MA 36: Magnetic Measurement Techniques

Time: Thursday 9:30–11:30 Location: H3

Invited Talk MA 36.1 Thu 9:30 H3

Towards single Nanoparticle detection: Element Specific Ferromagnetic Resonance - Microresonators in ScanningTransmission X-ray Microscopy — •Katharina Ollefs — ESRF, Grenoble, France

Magnetic nanoparticles find manifold applications from biomedicine over magnetic sensors to storage devices. For these applications the static but also the dynamic properties are important as for example the magnetic anisotropy energy is a key parameter determining the magnetic hardness and with that the thermal and temporal stability of the individual nanoparticle. These properties vary from particle to particle, for example, due to surface effects resulting from slightly different morphologies [1]. X-ray detected ferromagnetic resonance (XFMR), a combination of ferromagnetic resonance (FMR) and x-ray absorption spectroscopy (XAS) offers the unique possibility to study the static and dynamic spin and orbital magnetic moments and the magnetocrystalline anisotropy with elemental specificity. In this work XFMR is pursued combining the local resolution of a transmission x-ray microscope [2] with microresonators. These microresonators allow to measure FMR on nanosized objects by enhancing the filling-factor and therefore pave the way for XFMR measurements of nanoparticles.

This work is done in collaboration with A. Ney, R. Meckenstock, D. Spoddig, Ch. Schöppner, H. Ohldag and M. Farle.

[1] F. Kronast, N. Friedenberger, K. Ollefs, et al., Nano Lett. 11, 1710 (2011) [2] D. Zhu, et.al; Phys. Rev. Lett. 105, 043901 (2010)

MA 36.2 Thu 10:00 H3

Characterization of graphene micro Hall-Probe magnetometers — •Philipp Weber, Wolfgang Kroener, Michael Enzelberger, Klaus Gieb, and Paul Müller — Lehrstuhl für Experimentalphysik, Universität Erlangen, Germany

Due to its low charge carrier concentration and low dimensionality graphene is a promising candidate for high-sensitive Hall probes. We have produced Hall bar structures from commercially available CVD-graphene by means of electron beam lithography and oxygen plasma etching. Charge carrier concentration and mobility confirm the high quality of these devices. We were able to produce Hall probes with properties comparable to standard 2DEG GaAs Hall probes. Angular resolved magnetotransport measurements at magnetic fields up to 14 T and temperatures down to 300 mK are presented. We discuss in detail various parameters influencing the basic sensitivity for measuring magnetic moments. As a proof of concept we have performed magnetization measurements of several reference materials.

MA 36.3 Thu 10:15 H3

Multi-Segmented Delayline Detector: A new Data Acquisition Strategy for FEL and Other Timing Experiments — •P. Luschchyk[1], A. Oelsner[2], D. Kutnyakhov[1], A. Fognini[3], Y. Acremann[3], A. Vaterlaus[3], V. Rybnikov[4], and G. Schönhense[1] — [1]Johannes Gutenberg-Universität, Institut für Physik, D-55099 Mainz — [2]Surface Concept GmbH — [3]Laboratorium für Festkörperphysik, ETH Zürich, Switzerland — [4]FLASH, DESY, Hamburg

High-brilliance but low-repetition-rate sources like free electron lasers require new strategies of particle detection because many events have to be registered within one pulse. In this contribution we describe the design parameters and performance of a novel multi-segmented delayline detector (DLD). It consists of an array of 16x9=144 discrete anodes, where the 16 columns are read out by a 16-channel DLD electronics unit, whereas the 9 rows are separated by delayline coupling. The readout of each channel is designed such that all 9 in a row can register simultaneously a hit, thus all 144 anodes can register hits in parallel. The dead time of the detector is as short as 80 ns. This approach increases the detection efficiency by more than an order of magnitude (limited by Poisson statistics) in comparison to the standard DLD [1]. Data acquisition is based on LINUX and integrated in FLASH DAQ system to transfer all results synchronously per macrobunch. [1] A. Oelsner et al., Rev. Sci. Instrum. 72, 3968 (2001) Project funded by BMBF (05K12UM2)

MA 36.4 Thu 10:30 H3

Magneto-optical response of embedded permalloy thin film structures on Si and ZnO substrates investigated by vector-magneto-optical generalized ellipsometry — •Rajkumar Patra[1], Santanu Ghosh[1], Nan Du[2], Danilo Bürger[2,3], Ilona Skorupa[3], Roland Mattheis[4], Jeff McCord[5], Oliver G. Schmidt[2,6], and Heidemarie Schmidt[2] — [1]Indian Institute of Technology Delhi, Department of Physics, 110016 Delhi — [2]Faculty of Electrical Engineering and Information Technology, University of Technology Chemnitz, 09107 Chemnitz — [3]Institute of Ion Beam Physics and Materials Research, Helmholtz-Zentrum Dresden-Rossendorf — [4]Institute für Photonische Technologien e.V., 07702 Jena — [5]Institute of Materials Science, University of Kiel — [6]Institute for Integrative Nanosciences, IFW Dresden, 01609 Dresden

We investigated the magneto-optical coupling in nominal 5, 10, and 20 nm thick permalloy (Ni81Fe19) thin films embedded in a 3 nm thick Ta and a 3 nm thick Ru layer on Si and on ZnO substrates in the spectral range from 300 to 1100 nm by Mueller matrix ellipsometry measurements in a magnetic field of arbitrary orientation and magnitude up to 400 mT at room temperature [1]. The extracted magnetooptical coupling does not depend on the film thickness [2] and can be used to predict the magnetooptical response for differently designed Ru/permalloy/Ta/Si and Ru/permalloy/Ta/ZnO multilayer samples. [1] K. Mok, N. Du, H. Schmidt, Rev. Sci. Instrum. 82 (2011); [2] K. Mok, J. McCord et al., J. of Appl. Phys. 110 (2011) & Phys. Rev. B 84 (2011).

