liquefaction are the rare-earth compounds of the type RCo_2 and RAl_2, which have the so-called Laves phase crystal structure, in which the ferri- or ferromagnetic order appears at low temperatures [1]. In this work, we will present our recent results on the magnetocaloric effect of $DyCo_2$ and $Ho_{0.5}Dy_{0.5}Al_2$ in pulsed magnetic fields. Both compounds demonstrate large adiabatic temperature changes over a wide temperature window near their Curie temperatures (143 K for $DyCo_2$ and 44 K for $Ho_{0.5}Dy_{0.5}Al_2$). Especially the usage of $Ho_{0.5}Dy_{0.5}Al_2$ is interesting for a final stage of H_2 liquefaction in magnetic refrigerator devices. This work was supported by the Helmholtz Association via the Helmholtz-RSF Joint Research Group Project No. HRSF-0045.

[1] A. Kitanovski et. al, Int. J. Refrig. **57**, 288 (2015)

MA 57.4 Thu 15:00 P3

Multiscale modeling of magnon-phonon dynamics — •Pablo Nieves[1], Sergiu Arapan[1], Domink Legut[1], David Serantes[3], and Oksana Chubykalo-Fesenko[2] — [1]IT4Innovations, VŠB, Ostrava, Czech Republic — [2]Instituto de Ciencias de Materiales de Madrid, Madrid, Spain — [3]Universidade de Santiago de Compostela, Santiago de Compostela, Spain

Magnon-phonon scattering processes play an essential role in novel magnetic phenomena. Typically, the influence of temperature on the magnetization dynamics is studied. However, there is an inverse effect when the magnetization dynamics produces temperature change, for example in the magnetocaloric effect or during the heating under an ac applied magnetic field. Promising applications like magnetic refrigeration or magnetic hyperthermia treatment for cancer are based on these processes. Recently, we have developed a self-consistent micromagnetic approach to describe both magnetization and phonon temperature dynamics. The approach consists in the simultaneous solution of the quantum Landau-Lifshitz-Bloch micromagnetic equation coupled to the equation for the phonon temperature dynamics. The latter equation is derived from the self-consistent quantum mechanical treatment of the spin-phonon Hamiltonian, which includes direct transformation and Raman processes, based on the general theory for a spin system interacting weakly with a thermal bath. We discuss the main features of this novel micromagnetic approach, possible applications and its deep connection to spin-lattice simulations within a coarse-grained multiscale approach.

MA 57.5 Thu 15:00 P3

Charge and spin transport in $NiFe_2O_4$ thin films with varying lattice parameters — •Oliver Ritter, Jan Biedinger, Karsten Rott, and Timo Kuschel — Center for Spineletronic Materials and Devices, Bielefeld University, Germany

Nickel ferrite (NFO) as a ferrimagnetic insulator is a promising material for spin caloric applications [1]. In this work, twin samples of 45 nm NFO thin films have been prepared by sputter deposition on $MgAl_2O_4$ substrates and in-situ post annealed at different temperatures, thus modifying the lattice parameters of NFO. Subsequently, only one of each sample pair has been capped by 3 nm Pt for spin Seebeck effect studies. After standard structural and magnetic characterization of the samples, the electrical resistivity has been measured to identify the oxygen content [2,3]. The influence of the lattice parameters on thermally induced spin current transport has not been investigated so far, but will be discussed within this contribution.

[1] D. Meier et al., Phys. Rev. B 87, 054421 (2013)
[2] P. Bougiatioti, et al., Phys. Rev. Lett. 119, 227205 (2017)
[3] P. Bougiatioti, et al., J. App. Phys. 122, 225101 (2017)

MA 57.6 Thu 15:00 P3

Thermally generated spin transport in Fe_3O_4/NiO/Pt trilayers — •Johannes Demir[1], Stefan Becker[1], Lennart Schwan[2], Olga Kuschel[3], Joachim Wollschläger[3], and Timo Kuschel[1] — [1]Center for Spineletronic Materials and Devices, Bielefeld University, Germany — [2]Bielefeld Institute for Applied Materials Research (BIfAM), Bielefeld University of Applied Sciences, Department of Engineering Sciences and Mathematics, Germany — [3]Center of Physics and Chemistry of New Materials, Osnabrück University, Germany

We investigate the spin Seebeck effect (SSE) in Fe_3O_4/NiO/Pt trilayers by varying the thickness of the antiferromagnetic NiO layer from 0 to 20 nm. Furthermore, we compare the normalization of the SSE voltage to the temperature difference as well as to the experimentally detected heat flux [1]. The Fe_3O_4/NiO bilayer is grown in situ by molecular-beam epitaxy, while the Pt layer is deposited ex situ by DC sputtering. We discuss a possible enhancement of the spin-current signal in 1 nm NiO on 48 nm and 22 nm Fe_3O_4 for the temperature difference (as reported in literature [2]) as well as for the heat flux method. Additionally, we simulate the temperature gradient in Fe_3O_4 in an equivalent circuit model depending on the NiO thermal conductivity and the interface thermal conductances to examine the influence of the thermal depth profile of the NiO layer on the thermally induced spin current.

[1] A. Sola et al., Sci. Rep. 7, 46752 (2017)
[2] L. Baldrati et al., Phys. Rev. B 98, 014409 (2018)

MA 57.7 Thu 15:00 P3

Influence of post annealing on structural, magnetic and electric properties of sputter-deposited $NiFe_2O_4$ thin films — •Jan Biedinger, Luca Marnitz, Karsten Rott, and Timo Kuschel — Center for Spineletronic Materials and Devices, Bielefeld University, Germany

In the presented work, the structural, magnetic and electric properties of $NiFe_2O_4$ (NFO) thin films treated by post annealing in pure oxygen atmosphere have been studied. Therefore, NFO films (45 nm) were prepared via reactive dc magnetron co-sputtering on $MgAl_2O_4$ substrates [1] and post annealed in-situ with temperatures ranging from 350°C to 700°C. Each sample was subsequently characterized by ex-situ means of x-ray fluorescence, x-ray reflectivity, x-ray diffraction and alternating gradient magnetometry. Additionally, resistivity measurements have been performed to investigate the oxygen content of the NFO films [2,3]. The ferrimagnetic insulating characteristic was identified for all treated samples. According to the structural analysis, the out-of-plane lattice constant decreased by increasing the annealing temperature, indicating more bulk-like structural properties, whereas the film roughness rose for the highest temperature of 700°C. In a next step, these films will be used for thermally induced spin transport experiments.

[1] C. Klewe et al., J. Appl. Phys. 115, 123903 (2014).
[2] P. Bougiatioti et al., J. Appl. Phys. 122, 225101 (2017).
[3] P. Bougiatioti et al., Phys. Rev. Lett. 119, 227205 (2017).

MA 57.8 Thu 15:00 P3

Spin Seebeck effect in $NiFe_2O_4$ thin films deposited on differently doped $Nb:SrTiO_3(001)$ substrates — •Tobias Peters[1], Oliver Ritter[1], Jannis Thien[2], Jari Rodewald[2], Joachim Wollschläger[2], Ronja Heinen[3], Martina Müller[3,4], and Timo Kuschel[1] — [1]Center for Spinelectronic Materials and Devices, University of Bielefeld, Germany — [2]Center of Physics and Chemistry of New Materials, Osnabrück University, Germany — [3]Peter Grünberg Institut, Forschungszentrum Jülich, Germany — [4]Technical University of Dortmund, Germany

We investigated the spin Seebeck effect (SSE) in $Pt/NiFe_2O_4$ bilayers grown on differently doped $Nb:SrTiO_3(001)$ (STO) substrates and studied the influence of deposition techniques. The nickel ferrite (NFO) has been deposited in thicknesses of 30nm via magnetron sputtering[1], molecular beam epitaxy[2] and pulsed laser deposition[3] on STO substrates with Nb content of 0%, 0.05% and 0.5%. SSE measurements have been performed, based on the normalization of the SSE driven electrical field in the Pt to the applied heat flux instead to the temperature difference, to avoid uncertainties from varying thermal conductivities between sample and setup [1]. For the NFO films on doped STO substrates we found SSE magnitudes comparable to the SSE in NFO on MgO(001) independent of the deposition technique. Only differences in the signal-to-noise ratio could be connected to the choice of the substrate.

[1] A. Sola et al., Sci. Rep. 7, 46752 (2017)

MA 57.9 Thu 15:00 P3

Towards spin-polarized scanning tunneling spectroscopy of exfoliated 2D magnets — •Benjamin Pestka[1], Jeff Strasdas[1], Matthew Hamer[2], Astrid Weston[2], Adam Budniak[3], Efrat Lifshitz[3], Yaron Amouyal[3], Roman Gorbachev[2], and Markus Morgenstern[1] — [1]II. Institute of Physics B, RWTH Aachen University, Germany — [2]School of Physics and Astronomy, University of Manchester, UK — [3]Schulich Faculty of Chemistry, Department of Materials Engineering, Technion, Haifa 3200003, Israel

Magnetic properties of 2D van der Waals materials are of particular interest for studying magnetic nanoscale interactions. Among others, one has identified the 2D ferromagnets (FM) CrI3 and CrBr3 as well as the anti-ferromagnets (AFM) CrPS4 and MnPS3. Different magnetic couplings between layers due to stacking order have been found and switching by electric field between FM and AFM layer coupling has been demonstrated. Our study focuses on scanning tunneling microscopy (STM) of the FM semiconductor CrBr3 at 6 K and the exfoliation and transfer process of the AFM semiconductor CrPS4 as preparation for future STM investigations. For CrBr3 flakes exfoliated on HOPG in Ar-atmosphere followed by ultra-high-vacuum transfer to the STM, we show atomically resolved STM topography and spectroscopy measurements showcasing the band gap of CrBr3. First spin-polarized measurements with a Cr tip in varying magnetic fields are presented. For CrPS4, we employed different exfoliation processes on SiO2, HOPG and h-BN that led to thicknesses down to 4 layers as measured by atomic force microscopy and Raman spectroscopy.

