MA 46: MagneticThin Films II

Time: Thursday 15:00–17:15 Location: EB 202

MA 46.1 Thu 15:00 EB 202

Local pinning in Co ferromagnetic nanowires induced by ion irradiation — •Luis Serrano-Ramón[1,2], Amalio Fernández-Pacheco[3], Rosa Córdoba[2], Tolek Tyliszczak[4], Ricardo Ibarra[1,2], and José M. de Teresa[1,2] — [1]Instituto de Ciencias Materiales de Aragón, Zaragoza, Spain — [2]Laboratorio de Microscopías Avanzadas, Zaragoza, Spain — [3]Cavendish Laboratory, Cambridge, UK — [4]Lawrence Berkeley National Laboratory, Berkeley, USA

The control of the movement of a domain wall in a ferromagnetic nanowire has been systematicaly studied with the aim of building ultrafast spintronic logic or storing devices [1,2]. Geometric constrictions are widely used to create local confining potentials that act as pinning sites for individual domain walls. As an alternative, the local modification of magnetic propierties by ion irradiation is suitable to induce pinning sites [3]. In this work high purity Co nanowires grown by Focused Electron Beam Induced Deposition [4, 5] have been irradiated with Ga+ in order to study the change induced by this proccess in their magnetic propierties. A systematic increase in the nucleation field of the wires has been observed by Magneto-Optical Kerr Effect. Local pinning sites induced by the irradiation have been succesfully created on 250 nm wide wires. The pinning force has been studied by Scanning Transmission X-Ray Microscopy and MOKE. [1] Parkin et al, Science, 320,190-194,(2008); [2] D. A. Allwood et al, Science, 309, 1688-1692, (2005);[3] Andreas Vogel et al, APL, 98, 202501, (2011); [4] A. Fernandez-Pacheco et al, J. Phys D, 42, 055005, (2009); [5] L. Serrano-Ramón et al, ACSnano, 5, 7781,(2011).

MA 46.2 Thu 15:15 EB 202

Magnetic tunnel junctions based on zinc ferrite and cobalt — •Michael Bonholzer, Kerstin Brachwitz, Katja Mexner, Jan Zippel, Michael Lorenz, and Marius Grundmann — Universität Leipzig, Institut für Experimentelle Physik II, Linnéstraße 5, 04103 Leipzig, Germany

Magnetic tunnel junctions (MTJs) could play an important role in future computer architecture and spintronic systems. The oxide zinc ferrite shows a good tunability in magnetic and electric properties and is a promising candidate for oxide MTJ structures. We present magnetic tunnel junctions built from zinc ferrite, magnesium oxide and cobalt. Zinc ferrite, acting as soft magnetic bottom electrode, was grown by pulsed laser deposition (PLD) on MgO substrates. The thin films ($d \approx 200\,\mathrm{nm}$) were characterized by atomic force microscopy (AFM), X-ray diffraction (XRD), SQUID- and Hall-effect measurements and optimized in their conductivity ($\sigma \approx 50\,\mathrm{S/m}$) and surface roughness (rms $\approx 0.2\,\mathrm{nm}$). The thickness of the barrier material magnesium oxide was varied between 5 and 60 nm. It was also grown by PLD and the surface and stuctural properties were measured by AFM and RHEED. The cobalt top-electrode, which serves as hard magnetic electrode, was fabricated by thermal evaporation. The MTJ-structure was defined by multi-step photolitography with wet-chemical etching, using crossed-over masks in order to limit the contact area to $50 \times 50\,\mu\mathrm{m}^2$. Current-voltage measurements in dependence of an external magnetic field were performed and a tunnel-magnetoresistance (TMR) up to 65% was found.