MA 36.5 Thu 10:45 H3

The role of space charge in spin resolved photoemission experiments — •Gerard Salvatella[1], Andreas Fognini[1], Florian Sorgenfrei[2], Martina Dell'Angela[3], Martin Beye[2], Florian Hieke[3], Andrea Eschenlohr[2], Sanne de Jong[4], Roopali Kukreja[4], Natalia Gerasimova[5], Joerg Raabe[6], Christian Stamm[3], Urs Ramsperger[1], Hermann Dürr[4], Joachim Stöhr[4], Alexander Föhlisch[2], Wilfried Wurth[3], Andreas Vaterlaus[1], Thomas Michlmayr[1], and Yves Acremann[1] — [1]Laboratorium für Festkörperphysik, ETH Zürich, Schweiz — [2]HZB Berlin, Deutschland — [3]Institut für Experimentalphysik, Universität Hamburg, Deutschland — [4]SLAC, Stanford, USA — [5]DESY, Hamburg, Deutschland — [6]PSI, Villigen, Schweiz

Spin resolved photoemission from a solid is one of the most direct ways of measuring the magnetization. If the whole valence band is probed the measured average spin polarization is only weakly dependent on electronic excitations of the solid and represents therefore the magnetization of the sample. Here we present an experiment where the magnetization is measured by spin resolved photoemission of the cascade electrons from a thin Iron film. The sample is exposed to the radiation of the free electron laser (FEL) FLASH in Hamburg. The measured spin polarization depends on the fluence of the FEL radiation: Higher FEL fluence reduces the measured spin polarization. Space charge simulations show the most likely cause of this effect: Space charge of the electron cloud leaving the sample selectively suppresses the emission of lower energy photoelectrons which carry the largest spin polarization.

MA 36.6 Thu 11:00 H3

Resonant magnetic scattering at magnetic domains in Co/Pt multilayers using laser-generated XUV light — •Christian Weier[1,2], Roman Adam[1,2], Dennis Rudolf[1,2], Patrik Grychtol[4], André Kobs[3], Gerrit Winkler[3], Robert Frömter[3], Hans Peter Oepen[3], Margaret M. Murnane[4], Henry C. Kapteyn[4], and Claus M. Schneider[1,2] — [1]Peter Grünberg Institut (PGI-6), Forschungszentrum Jülich, 52425, Jülich, Germany — [2]JARA, Fundamentals of Future Information Technology — [3]Institut für Angewandte Physik, University of Hamburg, 20355, Hamburg, Germany — [4]Department of Physics and JILA, University of Colorado, Boulder, CO 80309-0440, USA

Laser-driven higher-harmonic generation (HHG) has recently been used for element-selective probing of magnetization dynamics in ferromagnets with a femtosecond temporal resolution. Tuning the energy of the probe beam to the M-absorption edges of Fe, Co and Ni located at 52 eV, 61 eV and 67 eV results in a resonant enhancement of the magneto-optic signal. On the other hand, the corresponding wavelength of approximately 20 nm from this tabletop source gives access to a variety of imaging techniques with unique features that are characteristic for a laser source, namely, a low divergence, high coherence and a high temporal resolution. In our small-angle resonant magnetic scattering experiment we employ laser-generated XUV radiation for investigations of Co/Pt-multilayers containing a magnetic, out-of-plane domain pattern. The resulting image in k-space is directly related to the average domain size in the multilayer of approximately 100 nm.

MA 36.7 Thu 11:15 H3

Quantitative magnetic force microscopy with out-of-plane and in-plane sensitivity — •Christopher Friedrich Reiche[1], Thomas Mühl[1], Silvia Vock[1], Volker Neu[1], Albrecht Leonhardt[1], Ludwig Schultz[1,2], and Bernd Büchner[1,2] — [1]Leibniz-Institut für Festkörper- und Werkstoffforschung IFW Dresden — [2]Institut für Festkörperphysik, Technische Universität Dresden

Magnetic force microscopy (MFM) is a powerful tool for mapping the spacial distribution of one component of the stray field gradient above a magnetic sample surface. We use iron filled carbon nanotubes (FeCNT) as monopole-like magnetic tips that can be easily calibrated [1] to make quantitative MFM possible.

In standard MFM only the out-of-plane stray field component is detected. By oscillating the cantilever with a higher flexural mode we are able to measure not only the out-of-plane component but also the in-plane component with the same sensor [2].

In our recent experiments we improved the sensitivity of the inplane measurement. Furthermore, we characterized the FeCNT sensor in both directions and confirmed the expected isotropic properties with respect to its effective monopole moment. This makes multiple component quantitative MFM possible with a single calibration measurement.

[1] F. Wolny, T. Mühl, U. Weissker, K. Lipert, J. Schumann, A. Leonhardt, and B. Büchner, Nanotechnology 21, 435501 (2010)

[2] T. Mühl, J. Körner, S. Philippi, C. F. Reiche, A. Leonhardt, and B. Büchner, Appl. Phys. Lett. 101, 112401 (2012)