MA 57.10 Thu 15:00 P3

Trends of higher-order exchange interactions in transition metal trilayers — •Mara Gutzeit, Soumyajyoti Haldar, and Stefan Heinze — Institute of Theoretical Physics and Astrophysics, University of Kiel, Leibnizstrasse 15, 24098 Kiel, Germany

Higher-order exchange interactions (HOI) beyond the pair-wise Heisenberg exchange can play a crucial role in the formation of the magnetic ground state of a system. Prominent examples are both Rh/Fe atomic bilayers on Ir(111) [1] and a monolayer Fe on Rh(111) [2] which are shown to exhibit a double-row-wise antiferromagnetic (↑↑↓↓) ground state stabilized by HOI. Here, employing density functional theory as implemented in the FLEUR and VASP code, we investigate the behaviour of HOI in magnetic trilayer systems. Choosing the above-mentioned Rh/Fe/Ir system as a starting point, we systematically study how the HOI change not only with the band filling as Rh (Ir) is replaced by other elements of the $4d$ ($5d$) series but also how they are affected by different stackings of the involved transition metals. Additionally, trends for HOI parameters are presented for the case that the central $3d$ element Fe is replaced by Co. Finally, the values obtained for the biquadratic exchange, the four-site-four-spin term and the three-site-four-spin interaction of the trilayers are compared with values calculated for respective ultrathin film systems.

[1] Romming *et al.* PRL 120, 207201 (2018)
[2] Krönlein *et al.* PRL 120, 207202 (2018)

MA 57.11 Thu 15:00 P3

Magnetism and spin dynamics in single-layer antiferromagnetic insulator $MnPS_3$ — •Martin Alliati[1], Richard F. L. Evans[2], and Elton J. G. Santos[1] — [1]School of Mathematics and Physics, Queen's University Belfast, BT7 1NN, UK — [2]Department of Physics, University of York, YO10 5DD, UK

Two-dimensional magnets have recently attracted considerable attention, both from a fundamental standpoint and in terms of their potential applications, e.g., the prospect of antiferromagnetic spintronics devices based on single-layer transition metal thiophosphates. In particular, the magnetic properties in $MnPS_3$ are intrinsically coupled to the crystal and electronic structures, and then can be affected by tunable parameters. This arises from an interplay between different electronic quantities that remains to be fully understood at the monolayer limit. Here we tackle this challenge through a multi-scale approach. First, ab-initio calculations were performed to understand the crystal and electronic structures of this material, as well as its magnetic properties such as easy-axis anisotropy and anisotropic exchange. Subsequently, nano-scale magnetic simulations were performed to unveil the effect of different perturbations on the magnetic ordering of this material through Monte Carlo methods and Landau-Lifshitz-Gilbert (LLG) dynamics. This includes a description of the magnetic domains at different temperatures, domain wall motion and ultrafast spin dynamics induced by pulsed magnetic fields. The results presented here broaden our understanding of single-layer $MnPS_3$, thus representing a step forward towards ultrathin antiferromagnetic spintronics.

MA 57.12 Thu 15:00 P3

Magnetoresistance effects in two-dimensional magnetic van der Waals systems — •Franziska Martin[1], Rui Wu[1], Romain Lebrun[1], Tanja Scholz[2], Jinbo Yang[3], Bettina Lotsch[2], and Mathias Kläui[1] — [1]Institute of Physics, Johannes Gutenberg-University Mainz, 55099 Mainz, Germany — [2]Max Planck Institute for solid state research, 70569 Stuttgart — [3]School of Physics, Peking University, 100871, Beijing, China

Two-dimensional materials exhibiting a weak interlayer van der Waals bonding provide the opportunity for mechanical exfoliation down to single atomic layers. While non magnetic two-dimensional materials, like transition metal dichalcogenides, offer a broad range of electronic properties [1], combining magnetism with the confinement of two dimensions opens up the potential of effective current control of magnetization [2]. We focus on metallic as well as insulating ferromagnetic and antiferromagnetic two-dimensional van der Waals materials, for which we have previously determined the temperature dependence of the anisotropies [3]. We measure the spin Hall magnetoresistance [4] to probe magnetization and the Néel vector in these systems. References: [1] Manzeli et al., Nat. Rev. Mater. 2, 17033 (2017), [2] Mak et al., Nat. Rev. Phys. 1, 646 (2019), [3] N. Richter et al., Phys. Rev. Mater. 2, 024004 (2018), [4] Nakayama et al., Phys. Rev. Lett. 110, 206601 (2013)

MA 57.13 Thu 15:00 P3

Ab initio studies of magnetic interactions in $MnBi_2Te_4$ and related monolayers — •Donya Mazhjoo, Gustav Bihlmayer, and Stefan Blügel — Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich, D-52425 Jülich, Germany

Novel 2D magnetic materials offer a versatile platform to study magnetism in two dimensions. Density functional theory (DFT) calculations can be used to find not only the ground statemagnetic structure but also to disentangle different magnetic interactions.Using the full-potential linearized augmented planewave method (FLAPW) as implemented in the Fleur-code [1], we investigate the magnetic properties of monolayers of $MnBi_2Te_4$, that is an antiferromagnetic topological insulator in the bulk [2] and compare to $MnBi_2Se_4$ and $MnSb_2Te_4$. We focus on the scalar exchange interaction energy and on spin-orbit coupling (SOC) effects like the magnetic anisotropy. Also, we explore the impact of the SOC on the exchange interaction energy and the magnetic ordering temperature of these materials.

[1] Ph. Kurz *et al.*, PRB 69, 024415 (2004).
[2] M. Otrokov *et al.*, arXiv:1809.07389(2018).

MA 57.14 Thu 15:00 P3

Hot carrier relaxation in two-dimensional materials — •Franz Fischer, Franziska Töpler, Nicki Frank Hinsche, Jürgen Henk, and Ingrid Mertig — Martin Luther University Halle-Wittenberg, Institute of Physics, 06099 Halle (Saale), Germany

Atomically thin layers of transition metal dichalcogenides attract remarkable interest due to their extraordinary electronic and optical properties. The lack of inversion symmetry in their crystal structure combined with strong spin-orbit interaction gives rise to an extra valley degree of freedom as well as large spin splittings in the Brillouin zone (BZ). The latter are accompanied by presumably large Berry curvature.

After gaining a net Berry curvature in the BZ by tuning the electronic band structure with electric and magnetic fields – which induce spatial and time symmetry breaking – we realized an anomalous Hall effect (AHE). We are developing a framework to study the time-dependent evolution of the AHE and other electronic transport properties in various 2D systems by solving time-dependent Boltzmann equation models. We aim to compare our results to those of theoretical and experimental many-temperature models to gain deeper insight into ultrafast carrier relaxation processes.

MA 57.15 Thu 15:00 P3

Relaxation behaviour of antiferromagnetic grains in polycrystalline exchange bias bilayers — •Maximilian Merkel, Rico Huhnstock, Meike Reginka, and Arno Ehresmann — Institute of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel

The macroscopic magnetic characteristics of polycrystalline exchange bias thin films (antiferromagnet/ferromagnet) are mainly linked to the grain size distribution of the antiferromagnetic layer, which can be divided into classes of thermally unstable as well as thermally stable grains. These grain classes are connected to the coercivity and the horizontal shift (exchange bias field) of the ferromagnetic hysteresis loop, respectively. In order to tune the contribution of rotatable and pinning grains, sets of IrMn/NiFe and IrMn/CoFe bilayers with varying antiferromagnetic layer thickness were fabricated via sputter-deposition. Applying the first-order reversal curve (FORC) formalism, the distribution of coercivities and interaction fields of the granular systems have been determined complementary to angular-resolved hysteresis measurements using Kerr-magnetometry in comparison to an extended Stoner-Wohlfarth model. The combination allowed for the quantitative determination of material parameters and the deconvolution of grain class contributions. Additionally, by changing the sweep rate of the external magnetic field during a magnetization reversal process enabled the investigation of the relaxation times of the antiferromagnet's thermally unstable and therefore rotatable grains.