MA 46.3 Thu 15:30 EB 202

Stretchable Magnetoelectronics — •Michael Melzer[1], Daniil Karnaushenko[1,2], Gungun Lin[1,2], Denys Makarov[1], Ingolf J. Mönch[1], and Oliver G. Schmidt[1,2] — [1]Institut für Integrative Nanowissenschaften, IFW Dresden, Helmholtzstraße 20, 01169 Dresden — [2]Materialsysteme der Nanoelektronik, Technische Universität Chemnitz, Reichenhainer Straße 70, 90107 Chemnitz

Currently, magnetic sensors are fabricated on rigid substrates like silicon wafers. However, successful operation of such devices on stretchable and flexible substrates can open up a variety of new applications due to arbitrary surface geometries possible after fabrication. Here, we exploit the surface wrinkling effect of thin metal layers on PDMS rubber membranes to create stretchable magnetoresistive (GMR) sensors [1]. The investigated systems include GMR multilayers as well as top pinned spin valves. Magneto-electric measurements reveal similar characteristics for such sensor elements on free-standing rubber membranes as on conventional silicon wafers, despite the different surface structures. The thermally induced wrinkling of the GMR layer along with the free-standing rubber membrane underneath allows for a totally elastic stretchability of the sensor element preventing the GMR film from cracking. In this respect the world's first elastically stretchable magnetic sensors are introduced and a new strategy for biosensors with intriguing advantages is outlined as an example for their application. The work was supported in part by the German federal ministry of education and research (project Nanett; FKZ: 03IS2011).

[1] M. Melzer et al., Nano Letters, 11, 2522 (2011).

MA 46.4 Thu 15:45 EB 202

Simulations of magneto-optical surface plasmon resonance (MOSPR) effects in Au/Co/Au trilayers for biosensing — •Sebastian Kübler, Kerstin Kämpf, Friedrich Wilhelm Herberg, and Arno Ehresmann — Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Str. 40, D-34132 Kassel

In the past years it has been shown that it is possible to improve the sensitivity of biosensors based on the surface plasmon resonance (SPR) effect by the combination of the SPR effect with the transverse magneto-optic Kerr effect (tMOKE). The magneto-optic SPR (MOSPR) of Au/Co/Au trilayer systems in transverse configuration for the dielectric layers air ($n = 1$) and water ($n = 1.33$) was simulated. The normalized difference of the reflectivity $R(H+)$ and $R(H-)$ (δ-signal) shows a strong thickness dependence. The magnitude of the δ-signal changes with the refractive index n of the dielectric layer. In order to mimic realistic biosensor conditions the δ-signal of a Au(10.75 nm)/Co(6 nm)/Au(20.25 nm) trilayer was calculated and compared with the reflectivity of a 50 nm Au layer within the typical refractive index range ($n = 1.33 - 1.4$) of commercial SPR sensors. In this range the amplitude of the resulting δ-signal decreased by a factor of ~ 64. For a refractive index change of 10^{-2} the δ-signal stays in the same order of magnitude. This finding demonstrates the essential need of defined metal layer thicknesses for distinct refractive index regions to exploit the sensitivity of an MOSPR based biosensor.

MA 46.5 Thu 16:00 EB 202

Spectroscopic observation of strain-assisted T_C enhancement in EuO upon Gd doping — •S. G. Altendorf[1,2], N. Hollmann[2], R. Sutarto[1,3], C. Caspers[1], R. C. Wicks[3], Y.-Y. Chin[1,2], Z. Hu[1,2], H. Kierspel[1], I. S. Elfimov[3], H. H. Hsieh[4], H.-J. Lin[5], C. T. Chen[5], and L. H. Tjeng[1,2] — [1]II. Physikalisches Institut, Universität zu Köln — [2]Max Planck Institute for Chemical Physics of Solids, Dresden — [3]Department of Physics and Astronomy, University of British Columbia, Canada — [4]Chung Cheng Institute of Technology, Taoyuan, Taiwan — [5]National Synchrotron Radiation Research Center, Hsinchu, Taiwan

EuO is a ferromagnetic semiconductor which, upon electron doping, shows a wealth of spectacular phenomena including insulator-to-metal transition and colossal magnetoresistance. Moreover, the doped charge carriers are propagating in an almost 100% spin polarized band, making EuO to be an attractive candidate for spintronics. To facilitate the use of EuO in device applications, it is important to increase the relatively low Curie temperature. The origin of the T_C enhancement of EuO upon Gd doping is studied using soft x-ray absorption spectroscopy on pure and Gd-doped EuO thin films. Temperature and doping dependent changes in the oxygen K edge spectra provide information about the correlation of magnetism and lattice. Band structure calculations reveal that these spectral changes and the increase of T_C to 125 K for Gd-doped EuO cannot be explained by electron doping alone. The compression of the crystal lattice due to the incorporation of the smaller Gd^{3+} ions plays also an important role.