MA 57.16 Thu 15:00 P3

Tailoring of exchange bias in magnetic thin films via electrochemical transformation of the ferromagnetic layer — •Rico Huhnstock[1], Jonas Zehner[2], Steffen Oswald[2], Ivan Soldatov[2], Arno Ehresmann[1], Kornelius Nielsch[2], Dennis Holzinger[1], and Karin Leistner[2] — [1]Institute of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel — [2]Leibniz Institute for Solid State and Materials Research Dresden, IFW Dresden, Helmholtzstr. 20, D-01069 Dresden

In recent research targeted modification of the interface related Exchange Bias (EB) effect in magnetic thin film systems is considered to be a crucial factor in designing artificial magnetic stray field landscapes which can be employed in e.g. biomedical point-of-care diagnostics. In this regard, the challenge of tuning the EB in a reversible and nonvolatile manner opens up new opportunities with the application of magnetoionic approaches potentially playing a key role in overcoming present obstacles. Hence, in this work we demonstrate an electrochemical routine for the electric control of EB by a Redox transformation of the ferromagnetic layer in a Fe/IrMn based thin film system [1]. The influence of several experimental parameters on the here investigated tailoring of EB will be discussed alongside a route towards reversible control of EB. To conclude, an outlook on structuring EB systems magnetically with the presented technique will be given.

[1] Zehner *et al.* (2019), Adv. Electron. Mater., 5(6):1900296.

MA 57.17 Thu 15:00 P3

X-ray magnetic linear dichroism as a probe for non-collinear magnetic state in ferrimagnetic single layer exchange bias systems — •Chen Luo[1,2,3], Hanjo Ryll[1], Christian Back[2,3], and Florin Radu[1] — [1]Helmholtz-Zentrum-Berlin für Materialen und Energie, Albert-Einstein-Strasse 15, 12489 Berlin, Germany — [2]Institute of Experimental and Applied Physics, University of Regensburg, 93053 Regensburg, Germany — [3]Institute of Experimental Physics of Functional Spin Systems, Technical University Munich, James-Franck-Str. 1, 85748 Garching b. München, Germany

Ferrimagnetic alloys are extensively studied for their unique magnetic properties leading to possible applications in perpendicular magnetic recording. On a prototype ferrimagnetic alloy we demonstrate fascinating properties that occur close to a critical temperature where the magnetization is vanishing, just as in an antiferromagnet. An anomalous 'wing shape' hysteresis loop is observed slightly above the compensation temperature. This bears the characteristics of an intrinsic exchange bias effect, referred to as atomic exchange bias. We further exploit the X-ray magnetic linear dichroism contrast for probing non-collinear states which allows us to discriminate between two main reversal mechanisms, namely perpendicular domain wall formation versus spin-flop transition. Ultimately, we analyze the elemental magnetic moments for the surface and the bulk parts, separately, which allows to identify in the phase diagram the temperature window where this effect takes place. Moreover, we suggests that this effect is a general phenomenon in ferrimagnetic thin films.

MA 57.18 Thu 15:00 P3

Investigation of Granular Magnetic Exchange Coupled Nano-Composites — Runbang Shao, Siming Zou, Nitish Jangale, Balati Kuerbanjiang, and •Ulrich Herr — Institut für Funktionelle Nanosysteme, Universität Ulm, Ulm, Deutschland

Exchange coupling of ferromagnetic (FM) nanoparticles (NPs) to antiferromagnets (AF) can increase the coercivity and the stability against superparamagnetic fluctuations. It has potential applications in magnetic data storage and permanent magnets. We have studied nanocomposites with FM Co or Ni NPs embedded in AF FeMn or IrMn thin films. After application of a field cooling procedure, exchange bias is observed in these nano-composites at low temperature. We observe a pronounced dependence of the exchange bias on FM volume filling factor. To determine the average size of NPs, the superparamagnetic room-temperature m-H curves of reference samples with FM NPs embedded in non-magnetic Cu films are fitted using a superposition of Langevin functions calculated for varying particle size. The fitted size distribution agrees well with the result obtained by T-SEM analysis of free standing NPs. Blocking temperatures are determined via zero field cooled (ZFC) and field cooled (FC) measurements. The switching field distributions (SFD) of NPs, which are measured by first order reversal curves (FORC), are analyzed to have a better understanding of the magnetic anisotropy. Comparison of the magnetic properties of different nano-composites reveals the influence of the exchange coupling on the magnetic energy landscape.

MA 57.19 Thu 15:00 P3

Interfacial Ferromagnetism of $LaMnO_3/SrMnO_3$ Superlattices — •Robert Gruhl and Vasily Moshnyaga — I. Physikalisches Institut, Georg-August-Universität Göttingen, Germany

Interfaces of transition metal oxides show unique properties which cannot be observed in the constituent bulk materials. The prominent example is the formation of a 2D electron gas in $LaAlO_3/SrTiO_3$. These emergent interfacial phenomena are believed to arise due to the complex charge, spin and orbital reconstructions at the interfaces. Superlattices (SLs) of $LaMnO_3$ (LMO) and $SrMnO_3$ (SMO) were prepared on $SrTiO_3$(100) and LSAT(100) substrates using the metalorganic aerosol deposition. The growth, controlled in-situ by optical ellipsometry, results in superlattices with flat and chemically sharp interfaces as well as in an atomically smooth surface morphology.

The prepared SLs show complex magnetic behavior with high- and low-temperature ferromagnetic phases. Samples with small superlattice periods and high interface densities were prepared to investigate the interfacial magnetism. Furthermore, the substrate-induced stress effects on the magnetic properties of SLs were studied. Financial support of the Deutsche Forschungsgemeinschaft via SFB 1073 TP A02 is acknowledged.

MA 57.20 Thu 15:00 P3

Static and dynamic demagnetization of MBE grown Fe/Gd films on W(110) investigated with XMCD-R — •Dominic Lawrenz[1], Jonathan Weber[1], Wibke Bronsch[1], Tim Amrhein[1], Jan Böhnke[1], Rinat Khanbekov[1], Sarah Krüger[1], Huijuan Xiao[1], Markus Gleich[1], Kamil Bobowski[1], Xinwei Zheng[1], Niko Pontius[2], Christian Schüssler-Langeheine[2], Torsten Kachel[2], Nele Thielemann-Kühn[1], and Martin Weinelt[1] — [1]Fachbereich Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin — [2]Helmholtz-Zentrum Berlin für Materialien und Energie GmbH, Albert-Einstein-Strasse 15, 12489 Berlin

Bilayers of ferrimagnetic Fe/Gd on W(110) were investigated at BESSY II. We examined the temperature-dependent magnetization of the bilayer element-specifically by measuring the Fe $L_{3,2}$- and the Gd $M_{5,4}$-edges using XMCD in reflection. We show that thermal magnetization-switching is dependent on the layer thickness. Further time-resolved experiments at the FEMTOSPEX facility show ultrafast demagnetization dynamics on a sub-ps timescale even for Gd, much faster than previously observed for pure Gd films. We attribute this to efficient interlayer spin currents.

MA 57.21 Thu 15:00 P3

Ferromagnetic resonance of $Mn_{1.6}$PtSn thin films — •Peter Swekis[1,2], Anastasios Markou[1], Jörg Sichelschmidt[1], Sebastian T.B. Gönnenwein[2,3], and Claudia Felser[1] — [1]Max Planck Institute for Chemical Physics of Solids, Nöthnitzer Straße 40, 01187 Dresden, Germany — [2]Institut für Festkörper- und Materialphysik, Technische Universität Dresden, 01062 Dresden, Germany — [3]Center for Transport and Devices of Emergent Materials, Technische Universität Dresden, 01062 Dresden, Germany

Inverse tetragonal Mn-based Heusler-type compounds can host topological non-coplanar spin textures, such as antiskyrmions in $Mn_{1.4}Pt_{0.9}Pd_{0.1}Sn$[1], that affect the electromagnetic properties in unconventional ways[2]. Investigation of the host materials and the underlying exchange mechanisms, such as the anisotropy, is therefore of utmost importance in order to control and understand the formation of those textures. The dynamic response to gigahertz frequencies becomes particularly interesting and has to be examined.

We studied $Mn_{1.6}$PtSn thin films of various thicknesses (20-100 nm) with cavity FMR (X-Band and Q-Band) as well as broadband FMR to determine damping, g-factor, effective magnetization, anisotropy constants and temperature dependence.

[1] A.K. Nayak et. al., Nature 548, 561 (2017)
[2] P. Swekis et. al., PRM 3, 013001(R) (2019)

MA 57.22 Thu 15:00 P3

Temperature and angular dependence of the anisotropic magnetoresistance in epitaxial Mn5Ge3 film — •Yufang Xie[1,3], Ye Yuan[2], Manfred Helm[1,3], Jörg Grenzer[1], Magdalena Birowska[4], Dominik Kriegner[3,5], Shengqiang Zhou[1], and Prucnal Slawomir[1] — [1]Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf, Bautzner Landstrasse 400, 01328 Dresden, Germany — [2]Physical Science and Engineering Division, King Abdullah University of Science and Technology, 23955-6900, Thuwal, Saudi Arabia — [3]Technische Universität Dresden, 01062 Dresden, Germany — [4]Faculty of Physics, Institute of Theoretical Physics, University of Warsaw, Pasteura 5, 02093 Warsaw, Poland — [5]Max Planck Institute for Chemical Physics of Solids, Nöthnitzer Str. 40, 01187 Dresden, Germany

The epitaxial ferromagnetic Mn5Ge3 films are made by ms-range diffusion of Mn into Ge (100). Temperature dependent angular magnetoresistance (AMR) measurements were performed on Mn5Ge3 films. The AMR changes strongly with temperature rising from 5K to 300K. The characteristic feature of the AMR is a twofold symmetry below 100 K and above 270K. From 100 K to 270 K, AMR shows an overall sixfold symmetry. The temperature dependent X-ray diffraction indicates there is remarkable structural deformation at 100 K, which probably results in the modification of the spin configuration from collinear to noncollinear. Considering temperature dependent magnetic properties, it is possible to conclude the transformation of spin configuration is responsible for the temperature dependent AMR.

MA 57.23 Thu 15:00 P3

Deposition and characterisation of ferromagnetic τ-MnAl thin films — •Daniel Scheffler[1], Michaela Lammel[2], Torsten Mix[2], Thomas G. Woodcock[2], Andy Thomas[2], and Sebastian T.B. Goennenwein[1] — [1]Institut für Festkörper- und Materialphysik, Technische Universität Dresden, 01062 Dresden, Germany — [2]Leibniz Institute for Solid State and Materials Research Dresden (IFW Dresden), 01069 Dresden, Germany

τ-MnAl is a ferromagnetic phase with high uniaxial magnetocrystalline anisotropy. This makes the material attractive for permanent magnet applications, such that the magnetic properties are well studied in polycrystalline bulk samples. In contrast, the properties of single crystalline thin films, especially magnetoresistance and magnetic damping, have not been systematically investigated. We have successfully grown single crystalline τ-MnAl thin films via cosputtering. We used high resolution X-ray diffraction and SQUID magnetometry to quantify the structural and magnetic properties of our films, and find good structural quality as well as a strong perpendicular magnetic anisotropy. We also discuss the impact of the deposition parameters like substrate temperature and the post annealing temperature, which are key parameters to improve the crystalline quality and magnetic properties of τ-MnAl films.

MA 57.24 Thu 15:00 P3

Irradiation-induced magneto-structural phase transition in $Fe_{60}V_{40}$ alloy thin films — •Md. Shadab Anwar[1], Vico Liersch[1], Benedikt Eggert[3], Alexander Schmeink[1], Kay Potzger[1], Jürgen Lindner[1], Jürgen Fassbender[1], Heiko Wende[3], Olav Hellwig[1,2], and Rantej Bali[1] — [1]Helmholtz-Zentrum Dresden-Rossendorf, Germany — [2]Technical University of Chemnitz, Germany — [3]University of Duisburg-Essen, Germany

Ion beam irradiation leads to an increased saturation magnetization (M_s) in non-ferromagnetic precursors of $Fe_{60}Al_{40}$[1], $Fe_{50}Rh_{50}$[2] and $Fe_{60}V_{40}$ alloy thin films. $Fe_{60}V_{40}$ films of 40 nm thickness were prepared using magnetron sputtering onto heated SiO_2/Si substrates. The as-grown films are weakly ferromagnetic with M_s<15 kA/m for growth temperatures between 300 and 673 K. Irradiation with Ne^+ ions at 25 keV and a fluence of 1 x 10^{15} ions/cm^2 leads to an increase of M_s to 54, 549 and 246 kA/m for films grown at 300, 573 and 673 K respectively. X-ray diffraction of the as-grown films shows a broad peak at $2\theta \approx 44°$, which suggests short range ordering. Ne^+-irradiation causes the formation of the A2 structure, which is ferromagnetic. This amorphous to crystalline structural phase transition can be controlled using ion-irradiation, thus leading to a drastic increase in M_s, which can be useful in magnetic pattering applications.

Financial support by DFG grants BA 5656/1-1 and WE 2623/14-1 is acknowledged

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[2] Kosugi, S. *et al., Phys. Res. B* 267, 1612 (2009).

MA 57.25 Thu 15:00 P3

CPA-RPA theory for magnetic materials — •Sebastian Paischer[1], Pawel Buczek[2], and Arthur Ernst[1] — [1]Johannes Kepler Universität Linz — [2]Hochschule für Angewandte Wissenschaften Hamburg

The coherent potential approximation (CPA) is widely used for the study of electronic properties of disordered materials. In the literature several approaches to the application of the CPA to magnetic systems are present but most of them suffer from inconvenient features: They either fail to recover the Goldstone-mode or are only applicable to a rather restricted group of simple lattices and interaction types. However, recently a new promising method was published by *Buzcek et. al.* [PRB 94 054407 (2016)] which is able handle an arbitrary structure and interaction while also recovering the Goldstone-mode. We extend the method to treat finite temperature effects within the random phase approximation. In this contribution the theory of this method is shown. Our results agree with the well known spectra from the zero-temperature regime and provide insights into the temperature behavior of magnetic properties.

MA 57.26 Thu 15:00 P3

Cation order control of magnetism in double perovskite system — •Supriyo Majumder, M. Tripathi, R. J. Choudhary, and D. M. Phase — UGC-DAE CSR, University campus, Indore-452001, India

The mislocation of transition metal ions in double perovskite (DP) $A_2B^{'}B^{''}O_6$ structures from ideal alternating site occupancy, known as anti-site disordering, have a huge bearing on physical properties. With this motive, we have controlled the B-site disorders and investigated consequent signatures on magnetic ground state of R_2NiMnO_6 (R= rare earth) DP systems. Ordered RNMO is commonly believed to show two distinct magnetic phase transitions viz, PM-FM transition at T_C due to Ni^{2+}-O-Mn^{4+} super exchange interaction and at T_f due to coupling of R spins with Ni-Mn network. In addition, anomalous inverted cusp trend in M(T), two step reversibility loop behavior in M(H) and drastic reduction of M_S etc. were observed in the disordered system. Presence of intrinsic anti-site disorder results in an additional AFM coupling, mediated by Ni^{2+}-O-Ni^{2+} and Mn^{4+}-O-Mn^{4+} pairs and consequently the competition between long range FM ordering with short scale AFM interaction governs the complex magnetic behavior in RNMO. The present study provides a pathway to control magnetism by proper tunning of cation ordering in DP system.

MA 57.27 Thu 15:00 P3

Temperature- and light-induced spin-state switching at submonolayer coverage in a sublimated spin-crossover film on graphite — •Sangeeta Thakur[1], Evangelos Golias[1], Ivar Kumberg[1], Kuppusamy S. Kumar[2], Rahil Hosseinifar[1], Jorge Torres[1], Lalminthang Kipgen[1], Lucas M. Arruda[1], Chen Luo[3], Florin Radu[3], Mario Ruben[2], and Wolfgang Kuch[1] — [1]Freie Universität Berlin, Institut für Experimentalphysik, Berlin, Germany — [2]Institut de Physique et Chimie des Materiaux (IPCMS), Université de Strasbourg, France — [3]Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin Germany

Molecular self-assembly of the complex $[Fe(H_2B(pz)_2)_2$-bipy] with $COOC_{12}H_{25}$ was used to fabricate thin spin-switchable surface-bound films, with programmable intermolecular interactions [1]. Thermal- and light-induced spin-crossover behavior of 0.4 ML of $[Fe(H_2B(pz)_2)_2COOC_{12}H_{25}$-bipy] was studied on a highly oriented pyrolytic graphite (HOPG) surface by x-ray absorption spectroscopy. The highest fraction of low-spin (LS) state is found around 40 K (42 %), while at 10 K soft-x-ray-induced excited spin-state trapping decreases the fraction of LS-state molecules to 36 %. Illumination with green light at 10 K leads to a complete spin conversion to the high-spin (HS) state. Although molecules undergo a complete spin-state conversion (HS ↔ LS) both in bulk and in a thick film on SiOx [1], this effect is not observed in the submonolayer deposit on HOPG, highlighting the role of molecule–substrate interactions.

[1] K. S. Kumar et al., Adv. Mater. **30**, 1705416 (2018).

MA 57.28 Thu 15:00 P3

X-ray magnetic circular dichroism measurements on SURMOF-2 structures — •Alexei Nefedov[1], Kai Mueller[1], Lars Heinke[1], Chen Luo[2], Kai Chen[2], Florin Radu[2], Evangelos Golias[3], Wolfgang Kuch[3], and Christof Woell[1] — [1]Karlsruhe Institute of Technology, Institute of Functional Interfaces, Eggenstein-Leopoldshafen, Germany — [2]Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany — [3]Freie Universität Berlin, Institut für Experimentalphysik, Berlin, Germany

Metal-organic frameworks (MOFs) are crystalline self-assembled solids from metal compounds and organic ligands. Recently, it was found that quasi-linear metal-ion chains within a particular type of MOFs exhibit 1-D magnetic properties. Thus, Friedländer et al. reported on the ferromagnetic (FM) ordering in SURMOF-2 (Surface-mounted MOFs) [1]. Contrary to the bulk MOF-2 crystals, where Cu^{2+} ions form antiferromagnetically coupled paddlewheels, the Cu^{2+} ions in SURMOF-2 are connected via carboxylate groups in a zipper-like fashion. This unusual coupling of the spin-1/2 ions within the resulting 1-D chains stabilizes a low-temperature FM phase. In this study, SURMOF-2 systems (CuBDC/CuPBDC) were loaded with metalocene (manganocene and nickelocene) and their magnetic properties were investigated. The presence of the FM phase in empty SURMOF-2 systems has been confirmed with a Curie temperature of 22 K. After loading of SURMOF-2 with metalocene molecules a different behavior of magnetic properties was found. The details of these effects will be discussed. [1] Stefan Friedländer et al., Angew. Chem. Int. Ed. 2016, 55, 12683.