MA 46.6 Thu 16:15 EB 202

Novel orbital ordering and Raman modes in 2p magnetic CsO2 — •baomin zhang[1], s. riyadi[2], t. t. m. palstra[2], g. a. de wijs[1], r. a. de groot[1], and g. r. blake[2] — [1]Electronic Structure of Materials, Institute of Molecules and Materials, Radboud University Nijmegen — [2]Solid State Materials for Electronics, Zernike Institute for Advanced Materials, Rijksuniversity Groningen

Aniogenic magnetism is a relatively new area recently. Antiferromagnetic CsO2 has a tetragonal stucture above 190 K, and the symmetry is reduced (accompanied by the tilting of oxygen dimers) at lower temperatures. Based on density functional calculation, we report a novel orbital ordering here, which is new in 2p magnetic materials. The highest occupied orbitals show ordered py and px characters, and the strong super exhange interaction between px and py orbitals realizes the one dimensional spin chain character found in experiments. Also, the calculated Raman frequencies 1118 cm-1 (streching of oxygen dimer), 195—200cm-1 (libration of dimer) and 66–75 cm-1 (exclusive movement of Cs along lattice c direction) agree well with experiments. The interpretation for latter two cases is given for the first time.

MA 46.7 Thu 16:30 EB 202

All-Electron Hybrid-Functional Calculations of the Europium Chalcogenides — •Martin Schlipf, Markus Betzinger, Marjana Ležaić, Christoph Friedrich, and Stefan Blügel — Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich and JARA, 52425 Jülich, Germany

High spin polarization in the Eu chalcogenides offers the prospect of efficient spin filters in semiconductors. EuO is particularly suited as it exhibits the highest Curie temperature among these materials and can be grown epitaxially on Si, GaN, and GaAs. Throughout the EuX (X = O, S, Se, Te) series, as the chalcogenide atoms become bigger, the band gaps increase whereas the magnetic coupling constants decrease, giving rise to a FM to AFM transition. For our theoretical investigation, we employ the hybrid exchange-correlation functionals PBE0 and HSE, which incorporate a fraction of nonlocal Hartree-Fock exchange and thus extend the realm of density functional theory (DFT) to strongly correlated materials. We present the electronic, structural, and magnetic ground state as predicted from first-principle calculations using the FLAPW method `FLEUR`, in which recently hybrid functionals were implemented [1,2]. The results show an excellent agreement with experimental observations from the literature. We investigate trends across the series and focus in particular on how the material properties are modified when the chalcogenide atom is changed.

We acknowledge funding by HGF-YIG, contract VH-NG-409.

[1] M. Betzinger, *et al.*, Phys. Rev. B **81**, 195117 (2010).
[2] M. Schlipf, *et al.*, Phys. Rev. B **84**, 125142 (2011).

MA 46.8 Thu 16:45 EB 202

Angular depedence of XMCD/XMLD of MnNi at Mn $L_{2,3}$ and $M_{2,3}$ edges — •Dominik Legut[1], Jan Rusz[2], and Peter Oppeneer[2] — [1]Nanotechnology Centre, Ostrava, Czech Republic — [2]Department of Physics and Astronomy, Uppsala, Sweden

The full angular dependence of the x-ray magnetic circular/linear dichroism (XMCD/XMLD) spectra on the crystalline orientation of the magnetization was investigated for MnNi. The anisotropic XMCD and XMLD spectra were computed in the single electron picture within the framework of the DFT. The excitation stemming from core 2p levels as well as from semicore 3p levels (edges) were considered. The calculated results show different behavior between $L_{2,3}$ and $M_{2,3}$ edges, because of hybridization of two $3p_{1/2}$ sub-levels and four $3p_{3/2}$ sub-levels (m_j levels).[1] The XMLD signal is strongly dependent on the magnetization direction with respect to the crystal axes. Furthermore, the influence of lattice distortion and the exchange-correlation approximation was studied. In experiments, the samples are usually thin over-layers, often possessing lower symmetry, thus the corresponding distortion affects the spectral shape. The non-cubic symmetry of the studied structures gives rise to x-ray natural linear dichroism contributions. Their magnitude with respect to the magnetic dichroism contribution is discussed.

References:
1. S. Valencia *et al.*,Phys. Rev. Lett. **104**, 187401 (2010).

15 min. break