MA 57.29 Thu 15:00 P3

Efficient Simulation of Powder Magnetism in Single Molecule Magnets — •Hetti M. Jayawardena[1], Julius Mutschler[1], Christopher E. Anson[2], Annie K. Powell[2], and Oliver Waldmann[1] — [1]Physikalisches Institut, Universität Freiburg, Germany — [2]Institut für Anorganische Chemie, Universität Karlsruhe, KIT, Germany

The possibility for unique applications of Single-Moleculer Magnets (SMMs), e.g. in data storage devices, drives researchers to study their quantumscale behavior in greater depth. Their magnetic properties can be studied by a variety of techniques, but powder magnetization is undoubtely the most frequently employed technique. Simulating and fitting the powder magnetization curves in heterometalic 3d-4f metal clusters is challenging due to the presence of a large number of ligand field parameters, powder averaging, and relatively large Hilbert space dimensions. This leads to a massive number of diaganalization steps (ca 10^7) and expected computation times of several 100 days, even for "small" systems such as Mn_2Ln_2 SMMs. In this poster we demonstrate that exploiting sparse matrix techniques and iterative methods for simulating the experimental low temperature powder magnetization data, allows us to reduce the effort by a factor of ∼1000, making the fits practical.

MA 57.30 Thu 15:00 P3

An Efficient Magnetothermal Actuation Setup for Biomedical Applications — •Amirarsalan Asharion and Cornelia Monzel — Experimental Medical Physics, Heinrich-Heine University Düsseldorf, 40225 Düsseldorf, Germany

Magnetic hyperthermia is a promising approach for biomedical applications. Here, magnetic nanoparticles are used as heating agents to increase the temperature in the nanometer vicinity of the particle surface with minimal side-effects on the surrounding tissue. The heat dissipation arises from energy delivered to the nanoparticles in the form of an alternating magnetic field. While clinical applications are in their nascent state, live-observations of single cells could be a huge asset to improve our understanding of the heating effect on cells or on individual heat-sensitive molecules. In this work, a magnetic hyperthermia setup with a small form factor is implemented under the microscope. The setup provides an alternating magnetic field with magnetic flux densities in the range of 10-100 mT, with a frequency of 10-500 kHz, applied to a volume of 1 cm^3. We discuss the different components of this setup, the electromagnet and electric circuit, as well as essential improvements to reduce power loss.

MA 57.31 Thu 15:00 P3

^{57}Fe Mössbauer spectroscopy on $FePcF_{16}$ and its μ-Oxo dimer in catalysis reaction — •Felix Seewald[1], Florian Puls[2], Hans-Joachim Knölker[2], and Hans-Henning Klauss[1] — [1]Institute of Solid State and Materials Physics, TU Dresden, D-01069, Germany — [2]Department Chemie, Technische Universität Dresden, Bergstraße 66, D-01069 Dresden, Germany

Iron-hexadecafluorophthalocyanine ($FePcF_{16}$) is used as a oxidation catalyst. Understanding its catalysis mechanism is part of current research.

Both $FePcF_{16}$ and its mu-Oxo dimer ($[FePcF_{16}]_2O$) are already identified as steps of the oxidation cycle.

The Mössbauer spectra of $[FePcF_{16}]_2O$ can be described by two sites at room temperature, both exhibiting quadrupole splitting. A temperature dependent reversible transition between both sites can be observed. Below 30 K the onset of a magnetic hyperfine field is observed obtaining a value of $B_{Hyp} = 48.77(12)$ T at 4.2 K.

The $FePcF_{16}$ spectra show one additional third site with a considerable quadrupole splitting and an electric field gradient largest principle component of $V_{zz} = 154(2)\,V/Å^2$. This site stays paramagnetic down to 4.2 K.

First measurements of the frozen reaction solution unveil an additional fourth site in an characteristic Fe(II) charge and high spin (S=2) state. We will discuss the implications of these findings on the catalysis process.

MA 57.32 Thu 15:00 P3

Light-, temperature-, and x-ray-induced spin-crossover tran-

sition of molecules adsorbed on a graphite surface — •Jorge Torres[1], Lalminthang Kipgen[1], Sascha Ossinger[2], Sangeeta Thakur[1], Ivar Kumberg[1], Rahil Hosseinifar[1], Lucas M. Arruda[1], Evangelos Golias[1], Chen Luo[3], Kai Chen[3], Florin Radu[3], Felix Tuczek[2], and Wolfgang Kuch[1] — [1]Freie Universität Berlin, Institut für Experimentalphysik, Berlin, Germany — [2]Christian-Albrechts-Universität zu Kiel, Institut für Anorganische Chemie, Kiel, Germany — [3]Helmholtz-Zentrum Berlin für Materialien und Energie, Berlin, Germany

The octahedral symmetry of the metal-ligand bonds of spin-crossover (SCO) molecules enables them to switch between high-spin (HS) and low-spin (LS) electronic configurations when exposed to light or temperature change. The cooperativity between SCO molecules can be studied from bottom-up growth of submonolayer coverages on well-defined substrates by X-ray absorption spectroscopy (XAS). A 0.4 monolayer coverage of $[Fe(H_2B(pypz)(pz))_2]$ was deposited on highly oriented pyrolytic graphite and measured by XAS. Analysis of the HS to LS fraction showed that light-induced excited spin-state trapping at 10 K doubles the high-spin fraction compared with the value reached by thermally induced spin-state transition at room temperature. On the other hand, due to the onset of soft-x-ray-induced excited spin-state trapping, the largest amount of LS-state molecules is reached at 60 K, while the transition temperature $T_{1/2}$ (50% HS and 50% LS) is at 300 K.

MA 57.33 Thu 15:00 P3

Atom manipulation on complex spin textures — •Andre Kubetzka, Kirsten von Bergmann, Jonas Spethmann, and Roland Wiesendanger — University of Hamburg, Germany

Atom manipulation with the tip of a scanning tunneling microscope (STM) is a widespread and straightforward technique to build complex nanostructures in an atom-by-atom fashion. Here we use atom manipulation of magnetic adatoms to investigate complex spin textures and identify the relevant (magnetic) adatom-surface interactions contributing to the manipulation process. Instead of measuring (spin-dependent) density of states a few atomic distances above the surface, as in standard (spin-polarized) STM, the manipulated adatom can be seen as an extension of the tip probing (spin-dependent) forces right at the surface [1]. This technique can be particularly useful to enhance the magnetic signal [2] or to decide whether a magnetic structure is commensurate with the atomic lattice. Examples are shown for atomic scale spin textures with different symmetries like the row-wise antiferromagnet and the 3Q state in Mn/Re(0001) and the different magnetic states found in Fe layers on Rh/Ir(111).

[1] B. Wolter, Y. Yoshida, A. Kubetzka, S.-W. Hla, K. von Bergmann, and R. Wiesendanger, Spin friction observed on the atomic scale. Phys. Rev. Lett. **109**, 116102 (2012).

[2] S. Ouazi, A. Kubetzka, K. von Bergmann, and R. Wiesendanger, Enhanced atomic-scale spin contrast due to spin friction, Phys. Rev. Lett. **112**, 076102 (2014).

MA 57.34 Thu 15:00 P3

Optimal control assisted widefield magnetometry with nitrogen vacancy centers in diamond — •Eva Florina Grossmann[1], Gerhard Wolff[1], Philipp Jan Vetter[1], Marco Rossignolo[1,2], Thomas Reisser[3,4], Tommaso Calarco[3,4], Simone Montangero[2], and Fedor Jelezko[1] — [1]Insitut für Quantenoptik, Universität Ulm, 89073 Ulm, Germany — [2]Dipartimento di Fisica e Astronomia G. Galilei, Università degli Studi di Padova, I-35131 Padova, Italy — [3]Forschungszentrum Jülich, Institute of Quantum Control (PGI-8), 52425 Jülich, Germany — [4]Institute for Theoretical Physics, University of Cologne, 50937 Cologne, Germany

The nitrogen vacancy (NV) center, a point defect in the diamond lattice, offers a remarkable high magnetic sensitivity with low detection volumes. Moving from single NVs to ensemble NVs increases the magnetic sensitivity even further. Aiming at large-scale NMR with NV centers we make use of the widefield imaging technique. This technique requires homogeneous illumination as well as qubit control in form of microwave fields. Therefore, we design homogeneous magnetic AC fields by combining novel microwave structures and optimized microwave pulses, to collectively control the NVs. Apart from the significantly larger sensing area, this technique further allows a much faster acquisition time.

MA 57.35 Thu 15:00 P3

Quantitative Magnetic Force Microscopy of Magnetic Storage Media and its Avail to Probe Calibration — •Johannes Fendt[1], Jan Gurzynski[1], Siming Zou[1], Runbang Shao[2], and Berndt Koslowski[1] — [1]Institut für Festkörperphysik, Universität Ulm, Albert-Einstein-Allee 11, D-89069 Ulm, Germany — [2]Institut für Funktionelle Nanosysteme, Universität Ulm, Albert-Einstein-Allee 47, D-89081 Ulm, Germany

One-dimensional periodic magnetic structures are interesting for magnetic force microscopy (MFM) because they can be used to calibrate the probes. The simplest of such structures is the Kittel domain structure, for which the magnetisation in the sample is alternating and perpendicular to the surface. It is established that the stray field of such a structure decays exponentially with distance and the decay length is $z_0 = \frac{P}{2\pi}$ with period P. In accord with former objections, we demonstrate that the decay length shows significant deviations from the expectations. Additionally, we show how such structures can be exploited to calibrate MFM probes within the pseudo-pole model of MFM-tips.

MA 57.36 Thu 15:00 P3

Measuring Superconducting Phase Transitions with Nitrogen-Vacancy Centers in Diamond — •Domenico Paone[1,2], Dinesh Pinto[1,3], Liwen Feng[1,4], Min-Jae Kim[1,4], Gideok Kim[1], Rainer Stöhr[2], Stefan Kaiser[1,4], Bernhard Keimer[1], Jörg Wrachtrup[1,2], and Klaus Kern[1,3] — [1]Max Planck Institute for Solid State Research, 70569 Stuttgart, Germany — [2]3rd Institute of Physics and Research Center SCoPE, University Stuttgart, 70569 Stuttgart, Germany — [3]Institute de Physique, Ecole Polytechnique Fédérale de Lausanne, 1015 Lausanne, Switzerland — [4]4th Institute of Physics and Research Center SCoPE, University Stuttgart, 70569 Stuttgart, Germany

The magnetism in superconductors is often accompanied by exotic electronic phases such as the vortex formation in high temperature type II superconductors. Several experimental tools have been developed to study magnetic phase transitions within these systems. However, the local sensing of dynamical mechanisms in superconductors still remains a challenge. A sensor scheme based on an atomic sized quantum sensor, the nitrogen-vacancy (NV) center in diamond, pushes the sensitivity to the local read out of weak magnetic fields. Here, we present a spatially resolved study of the Meissner effect by using the fluorescence count rate of an NV center ensemble. We are able to observe a correlation between the NV fluorescence and the Meissner state of a Lanthanum Strontium Cooper Oxide (LSCO) thin film. Implementing the NV center emission into time resolved pump probe experiments could enable the local measurement of dynamical processes.

MA 57.37 Thu 15:00 P3

The spectrum of a single molecular electron spin qubit — •Tim Dierker[1], Dinesh Pinto[2,3], and Wolfgang Harneit[1] — [1]University of Osnabrück — [2]Max Planck Institute for Solid State Research, Stuttgart — [3]Institut de Physique, École Polytechnique Fédérale de Lausanne

A single-spin electron paramagnetic resonance (EPR) measurement of $N@C_{60}$ within a C_{60} matrix using a single near surface nitrogen vacancy (NV) center was realized at low temperatures. Utilizing optically detected magnetic resonance (ODMR) a double electron-electron resonance (DEER) spectrum was obtained, showing a hyperfine structure reminiscent of $N@C_{60}$ but slightly distorted [1]. The features of the measured spectrum are compared to theoretical calculations resulting from second order perturbation theory. Here especially the possibilities for asymmetric splitting are investigated for zero-field splitting and non-isotropic hyperfine effects containing orientational dependencies.

[1] Dinesh Pinto, Domenico Paone, Bastian Kern, Tim Dierker, René Wieczorek, Durga Dasari, Amit Finkler, Wolfgang Harneit, Jörg Wrachtrup, and Klaus Kern, Readout and control of a single endofullerene electronic spin, to be published (submitted to ncomms)

MA 57.38 Thu 15:00 P3

Decoherence of a singlet-triplet superposition state under dipolar interactions of an uncorrelated environment — •Patrick Vorndamme and Jürgen Schnack — Universität Bielefeld, PF 100131, D-33501 Bielefeld

By means of an STM it was shown recently that it is experimentally possible to stimulate clock transitions between the singlet and nonmagnetic triplet state of a single Heisenberg coupled spin dimer. Large decoherence times of clock like states normally refer to ensembles of spins which do not dephase. Here we are interested in decoherence of one single dimer only. For this reason we simulate how a single entity of this dimers behaves in an environment of other spins which couple to the dimer via dipolar interactions. We perform unitary time evolutions in the complete Hilbert space, including dimer and a reasonably large environment. We find that for a weak environment this approach confirms long decoherence times for the clock like state, but with stronger couplings this statement does not hold. As a reference we compare the behavior of the dimer with other, non-clock like, superposition states. Furthermore, we show that the internal dynamics of the bath plays an important role for the decoherence time of the system. In a regime where the system is weakly coupled to the bath, stronger interactions between environmental spins worsen the decoherence time up to a certain degree while if system and bath are coupled strongly, stronger interactions in the environment improve decoherence times.

MA 57.39 Thu 15:00 P3

Detecting an Electron Transfer Reaction in the Single-Molecule Regime Using a Diamond-Based Quantum Sensor — •Jan-Magnus Kurzhals, René Wieczorek, and Wolfgang Harneit — Universität Osnabrück

NV center-assisted optically detected magnetic resonance measurements are used to address the electrochemical behaviour of few neutral EPR-silent transition metal complex molecules, namely nickel bis(diphenyldithiolene), onto an oxygen-terminated diamond surface. By employing a nearby located NV center quantum sensor we gain strong evidence of a reduction process occurring on the nickel complex which we ascribe to an electron transfer from the diamond substrate. Both, Hahn echo spin locking and double electron electron resonance quantum sensing protocols, certify that our experiments probe the single-molecule regime where thermal polarization is overcome. Our insights into the nature of the electron transfer reaction are supported by quantum chemical calculations.

MA 57.40 Thu 15:00 P3

Investigation of highly ordered granular GMR structures manufactured by focused electron beam induced deposition of Co — •Björn Büker[1], Laila Bondzio[1], Daniel Kappe[1], Christian Schröder[2], Inga Ennen[1], and Andreas Hütten[1] — [1]Bielefeld University, Bielefeld, Germany — [2]FH Bielefeld University of Applied Sciences, Bielefeld, Germany

Recently focused electron beam induced deposition of metals from metal-organic precursor molecules (FEBID) has attracted a lot of attention for successfully printing 3D structures with sub-micron resolution[1]. In this work we deposited Co from the precursor $Co_2(CO)_8$ to investigate the magnetic properties of FEBID materials, which tend to be granular and embedded in a C matrix in the as deposited state. Furthermore different approaches to purification of the deposited Co structures are compared with regard to the effect on their magnetic properties. Simulations on highly ordered granular magnetic structures show a potential high giant magnetoresistance (GMR) when embedded in a weakly conducting matrix. Ultimately, we are depositing highly lattices of Co islands with FEBID in conjunction with a conducting gel matrix to verify these simulations and to assess the viability of such devices in a sensor application.

References

1. Huth *et. al.* Focused electron beam induced deposition meets materials science, Microelectronic Engineering 185-186, 2018

MA 57.41 Thu 15:00 P3

Investigation of the dipole interaction in and between ordered arrangements of magnetic nanoparticles — •Nils Neugebauer, Alexander Fabian, Matthias T. Elm, Michael Czerner, Christian Heiliger, and Peter J. Klar — Institute of Experimental Physics I, Heinrich-Buff-Ring 16, 35392 Gießen, Germany

Magnetite nanoparticles (Fe_3O_4) with an average diameter of 20 nm were arranged into regular arrays of circular assemblies with well controlled dimensions by combining top-down lithographic methods with the meniscus force deposition method. Angle-dependent ferromagnetic resonance (FMR) measurements were carried out in order to characterize the specific properties of these assemblies. The measurements show that several resonances appear exhibiting a different dependence on the orientation of the external magnetic field, the degree of filling of the assemblies, and the spacings of the underlying grid. By varying the surface-to-volume ratio of the circular assemblies, we were able to manipulate the intensity and the resonance position of the resonances observed. In addition, micromagnetic simulations were performed to assign each resonance to characteristic collective oscillations within the nanoparticle assemblies.

MA 57.42 Thu 15:00 P3

3D Nano-Lithography and its Applications — •Jana Kredl[1], Christian Denker[1], Cornelius Fendler[2], Julia Bethune[4], Nina Meyer[1], Tobias Tubandt[1], Finn-Frederik Lietzow[1], Neha Jha[1], Chris Badenhorst[3], Alena Rong[5], Jakob Walowski[1], Mark Doerr[3], Raghavendra Plankar[4], Mihaela Delcea[5], Uwe T. Bornscheuer[3], Robert Blick[2], Swadhin Mandal[6], and Markus Münzenberg[1] — [1]Institute of Physics, University Greifswald, Germany — [2]Institute of Nanostructure- and Solid State Physics, University Hamburg, Germany — [3]Institute of Biochemistry, University Greifswald, Germany — [4]Institute of Immunology and Transfusion Medicine, University Medicine Greifswald, Germany — [5]Centre for Innovation Competence - Humoral Immune Reactions in Cardiovascular Diseases, University Greifswald, Germany — [6]Indian Institute of Science Education and Research Kolkata, India

3D 2-Photon-Lithography, originally developed for 3D photonic crystals, opens a wide range of new possible applications in many fields, e.g. life sciences, micro-optics and mechanics. We will present our recent applications of 3D 2-Photon-Lithography and show 3D evaporation masks for in-situ device fabrication using different deposition angles, infra-red laser light focusing lenses directly fabricated on optical fibers, tunnel structures for guiding growth of neurons [1], pillars for investigation of cell mechanics and master-mold fabrication for Polydimethylsiloxane (PDMS) micro-fluidic channels. Based on our experience we will discuss possible applications in magnetism. [1] C. Fendler et al., Adv. Biosys. 5 (2019) doi: 10.1002/adbi.201970054

MA 57.43 Thu 15:00 P3

Driving power dependency of thin-film GMI sensors with insulating layers — •Gregor Buettel, Vlad Serea, and Uwe Hartmann — Institute of Experimental Physics, Saarland University, P. O. Box 151150, D66041, Saarbrücken, Germany

The dependence of the ac current on the giant magnetoimpedance (GMI) effect of Permalloy-based thin-film GMI sensors with an insulating SiO2 layer between the Cu core layer and surrounding magnetic NiFe/Ti multilayers was investigated [1]. The input power is decreased from 0 to -25 dBm without showing a decrease of the maximum GMI ratio in the skin-effect regime and decreasing the necessary ac frequency. In the ferromagnetic resonance regime a significant and unreported modification of the shape of the GMI curve shows up, especially at the Kittel mode frequency. It strongly depends on the driving power, which is contributed to microwave-assisted domain switching. In comparison with conventionally fabricated thin-film Permalloy GMI sensors [2], the control of the current path in this newly designed device geometry by insulating layers and multilevel deposition shows a strong potential to increase the GMI ratio and field sensitivity and to reduce the driving power.

[1] R. Betzholz et al., EPL 101, 17005 (2013) [2] G. Buettel et al., APL 111, 232401 (2017)

MA 57.44 Thu 15:00 P3

Fabrication and characterization of 3d-sputtered giant magnetoimpedance sensors — •Indujan Sivanesarajah, Rudolph Gerlich, Gregor Buettel, and Uwe Hartmann — Institute of Experimental Physics, Saarland University, P. O. Box 151150, D66041, Saarbrücken, Germany

The influence of the variable width of a microstructured Cu spacer layer between microstructured NiFe/Ti multilayers with a fixed width on the magnetic softness, domain structure and giant magnetoimpedance (GMI) effect was investigated. The whole microstructure is fabricated by a multilevel lithography and sputtering process to accurately control alignment and width of the Cu spacer layer. Wide-field Kerr microscopy and MFM is employed to record differences of flux closure and subdomain structures at the edges of the microstructures and compared with hysteresis curves obtained by vibrating sample magnetometry of arrays of such microstructures. Additionally, SiO2 layers are deposited between the Cu and NiFe layers and their influence on the GMI studied by vector network analyser measurements. The results allow further optimization of field sensitivity and power consumption of thin-film based GMI sensors.

MA 57.45 Thu 15:00 P3

EPR on-a-Chip for Operando XES Experiments — •Ekaterina Shabratova[1], Silvio Künstner[1], Raul Garcia-Diez[2], René Grüneberger[2], Matthias Neeb[2], Katja Höflich[2], Volker Niemann[3], Rainer Pietig[3], Boris Naydenov[1], Jens Anders[4], and Klaus Lips[1] — [1]Berlin Joint EPR Laboratory, Helmholtz-Zentrum Berlin — [2]Helmholtz-Zentrum Berlin — [3]Bruker BioSpin GmbH — [4]Institute of Smart Sensors, Universität Stuttgart

Electron Paramagnetic Resonance (EPR) has proven to be an effective quantitative technique to study paramagnetic materials. Despite many advantages of this method, it still has some limitations. In particular, there are restrictions to the sample's environment due to usage of resonators, so *operando* experiments are hard to perform and the microwave frequency cannot be swept. The new EPR-on-a-Chip (EPRoC) technique allows to eliminate these limitations by using Voltage Controlled Oscillators (VCO). The sample is placed on the coil of a VCO, causing a change of its oscillation frequency that is detected as the EPR signal. EPRoC allows frequency sweeps, so a permanent magnet can be used as a source of the static magnetic field B_0. Moreover, EPRoC, being in size around 1 mm^2, can be integrated into the sample environment thus allowing *operando* investigations of different processes. Here, we will discuss the EPRoC setup and how it is planned to be implemented in the ambient pressure X-ray emission spectroscopy cell at the BESSY II synchrotron beamline. We present first steps towards this goal, and focus on the development of an electro- and permanent magnet with homogeneous magnetic field.

MA 57.46 Thu 15:00 P3

Automated evaluation of EMCD measurements — •Chris Taake, Inga Ennen, Daniela Ramermann, and Andreas Hütten — Thin Films & Physics of Nanostructures, University of Bielefeld, Bielefeld, Germany

To measure the magnetic properties of a sample at high resolution the electron magnetic circular dichroism (EMCD) has become apparent to be a good method. One big problem in evaluating EMCD measurements is, that the outcome is highly dependent on the parameters chosen for the evaluation. Combined with the limited setting options in common software this makes reproducibility almost impossible. Here we programmed a matlab based software to automate the evaluation process and make it as independent of user inputs as possible. The algorithm can operate on the basis of a spectrum image or two spectra obtained on the EMCD positions and returns the ratio between the spin and orbital magnetic moment. The calculation of the single magnetic moments is not yet provided, but can easily be added in the future by expanding the material library with the necessary values.

MA 57.47 Thu 15:00 P3

Model Based Characterization of Conductive Magnetic Bulk Materials for High Frequency Applications — •Lennart Schwan[1,2], Andreas Hütten[2], and Sonja Schöning[1] — [1]Bielefeld Institute for Applied Materials Research (BIfAM), Bielefeld University of Applied Sciences, Department of Engineering Sciences and Mathematics, Interaktion 1, 33619 Bielefeld — [2]Thin Films & Physics of Nanostructures, Bielefeld University, Department of Physics, Universitätsstrasse 25, 33615 Bielefeld, Germany

FEM simulations are a powerful tool for the optimization of industrial high frequency applications such as induction hobs. These simulations require reliable material parameters. Magnetic bulk materials for industrial electrical applications are usually characterized with the help of ring samples, which act as magnetic core. Two coils are wound around the core to generate the magnetic field and measure the induced voltage to calculate the magnetic flux density. With increasing frequency and depending on conductivity and relative permeability the skin effect influences the measurement and makes it difficult to determine parameters characterizing the entire material. The skin effect prevents the magnetic field from completely penetrating the sample, which is normally not considered by conventional analytic approaches simply assuming a homogeneous magnetization of the magnetic core. Here, we propose an alternative model approach based on an analytical solution of Maxwell Equations representing a simplified description of the magnetic core including the skin effect in order to extract useful material parameter as input for FEM simulations.

MA 57.48 Thu 15:00 P3

Determination of the bulk spin polarization of Fe_3O_4 (111) thin films by means of spin-resolved hard X-ray time-of-flight microscopy — •Matthias Schmitt[1], Ozan Kirilmaz[1], Sergey Chernov[2], Sergey Babenkov[2], Dmitry Vasilyev[2], Katerina Medjanik[2], Olena Fedchenko[2], Yuri Matveyev[3], Andrei Gloskowski[3], Christoph Schlueter[3], Hans-Joachim Elmers[2], Gerd Schönhense[2], Michael Sing[1], and Ralph Claessen[1] — [1]Universität Würzburg, Physikalisches Institut and Würzburg-Dresden Cluster of Excellence ct.qmat, 97074 Würzburg, Germany — [2]Universität Mainz, Institut für Physik, 55128 Mainz, Germany — [3]DESY Photon Science, 22607 Hamburg, Germany

The electronic structure of ferrimagnetic magnetite Fe_3O_4 has previously been studied by spin-resolved soft X-ray photoemission [1,2]. However, the theoretically predicted spin polarization of -100% at the Fermi level [3] has never been experimentally shown. We have studied 30 nm thick Fe_3O_4 (111) films on ZnO(0001) using spin-resolved hard X-ray photoemission (beamline P22, PETRA III, Hamburg) with a ToF microscope [4] and a novel 3D spin detector. Benefitting from the large probing depth at photon energies of up to 5 keV surface effects like a magnetically dead layer, lowering the measured spin polarization, are negligible. We thus have been able to measure the true bulk spin polarization and discuss our findings as derived from the complex analysis of the microscopy data. [1] Phys. Rev. B **65**, 064417 (2002); [2] J. Phys.: Condens. Matter **19**, 315218 (2007); [3] J. Phys. Soc. Jpn. **68**, 1607 (1999); [4] J. Synchr. Rad. **26**, 1996 (2019)

MA 57.49 Thu 15:00 P3

Convergent electron beam diffraction: an old technique applied on new magnetic materials — •Inga Ennen, Bernhard Kaltschmidt, and Andreas Hütten — Universität Bielefeld, Dünne Schichten und Physik der Nanostrukturen, Universitätsstr. 25, 33615 Bielefeld, Germany

Convergent electron beam diffraction (CEBD) is a well-known technique for qualitative and quantitative analysis of crystal structures in a transmission electron microscope (TEM). Here, a convergent electron beam illuminates a small specimen area, typically with a diameter of 10 nm or less, resulting in a disk shaped diffraction pattern. From the intensity distribution of the diffraction pattern sample characteristics like specimen thickness, lattice parameters or features of crystal defects can be determined.

In this contribution we present CBED analysis on magnetic materials like the Co2MnSi Heusler compound as a test sample. Our focus is on the analysis of the lattice parameters and the influence of adjacent V layers on the crystal structure of the Heusler. Furthermore, the advantage of an in-column energy filter for CBED analysis will be demonstrated, which allows us to improve the signal to noise ratio of the diffraction pattern and thus to perform more precise structure analysis.

MA 57.50 Thu 15:00 P3

Investigation of nanomagnetic phenomena employing co-resonant coupled cantilever sensors — •Maneesha Sharma[1], Qifeng Pan[1,3], Bernd Büchner[1,2], and Thomas Mühl[1] — [1]Leibniz-Institut für Festkörper- und Werkstoffforschung IFW Dresden, Dresden, Germany — [2]Institut für Festkörperphysik, Technische Universität Dresden, Dresden, Germany — [3]Institut für Luftfahrtantriebe, Universität Stuttgart, Stuttgart, Germany

Cantilever magnetometry is one of the most sensitive techniques used for the study of magnetic properties of small particles. [1] This approach allows to study magnetic moment, anisotropy and switching behavior of single particles and nanowires. We use the co-resonant concept for enhancing the sensitivity of dynamic mode cantilever magnetometry. The coupled modes can be easily read out at the micro-cantilever. [2]

Magnetization reversal is an important process in the study of single domain particles. Quasi periodic magnetization reversal can be induced by torsional oscillations in static magnetic fields. [3] We present a detailed numerical analysis how quasi-instantaneous events like magnetization reversal in a tiny sample attached to the nano-cantilever affect the transient oscillation of both the micro- and the nano- cantilevers of a coupled system. Furthermore, we discuss the applicability of the spring mass model for coupled cantilever systems and energy transfer mechanisms. Also, we present a novel V-shaped design of CNT based nano-cantilever.

MA 57.51 Thu 15:00 P3

Investigation of nanomagnetic phenomena employing co-resonant coupled cantilever sensors — •Maneesha Sharma[1], Qifeng Pan[1,3], Bernd Büchner[1,2], and Thomas Mühl[1] — [1]Leibniz-Institut für Festkörper- und Werkstoffforschung IFW Dresden, Dresden, Germany — [2]Institut für Festkörperphysik, Technische Universität Dresden, Dresden, Germany — [3]Institut für Luftfahrtantriebe, Universität Stuttgart, Stuttgart, Germany

Cantilever magnetometry is one of the most sensitive techniques used for the study of magnetic properties of small particles. We use the co-resonant concept for enhancing the sensitivity of dynamic mode cantilever magnetometry.[1] A co-resonant coupled sensor is a combination of a standard AFM cantilever and a high aspect ratio nanowire, e.g., a carbon nanotube (CNT).

Magnetization reversal is an important process in the study of single domain particles. Quasi periodic magnetization reversal can be induced by torsional oscillations in static magnetic fields.[2] The steady state of coupled cantilever oscillations has already been investigated in detail but it*s equally important to study the transient behavior of the coupled system. We present a detailed numerical analysis how quasi-instantaneous events like magnetization reversal in a tiny sample attached to the nano-cantilever affect the transient oscillation of both the micro- and the nano- cantilevers of a coupled system. Also, we present a novel V-shaped design of the CNT based nano-cantilever.

References: [1] J. Körner, Beilstein J. Nanotechnology 9, 2546/2560 (2018) [2] S. Philippi et al., Nanotechnology 29, 405503 (2018)

MA 57.52 Thu 15:00 P3

Investigation of nanomagnetic phenomena employing co-resonantly coupled cantilever sensors — •Maneesha Sharma[1], Qifeng Pan[1,3], Bernd Büchner[1,2], and Thomas Mühl[1] — [1]Leibniz-Institut für Festkörper- und Werkstoffforschung IFW Dresden, Dresden, Germany — [2]Institut für Festkörperphysik, Technische Universität Dresden, Dresden, Germany — [3]Institut für Luftfahrtantriebe, Universität Stuttgart, Stuttgart, Germany

Cantilever magnetometry is one of the most sensitive techniques used for the study of magnetic properties of small particles. We use the co-resonant concept for enhancing the sensitivity of dynamic mode cantilever magnetometry. [1] A co-resonantly coupled sensor is a combination of a standard AFM cantilever and a high aspect ratio nanowire, e.g., a carbon nanotube (CNT). The coupled modes of the coupled system can easily be read at the microcantilever.

Magnetization reversal is an important process in the study of single domain particles. Quasi periodic magnetization reversal can be induced by torsional oscillations in static magnetic fields. [2] We present a detailed numerical analysis how quasi-instantaneous events like magnetization reversal in a tiny sample attached to the nanocantilever affect the transient oscillation of both the micro and the nano cantilevers of a coupled system. Also, we present a novel V-shaped design of the CNT based nanocantilever.

References: [1] J. Körner, Beilstein J. Nanotechnology 9, 2546-2560 (2018) [2] S. Philippi et al., Nanotechnology 29, 405503 (2018)

MA 57.53 Thu 15:00 P3

Sensitivity improvements of EPR-on-a-Chip with rapid scan — •Silvio Künstner[1], Anh Chu[2], Boris Naydenov[1], Alexander Schnegg[3], and Klaus Lips[1] — [1]Berlin Joint EPR Lab, Helmholtz-Zentrum Berlin — [2]Institute of Smart Sensors, Universität Stuttgart — [3]EPR4Energy, Max-Planck-Institut für Chemische Energiekonversion, Mülheim a.d. Ruhr

Electron paramagnetic resonance (EPR) is the method of choice to investigate and quantify paramagnetic impurities in e.g. semiconductor devices, proteins, catalysts and molecular nanomagnets. The design of conventional EPR spectrometers, however, limits the versatility for operando measurements. Here, we present an improved design of a miniaturised EPR spectrometer, implemented on a single microchip (EPRoC). On the chip, an array of coils, each from a voltage-controlled oscillator (VCO), with a diameter of a few 100 μm is used as both, mw source and detector. Due to its compactness, EPRoC can be incorporated in growth reactors, (electro)chemical cells or in UHV environments. However, EPRoC suffers from rather poor concentration sensitivity. The usage of a VCO allows frequency sweeps with scan rates up to 2,000 THz/s rendering EPRoC perfect for rapid frequency scan EPR. Rapid scan EPR can lead to a signal-to-noise improvement especially for samples with long relaxation times, which would otherwise be saturated in continuous wave EPR. In this contribution, we demonstrate the increased sensitivity of rsEPRoC, by investigating standard EPR samples and discuss applications that will benefit from the increased sensitivity.

MA 57.54 Thu 15:00 P3

Transport of magnetic particles by custom-made magnetic pulse sequenceswith varied alteration rates — •Nikolai Weidt, Meike Reginka, and Ehresmann Arno — Department of Physics and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel

In order to design microfluidic analysis devices, a controlled and directed transport of particles is needed. The transport of superparamagnetic particles above magnetically stripe-patterned exchange bias layer systems with head-to-head and tail-to-tail orientation of the magnetization in adjacent stripe domains vertical to the long stripe axis, manufactured by ion bombardment induced magnetic patterning, is a promising approach to achieve this remote-controlled and directed transport. The superparamagnetic particles are transported by periodically transforming the magnetic field landscape above the layer system with an external magnetic field [1]. Microfluidic experiments revealed influences of the alteration rate of the applied magnetic field sequences on the particle velocities. It was observed that the particles' trajectories vary with the shape of these trapezoidal magnetic field pulses, concluding in a smoother movement of the particles for smaller alteration rates. These findings are supported by trajectories from simulations based on the consideration of the surface and magnetic forces acting on a particle. [1] D. Holzinger, I. Koch, S. Burgard, and A.Ehresmann, ACS Nano 9, 7323 (2015)

MA 57.55 Thu 15:00 P3

Study of nanoparticle dynamics in binary solutions across phase transitions — •Juri Kopp[1], Joachim Landers[1], Samira Webers[1], Soma Salamon[1], Julian Seifert[2], Karin Koch[2], Annette M. Schmidt[2], and Heiko Wende[1] — [1]Faculty of Physics and Center for Nanointegration Duisburg-Essen (CENIDE), University of Duisburg-Essen — [2]Institute for Physical Chemistry, University of Cologne

In previous magnetorheological measurements of cobalt ferrite nanoparticles in aqueous polymer solutions, Webers et al. [1] studied the thermomagnetic behavior across phase transitions showing a distinct change in magnetization. To prepare pre-aligned hybrid materials, it is important to know their stability and magnetic behavior under the influence of phase transitions such as crystallization. Here, we study the dynamics of hematite nanospindles and cobalt ferrite nanoparticles in sucrose solutions of different concentration via temperature dependent Mössbauer spectroscopy and AC-susceptometry (ACS). These methods enable us to analyze the particle mobility and particle orientation across phase transitions. ACS data obtained upon decreasing temperature reveal a supercooled state and spontaneous crystallization whereas during the heating process a mixed-fluid phase is observed, which has also been shown in the Mössbauer spectroscopy results of the sample with the smallest amount of sucrose. This work is supported by the DFG, priority programme SPP1681 (WE 2623/7-3).

[1] S. Webers et al., submitted to ACS Appl. Polym. Mat. (Jul. 2019)